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The WONDERS of NATURE and the ACHIEVEMENTS OF MAN

With an Introduction by
IRA REMSEN, Ph.D., LL.D.

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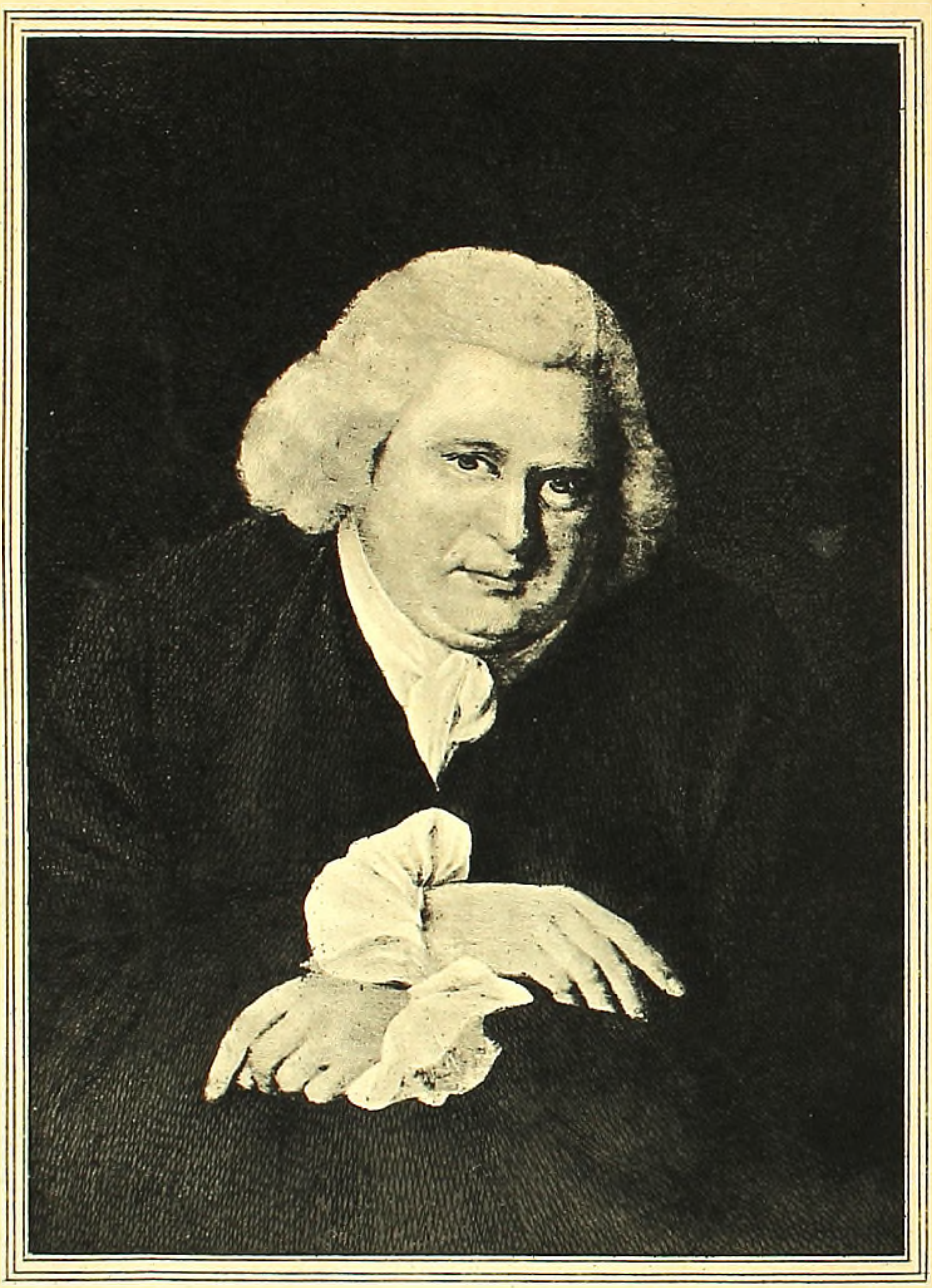

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ERASMUS DARWIN,

The grandfather of Charles Darwin.

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The Descent of Man

AND SELECTION IN RELATION TO SEX

By

Charles R. Darwin, M.A., LL.D., F.R.S.

VOL 1

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INTRODUCTION.

THE LAST LINK.[1]

By Ernst Haeckel.

AT the end of the nineteenth century, the age of "natural science," the department of knowledge that has made most progress is zoology. From zoology has arisen the study of transformism, which now dominates the whole of biology. Lamarck laid its foundation in 1809, and forty years ago Charles Darwin obtained for it a recognition which is now universal. It is not my task to repeat the well-known principles of Darwinism. I am not concerned to explain the scientific value of the whole theory of descent. The whole of our biological study is pervaded by it. No general problem in zoology and botany, in anatomy and physiology, can be discussed without the question arising, How has this problem originated? What are the real causes of its development?

This question was almost unknown seventy years ago, when Charles Darwin, the great reformer of biology, began his academical career at Cambridge as a student of theology. In the same year, 1828, Carl Ernst von Baer published in Germany his classical work on the embryology of animals, the first successful attempt to elucidate by "observation and reflection" the mysterious origin of the animal body from the egg, and to explain in every respect the "history of the growing individuality." Darwin at that time had no knowledge of this great advance, and he could not divine that forty years later

[1] This introduction is a reprint of an address delivered at the Fourth International Congress of Zoology, at Cambridge, England, August 26, 1898, by Professor Ernst Haeckel, of Jena, the most celebrated of German evolutionists.

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embryology would be one of the strongest supports of his own life's work — of that very theory of transformism which, founded by Lamarck in the year of Darwin's birth, was accepted with enthusiasm by Charles' grandfather Erasmus. There is no doubt that of all the celebrated naturalists of the nineteenth century Darwin achieved the greatest success, and we should be justified in designating the last forty years as the Age of Darwin.

In searching for the causes of this unexampled success, we must clearly separate three sets of considerations: first, the comprehensive reform of Lamarck's transformism, and its firm establishment by the many arguments drawn from modern biology; secondly, the construction of the new theory of selection, as established by Darwin, and independently by Alfred Wallace (a theory called Darwinism in the proper sense); thirdly, the deduction of anthropogeny, that most important conclusion of the theory of descent, the value of which far surpasses all the other truths in evolution.

It is the third point of Darwin's theory that I shall discuss here; and I shall discuss it chiefly with the intention of examining critically the evidence and the different conclusions which at present represent our scientific knowledge of the descent of man and of the different stages of his animal pedigree.

It is now generally admitted that this problem is the most important of all biological questions. Huxley was right when in 1863 he called it the question of questions for mankind. The problem which underlies all others, and is more deeply interesting than any other, is as to the place which man occupies in nature and his relations to the universe of things. "Whence our race has come; what are the limits of our power over nature, and of nature's power over us; to what goal are we tending — these are the problems which present themselves anew and with undiminished interest to every man born into the world." This impressive view was explained by Huxley thirty-five years ago in his three celebrated essays on "Evidence as to Man's Place in Nature." The first is entitled "On the Natural History of the Man-like Apes"; the second, "On the Relations of Man to the Lower Animals"; the third, "On some Fossil Remains of Man." Darwin himself felt the burden of these problems as much as Huxley; but in his chief work, "On the Origin of

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Species," in 1859, he had purposely only just touched them, suggesting that the theory of descent would shed light upon the origin of man and his history. Twelve years later, in his celebrated work on "The Descent of Man, and Selection in Relation to Sex," Darwin discussed fully and ingeniously all the different sides of this "question of questions" from the morphological, historical, physiological, and psychological points of view. As early as 1866 I myself had applied in the "Generelle Morphologie der Organismen" the theory of transformism to anthropology, and had shown that the fundamental law of biogeny claims the same value for man as for all the other animals. The intimate causal connection between ontogeny and phylogeny, between the development of the individual and the history of its ancestors, enables us to gain a safe and certain knowledge of our ancestral series. I had at that time distinguished in this series ten chief degrees of vertebrate organization. I attributed the highest importance to the logical connection of anthropogeny with transformism. If the latter be true, the truth of the former is absolute. "Our theory that man is descended from lower vertebrates, and immediately from apes or primates, is a case of special *deduction* which follows with absolute certainty from the general *induction* of the theory of descent."

During the forty years which have elapsed since Darwin's first publication of his theories an enormous literature, discussing the *general problems* of transformism as well as its special application to man, has been published. In spite of the wide divergence of the different views, all agree in one main point: the natural development of man cannot be separated from general transformism. There are only two possibilities. Either all the various species of animals and plants have been created independently by supernatural forces (and in this case the creation of man also is a miracle); or the species have been produced in a natural way by transmutation, by adaptation and progressive heredity (and in this case man also is descended from other vertebrates, and immediately from a series of primates). We are absolutely convinced that only the latter theory is fully scientific. To prove its truth, we have to examine critically the strength of the different arguments claimed for it.

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I.

First, we have to consider the relative place which comparative anatomy concedes to man in the "natural system" of animals, for the true value of our "natural classification" is based upon its meaning as a pedigree. All the minor and major groups of the system — the classes, legions, orders, families, genera, the species — are only different branches of the same pedigree. For man himself, his place in the pedigree has been fixed since Lamarck, in 1801, defined the group of vertebrates. The most perfect[1] of these are the Mammalia; and at the head of this class stands the order Primates, in which Linnæus, in 1735, united four "genera"— Homo, Simia, Lemur, and Vespertilio. If we exclude the last-named, the Chiroptera of modern zoology, there remain three natural groups of Primates — the Lemures, the Simiæ, and the Anthropi or Hominidæ. This is the classification of the majority of zoologists; but if we compare man with the two chief groups of monkeys — the Eastern monkeys (or Catarhinæ) and the Western or American monkeys (Platyrhinæ) — there can be no doubt that the former group is much more closely related to man than is the latter. In the natural order of the Catarhinæ we find united a long series of lower and higher forms. The lowest, the Cynopitheci, appear still closely related to the Platyrhinæ and to the Lemures; while, on the other hand, the tailless apes (Anthro-

[1] *Perfect*, in the sense of highest stage of evolution, may seem a *petitio principii.* Leaving aside the consideration that no living creature is absolutely perfect, in the sense that its organization cannot become more efficient or proficient, we have here to deal with relative perfection of the whole organization. A fish or a snake is in its way more specialized than a mammal; but specialization does not necessarily mean height of development: it generally means life in a comparatively narrow groove. The acts of giving birth and nourishing the young with the mother's milk is a much higher stage than the act of laying eggs and letting them run their chance. The development of a hairy coat goes along with heightened temperature of the blood, subsequent greater independence of the surrounding temperature, and increased steady activity of the brain and other nerve-centres. The brain of the Mammalia, in its minute structure, is much more complex. This rule applies to some of the principal sense organs, chiefly the nose and the ear. The skeleton, not so much as a whole as in the various bones and joints, is more neatly finished, and built up more in conformity with "scientific principles," than is the case even with birds, in spite of their marvelous specialization. The same is the case with the vascular system, notably the heart and the veins, and with the excretory organs. In all of these many imperfections, still to be found in the other classes, have been corrected in Mammalia. The Primates take an easy first by their hands, and among them the apes and man himself by their brains.

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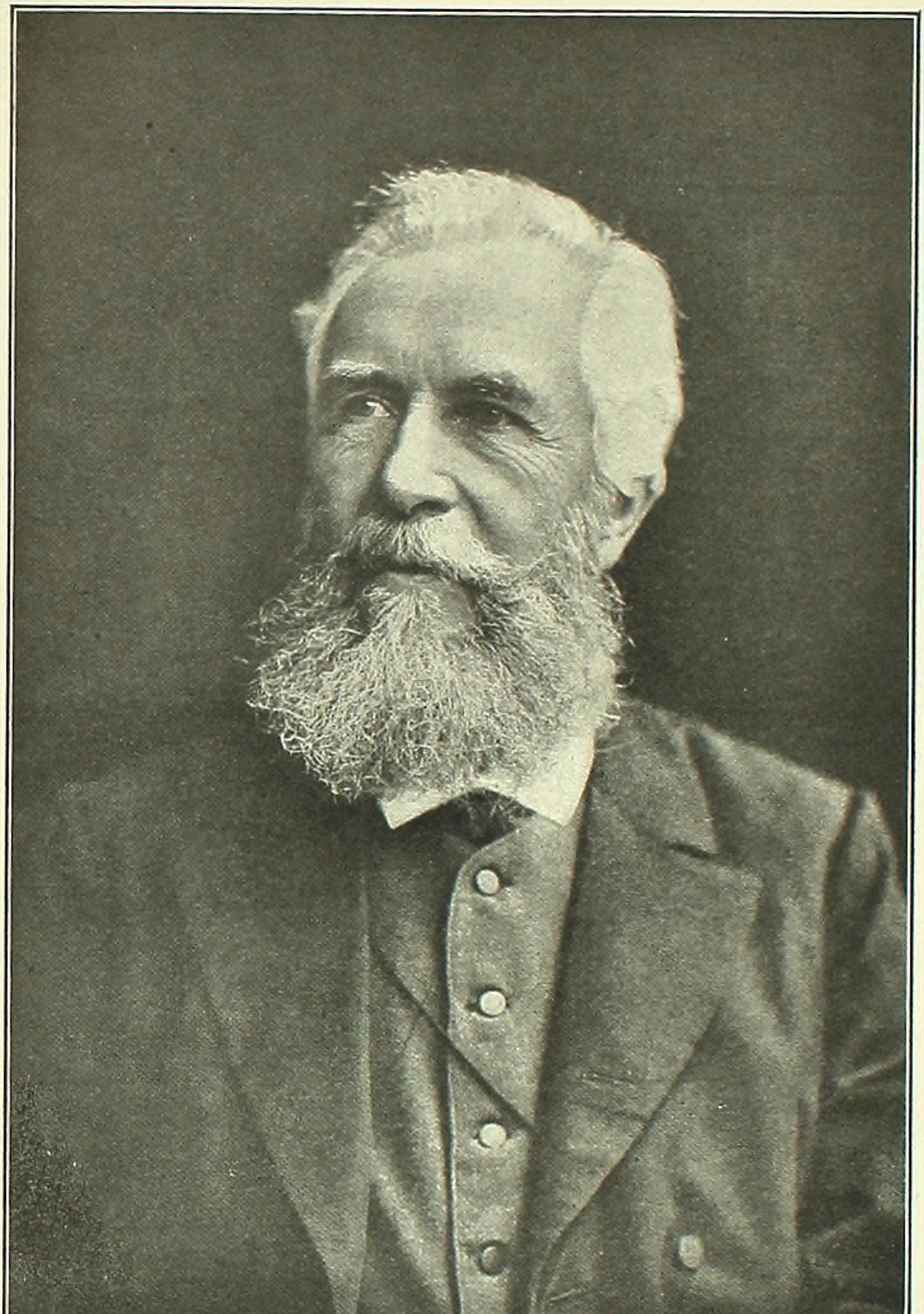

ERNST HAECKEL.

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pomorphæ) approach man through their higher organization. Hence one of our best authorities on the Primates, Robert Hartmann, proposed to subdivide the whole order of the Simiæ into three groups: (1) Primarii, man together with the other Anthropomorphæ, or tailless apes; (2) Simiæ, all the other monkeys; (3) Prosimiæ, or Lemurs. This arrangement has received strong support from the interesting discovery by Selenka that the peculiar placentation of the human embryo is the same as in the great apes, and different from that of all the other monkeys. Our choice between these different classifications of Primates is best determined by the important thesis of Huxley, in which, in 1863, he carried out a most careful and critical comparison of all the anatomical gradations within this order. In my opinion, this ingenious thesis — which I have called the Huxleyan Law, or the "Pithecometra-thesis of Huxley" — is of the utmost value. It runs as follows: "Thus, whatever system of organs be studied, the comparison of their modifications in the ape-series leads to one and the same result — that the structural differences which separate man from the gorilla and the chimpanzee are not so great as those which separate the gorilla from the lower apes." If we accept the Huxleyan law without prejudice, and apply it to the natural classification of the Primates, we must concede that man's place is within the order of the Simiæ. On examining this relation with care, and judging with logical persistence, we may even go a step further. Instead of the wider conception of "Simiæ," we must use the restricted term of Catarhinæ, and our Pithecometra-thesis has then to be formulated as follows: *The comparative anatomy of all organs of the group of Catarhine Simiæ leads to the result that the morphological differences between man and the great apes are not so great as are those between the man-like apes and the lowest Catarhinæ.* In fact, it is very difficult to show why man should not be classed with the large apes in the same zoological family. We all know a man from an ape; but it is quite another thing to find differences which are absolute and not of degree only. Speaking generally, we may say that man alone combines the four following features: (1) Erect walk; (2) extremities differentiated accordingly; (3) articulate speech; (4) higher reasoning power. Speech and reason are obviously relative distinctions only — the direct result of more

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brains and more brain-power, the so-called mental faculties. The erect walk is not an absolutely distinguishing characteristic: the large apes likewise walk on their feet only, supporting their bodies by touching the ground with the backs of their hands — in fact, with their knuckles — and this is a mode of progression very different from that of the tailed monkeys, which walk upon the palms of their hands. There are, however, two obvious differences in the development of the muscles. In man alone the gastrocnemius and the soleus muscle are thick enough to form the calf of the leg, and the glutæus maximus is enlarged into the buttocks. A fourth glutæal muscle occurs occasionally in man, while it is constantly present in apes as the so-called musculus scansorius. Concerning the muscles of the whole body, we cannot do better than quote Testut's summary: "The mass of recorded observations upon the muscular anomalies in man is so great, and the agreement of many of these with the condition normal in apes is so marked, that the gap which usually separates the muscular system of man from that of the apes appears to be completely bridged over."

There are, for example, the muscles of the ear. In most people the majority, or even all of them, are no longer movable at will, while in the apes they are still in use. The important point, however, is that these muscles are still present in man, although often in a reduced condition. They are the following: (1) Musculus auricularis anterior or attrahens auris, which is frequently much reduced and no longer reaches the ear at all, being then absolutely useless; (2) Musculus auricularis superior or attollens auris, more constant than the former; (3) Musculus auricularis posterior or retrahens auris, likewise often functional. Occasionally smaller slips differentiated from these three muscles are present, and as so-called intrinsic muscles are restricted to the ear itself; their function is, or was, that of curling up or opening the external ear.

In connection with the ear, I may touch upon another interesting and most suggestive little feature which is present in many individuals — namely, "Darwin's point." This is the last remnant of the original tip of the ear, before the outer, upper, and hinder rim became doubled up or folded in. It is a feature quite useless, and absolutely impossible of interpretation, ex-

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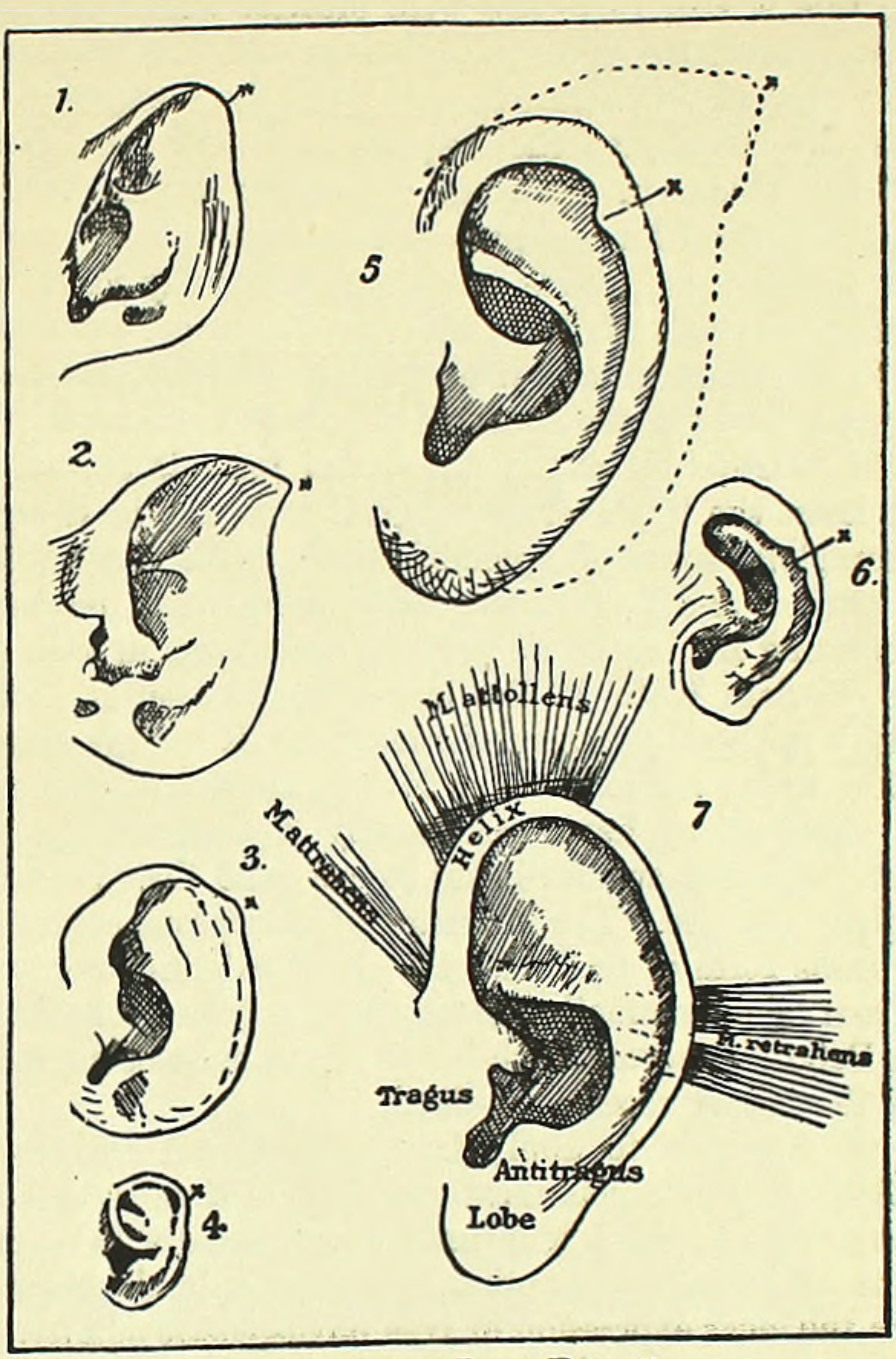

OUTLINES OF THE LEFT EAR OF—

1. *Lemur macaco;* 2. *Macacus rhesus*, the Rhesus monkey; 3. Cercopithecus, a macaque; 4. human embryo of six months; 5. man, with Darwin's point well retained: the dotted outline is that of the ear of a baboon; 6. orang-utan (after G. Schwalbe): * the original tip of the ear; 7. human ear with the principal muscles.

cepting as the vestige of such previous ancestral conditions as are normal in the monkeys.

In some cases the reduction of muscles has proceeded further in apes than in man — for example, the muscles of the little toe. Another instance is afforded by the coccyx or vestige of

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the tail; this is still furnished with muscles which are now in man, as well as in the apes, quite useless, and vary considerably with every sign of degeneration, most so in the orang-utan.

Darwin has mentioned the frequent action of the "snarling muscle," by which, in sneering, our upper canine teeth are exposed, like those of a dog prepared to fight.

Monkeys and apes possess vocal sacs, especially large in the orang-utan; survivals of them, although no longer used, persist in man in the shape of a pair of small diverticula, the pouches of Morgagni, between the true and the false vocal cords.

"In the native Australians, the dental formula appears least removed from the hypothetical original type, for in it are still found complete rows of splendid teeth, with powerfully-developed canines and molars, the latter being either uniform, or even increasing in size, as we proceed backwards, in such a way that the wisdom tooth is the largest of the series. This is decidedly a pithecoid characteristic which is always found in apes. The upper incisors of the Malay, apart from their prognathous disposition, have occasionally a distinctly pithecoid form, their anterior surface being convex, and their lingual surface slightly concave. The ancestors of Europeans seem to have had the same form of teeth, for the oldest existing fragments of skulls from the Mammoth age (e. g., the jaws from La Naulette, in Belgium) reveal tooth-forms which must be classed with those of the lowest races of to-day."

Now we are able to apply this fundamental Pithecometrathesis directly to the classification of the Primates and to the phylogeny of man, which is intimately connected with it, because in this order, as in all the other groups of animals, the natural system is the clear expression of true phylogenetic affinity. Four results follow from our thesis: (1) The Primates, as the highest legion or order of mammals, form one natural, monophyletic group. All the Lemures, Simiæ, and Homines descend from one common ancestral form, from a hypothetical "Archiprimas." (2) The Lemures are the older and lower of the natural groups of the Primates; they stand between the oldest Placentalia (Prochoriata) and the true Simiæ. (3) All the Catarhinæ, or Eastern Simiæ, form one natural monophyletic group. Their hypothetical common ancestor, the Archipithecus, may have descended directly or indirectly from a branch of the Lemures.

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(4) Man is descended directly from one series of extinct Catarhine ancestors. The more recent ancestors of this series were tailless anthropoids (similar to the Anthropopithecus), with five sacral vertebræ. The more remote ancestors were tailed Cercopitheci, with three or four sacral vertebræ.

These four theses possess, in my opinion, absolute certainty. They are independent of all future anatomical, embryological, and palæontological discoveries which may possibly throw more light upon the details of our phyletic anthropogenesis.

II.

The next question is, how the facts of palæontology agree with these most important results of comparative anatomy and ontogeny. The fossils are the true historical "medals of creation," the palpable evidence of the historical succession of all those innumerable organic forms which have peopled the globe for many millions of years. Here the question arises, If the known fossil specimens of Mammalia, and particularly of Primates, give proof of these Pithecometra-theses, do they confirm directly the descent of man from ape-like creatures? The answer to this question is, in my opinion, affirmative.

It is true that the gaps in the palæontological evidence, here as elsewhere, are many and keenly felt. In the order of the Primates they are greater than in many other orders, chiefly because of the arboreal life of our ancestors. The explanation is very simple. It is really due to a long chain of favorable coincidences if the skeleton of a vertebrate, covered as it was with flesh and skin, and containing still more perishable viscera, is petrified at all. The body may be devoured by other creatures, and its bones scattered about; or it rots away and crumbles to pieces. Many animals hide in thick undergrowth when death approaches them; and, leading an almost entirely arboreal life, the Primates are especially likely to disappear without being fossilized. It is only when the body is quickly covered with sand, or is imbedded in suitable mud containing lime and silica, that the process of petrifaction can come to pass. Even then it is only by great good luck that we come across such a fossil. Very few countries have been searched systematically, and the areas that have been searched amount to little in comparison

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with the whole surface of the land, even if we leave out of account the fact that more than two-thirds of the globe are covered by water.

These deplorable deficiencies of empirical palæontology are balanced on the other side by a growing number of positive facts, which possess an inestimable value in human phylogeny. The most interesting and most important of these is the celebrated fossil *Pithecanthropus erectus,* discovered in Java in 1894 by Dr. Eugène Dubois. Three years ago this now famous ape-like man provoked an animated discussion at the third International Zoological Congress at Leyden. I may therefore be allowed to say a few words as to its scientific significance. Unfortunately, the fossil remains of this creature are very scanty: the skull-cap, a femur, and two teeth. It is obviously impossible to form from these scanty remains a complete and satisfactory reconstruction of this remarkable Pliocene Primate.

The more important points are the following: The remains in question rested upon a conglomerate which lies upon a bed of marine marl and sand of Pliocene age. Together with the bones of Pithecanthropus were found those of Stegodon, Leptobos, Rhinoceros, Sus, Felis, Hyæna, Hippopotamus, Tapir, Elephas, and a gigantic Pangolin. It is remarkable that the first two of these genera are now extinct, and that neither hippopotamus nor hyæna exists any longer in the Oriental region. If we may judge from these fossil remains, the bones of Pithecanthropus are not younger than the oldest Plistocene, and probably belong to the upper Pliocene. The teeth are like those of man. The femur, also, is very human, but shows some resemblances to that of the gibbons. Its size, however, indicates an animal which stood when erect not less than 5 feet 6 inches high. The skull-cap also is very human, but with very prominent eyebrow ridges, like those of the famous Neanderthal cranium. It is certainly not that of an idiot. It had an estimated cranial capacity of about 1000 cubic centimeters — that is to say, much more than that of the largest ape, which possesses not more than 600 c. c. The crania of female Australians and Veddahs measure not more than 1,100, some even less than 1,000 c. c.; but, as these Veddah women stand only about 4 feet 9 inches high, the computed cranial capacity of the

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much taller Pithecanthropus is comparatively very low indeed.[1]

The final result of the long discussion at Leyden was that, of twelve experts present, three held that the fossil remains belonged to a low race of man; three declared them to be those of a man-like ape of great size; the rest maintained that they belonged to an intermediate form, which directly connected primitive man with the anthropoid apes. This last view is the right one, and accords with the laws of logical inference. *Pithecanthropus erectus* of Dubois is truly a Pliocene remainder of that famous group of highest Catarhines which were the immediate pithecoid ancestors of man. He is, indeed, the long-searched-for "missing link," for which, in 1866, I myself had proposed the hypothetical genus Pithecanthropus, species Alalus.

It must, however, be admitted that this opinion is still strongly combated by some distinguished authorities. At the Leyden congress it was attacked by the illustrious pathologist Rudolf Virchow. He, however, is one of the minority of leading men of science who set themselves to refute the theory of Evolution in every possible way. For thirty years he has defended the thesis: "It is quite certain that man is not a descendant of apes." He declares any intermediate form to be unimaginable save in a dream.

Virchow went to the Leyden Congress with the set purpose of disproving that the bones found by Dubois belonged to a creature which linked together apes and man. First, he maintained that the skull was that of an ape, while the thigh belonged to man. This insinuation was at once refuted by the expert palæontologists, who declared that without the slightest doubt the bones belonged to one and the same individual. Next, Virchow explained that certain exostoses or growths observable on the thigh proved its human nature, since only under careful treatment the patient could have healed the original injury. Thereupon Professor Marsh, the celebrated palæontologist, exhibited a number of thigh-bones of wild monkeys which showed similar exostoses and had healed without hospital treatment. As a last argument the Berlin pathologist declared that the deep

[1] On the day after the delivery of this address Dr. Dubois exhibited the cranium of Pithecanthropus, from which he had removed the stony matrix which filled the inside, in order to examine the impression left by the cerebral convolutions. He was able to show that they also are very human, and more highly developed than those of the recent apes.

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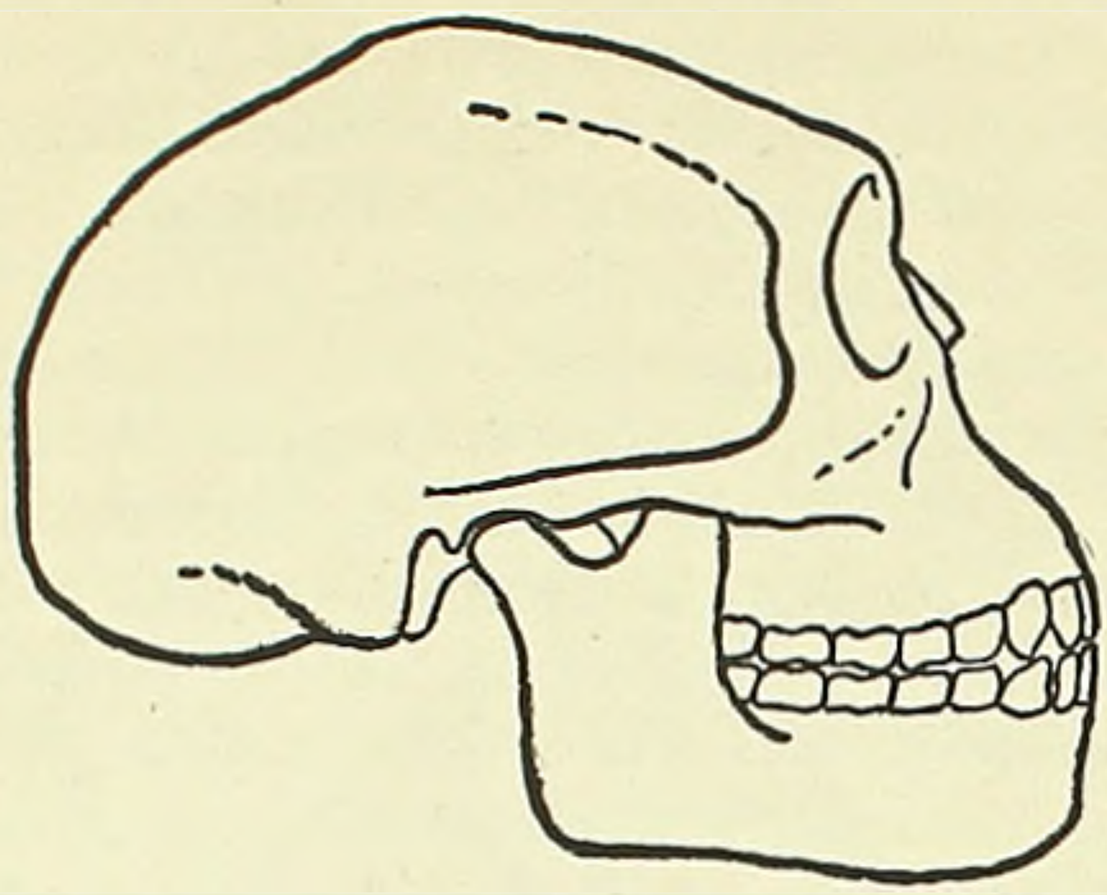

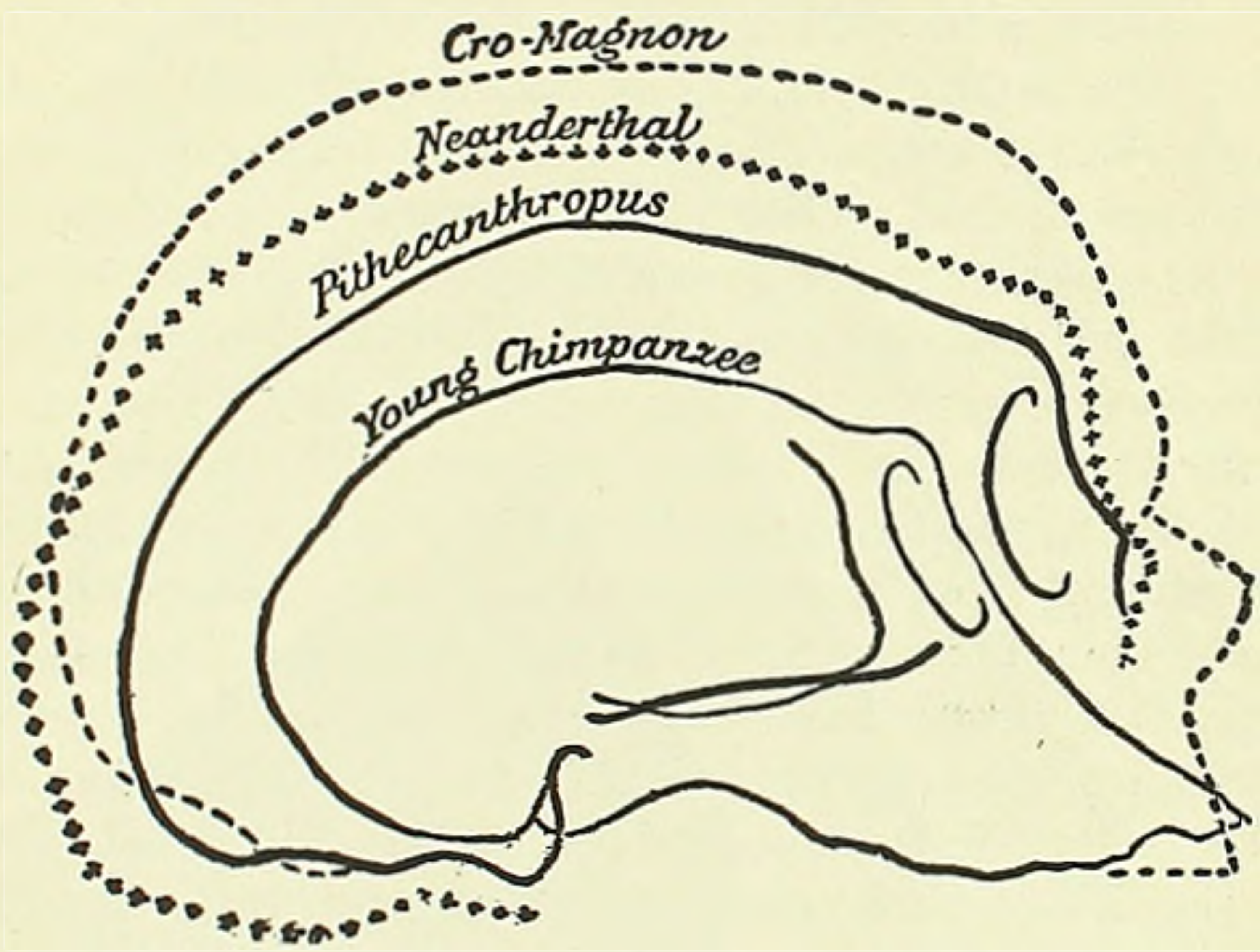

The upper figure represents the outlines of the skull of Pithecanthropus, as restored by Manouvier. The lower figure shows the comparative size and shape of Pithecanthropus, the Neanderthal skull a specimen of the Cro-Magnon race of neolithic France, and a Young Chimpanzee before the full development of the supraorbital crests, also after Manouvier.

constriction behind the upper margin of the orbits proved that the skull was that of an ape, as such never occurred in man. It so happened that a few weeks later Professor Nehring of

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Berlin demonstrated exactly the same formation on a human prehistoric skull received by him from Santos, in Brazil.

Virchow was, in fact, just as unlucky in Leyden in his fight with our pliocene ancestor as he had been unfortunate in his opinion on the famous skulls of Neanderthal, Spy, La Naulette, etc., everyone of which he explained as a pathological abnormality. It would be a very curious coincidence indeed if all these and other fossil human remains were those of idiots or otherwise abnormal individuals, provided they are old and low enough in their organization to be of phylogenetic value to the unbiased zoologist.

As the sworn adversary of Evolution, transformism, and Darwinism in particular, but a believer in the constancy of species, the great and renowned pathologist has been driven to the incredible contention that all variations of organic forms are pathological.

Four years ago, as honorary president of the Anthropological Congress at Vienna, he attacked Darwinism in the severest manner, and declared that "man may be as well descended from the elephant or from the sheep as from the ape." Such attacks on the theory of transformism indicate a failure to understand the principles of the theory of Evolution and to appreciate the significance of palæontology, comparative anatomy, and ontogeny.

The thousands of other objections which have been made during the last forty years (chiefly by outsiders) may be passed over in silence. They do not require serious refutation. In spite of, or perhaps because of, these attacks, the theory of Evolution stands established more firmly than ever.

It is easy for the outsider to exult over the difficulties which our problem implies — difficulties which we who have given our lives to the study understand likewise, and try our best not only to bridge over, but also to point out. Anyhow, we do not conceal them; while those who reject the explanation offered by Evolution make the most of the gaps, and pass silently over the far more numerous points favorable to our theory.

How fruitful during the last thirty years the astonishing progress in our palæontological knowledge has been for our Pithecometra-thesis is best shown by a short glance at the growth of our knowledge of fossil Primates. Cuvier, the founder of

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palæontology, continued up to the time of his death, in 1832, to assert that fossil remains of monkeys and lemurs did not exist. The only skull of a fossil lemuroid which he described (namely, Adapis) he declared to be that of an ungulate. Not until 1836 were the first fragments of extinct monkeys found in India; it was two years later, near Athens, that the skeleton of *Mesopithecus penthelicus* was discovered. Other remains of lemurs were found in 1862. But during the last twenty years the number of fossil Primates has been augmented by the remarkable discoveries of Gaudry, Filhol, Milne Edwards, Seeley, Schlosser, and others in Europe; of Marsh, Cope, Osborn, Leidy, Ameghino, in South America; and Forsyth Major in Madagascar. These tertiary remains, chiefly of Eocene and Miocene date, fill many gaps between existing genera of Primates, and afford us quite a clear insight into the phyletic development of this order during the millions of years of the Cænozoic age.

The most important difference between the two groups of existing monkeys is indicated by their dentition. Adult man possesses, like all the other Catarhine Simiæ, thirty-two teeth, whilst the American monkeys (the Platyrhinæ) have thirty-six teeth — namely, one pair of premolars more in the upper and lower jaws. Comparative odontology leads us to the phylogenetic conclusion that this number has been produced by reduction from a still older form with forty-four teeth. This typical dental formula (three incisors, one canine, four premolars, and three molars, in each half-jaw) is common to all those most important older mammals which in the beginning of the Eocene period constituted the four large groups of Lemuravida, Condylarthra, Esthonychida, and Ictopsida. These are the four ancestral groups of the four main orders of Placentalia — namely, of the Primates, Ungulata, Rodentia, and Carnassia. They seem to be so closely related by their primitive organization that they may be united in one common super-order Prochoriata.

With a considerable degree of probability, we are led to formulate the further hypothesis that all the orders of Placentalia — from the lowest Prochoriata upwards to man — have descended from some unknown common ancestor living in the Cretaceous period, and that this oldest placental form originated from some Jurassic group of marsupials.

Among these numerous fossil Lemurs which have been dis-

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covered within the last twenty years, there exist, indeed, all the connecting forms of the older series of Primates, all the "missing links" sought for by comparative odontology.

The oldest Lemures of the tertiary age are the Eocene Pachylemures, or Hyopsodina. They possess the complete dentition of the Prochoriata — namely, forty-four teeth. Then follow the Eocene Palæolemures, or Adapida, with forty teeth, they having lost one pair of incisors in each jaw. To these are attached the younger Autolemures, or Stenopida, with thirty-six teeth, they thus possessing already the same dentition as the Platyrhinæ. The characteristic dentition of the Catarhinæ is derived from this formula by the loss of another premolar.

These relations are so clear and so closely connected with a gradual transformation of the whole skull, and with the progressive differentiation of the Primate-form, that we are justified in saying that the pedigree of the Primates, from the oldest Eocene Lemures upwards to man, is now so well known, its principal features so firmly fixed within the Tertiary age, that there is no missing link whatever.

Quite different, and much more incomplete, is the palæontological evidence, if we go further back into the Secondary or Mesozoic age, and look there for the older ancestors of the mammalian series. There we meet everywhere with wide gaps, and the scarce fragments of fossil Mesozoic mammals (excessively rare in the Cretaceous formation) are too poor to permit definite conclusions as to their systematic position. Indeed, comparative anatomy and ontogeny lead us to the hypothesis that the oldest Cretaceous Mammalia — the Prochoriata — are descended from Jurassic marsupials, and these again from Monotremes. We may also suppose with high probability that among the unknown Cretaceous Prochoriata there have been Lemuravida and forms intermediate between these and the Jurassic Amphitheriidæ, and that these marsupials in their turn are descendants of Pantotheria or similar monotreme-like creatures of the Triassic age. Any certain evidence for these hypotheses is at present still wanting. One important fact, however, is established — namely, that these interesting and oldest Mammalia — the Pantotheria of Marsh, the Triassic Dromatheriidæ, and the Jurassic Triconodontidæ of Osborn — were small insectivorous mammals with a very primitive organization. Probably they were Monotremes, and

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may be derived directly from Permian Sauromammalia, an ill-defined mixture of Mammalia and Reptilia.

This generalized characteristic supports our view that *the whole class of Mammalia is monophyletic,* and that all its members, from the oldest Monotremes upwards to man, have descended from one common ancestor living in the older Triassic, or perhaps in the Permian, age. To acquire full conviction of this important conception, we have only to think of the hair and the glands of our human skin, of our diaphragm, the heart and the blood corpuscles without a nucleus, our skull with its squamoso-mandibular articulation. All these singular and striking modifications of the vertebrate organization are common to mammals, and distinguish them clearly from the other Craniota. This characteristic combination and correlation proves that they have been developed only *once* in the history of the vertebrate stem, and that they have been transferred by heredity from one common ancestor to all the members of the class of Mammalia.

The next step, as we trace our human phylogeny to its origin, leads us further back into the lower Vertebrata, into that obscure Palæozoic age the immeasurable length of which (much greater than that of the Mesozoic) may, according to one of the newest geological calculations, have comprised about one thousand millions of years.

The first important fact we have to face here is the complete absence of mammalian remains. Instead of these we find in the later Palæozoic period, the Permian, air-breathing *reptiles* as the earliest representatives of Amniota. They belong to the most primitive order of that class, the Tocosauria; and besides them there were the Theromorpha, which approach the Mammalia in a remarkable manner. These reptiles in turn were preceded, in the Carboniferous period, by true Amphibia, most of them belonging to the armor-clad Stegocephali. These interesting Progonamphibia were the oldest Tetrapoda, the first vertebrates which had adapted themselves to the terrestrial mode of life; in them the swimming fin of fishes and Dipneusta was transformed into the pentadactyle extremities characteristic of quadrupeds.

To appreciate the high importance of this metamorphosis, we need only compare the skeleton of our own human limbs with that of the living Amphibia. We find in the latter the same

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characteristic composition as in man: the same shoulder and pelvic girdle; the same single bone, the humerus or the femur, followed by the same pair of bones in the forearm and leg; then the same skeletal elements composing the wrist and the ankle regions; and, lastly, the same five fingers and toes.

The arrangement of these bones, peculiar and often complicated, but everywhere essentially the same in all the Tetrapoda, is a striking evidence that man is a descendant from the oldest pentadactyle Amphibia of the Carboniferous period. In man the pentadactyle type has been better preserved by constant heredity than in many other Mammalia, notably the Ungulata.

The oldest Carboniferous Amphibia, the armor-clad Stegocephali, and especially the remarkable Branchiosauri discovered by Credner, are now regarded by all competent zoologists as the indubitable common ancestral group of all Tetrapoda, comprising both Amphibia and Amniota. But whence this most remote group of Tetrapoda? That difficult question is answered by the marvelous progress of modern palæontology, and the answer is in complete harmony with the older results arrived at by comparative anatomy and ontogeny. Thirty-four years ago Carl Gegenbaur, the great living master of comparative anatomy, had demonstrated in a series of works how the skeletal parts of the various classes of Vertebrata, especially the skull and the limbs, still represent a continuous scale of phyletic gradations. Apart from the Cyclostomes, there are the fishes, and among them the Elasmobranchi (sharks and rays), which have best preserved the original structure in all its essential parts of organization. Closely connected with the Elasmobranchi are the Crossopterygii, and with these the Dipneusta or Dipnoi. Among the latter the highest importance attaches to the ancient Australian Ceratodus. Its organization and development is now, at last, becoming well known. This transitional group of Dipnoi, "fishes with lungs," but without pentadactyle limbs, is the morphological bridge which joins the Ganoids and the oldest Amphibia. With this chain of successive groups of Vertebrata, constructed anatomically, the palæontological facts agree most satisfactorily. Selachians and Ganoids existed in the Silurian times, Dipnoi in the Devonian, Amphibia in the Carboniferous, Reptilia in the Permian, Mammalia in the Trias. These are historical facts of first rank. They connote in the most convincing manner that remarkable

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ascending scale in the series of vertebrates for our knowledge of which we are indebted to the works of Cuvier and Blainville, Meckel, Johannes Mueller and Gegenbaur, Owen and Huxley. The historical succession of the classes and orders of the Vertebrata in the course of untold millions of years is definitely fixed by the concordance of those leading works, and this invaluable acquisition is much more important for the foundation of our human pedigree than would be a complete series of all possible skeletons of Primates.

Greater and more frequent difficulties arise if we penetrate further into the most remote part of the human phylogeny, and attempt to derive the vertebrate stem from an older stem of invertebrate ancestors. None of those had a skeleton which could be petrified; and the same remark applies to the lowest classes of Vertebrata — to the Cyclostomes and the Acrania. Palæontology, therefore, can tell us nothing about them; and we are limited to the other two great documents of phylogeny — the results of comparative anatomy and ontogeny. The value of their evidence is, however, so great that every competent zoologist can perceive the most important features of the most remote portion of our phylogeny.

Here the first place belongs to the invaluable results which modern comparative ontogeny has gained by the aid of the biogenetic law or the theory of recapitulation. The foundation-stones of vertebrate embryology had been laid by the works of Von Baer, Bischoff, Remak, and Koelliker; but the clearest light was thrown upon it by the famous discoveries of Kowalevsky in 1866. He proved the identity of the first developmental stages of Amphioxus and the Ascidians, and thereby confirmed the divination of Goodsir, who had already announced the close affinity of Vertebrates and Tunicates. The acknowledgment of this affinity has proved of increasing importance, and has abolished the erroneous hypothesis that the Vertebrata may have arisen from Annelids or from other Articulata. Meanwhile, from 1866 to 1872, I myself had been studying the development of the Spongiæ, Medusæ, Siphonophora, and other Cœlenterata. Their comparison led me to the statements embodied in the "Gastræatheorie," the first abstract of which was published in 1872 in my monograph of the Calcispongiæ.

These ideas were carried on and expanded during the sub-

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sequent ten years by the help of many excellent embryologists — first of all by E. Ray Lankester and Francis Balfour. The most fruitful result of these widely extended researches was the conclusion that the first stages of embryonic development are essentially the same in all the different Metazoa, and that we may derive from these facts certain views on the common descent of all from one ancestral form. The unicellular egg repeats the stage of our Protozoan ancestors; the Blastula is equivalent to an ancestral cœnobium of Magosphæra or Volvox; the Gastrula is the hereditary repetition of the Gastræa, the common ancestor of all the Metazoa.

Man agrees in all these respects with the other vertebrates, and and must have descended with them from the same common root.

Particularly obscure is that part of our phylogeny which extends from the Gastræa to Amphioxus. The morphological importance of the last small creature had been perceived by Johannes Mueller, who in 1842 gave the first accurate description of it. It would not, of course, be correct to proclaim the modern Amphioxus the common ancestor of all the vertebrates; but he must be regarded as closely related to them, and as the only survivor of the whole class of Acrania. If the Amphioxidæ had through some unfortunate accident become extinct, we should not have been able to gain anything like a positive glimpse at our most remote vertebrate ancestor. On the one hand, Amphioxus is closely connected with the early larva of the Cyclostomes, which are the oldest Craniota, and the pre-Silurian ancestors of the fishes. On the other hand, the ontogeny of Amphioxus is in harmony with that of the Ascidians, and if this agreement is not merely coincidental, but due to relationship, we are justified in reconstructing for both Ascidians and Amphioxus one common ancestral group of chordate animals, the hypothetical *Prochordonia.* The modern Copelata give us a remote idea of their structure. The curious Balanoglossus, the only living form of Enteropneusta, seems to connect these Prochordonia with the Nemertina and other Vermalia, which we unite in one large class — Frontonia.

No doubt these pre-Cambrian Vermalia, and the common root of all Metazoa, the Gastræades, were connected during the Laurentian period by a long chain of intermediate forms, and prob-

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ably among these were some older forms of Rotatoria and Turbellaria; but at present it is not possible to fill this wide gap with hypotheses that are satisfactory, and we have to admit that here indeed are many missing links in the older history of the Invertebrata. Still, every zoologist who is convinced of the truth of transformism, and is accustomed to phylogenetic speculations, knows very well that their results are most unequal, often incomplete.

III.

Let us now recapitulate the ancestral chain of man, as it is set forth in the accompanying diagram (p. xxvi), which represents our present knowledge of our descent. For simplicity's sake the many side-issues or branches which lead to groups not in the main line of our descent have been left out, or have been indicated merely. Many of the stages are of course hypothetical, arrived at by the study of comparative anatomy and ontogeny; but an example for each of them has been taken from those living or fossil creatures which seem to be their nearest representatives.

1. The most remote ancestors of all living organisms were living beings of the simplest imaginable kind, organisms without organs, like the still existing *Monera.* Each consisted of a simple granule of protoplasm, a structureless mass of albuminous matter or plasson, like the recent Chromaceæ and Bacteriæ. The morphological value of these beings is not yet that of a cell, but that of a cytode, or cell without a nucleus. Cytoplasm and nucleus were still undifferentiated.

I assume that the first Monera owe their existence to spontaneous creation out of so-called unorganic combinations, consisting of carbon, hydrogen, oxygen, and nitrogen. An explanation of this hypothesis I have given in my "Generelle Morphologie."

The Monera probably arose early in the Laurentian period. The oldest are the Phytomonera, with vegetable metabolism. They possessed the power (characteristic of plants) of forming albumin by synthesis from carbon, water, and ammonia. From some of these plasma-forming Monera arose the plasmophagous Zoomonera with animal metabolism, living directly upon the produce of their plasmodomous or plasma-forming sisters. This is the first instance of the great principle of division of labor.

2. The second stage is that of the *simple and single cell,* a bit

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of protoplasm with a nucleus. Such unicellular organisms are still very common. The *Amœbæ* are their simplest representatives. The morphological value of such beings is the same as that of the egg of any animal. The naked egg cells of the sponges creep about in an amœboid fashion, scarcely distinguishable from Amœba. The same remark applies to the egg-cell of man himself in its early stages before it is enclosed in a membrane. The first unicellular organisms arose from Monera through differentiation of the inner nucleus from the outer protoplasm.

3. Repeated division of the unicellular organism produces the *Synamœbium,* or community of Amœbæ, provided the divisional products, or new generations of the original cell, do not scatter, but remain together. The existence of such a *Cœnobium,* a number of equal and only loosely-connected cells, as a separate stage in the ancestral history of animals, is made highly probable by the fact that the eggs of all animals undergo after fertilization such a process of repeated self-division, or "cleavage," until the single egg cell is transformed into a heap of cells closely packed together, not unlike a mulberry (*morula*)—hence *morula* stage in ontogeny.

4. The morula of most animals further changes into a *Blastula,* a hollow ball filled with fluid, the wall being formed by a single layer of cells, the blastoderm or germinal layer. This modification is brought about by the action of the cells — they conveying nourishing fluid into the interior of the whole cell colony and thereby being themselves forced towards the surface. The Blastula of most Invertebrata, and even that of Amphioxus, is possessed of fine ciliæ, or hair-like processes, the vibrating motion of which causes the whole organism to rotate and advance in the water. Living representatives of such Blastæads, namely, globular gelatinous colonies of cells enclosing a cavity, are Volvox and Magosphæra.

5. The Blastula of most animals assumes a new larval form called *Gastrula,* in which the essential characteristics are that a portion of the blastoderm by invagination converts the Blastula into a cup with double walls, enclosing a new cavity, the primitive gut. This invagination or bulging-in obliterates the original inner cavity of the Blastula. The outer layer of the Gastrula is the ectoderm, the inner the endoderm: both pass into each other

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at the blastoporus, or opening of the gut cavity. The Gastrula is a stage in the embryonic development of the various great groups of animals, and some such primitive form as ancestral to all Metazoa is thus indicated. This hypothetical *Gastræa* is still very essentially represented by the lower Cœlenterates — e. g., Olynthus, Hydra.

6. The sixth stage — that of the *Platodes*, or flat-worms — is very hypothetical. They are bilateral gastræads, with a flattened oblong body, furnished with ciliæ, with a primitive nervous system, simple sensory and reproductive organs, but still without appendages, body cavity, vent, and blood-vessels. The nearest living representatives of such creatures are the acœlous Turbellarians — e. g., Convoluta, a free-swimming, ciliated creature.

7. The next higher stage is represented by such low animals as the *Gastrotricha* — e. g., Chætonotus among the Rotatoria, which differ from the rhabdocœlous Turbellarians chiefly by the formation of a vent and the beginnings of a cœlom, or cavity, between gut and body wall. The addition of a primitive vascular system and a pair of nephridia, or excretory organs, is first met with in the *Nemertines*.

8. These, together with the *Enteropneusta* (Balanoglossus), are comprised under the name of Frontonia, or Rhynchelminthes, and form the highest group of the Vermalia. The Enteropneusta especially fix our attention, because they alone, although essentially "worms," exhibit certain characteristics which make it possible to bridge over the gulf which still separates the invertebrata from the vertebrate phylum. The anterior portion of the gut is transformed into a breathing apparatus — hence Gegenbaur's term of Enteropneusta, or Gut-breathers. Moreover, Balanoglossus and Cephalodiscus possess another modification of the gut — namely, a peculiar diverticulum, which, in the present state of our knowledge, may be looked upon as the forerunner of the chorda dorsalis.

9. Stage of *Prochordonia,* as indicated by the larval form, called Chordula, which is common to the Tunicata and all the Vertebrata. These two groups possess three most important features: (*a*) A chorda dorsalis, a stiff rod lying in the long axis of the body, dorsally from the gut and below the central nervous system. This latter, for the first time in the animal kingdom, appears in the shape of a spinal cord. (*b*) The use of the anterior

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portion of the gut for respiratory purposes. (*c*) The larval development of the Tunicata is essentially the same as that of the Vertebrata in its early stages. Only the free-swimming Copelata or Appendicularia among the Tunicates retain most of these features. The others, which become sessile — namely, the Ascidiæ, or sea-squirts — degenerate and specialize away from the main line.

10. Stage of the *Acrania,* represented by Amphioxus. The early development of this little marine creature agrees closely with that of the Tunicates; but one important feature is added to its organization — namely, metamerism, segmentally arranged mesoderm. Amphioxus still possesses neither skull nor vertebræ, neither ribs nor jaws, and no limbs. But it is a member of the Vertebrata if we define these as follows: Bilateral symmetrical animals with segmentally arranged mesoderm, with a chorda dorsalis between the tubular nervous system and the gut, and with respiratory organs which arise from the anterior portion of the gut. We do not assume that Amphioxus stands in the direct ancestral line; it is probably much specialized, partly degenerated, and represents a side-branch; but it is, nevertheless, the only creature, hitherto known, which satisfactorily connects the Vertebrata with their invertebrate ancestors. Many other efforts have been made to solve the mystery of the origin of the Vertebrata — all less satisfactory than the present suggestion, or even absolutely futile. This remark applies especially to the attempts to derive them from either Articulata or Echinoderms. The other great and highly developed phylum, the Mollusca, is quite out of the question. We have to go back to a level at which all these principal phyla meet, and there we find the Vermalia, the lower of which alone permit connection in an upward direction with the higher phyla.

11. Stage of *Cyclostomata.* This now small group of Lampreys and Hagfishes represents the lowest Craniota; and although much specialized as a side-branch of the main-stem from which the other Craniota have sprung, they give us an idea of what the direct ancestors of the latter must have been like:— still without visceral arches, without jaws and without paired limbs; with a persistent pronephros; the ear with one semicircular canal only; mouth suctorial; cranium very primitive; and the metamerism of the vertebral column indicated

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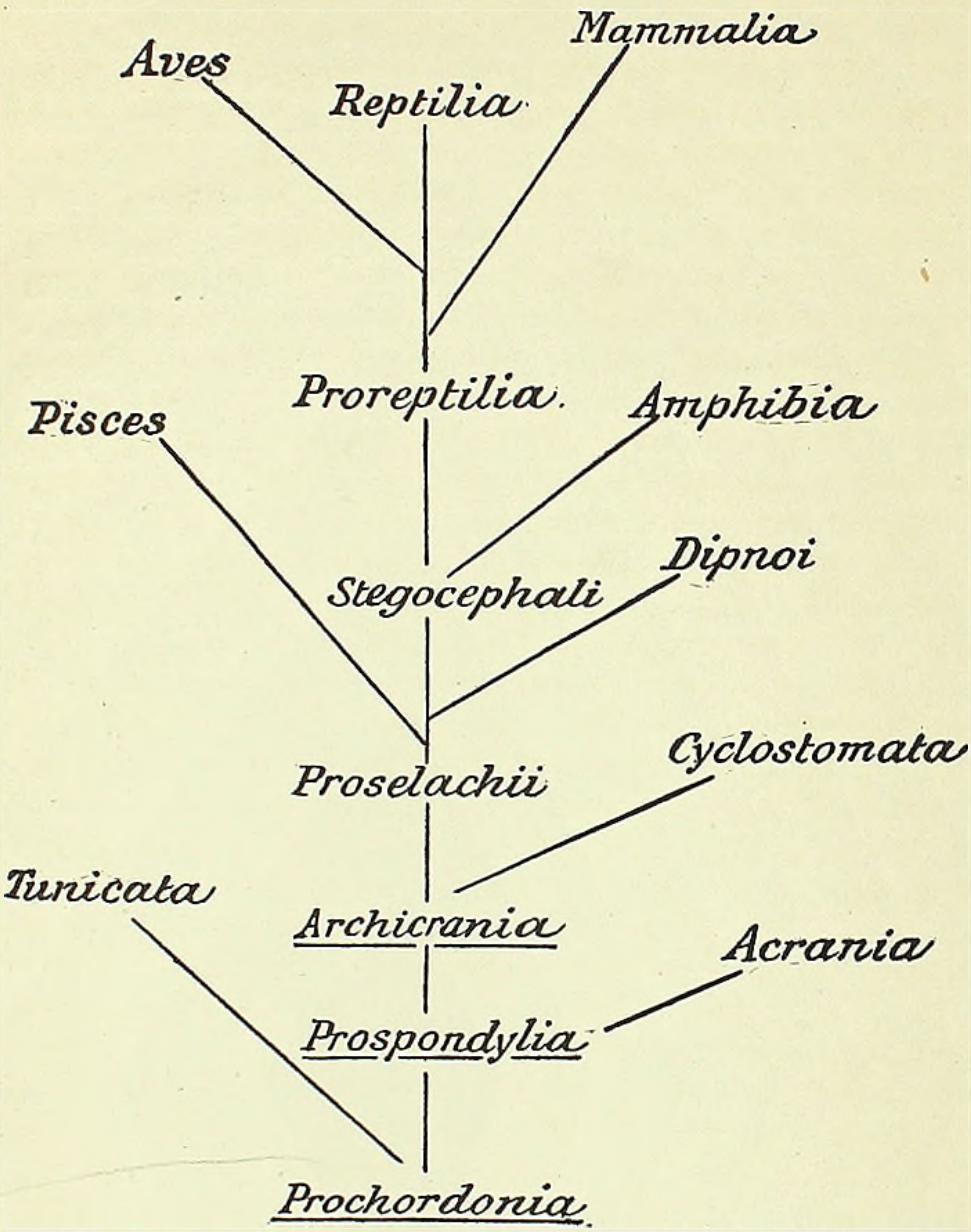
ANCESTRAL TREE OF THE VERTEBRATA.

Abridged from "Systemat. Phylogenie," § 15.
Names underlined refer to hypothetical groups.



only by little blocks of cartilage in the perichordal sheath. Such creatures must have existed at least as early as the Lower Silurian epoch; but until 1890 fossil Cyclostomes were unknown. Their life in the mud, or as endoparasites of fishes, coupled with their soft structure, makes them very unfit for preservation. This gives all the greater importance to Traquair's discovery, in 1890, of

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many little creatures, called by him *Palæospondylus gunni,* in the Old Red Standstone of Caithness, which seem to be very closely allied to Cyclostomata.

12. The *Elasmobranchi* (sharks and skates), with their immediate forerunners, the Acanthodi of the Devonian and Carboniferous age, are the first typical fishes. That they existed as far back as the Silurian age is proved by many enameled spines of the dermal armor, chiefly from the dorsal fins. This higher stage is characterized by the possession of typical jaws, by visceral or gill-bearing arches, and by two pairs of limbs. None of the Elasmobranchs, fossil or recent, stands in the direct ancestral line; but they are the lowest Gnathostomata, jaw-and-limb-possessing creatures, known.

13. Closely connected with the Elasmobranchs in a wider sense are the *Crossopterygii,* which begin in the Devonian age as a large group, but have left only two survivals, the African Polypterus and Calamoichthys. They are possessed of dermal bones and other ossifications, and are characterized by their lobate paired fins, which have a thick axis beset with biserial fin rays. Their gill-clefts are covered by an operculum, and they have a well-developed air-bladder. Whilst they are in many respects more highly developed than the Elasmobranchs, and are intimately connected with the typical Ganoids and other bony fishes (all of which form a great, manifold side-branch of the general vertebrate stem), they stand in many other respects (notably, the structure of the paired fins, the vertebral column, and the air-bladder) nearer the main-stem of our own ancestral line.

14. This is shown by their intimate relation to the *Dipnoi,* which are still represented by the Australian, African, and South American mud-fishes: Ceratodus, Protopterus, and Lepidosiren. The genus Ceratodus existed in the Upper Trias, whence various other unmistakably dipnoous forms lead down through the Carboniferous (e. g., Ctenodus) to the Devonian strata — e. g., Dipterus. They are characterized as follows: The paired fins still retain the archipterygial form (namely, one axis with biserial rays) ; the heart is already trilocular, and receives blood which is mixed arterial and venous, owing to the gills being retained, while the air-bladder has been modified into a lung. In fact, the generalized Dipnoi form the actual link between fishes and *Amphibia.*

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15. *Amphibia.* The earliest amphibian fossils occur in the Carboniferous strata. They alone — the Stegocephali or Phractamphibia — stand in the ancestral line, while the Lissamphibia, to which all the recent forms belong, are side-branches. The Stegocephali are the earliest Tetrapoda, the archipterygial paired fins having been transformed into the pentadactyle fore and hind limbs, which are so characteristic of all the higher Vertebrata. The cranium is roofed over by dermal bones, of which, besides others, supra-occipitals, supra-orbitals, and supra-temporals are always present. The lowest members (Branchiosauri) still retained gills besides the lungs, while others (Microsauri) have lost the gills. Be it remembered that all the recent Amphibia still undergo the same metamorphosis during their ontogenetic development.

In the very important Temnospondyli, a subgroup of the Stegocephali — e. g., Trimerorhachis of the Lower Red Sandstone or Lower Permian — the component cartilaginous or bony units which compose the vertebræ still remained in a separate, unfused state, showing at the same time an arrangement whence has arisen that which is typical of the Amniota. The same applies to the limbs and their girdles. In fact, the Stegocephali, taken as a whole, lead imperceptibly to the *Proreptilia.*

16. *Proreptilia* are represented by the Permian genera Eryops and Cricotus. Until quite recently these and many other fossils from the Carboniferous strata were looked upon as Amphibia, while many undoubted fossil Amphibia were mistaken for reptiles, as indicated by the frequent termination "-saurus" in their names.

The nearest living representative of these extinct Proreptilia is the New Zealand reptile Hatteria, or Sphenodon, close relations of which are known from the Upper Trias; while others — e. g., Palæohatteria — have been discovered in the Permian. Anyhow, Sphenodon is the reptile which stands nearest to the main stem of our ancestry.

The most important characteristics of the Reptilia, which mark a higher stage or level, are (1) The entire suppression of the gills — although during the embryonic development the gill-clefts still appear in all reptiles, birds, and mammals; (2) The development of an amnion and an allantois, both for the embryonic life only, but so characteristic that all these animals are

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comprised under the name of Amniota; (3) The articulation of the skull with the first neck vertebræ by well-developed condyles, either single (really triple) or double (such a condylar arrangement begins with the Amphibia, but only the two lateral condyles are developed, while the middle portion, belonging to the basi-occipital element, remains rudimentary[1]); (4) The formation of centra, or bodies of the vertebræ, mainly by a ventral pair of the original quadruple constituents, or arcualia.

17. Between the Proreptilia and the Mammalia, which latter occur in the Upper Triassic epoch, we have necessarily to intercalate a group of very low reptiles, which are still so generalized that their descendants could branch off either into the Reptilia proper or into the Mammalia. The changes concerned chiefly the brain and the heart; of the skeleton, the skull and the pelvis; and, of the tegumentary structures, the formation of a hairy covering. Many such creatures existed in the Triassic epoch — namely, the *Theromorpha* — some of which indeed possess so many characteristics which otherwise occur in the Mammalia only, that these creatures have been termed *Sauro-Mammalia.* However, it has to be emphasized that none of the Theromorpha hitherto discovered fulfils all the requirements which would entitle them to this important linking position. They only give us an approximate idea of what this link was like.

18. Stage of the *Promammalia,* or *Prototheria.* The only surviving members are the famous duck-bill, Ornithorhynchus, and the spiny ant-eaters, Echidna and Proechidna, of the Australian region. These few genera, however, differ so much from one another in various important respects that they cannot but be remnants of an originally much larger group. Indeed, many fossils from the Upper Triassic and from the Jurassic strata have without much doubt to be referred to the Prototheria. The Prototheria are typical mammals, because they possess the following characteristics: The heart is completely quadrilocular; the blood is warm, and its red corpuscles have, owing to the loss of

[1] Similar conditions seem to have prevailed among the Proreptilia; but in those of their descendants which have specialized into Reptiles and Birds the basi-occipital element becomes more and more predominant in that formation which ultimately leads to the apparently single condyle. Hence it is misleading to divide the Tetrapoda into the two main groups of Amphi- and Mono-condylia, and therefrom to conclude that the two-condyled Mammalia are more closely related to the likewise amphicondylous Amphibia than to the so-called monocondylous Reptiles.

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their nucleus, been modified from biconvex into biconcave discs; they have a hairy coat and sweat glands, and two occipital condyles; the ilio-sacral connection is preacetabular; the ankle-joint is cruro-tarsal; the quadrate bone of the Reptilia has ceased to carry the under jaw, which now articulates directly with the squamosal portion of the skull. Their low position is shown by the retention of the following reptilian features: Complete coracoid bones and a T-shaped interclavicle; a cloaca, or common chamber for the passage of the fæces, the genital and the urinary products; they are still oviparous; the embryo develops without a chorion, and is therefore not nourished through a placenta. Even the milk glands, which are absolutely peculiar to the Mammalia, are still in a very primitive stage, and do not yet produce milk proper; and there is only a temporary shallow marsupium.

19. Stage of *Metatheria*, or *Marsupialia*. Are direct descendants of Prototheria; but they show higher development by the reduction of the coracoid bones and the interclavicle. The original cloaca is divided into a rectal chamber and a uro-genital sinus, completely separated, at least in the males; they are viviparous; the young are received into a permanent marsupium, in the walls of which are formed typical milk glands and nipples, but the embryo is still devoid of a placenta, although some recent marsupials show indications of such an organ. The corpus callosum in the brain is still very weak.

Most of the marsupials are extinct. They occur from the Upper Trias onwards, and had in the Jurassic epoch attained a wide distribution both in Europe and in America. Since the Tertiary epoch they have been restricted to America and to the Australian region, and are now represented by about 150 species.

20. Stage of *Prochoriata*, or early *Placentalia*: a further development of the Metatheria by the development of a placenta, loss of the marsupium and the marsupial bones, complete division by the perineum of the anal and uro-genital chambers, stronger development of the corpus callosum, or chief commissure of the two hemispheres of the brain.

Placentalia must have come into existence during the Cretaceous epoch. Up to that time all the Mammalia seem to have belonged to either Prototheria or to Metatheria; but in the early Eocene we can distinguish the main groups of Placentalia—

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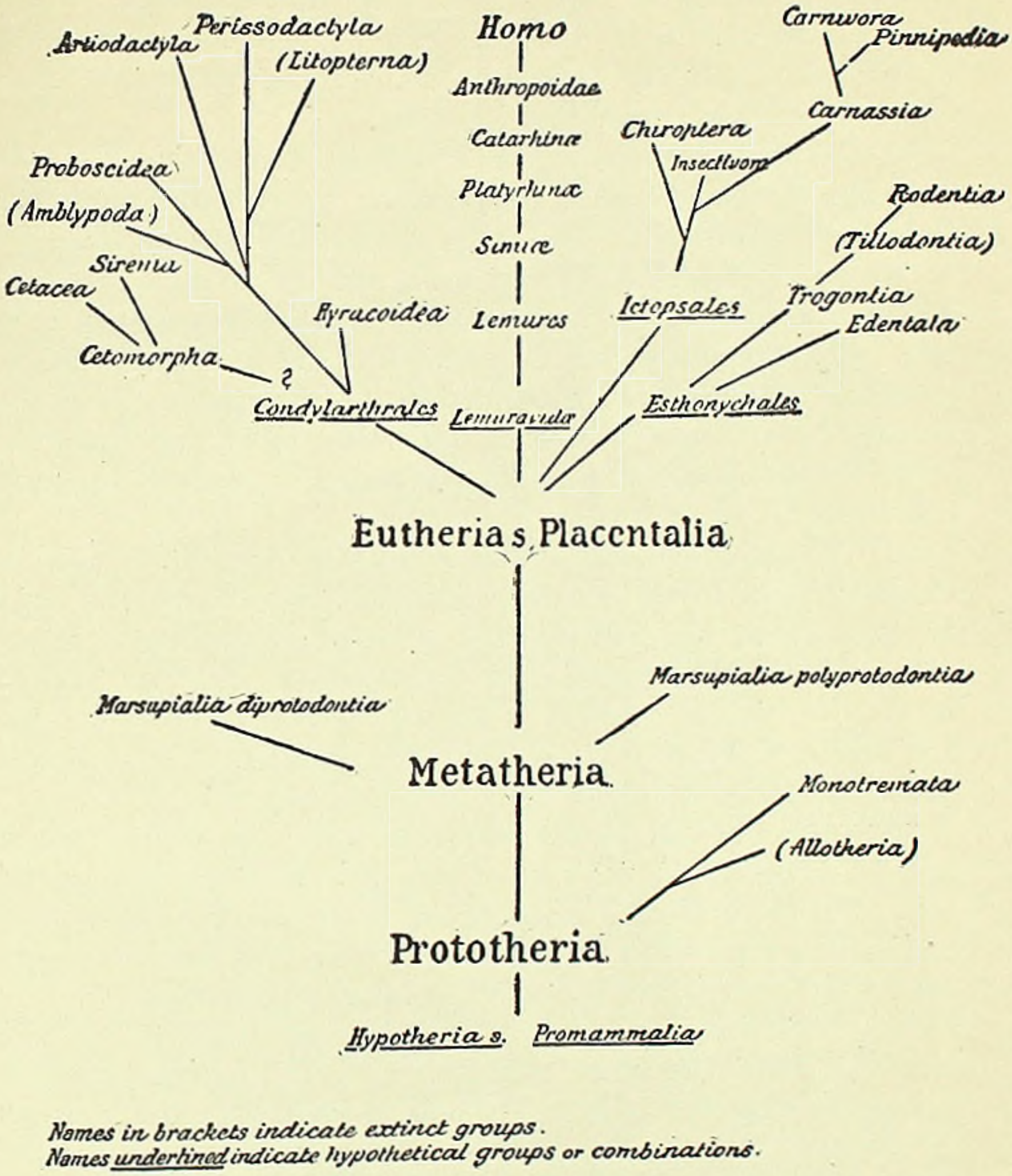
ANCESTRAL TREE OF THE MAMMALIA.

"*Systematische Phylogenie,*" § 386.



namely, (1) Trogontia, now represented by the rodents; (2) Edentata, or sloths, armadilloes, etc.; (3) Carnassia, or Insectivora and Carnivora; (4) Chiroptera, or bats; (5) Cetomorpha, or whales and dugongs; (6) Ungulata; (7) Primates. Of these groups, the first and second, third and fourth, fifth and sixth, can perhaps, to judge from palæontological evidence, be combined into three greater groups, as indicated by the fossil Esthonychida,

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Ictopsida, and Condylarthra, in addition to the ancestral Primates, or Lemuravida, as the fourth large branch of the ancestral-tree where this has reached the placental level. Among none of the first three branches can we look for the ancestors of the Primates. The Lemuravida, therefore, represent a branch equivalent to the three other branches.

21. Stage of *Lemures,* or *Prosimiæ,* comprising the older members of the Primates, consequently approaching most nearly to the Lemuravida. The limbs are modified into pentadactyle hands and feet of the arboreal type, and are protected by nails. The dentition is of the frugivorous or omnivorous type, with an originally complete series of teeth, with milk teeth and with permanent. The orbit is surrounded by a complete bony ring, posteriorly by a fronto-jugal arch, but still widely communicating with the temporal fossa. The placenta is diffuse and non-deciduous.

22. Stage of *Simiæ.* Orbit completely separated from the temporal fossa by an inward extension of the frontal and malar bones meeting the alisphenoid. Placenta consolidated into a disc, and with a maternal deciduous portion. Mammæ pectoral only. The dental formula is 2.1.3.3. All the fingers and toes are protected by flat nails. The tail is long. The American prehensile-tailed monkeys are a lower side-branch.

23. Stage of *Catarhinæ Ceropithecidæ.* The dental formula is 2.1.2.3, owing to the loss of one pair of premolars in each jaw. The frontal and alisphenoid bones are in contact, separating the parietal from the malar bone; this feature is correlated with the enlarged brain. The internarial septum is narrow, and the nostrils look forwards and downwards instead of sidewards — hence the term "Catarhinæ." The external auditory meatus is long and bony. The tail is long, with the exception of *Macacus inuus.* The body is covered with a thick coat of furry hair. Catarhine monkeys have existed, we know with certainty, since the Miocene.

24. Stage of *Catarhinæ Anthropoidæ,* or *Apes.* Now represented by the large apes — namely, the Hylobates or gibbon of South-Eastern Asia, *Simia satyrus,* the orang-utan of Sumatra and Borneo, *Troglodytes gorilla, T. niger* and *T. calvus,* the gorilla and the chimpanzees from Western Equatorial Africa. Of fossils are to be mentioned Pliopithecus and Dryopithecus

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from European Miocene, and *Troglodytes sivalensis* from the Pliocene of the Punjaub. The tail is reduced to a few caudal vertebræ, which are transformed into a coccyx, not visible externally: but in the embryos of apes and man the tail is still a conspicuous feature. The walk is semi-erect; in adaptation to the prevailing arboreal life, the arms are longer than the legs. The hair of the body is considerably more scanty than in the tailed monkeys. *Troglodytes calvus,* a species or variety of chimpanzee, is bald-headed. None of the recent genera of apes can lay claim to a place in the ancestry of mankind.

25. Stage of *Pithecanthropi.* Hitherto the only known representative is *Pithecanthropus erectus,* from the Upper Pliocene of Java. In adaptation to a more erect gait, the legs have become stronger and the hind-hand has been turned into a flat-soled walking "foot." The brain is considerably enlarged. Presumably it is still devoid of so-called articulate speech; this is indicated by the fact that children have to learn the language of their parents, and by the circumstance that comparative philology declares it impossible to reduce the chief human languages to anything like one common origin.

26. *Man.* Known with certainty to have existed as an implement-using creature in the last Glacial epoch. His probable origin cannot, therefore, have been later than the beginning of the Plistocene. The place of origin was probably somewhere in Southern Asia.

Whilst we have to admit that there are great defects in the older (invertebrate) portion of our pedigree, we have all the more reason to be satisfied with the positive results of our investigation of the more recent (vertebrate) part of it. All modern researches have confirmed the views of Lamarck, Darwin, and Huxley, and they allow of no doubt that the nearest vertebrate ancestors of mankind were a series of Tertiary Primates.

Particularly valuable are the admirable attempts of the two zoologists, Paul and Fritz Sarasin, to throw light upon the human phylogeny by painstaking comparison of all the skeletal parts of man with those of the anthropoid apes. They have shown that among the lower races of man the primitive Veddahs of Ceylon approach the apes most nearly, and that among the latter the chimpanzee stands nearest to man.

The direct descent of man from some extinct ape-like form

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is now beyond doubt, and admits of being traced much more clearly than the origin of many another mammalian order. The pedigrees of the Elephants, the Sirenia, the Cetàcea, and above all, of the Edentata, for example, are much more obscure and difficult to explain. In many parts of their organization — for example, in the number and structure of his five digits and toes — man and monkeys have remained much more primitive than most of the Ungulata.

The immense significance of this positive knowledge of the origin of man from some Primate does not require to be enforced. Its bearing upon the highest questions of philosophy cannot be exaggerated. Among modern philosophers no one has perceived this more deeply than Herbert Spencer. He is one of those older thinkers who before Darwin were convinced that the theory of development is the only way to solve the "enigma of the world." Spencer is also the champion of those evolutionists who lay the greatest weight upon *progressive heredity*, or the much combated *heredity of acquired characters*. From the first he has severely attacked and criticised the theories of Weismann, who denies this most important factor of phylogeny, and would explain the whole of transformism by the "all-sufficiency of selection." In England the theories of Weismann were received with enthusiastic acclamation, much more so than on the Continent, and they were called 'Neo-Darwinism," in opposition to the older conception of Evolution, or "Neo-Lamarckism." Neither of those expressions is correct. Darwin himself was convinced of the fundamental importance of progressive heredity quite as much as his great predecessor Lamarck; as were also Huxley and Spencer.

Three times I had the good fortune to visit Darwin at Down, and on each occasion we discussed this fundamental question in complete harmony. I agree with Spencer in the conviction that progressive heredity is an indispensable factor in every true monistic theory of Evolution, and that it is one of its most important elements. If one denies with Weismann the heredity of acquired characters, then it becomes necessary to have recourse to purely mystical qualities of germplasm. I am of the opinion of Spencer, that in that case it would be better to accept a mysterious creation of all the various species as described in the Mosaic account.

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If we look at the results of modern anthropogeny from the highest point of view, and compare all its empirical arguments, we are justified in affirming that *the descent of man from an extinct Tertiary series of Primates is not a vague hypothesis, but an historical fact.*

Of course, this fact cannot be proved *exactly*. We cannot explain all the innumerable physical and chemical processes, all the physiological mutations, which have led during untold millions of years from the simplest Monera and from the unicellular Protista upwards to the chimpanzee and to man. But the same consideration applies to all historical facts. We all believe that Aristotle, Cæsar, and King Alfred did live; but it is impossible to give a proof within the meaning of modern exact science. We believe firmly in the former existence of these and other great heroes of thought, because we know well the works they have left behind them, and we see their effects in the history of human culture. These indirect arguments do not furnish stronger evidence than those of our history as vertebrates. We know of many Jurassic mammals only a single bone, the under jaw. We all believe that these mammals possessed also an upper jaw, a skull, and other bones. But the so-called "exact school," which regards the transformation of species as a hypothesis not proven, must suppose that the mandibula was the only bone in the body of these curious animals.

Looking forward to the twentieth century, I am convinced that it will universally accept our theory of descent, and that future science will regard it as the greatest advance made in our time. I have no doubt that the influence of the study of anthropogeny upon all other branches of science will be fruitful and auspicious. The work done in the present century by Lamarck and Darwin will in all future times be considered one of the greatest conquests made by thinking man.

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PREFACE TO THE SECOND EDITION.

During the successive reprints of the first edition of this work I was able to introduce several important corrections; and now that more time has elapsed, I have endeavored to profit by the fiery ordeal through which the book has passed, and have taken advantage of all the criticisms which seem to me sound. I am also greatly indebted to a large number of correspondents for the communication of a surprising number of new facts and remarks. These have been so numerous, that I have been able to use only the more important ones. Some new illustrations have been introduced, and four of the old drawings have been replaced by better ones, done from life by Mr. T. W. Wood. I must especially call attention to some observations which I owe to the kindness of Prof. Huxley on the nature of the differences between the brains of man and the higher apes. I have been particularly glad to give these observations, because during the last few years several memoirs on the subject have appeared on the Continent, and their importance has been, in some cases, greatly exaggerated by popular writers.

I may take this opportunity of remarking that my critics frequently assume that I attribute all changes of corporeal structure and mental power exclusively to the natural selection of such variations as are often called spontaneous; whereas, even in the first edition of the "Origin of Species," I distinctly stated that great weight must be attributed to the inherited effects of use and disuse, with respect both to the body and mind. I also attributed some amount of modification to the direct and prolonged action of changed conditions of life. Some allowance, too, must be made for occasional reversions of structure; nor must we forget what I have called "correlated" growth, meaning, thereby, that various parts of

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the organization are in some unknown manner so connected, that when one part varies, so do others; and if variations in the one are accumulated by selection, other parts will be modified. Again, it has been said by several critics, that when I found that many details of structure in man could not be explained through natural selection, I invented sexual selection; I gave, however, a tolerably clear sketch of this principle in the first edition of the "Origin of Species," and I there stated that it was applicable to man. This subject of sexual selection has been treated at full length in the present work, simply because an opportunity was here first afforded me. I have been struck with the likeness of many of the half-favorable criticisms on sexual selection, with those which appeared at first on natural selection; such as, that it would explain some few details, but certainly was not applicable to the extent to which I have employed it. My conviction of the power of sexual selection remains unshaken; but it is probable, or almost certain, that several of my conclusions will hereafter be found erroneous; this can hardly fail to be the case in the first treatment of a subject. When naturalists have become familiar with the idea of sexual selection, it will, as I believe, be much more largely accepted; and it has already been fully and favorably received by several capable judges.

CHARLES DARWIN.

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THE DESCENT OF MAN;

AND

SELECTION IN RELATION TO SEX.

INTRODUCTION.

THE nature of the following work will be best understood by a brief account of how it came to be written. During many years I collected notes on the origin or descent of man, without any intention of publishing on the subject, but rather with the determination not to publish, as I thought that I should thus only add to the prejudices against my views. It seemed to me sufficient to indicate, in the first edition of my "Origin of Species," that by this work "light would be thrown on the origin of man and his history"; and this implies that man must be included with other organic beings in any general conclusion respecting his manner of appearance on this earth. Now the case wears a wholly different aspect. When a naturalist like Carl Vogt ventures to say in his address as President of the National Institution of Geneva (1869), "no person, in Europe at least, dares any longer to maintain the doctrine of the independent and unmodified creation of species," it is manifest that at least a large number of naturalists must admit that species are the modified descendants of other species; and this especially holds good with the younger and rising naturalists. The greater number accept the agency of natural selection; though some urge, whether with justice the future must decide, that I have greatly overrated its importance. Of the older and honored chiefs in natural science, many unfortunately are still opposed to evolution in every form.

In consequence of the views now adopted by most naturalists, and which will ultimately, as in every other case, be

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followed by others who are not scientific, I have been led to put together my notes, so as to see how far the general conclusions arrived at in my former works were applicable to man. This seemed all the more desirable, as I had never deliberately applied these views to a species taken singly. When we confine our attention to any one form, we are deprived of the weighty arguments derived from the nature of the affinities which connect together whole groups of organisms — their geographical distribution in past and present times, and their geological succession. The homological structure, embryological development, and rudimentary organs of a species remain to be considered, whether it be man or any other animal, to which our attention may be directed; but these great classes of facts afford, as it appears to me, ample and conclusive evidence in favor of the principle of gradual evolution. The strong support derived from the other arguments should, however, always be kept before the mind.

The sole object of this work is to consider, firstly, whether man, like every other species, is descended from some preexisting form; secondly, the manner of his development; and thirdly, the value of the differences between the so-called races of man. As I shall confine myself to these points, it will not be necessary to describe in detail the differences between the several races — an enormous subject which has been fully discussed in many valuable works. The high antiquity of man has recently been demonstrated by the labors of a host of eminent men, beginning with M. Boucher de Perthes; and this is the indispensable basis for understanding his origin. I shall, therefore, take this conclusion for granted, and may refer my readers to the admirable treatises of Sir Charles Lyell, Sir John Lubbock, and others. Nor shall I have occasion to do more than to allude to the amount of difference between man and the anthropomorphous apes; for Prof. Huxley in the opinion of most competent judges, has conclusively shown that in every visible character man differs less from the higher apes, than these do from the lower members of the same order of Primates.

This work contains hardly any original facts in regard to man; but as the conclusions at which I arrived, after drawing up a rough draft, appeared to me interesting, I thought that

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they might interest others. It has often and confidently been asserted, that man's origin can never be known; but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science. The conclusion that man is the co-descendant with other species of some ancient, lower, and extinct form, is not in any degree new. Lamarck long ago came to this conclusion, which has lately been maintained by several eminent naturalists and philosophers; for instance, by Wallace, Huxley, Lyell, Vogt, Lubbock, Büchner, Rolle, etc., and especially by Häckel. This last naturalist, besides his great work, "Generelle Morphologie" (1866), has recently (1868, with a second edit. in 1870), published his "Natürliche Schöpfungsgeschichte," in which he fully discusses the genealogy of man. If this work had appeared before my essay had been written, I should probably never have completed it. Almost all the conclusions at which I have arrived I find confirmed by this naturalist, whose knowledge on many points is much fuller than mine. Wherever I have added any fact or view from Prof. Häckel's writings, I give his authority in the text; other statements I leave as they originally stood in my manuscript, occasionally giving in the foot-notes references to his works, as a confirmation of the more doubtful or interesting points.

During many years it has seemed to me highly probable that sexual selection has played an important part in differentiating the races of man; but in my "Origin of Species" I contented myself by merely alluding to this belief. When I came to apply this view to man, I found it indispensable to treat the whole subject in full detail.[1] Consequently the second part of the present work, treating of sexual selection, has extended to an inordinate length, compared with the first part; but this could not be avoided.

I had intended adding to the present volumes an essay on the expression of the various emotions by man and the lower animals. My attention was called to this subject many years ago by Sir Charles Bell's admirable work. This illustrious

[1] Prof. Häckel was the only author who, at the time when this work first appeared, had discussed the subject of sexual selection, and had seen its full importance, since the publication of the "Origin"; and this he did in a very able manner in his various works.

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anatomist maintains that man is endowed with certain muscles solely for the sake of expressing his emotions. As this view is obviously opposed to the belief that man is descended from some other and lower form, it was necessary for me to consider it. I likewise wished to ascertain how far the emotions are expressed in the same manner by the different races of man. But owing to the length of the present work, I have thought it better to reserve my essay for separate publication.

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PART I.

THE DESCENT OF MAN

CHAPTER I.

THE EVIDENCE OF THE DESCENT OF MAN FROM SOME LOWER FORM.

Nature of the evidence bearing on the origin of man — Homologous structures in man and the lower animals — Miscellaneous points of correspondence — Development — Rudimentary structures, muscles, sense-organs, hair, bones, reproductive organs, etc.— The bearing of these three great classes of facts on the origin of man.

HE who wishes to decide whether man is the modified descendant of some pre-existing form, would probably first inquire whether man varies, however slightly, in bodily structure and in mental faculties; and if so, whether the variations are transmitted to his offspring in accordance with the laws which prevail with the lower animals. Again, are the variations the result, as far as our ignorance permits us to judge, of the same general causes, and are they governed by the same general laws, as in the case of other organisms; for instance, by correlation, the inherited effects of use and disuse, etc.? Is man subject to similar malconformations, the result of arrested development, or reduplication of parts, etc., and does he display in any of his anomalies reversion to some former and ancient type of structure? It might also naturally be inquired whether man, like so many other animals, has given rise to varieties and sub-races, differing but slightly from each other, or to races differing so much that they must be classed as doubtful species? How are such races distributed over the world; and how, when crossed, do they react on each other in the first and succeeding generations? And so with many other points.

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The inquirer would next come to the important point, whether man tends to increase at so rapid a rate, as to lead to occasional severe struggles for existence; and consequently to beneficial variations, whether in body or mind, being preserved, and injurious ones eliminated. Do the races or species of men, whichever term may be applied, encroach on and replace one another, so that some finally become extinct? We shall see that all these questions, as indeed is obvious in respect to most of them, must be answered in the affirmative, in the same manner as with the lower animals. But the several considerations just referred to may be conveniently deferred for a time: and we will first see how far the bodily structure of man shows traces, more or less plain, of his descent from some lower form. In succeeding chapters the mental powers of man, in comparison with those of the lower animals, will be considered.

The Bodily Structure of Man.— It is notorious that man is constructed on the same general type or model as other mammals. All the bones in his skeleton can be compared with corresponding bones in a monkey, bat, or seal. So it is with his muscles, nerves, blood-vessels and internal viscera. The brain, the most important of all the organs, follows the same law, as shown by Huxley and other anatomists. Bischoff, who is a hostile witness, admits that every chief fissure and fold in the brain of man has its analogy in that of the orang; but he adds that at no period of development do their brains perfectly agree; nor could perfect agreement be expected, for otherwise their mental powers would have been the same. Vulpian remarks: "The real differences which exist between the brain of man and that of the superior apes are very slight. It is not necessary to delude oneself in this respect. In the anatomical characters of his brain man is much nearer the anthropomorphous apes than the latter are near to other mammals, and even to certain quadrumana, such as the guenon and the macaque."

But it would be superfluous here to give further details on the correspondence between man and the higher mammals in the structure of the brain and all other parts of the body.

It may, however, be worth while to specify a few points, not directly or obviously connected with structure, by which this correspondence or relationship is well shown.

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Man is liable to receive from the lower animals, and to communicate to them, certain diseases, as hydrophobia, variola, the glanders, syphilis, cholera, herpes, etc., and this fact proves the close similarity of their tissues and blood, both in minute structure and composition, far more plainly than does their comparison under the best microscope, or by the aid of the best chemical analysis. Monkeys are liable to many of the same non-contagious diseases as we are; thus Rengger, who carefully observed for a long time the *Cebus Azaræ* in its native land, found it liable to catarrh, with the usual symptoms, and which, when often recurrent, led to consumption. These monkeys suffered also from apoplexy, inflammation of the bowels, and cataract in the eye. The younger ones when shedding their milk-teeth often died from fever. Medicines produced the same effect on them as on us. Many kinds of monkeys have a strong taste for tea, coffee, and spirituous liquors: they will also, as I have myself seen, smoke tobacco with pleasure.[1] Brehm asserts that the natives of north-eastern Africa catch the wild baboons by exposing vessels with strong beer, by which they are made drunk. He has seen some of these animals, which he kept in confinement, in this state; and he gives a laughable account of their behavior and strange grimaces. On the following morning they were very cross and dismal; they held their aching heads with both hands, and wore a most pitiable expression: when beer or wine was offered them, they turned away with disgust, but relished the juice of lemons. An American monkey, an Ateles, after getting drunk on brandy, would never touch it again, and thus was wiser than many men. These trifling facts prove how similar the nerves of taste must be in monkeys and man, and how similarly their whole nervous system is affected.

Man is infested with internal parasites, sometimes causing fatal effects; and is plagued by external parasites, all of which belong to the same genera or families as those infesting other mammals, and in the case of scabies to the same species. Man is subject, like other mammals, birds, and even insects, to that mysterious law, which causes certain normal processes, such as

[1] The same tastes are common to some animals much lower in the scale. Mr. A. Nicols informs me that he kept in Queensland, in Australia, three individuals of the *Phaseolarctus cinereus;* and that, without having been taught in any way, they acquired a strong taste for rum, and for smoking tobacco.

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gestation, as well as the maturation and duration of various diseases, to follow lunar periods. His wounds are repaired by the same process of healing; and the stumps left after the amputation of his limbs, especially during an early embryonic period, occasionally possess some power of regeneration, as in the lowest animals.

The whole process of that most important function, the reproduction of the species, is strikingly the same in all mammals; from the first act of courtship by the male, to the birth and nurturing of the young. Monkeys are born in almost as helpless a condition as our own infants; and in certain genera the young differ fully as much in appearance from the adults, as do our children from their full-grown parents. It has been urged by some writers, as an important distinction, that with man the young arrive at maturity at a much later age than with any other animal; but if we look to the races of mankind which inhabit tropical countries the difference is not great, for the orang is believed not to be adult till the age of from ten to fifteen years. Man differs from woman in size, bodily strength, hairiness, etc., as well as in mind, in the same manner as do the two sexes of many mammals. So that the correspondence in general structure, in the minute structure of the tissues, in chemical composition and in constitution, between man and the higher animals, especially the anthropomorphous apes, is extremely close.

Embryonic Development.— Man is developed from an ovule, about the 125th of an inch in diameter, which differs in no respect from the ovules of other animals. The embryo itself at a very early period can hardly be distinguished from that of other members of the vertebrate kingdom. At this period the arteries run in arch-like branches, as if to carry the blood to branchiæ which are not present in the higher vertebrata, though the slits on the sides of the neck still remain (*f, g,* fig. 1), marking their former position. At a somewhat later period, when the extremities are developed, "the feet of lizards and mammals," as the illustrious Von Baer remarks, "the wings and feet of birds, no less than the hands and feet of man, all arise from the same fundamental form." It is, says Prof. Huxley, "quite in the later stages of development that the young human being presents marked differences from the young ape, while the latter

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departs as much from the dog in its developments, as the man does. Startling as this last assertion may appear to be, it is demonstrably true."

As some of my readers may never have seen a drawing of an embryo, I have given one of man and another of a dog, at about the same early stage of development, carefully copied from two works of undoubted accuracy.[2]

After the foregoing statements made by such high authorities, it would be superfluous on my part to give a number of borrowed details, showing that the embryo of man closely resembles that of other mammals. It may, however, be added, that the human embryo likewise resembles certain low forms when adult in various points of structure. For instance, the heart at first exists as a simple pulsating vessel; the excreta are voided through a cloacal passage; and the os coccyx projects like a true tail, "extending considerably beyond the rudimentary legs."[3] In the embryos of all air-breathing vertebrates, certain glands, called the corpora Wolffiana, correspond with, and act like the kidneys of mature fishes.[4] Even at a later embryonic period, some striking resemblances between man and the lower animals may be observed. Bischoff says "that the convolutions of the brain in a human fœtus at the end of the seventh month reach about the same stage of development as in a baboon when adult." The great toe, as Professor Owen remarks, "which forms the fulcrum when standing or walking, is perhaps the most characteristic peculiarity in the human structure;" but in an embryo, about an inch in length, Prof. Wyman found "that the great toe was shorter than the others; and, instead of being parallel to them, projected at an angle from the side of the foot, thus corresponding with the permanent condition of this part of the quadrumana." I will conclude with a quotation from Huxley, who after asking, does man originate in a different way from a dog, bird, frog or

[2] The human embryo (upper fig.) is from Ecker, "Icones Phys.," 1851–1859, tab. xxx. fig. 2. This embryo was ten lines in length, so that the drawing is much magnified. The embryo of the dog is from Bischoff, "Entwicklungsgeschichte des Hunde-Eies," 1845, tab. xi. fig. 42. B. This drawing is five times magnified, the embryo being twenty-five days old. The internal viscera have been omitted, and the uterine appendages in both drawings removed. I was directed to these figures by Prof. Huxley, from whose work, "Man's Place in Nature," the idea of giving them was taken. Häckel has also given analogous drawings in his "Schöpfungsgeschichte."

[3] Prof. Wyman in "Proc. of American Acad. of Sciences," vol. iv.

[4] Owen, "Anatomy of Vertebrates," vol. i. p. 533.

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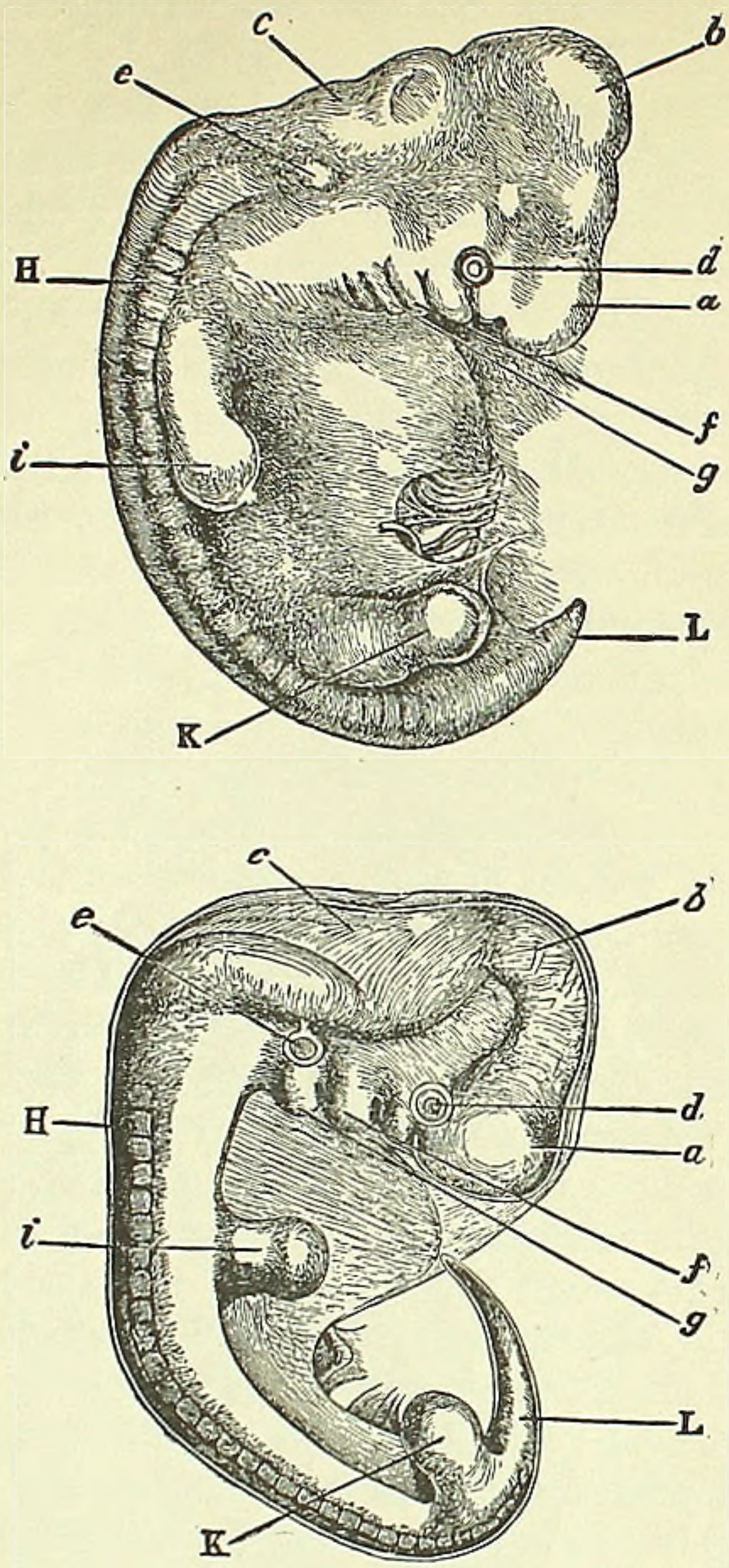

Fig. 1.— Upper figure human embryo, from Ecker. Lower figure that of a dog, from Bischoff.

a. Fore-brain, cerebral hemispheres, etc.
b. Mid-brain, corpora quadrigemina.
c. Hind-brain, cerebellum, medulla oblongata.
d. Eye.
e. Ear.
f. First visceral arch.
g. Second visceral arch.
H. Vertebral columns and muscles in process of development.
i. Anterior } extremities.
K. Posterior } extremities.
L. Tail or os coccyx.

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fish? says, "the reply is not doubtful for a moment; without question, the mode of origin, and the early stages of the development of man, are identical with those of the animals immediately below him in the scale: without a doubt in these respects, he is far nearer to apes than the apes are to the dog."

Rudiments.— This subject, though not intrinsically more important than the two last, will for several reasons be treated here more fully. Not one of the higher animals can be named which does not bear some part in a rudimentary condition; and man forms no exception to the rule. Rudimentary organs must be distinguished from those that are nascent; though in some cases the distinction is not easy. The former are either absolutely useless, such as the mammæ of male quadrupeds, or the incisor teeth of ruminants which never cut through the gums; or they are of such slight service to their present possessors, that we can hardly suppose that they were developed under the conditions which now exist. Organs in this latter state are not strictly rudimentary, but they are tending in this direction. Nascent organs, on the other hand, though not fully developed, are of high service to their possessors, and are capable of further development. Rudimentary organs are eminently variable; and this is partly intelligible, as they are useless, or nearly useless, and consequently are no longer subjected to natural selection. They often become wholly suppressed. When this occurs, they are nevertheless liable to occasional reappearance through reversion — a circumstance well worthy of attention.

The chief agents in causing organs to become rudimentary seem to have been disuse at that period of life when the organ is chiefly used (and this is generally during maturity), and also inheritance at a corresponding period of life. The term "disuse" does not relate merely to the lessened action of muscles, but includes a diminished flow of blood to a part or organ, from being subjected to fewer alternations of pressure, or from becoming in any way less habitually active. Rudiments, however, may occur in one sex of those parts which are normally present in the other sex; and such rudiments, as we shall hereafter see, have often originated in a way distinct from those here referred to. In some cases, organs have been reduced by means of natural selection, from having become injurious to the species under changed habits of life. The process of reduction is probably

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often aided through the two principles of compensation and economy of growth; but the later stages of reduction, after disuse has done all that can fairly be attributed to it, and when the saving to be effected by the economy of growth would be very small, are difficult to understand. The final and complete suppression of a part, already useless and much reduced in size, in which case neither compensation nor economy can come into play, is perhaps intelligible by the aid of the hypothesis of pangenesis. But as the whole subject of rudimentary organs has been discussed and illustrated in my former works, I need here say no more on this head.

Rudiments of various muscles have been observed in many parts of the human body;[5] and not a few muscles, which are regularly present in some of the lower animals can occasionally be detected in man in a greatly reduced condition. Every one must have noticed the power which many animals, especially horses, possess of moving or twitching their skin; and this is effected by the *panniculus carnosus.* Remnants of this muscle in an efficient state are found in various parts of our bodies; for instance, the muscle on the forehead, by which the eyebrows are raised. The *platysma myoides,* which is well developed on the neck, belongs to this system. Prof. Turner, of Edinburgh, has occasionally detected, as he informs me, muscular fasciculi in five different situations, namely in the axillæ, near the scapulæ, &c., all of which must be referred to the system of the *panniculus.* He has also shown that the *musculus sternalis* or *sternalis brutorum,* which is not an extension of the *rectus abdominalis,* but is closely allied to the *panniculus,* occurred in the proportion of about three per cent. in upward of 600 bodies: he adds, that this muscle affords "an excellent illustration of the statement that occasional and rudimentary structures are especially liable to variation in arrangement."

Some few persons have the power of contracting the superficial muscles on their scalps; and these muscles are in a variable and partially rudimentary condition. M. A. de Candolle has

[5] For instance, M. Richard ("Annales des Sciences Nat.," 3d series, Zoolog. 1852, tom. xviii. p. 13) describes and figures rudiments of what he calls the "muscle pédieux de la main," which he says is sometimes "infiniment petit." Another muscle, called "le tibial postérieur," is generally quite absent in the hand, but appears from time to time in a more or less rudimentary condition.

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communicated to me a curious instance of the long-continued persistence or inheritance of this power, as well as of its unusual development. He knows a family, in which one member, the present head of the family, could, when a youth, pitch several heavy books from his head by the movement of the scalp alone; and he won wagers by performing this feat. His father, uncle, grandfather, and his three children possess the same power to the same unusual degree. This family became divided eight generations ago into two branches; so that the head of the above-mentioned branch is cousin in the seventh degree to the head of the other branch. This distant cousin resides in another part of France; and on being asked whether he possessed the same faculty, immediately exhibited his power. This case offers a good illustration how persistent may be the transmission of an absolutely useless faculty, probably derived from our remote semi-human progenitors; since many monkeys have, and frequently use the power, of largely moving their scalps up and down.

The extrinsic muscles which serve to move the external ear, and the intrinsic muscles which move the different parts, are in a rudimentary condition in man, and they all belong to the system of the *panniculus;* they are also variable in development, or at least in function. I have seen one man who could draw the whole ear forwards; other men can draw it upwards; another who could draw it backwards; and from what one of these persons told me, it is probable that most of us, by often touching our ears, and thus directing our attention towards them, could recover some power of movement by repeated trials. The power of erecting and directing the shell of the ears to the various points of the compass, is no doubt of the highest service to many animals, as they thus perceive the direction of danger; but I have never heard, on sufficient evidence, of a man who possessed this power, the one which might be of use to him. The whole external shell may be considered a rudiment, together with the various folds and prominences (helix and anti-helix, tragus and anti-tragus, etc., which in the lower animals strengthen and support the ear when erect, without adding much to its weight. Some authors, however, suppose that the cartilage of the shell serves to transmit vibrations to the acoustic nerve; but Mr.

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Toynbee,[6] after collecting all the known evidence on this head, concludes that the external shell is of no distinct use. The ears of the chimpanzee and orang are curiously like those of man, and the proper muscles are likewise but very slightly developed. I am also assured by the keepers in the Zoological Gardens that these animals never move or erect their ears; so that they are in an equally rudimentary condition with those of man, as far as function is concerned. Why these animals, as well as the progenitors of man, should have lost the power of erecting their ears, we can not say. It may be, though I am not satisfied with this view, that owing to their arboreal habits and great strength they were but little exposed to danger, and so during a lengthened period moved their ears but little, and thus gradually lost the power of moving them. This would be a parallel case with that of those large and heavy birds, which, from inhabiting oceanic islands, have not been exposed to the attacks of beasts of prey, and have consequently lost the power of using their wings for flight. The inability to move the ears in man and several apes is, however, partly compensated by the freedom with which they can move the head in a horizontal plane, so as to catch sounds from all directions. It has been asserted that the ear of man alone possesses a lobule; but "a rudiment of it is found in the gorilla"; and, as I hear from Prof. Preyer, it is not rarely absent in the negro.

The celebrated sculptor, Mr. Woolner, informs me of one little peculiarity in the external ear, which he has often observed both in men and women, and of which he perceived the full significance. His attention was first called to the subject whilst at work on his figure of Puck, to which he had given pointed ears. He was thus led to examine the ears of various monkeys, and subsequently more carefully those of man. The peculiarity consists in a little blunt point, projecting from the inwardly folded margin, or helix. When present, it is developed at birth, and, according to Prof. Ludwig Meyer, more frequently in man than in woman. Mr. Woolner made an exact model of one such case, and sent me the accompanying drawing. (Fig. 2.) These points not only project inwards towards the

[6] "The Diseases of the Ear," by J. Toynbee, F. R. S., 1860, p. 12. A distinguished physiologist, Prof. Preyer, informs me that he had lately been experimenting on the function of the shell of the ear, and has come to nearly the same conclusion as that given here.

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centre of the ear, but often a little outwards from its plane, so as to be visible when the head is viewed from directly in front or behind. They are variable in size, and somewhat in position, standing either a little higher or lower; and they sometimes occur on one ear and not on the other. They are not confined to mankind, for I observed a case in one of the spider-monkeys (*Ateles beelzebuth*) in our Zoological Gardens; and Mr. E. Ray Lankester informs me of another case in a chimpanzee in the gardens at Hamburg. The helix obviously consists of the extreme margin of the ear folded inwards; and this folding appears to be in some manner connected with the whole external ear being permanently pressed backwards. In many monkeys, which do not stand high in the order, as baboons and some species of macacus, the upper portion of the ear is slightly pointed, and the margin is not at all folded inwards; but if the margin were to be thus folded, a slight point would necessarily project inwards towards the centre, and probably a little outwards from the plane of the ear; and this I believe to be their origin in many cases. On the other hand, Prof. L. Meyer, in an able paper recently published, maintains that the whole case is one of mere variability; and that the projections are not real ones, but are due to the internal cartilage on each side of the points not having been fully developed. I am quite ready to admit that this is the correct explanation in many instances, as in those figured by Prof. Meyer, in which there are several minute points, or the whole margin is sinuous. I have myself seen, through the kindness of Dr. L. Down, the ear of a microcephalous idiot, on which there is a projection on the outside of the helix, and not on the inward folded edge, so that this point can have no relation to a former apex of the ear. Nevertheless in some cases, my original view, that the points are vestiges of the tips of formerly erect and pointed ears, still seems to me probable. I think so from the frequency of their occurrence, and from the general correspondence in position with that of the tip of a

FIG. 2.—Human Ear, modelled and drawn by Mr. Woolner. *a*. The projecting point.

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pointed ear. In one case, of which a photograph has been sent me, the projection is so large, that supposing, in accordance with Prof. Meyer's view, the ear to be made perfect by the equal development of the cartilage throughout the whole extent of the margin, it would have covered fully one-third of the whole ear. Two cases have been communicated to me, one in North America, and the other in England, in which the upper margin is not at all folded inwards, but is pointed, so that it closely resembles the pointed ear of an ordinary quadruped in outline. In one of these cases, which was that of a young child, the father compared the ear with the drawing which I have given of the ear of a monkey, the *Cynopithecus niger,* and says that their outlines are closely similar. If, in these two cases, the margin had

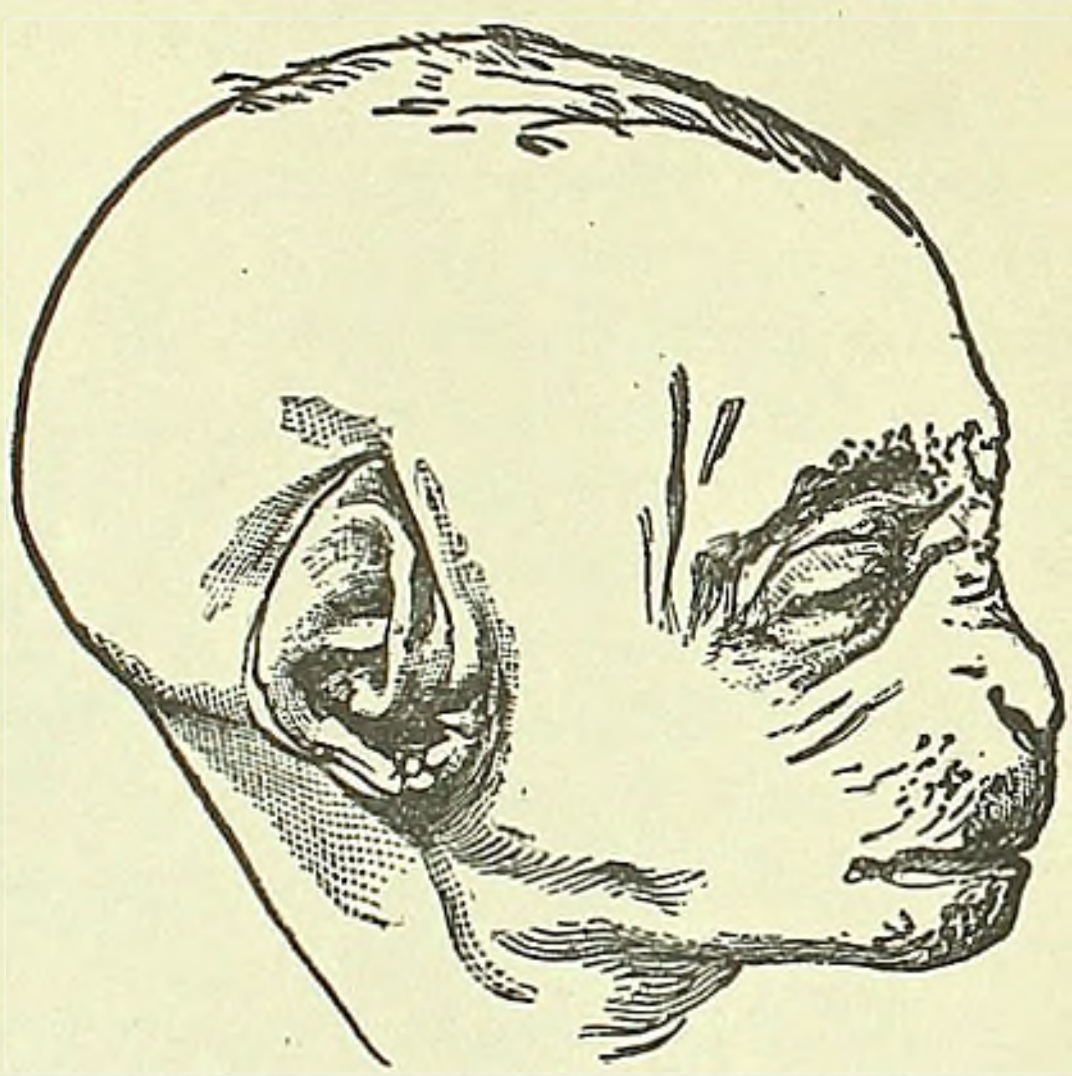

FIG. 3.— Fœtus of an Orang. Exact copy of a photograph, showing the form of the ear at this early age.

been folded inwards in the normal manner, an inward projection must have been formed. I may add that in two other cases the outline still remains somewhat pointed, although the margin of the upper part of the ear is normally folded inwards — in one of them, however, very narrowly. The foregoing woodcut (No. 3) is an accurate copy of a photograph of the fœtus of an orang (kindly sent me by Dr. Nitsche), in which it may be seen how different the pointed outline of the ear is at this period from its adult condition, when it bears a close general resemblance to that of man. It is evident that the folding over of the tip of such

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an ear, unless it changed greatly during its further development, would give rise to a point projecting inwards. On the whole, it still seems to me probable that the points in question are in some cases, both in man and apes, vestiges of a former condition.

The nictitating membrane, or third eyelid, with its accessory muscles and other structures, is especially well developed in birds, and is of much functional importance to them, as it can be rapidly drawn across the whole eyeball. It is found in some reptiles and amphibians, and in certain fishes, as in sharks. It is fairly well developed in the two lower divisions of the mammalian series, namely, in the monotremata and marsupials, and in some few of the higher mammals, as in the walrus. But in man, the quadrumana, and most other mammals, it exists, as is admitted by all anatomists, as a mere rudiment, called the semilunar fold.[7]

The sense of smell is of the highest importance to the greater number of mammals — to some, as the ruminants, in warning them of danger; to others, as the carnivora, in finding their prey; to others, again, as the wild boar, for both purposes combined. But the sense of smell is of extremely slight service, if any, even to the dark colored races of men, in whom it is much more highly developed than in the white and civilized races.[8] Nevertheless it does not warn them of danger, nor guide them to their food; nor does it prevent the Esquimaux from sleeping in the most fetid atmosphere, nor many savages from eating half-putrid meat. In Europeans the power differs greatly in different individuals, as I am assured by an eminent naturalist who possesses this sense highly developed, and who has attended to the subject. Those who believe in the principle of gradual evolu-

[7] Müller's "Elements of Physiology," Eng. translat., 1842, vol. ii. p. 1117. Owen, "Anatomy of Vertebrates," vol. iii. p. 260; ibid. on the Walrus, "Proc. Zoolog. Soc." November 8th, 1854. See also R. Knox, "Great Artists and Anatomists," p. 106. This rudiment apparently is somewhat larger in Negroes and Australians than in Europeans, see Carl Vogt, "Lectures on Man," Eng. translat. p. 129.

[8] The account given by Humboldt of the power of smell possessed by the natives of South America is well known, and has been confirmed by others. M. Houzeau ("Etudes sur les Facultés Mentales," etc., tom. i. 1872, p. 91) asserts that he repeatedly made experiments, and proved that Negroes and Indians could recognize persons in the dark by their odor. Dr. W. Ogle has made some curious observations on the connection between the power of smell and the coloring matter of the mucous membrane of the olfactory region, as well as of the skin of the body. I have, therefore, spoken in the next of the dark-colored races having a finer sense of smell than the white races. See his paper, "Medico-Chirurgical Transactions," London, vol. liii. p. 276.

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tion, will not readily admit that the sense of smell in its present state was originally acquired by man, as he now exists. He inherits the power in an enfeebled and so far rudimentary condition, from some early progenitor, to whom it was highly serviceable, and by whom it was continually used. In those animals which have this sense highly developed, such as dogs and horses, the recollection of persons and of places is strongly associated with their odor; and we can thus perhaps understand how it is, as Dr. Maudsley has truly remarked, that the sense of smell in man "is singularly effective in recalling vividly the ideas and images of forgotten scenes and places."

Man differs conspicuously from all the other Primates in being almost naked. But a few short straggling hairs are found over the greater part of the body in the man, and fine down on that of the woman. The different races differ much in hairiness; and in the individuals of the same race the hairs are highly variable, not only in abundance, but likewise in position: thus in some Europeans the shoulders are quite naked, whilst in others they bear thick tufts of hair. There can be little doubt that the hairs thus scattered over the body are the rudiments of the uniform hairy coat of the lower animals. This view is rendered all the more probable, as it is known that fine, short, and pale-colored hairs on the limbs and other parts of the body, occasionally become developed into "thickset, long, and rather coarse dark hairs," when abnormally nourished near old-standing inflamed surfaces.

I am informed by Sir James Paget that often several members of a family have a few hairs in their eyebrows much longer than the others; so that even this slight peculiarity seems to be inherited. These hairs, too, seem to have their representatives; for in the chimpanzee, and in certain species of Macacus, there are scattered hairs of considerable length rising from the naked skin above the eyes, and corresponding to our eyebrows; similar long hairs project from the hairy covering of the superciliary ridges in some baboons.

The fine wool-like hair, or so-called lanugo, with which the human fœtus during the sixth month is thickly covered, offers a more curious case. It is first developed, during the fifth month, on the eyebrows and face, and especially round the mouth, where it is much longer than that on the head. A moustache of this

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kind was observed by Eschricht on a female fœtus; but this is not so surprising a circumstance as it may at first appear, for the two sexes generally resemble each other in all external characters during an early period of growth. The direction and arrangement of the hairs on all parts of the fœtal body are the same as in the adult, but are subject to much variability. The whole surface, including even the forehead and ears, is thus thickly clothed; but it is a significant fact that the palms of the hands and the soles of the feet are quite naked, like the inferior surfaces of all four extremities in most of the lower animals. As this can hardly be an accidental coincidence, the woolly covering of the fœtus probably represents the first permanent coat of hair in those mammals which are born hairy. Three or four cases have been recorded of persons born with their whole bodies and faces thickly covered with fine long hairs; and this strange condition is strongly inherited, and is correlated with an abnormal condition of the teeth.[9] Prof. Alex. Brandt informs me that he has compared the hair from the face of a man thus characterized, aged thirty-five, with the lanugo of a fœtus, and finds it quite similar in texture; therefore, as he remarks, the case may be attributed to an arrest of development in the hair, together with its continued growth. Many delicate children, as I have been assured by a surgeon to a hospital for children, have their backs covered by rather long silky hairs; and such cases probably come under the same head.

It appears as if the posterior molar or wisdom-teeth were tending to become rudimentary in the more civilized races of man. These teeth are rather smaller than the other molars, as is likewise the case with the corresponding teeth in the chimpanzee and orang; and they have only two separate fangs. They do not cut through the gums till about the seventeenth year, and I have been assured that they are much more liable to decay, and are earlier lost than the other teeth; but this is denied by some eminent dentists. They are also much more liable to vary, both in structure and in the period of their development, than the other teeth. In the Melanian races, on the other hand, the wisdom-teeth are usually furnished with three separate fangs, and are generally

[9] Prof. Alex. Brandt has recently sent me an additional case of a father and son, born in Russia, with these peculiarities. I have received drawings of both from Paris.

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sound; they also differ from the other molars in size, less than in the Caucasian races. Prof. Schaaffhausen accounts for this difference between the races by "the posterior dental portion of the jaw being always shortened" in those that are civilized, and this shortening may, I presume, be attributed to civilized men habitually feeding on soft, cooked food, and thus using their jaws less. I am informed by Mr. Brace that it is becoming quite a common practice in the United States to remove some of the molar teeth of children, as the jaw does not grow large enough for the perfect development of the normal number.[10]

With respect to the alimentary canal, I have met with an account of only a single rudiment, namely the vermiform appendage of the cæcum. The cæcum is a branch or diverticulum of the intestine, ending in a cul-de-sac, and is extremely long in many of the lower vegetable-feeding mammals. In the marsupial koala it is actually more than thrice as long as the whole body. It is sometimes produced into a long gradually-tapering point, and is sometimes constricted in parts. It appears as if, in consequence of changed diet or habits, the cæcum had become much shortened in various animals, the vermiform appendage being left as a rudiment of the shortened part. That this appendage is a rudiment, we may infer from its small size, and from the evidence which Prof. Canestrini has collected of its variability in man. It is occasionally quite absent, or again is largely developed. The passage is sometimes completely closed for half or two-thirds of its length, with the terminal part consisting of a flattened solid expansion. In the orang this appendage is long and convoluted: in man it arises from the end of the short cæcum, and is commonly from four to five inches in length, being only about the third of an inch in diameter. Not only is it useless, but it is sometimes the cause of death, of which fact I have lately heard two instances: this is due to small hard bodies, such as seeds, entering the passage, and causing inflammation.[11]

In some of the lower Quadrumana, in the Lemuridæ and Car-

[10] Prof. Montegazza writes to me from Florence, that he has lately been studying the last molar teeth in the different races of man, and has come to the same conclusion as that given in my text, viz., that in the higher or civilized races they are on the road towards atrophy or elimination.

[11] M. C. Martins in "Revue des Deux Mondes," and Häckel ("Generelle Morphologie"), have both remarked on the singular fact of this rudiment sometimes causing death.

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nivora, as well as in many marsupials, there is a passage near the lower end of the humerus, called the supra-condyloid foramen, through which the great nerve of the fore limb and often the great artery pass. Now in the humerus of man, there is generally a trace of this passage, which is sometimes fairly well developed, being formed by a depending hook-like process of bone, completed by a band of ligament. Dr. Struthers,[12] who has closely attended to the subject, has now shown that this peculiarity is sometimes inherited, as it has occurred in a father, and in no less than four out of his seven children. When present, the great nerve invariably passes through it; and this clearly indicates that it is the homologue and rudiment of the supra-condyloid foramen of the lower animals. Prof. Turner estimates, as he informs me, that it occurs in about one per cent. of recent skeletons. But if the occasional development of this structure in man is, as seems probable, due to reversion, it is a return to a very ancient state of things, because in the higher Quadrumana it is absent.

There is another foramen or perforation in the humerus, occasionally present in man, which may be called the inter-condyloid. This occurs, but not constantly, in various anthropoid and other apes, and likewise in many of the lower animals. It is remarkable that this perforation seems to have been present in man much more frequently during ancient times than recently. Mr. Busk[13] has collected the following evidence on this head: Prof. Broca "noticed the perforation in four and a half per cent. of the arm-bones collected in the 'Cimetière du Sud,' at Paris; and in the Grotto of Orrony, the contents of which are referred to the Bronze period, as many as eight humeri out of thirty-two were perforated; but this extraordinary proportion, he thinks, might be due to the cavern having been a sort of 'family vault.' Again, M. Dupont found thirty per cent. of perforated bones

[12] With respect to inheritance, see Dr. Struthers in the "Lancet," Feb. 15, 1873, and another important paper, ibid., Jan. 24, 1863, p. 83. Dr. Knox, as I am informed, was the first anatomist who drew attention to this peculiar structure in man; see his "Great Artists and Anatomists," p. 63. See also an important memoir on this process by Dr. Gruber, in the "Bulletin de l'Acad. Imp. de St. Pétersbourg," tom. xii. p. 448.

[13] "On the Caves of Gibraltar," "Transact. Internat. Congress of Prehist. Arch." Third Session, 1869, p. 159. Prof. Wyman has lately shown (Fourth Annual Report, Peabody Museum, 1871, p. 20), that this perforation is present in thirty-one per cent. of some human remains from ancient mounds in the Western United States, and in Florida. It frequently occurs in the negro.

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in the caves of the Valley of the Lesse, belonging to the Reindeer period; whilst M. Leguay, in a sort of *dolmen* at Argenteuil, observed twenty-five per cent. to be perforated; and M. Pruner-Bey found twenty-six per cent. in the same condition in bones from Vauréal. Nor should it be left unnoticed that M. Pruner-Bey states that this condition is common in Guanche skeletons." It is an interesting fact that ancient races, in this and several other cases, more frequently present structures which resemble those of the lower animals than do the modern. One chief cause seems to be that the ancient races stand somewhat nearer in the long line of descent to their remote animal-like progenitors.

In man, the os coccyx, together with certain other vertebræ hereafter to be described, though functionless as a tail, plainly represent this part in other vertebrate animals. At an early embryonic period it is free, and projects beyond the lower extremities; as may be seen in the drawing (Fig. 1.) of a human embryo. Even after birth it has been known, in certain rare and anomalous cases,[14] to form a small external rudiment of a tail. The os coccyx is short, usually including only four vertebræ, all anchylosed together: and these are in a rudimentary condition, for they consist, with the exception of the basal one, of the centrum alone. They are furnished with some small muscles; one of which, as I am informed by Prof. Turner, has been expressly described by Theile as a rudimentary repetition of the extensor of the tail, a muscle which is so largely developed in many mammals.

The spinal cord in man extends only as far downwards as the last dorsal or first lumbar vertebra; but a thread-like structure (the *filum terminale*) runs down the axis of the sacral part of the spinal canal, and even along the back of the coccygeal bones. The upper part of this filament, as Prof. Turner informs me, is undoubtedly homologous with the spinal cord; but the lower part apparently consists merely of the *pia mater*, or vascular investing membrane. Even in this case the os coccyx may be said to possess a vestige of so important a structure as the spinal cord, though no longer enclosed within a bony canal. The following

[14] Quatrefages has lately collected the evidence on this subject. "Revue des Cours Scientifiques," 1867-1868, p. 625. In 1840 Fleischmann exhibited a human fœtus bearing a free tail, which, as is not always the case, included vertebral bodies; and this tail was critically examined by the many anatomists present at the meeting of naturalists at Erlangen (see Marshall in Niederländischen Archiv für Zoologie, December 1871).

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fact, for which I am also indebted to Prof. Turner, shows how closely the os coccyx corresponds with the true tail in the lower animals: Luschka has recently discovered at the extremity of the coccygeal bones a very peculiar convoluted body, which is continuous with the middle sacral artery; and this discovery led Krause and Meyer to examine the tail of a monkey (Macacus), and of a cat, in both of which they found a similarly convoluted body, though not at the extremity.

The reproductive system offers various rudimentary structures; but these differ in one important respect from the foregoing cases. Here we are not concerned with the vestige of a part which does not belong to the species in an efficient state, but with a part efficient in the one sex, and represented in the other by a mere rudiment. Nevertheless, the occurrence of such rudiments is as difficult to explain, on the belief of the separate creation of each species, as in the foregoing cases. Hereafter I shall have to recur to these rudiments, and shall show that their presence generally depends merely on inheritance, that is, on parts acquired by one sex having been partially transmitted to the other. I will in this place only give some instances of such rudiments. It is well known that in the males of all mammals, including man, rudimentary mammæ exist. These in several instances have become well developed, and have yielded a copious supply of milk. Their essential identity in the two sexes is likewise shown by their occasional sympathetic enlargement in both during an attack of the measles. The *vesicula prostatica*, which has been observed in many male mammals, is now universally acknowledged to be the homologue of the female uterus, together with the connected passage. It is impossible to read Leuckart's able description of this organ, and his reasoning, without admitting the justness of his conclusion. This is especially clear in the case of those mammals in which the true female uterus bifurcates, for in the males of these the vesicula likewise bifurcates.[15]. Some other rudimentary structures belonging to the reproductive system might have been here adduced.

The bearing of the three great classes of facts now given is unmistakable. But it would be superfluous fully to recapitulate

[15] Leuckart, in Todd's "Cyclop. of Anat." vol. iv. p. 1415. In man this organ is only from three to six lines in length, but, like so many other rudimentary parts, it is variable in development as well as in other characters.

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the line of argument given in detail in my "Origin of Species." The homological construction of the whole frame in the members of the same class is intelligible, if we admit their descent from a common progenitor, together with their subsequent adaptation to diversified conditions. On any other view, the similarity of pattern between the hand of a man or monkey, the foot of a horse, the flipper of a seal, the wing of a bat, etc., is utterly inexplicable.[16] It is no scientific explanation to assert that they have all been formed on the same ideal plan. With respect to development, we can clearly understand, on the principle of variation supervening at a rather late embryonic period, and being inherited at a corresponding period, how it is that the embryos of wonderfully different forms should still retain, more or less perfectly, the structure of their common progenitor. No other explanation has ever been given of the marvelous fact that the embryos of a man, dog, seal, bat, reptile, etc., can at first hardly be distinguished from each other. In order to understand the existence of rudimentary organs, we have only to suppose that a former progenitor possessed the parts in question in a perfect state, and that under changed habits of life they became greatly reduced, either from simple disuse, or through the natural selection of those individuals which were least encumbered with a superfluous part, aided by the other means previously indicated.

Thus we can understand how it has come to pass that man and all other vertebrate animals have been constructed on the same general model, why they pass through the same early stages

[16] Prof. Bianconi, in a recently published work, illustrated by admirable engravings ("La Théorie Darwinienne et la création dite indépendante," 1874), endeavors to show that homological structures, in the above and other cases, can be fully explained on mechanical principles, in accordance with their uses. No one has shown so well, how admirably such structures are adapted for their final purpose; and this adaptation can, as I believe, be explained through natural selection. In considering the wing of a bat, he brings forward (p. 218) what appears to me (to use Auguste Comte's words) a mere metaphysical principle, namely, the preservation "in its integrity of the mammalian nature of the animal." In only a few cases does he discuss rudiments, and then only those parts which are partially rudimentary, such as the little hoofs of the pig and ox, which do not touch the ground; these he shows clearly to be of service to the animal. It is unfortunate that he did not consider such cases as the minute teeth, which never cut through the jaw in the ox, or the mammæ of male quadrupeds, or the wings of certain beetles, existing under the soldered wing-covers, or the vestiges of the pistil and stamens in various flowers, and many other such cases. Although I greatly admire Prof. Bianconi's work, yet the belief now held by most naturalists seems to me left unshaken, that homological structures are inexplicable on the principle of mere adaptation.

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of development, and why they retain certain rudiments in common. Consequently we ought frankly to admit their community of descent; to take any other view, is to admit that our own structure, and that of all the animals around us, is a mere snare laid to entrap our judgment. This conclusion is greatly strengthened, if we look to the members of the whole animal series, and consider the evidence derived from their affinities or classification, their geographical distribution and geological succession. It is only our natural prejudice, and that arrogance which made our forefathers declare that they were descended from demigods, which leads us to demur to this conclusion. But the time will before long come, when it will be thought wonderful that naturalists, who were well acquainted with the comparative structure and development of man, and other mammals, should have believed that each was the work of a separate act of creation.

CHAPTER II.

ON THE MANNER OF DEVELOPMENT OF MAN FROM SOME LOWER FORM.

Variability of body and mind in man — Inheritance — Causes of variability — Laws of variation the same in man as in the lower animals — Direct action of the conditions of life — Effects of the increased use and disuse of parts — Arrested development — Reversion — Correlated variation — Rate of increase — Checks to increase — Natural selection — Man the most dominant animal in the world — Importance of his corporeal structure — The causes which have led to his becoming erect — Consequent changes of structure — Decrease in size of the canine teeth — Increased size and altered shape of the skull — Nakedness — Absence of a tail — Defenseless condition of man.

IT is manifest that man is now subject to much variability. No two individuals of the same race are quite alike. We may compare millions of faces, and each will be distinct. There is an equally great amount of diversity in the proportions and dimensions of the various parts of the body; the length of the legs being one of the most variable points.[1] Although in

[1] "Investigations in Military and Anthropolog. Statistics of American Soldiers," by B. A. Gould, 1869, p. 256.

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some quarters of the world an elongated skull, and in other quarters a short skull prevails, yet there is great diversity of shape even within the limits of the same race, as with the aborigines of America and South Australia — the latter a race "probably as pure and homogeneous in blood, customs, and language as any in existence"— and even with the inhabitants of so confined an area as the Sandwich Islands. An eminent dentist assures me that there is nearly as much diversity in the teeth as in the features. The chief arteries so frequently run in abnormal courses, that it has been found useful for surgical purposes to calculate from 1040 corpses how often each course prevails. The muscles are eminently variable: thus those of the foot were found by Prof. Turner not to be strictly alike in any two out of fifty bodies; and in some the deviations were considerable. He adds, that the power of performing the appropriate movements must have been modified in accordance with the several deviations. Mr. J. Wood has recorded the occurrence of 295 muscular variations in thirty-six subjects, and in another set of the same number no less than 558 variations, those occurring on both sides of the body being only reckoned as one. In the last set, not one body out of the thirty-six was "found totally wanting in departures from the standard descriptions of the muscular system given in anatomical text books." A single body presented the extraordinary number of twenty-five distinct abnormalities. The same muscle sometimes varies in many ways: thus Prof. Macalister describes no less than twenty distinct variations in the *palmaris accessorius.*

The famous old anatomist, Wolff, insists that the internal viscera are more variable than the external parts: *Nulla particula est quæ non aliter et aliter in aliis se habeat hominibus.* He has even written a treatise on the choice of typical examples of the viscera for representation. A discussion on the beau-ideal of the liver, lungs, kidneys, &c., as of the human face divine, sounds strange in our ears.

The variability or diversity of the mental faculties in men of the same race, not to mention the greater differences between the men of distinct races, is so notorious that not a word need here be said. So it is with the lower animals. All who have had charge of menageries admit this fact, and we see it plainly in our dogs and other domestic animals. Brehm especially insists

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that each individual monkey of those which he kept tame in Africa had its own peculiar disposition and temper: he mentions one baboon remarkable for its high intelligence; and the keepers in the Zoological Gardens pointed out to me a monkey, belonging to the New World division, equally remarkable for intelligence. Rengger, also, insists on the diversity in the various mental characters of the monkeys of the same species which he kept in Paraguay; and this diversity, as he adds, is partly innate, and partly the result of the manner in which they have been treated or educated.

I have elsewhere so fully discussed the subject of Inheritance, that I need here add hardly anything. A greater number of facts have been collected with respect to the transmission of the most trifling, as well as of the most important characters in man, than in any of the lower animals; though the facts are copious enough with respect to the latter. So in regard to mental qualities, their transmission is manifest in our dogs, horses, and other domestic animals. Besides special tastes and habits, general intelligence, courage, bad and good temper, etc., are certainly transmitted. With man we see similar facts in almost every family; and we now know, through the admirable labors of Mr. Galton,[2] that genius, which implies a wonderfully complex combination of high faculties, tends to be inherited; and, on the other hand, it is too certain that insanity and deteriorated mental powers likewise run in families.

With respect to the causes of variability, we are in all cases very ignorant; but we can see that in man as in the lower animals, they stand in some relation to the conditions to which each species has been exposed, during several generations. Domesticated animals vary more than those in a state of nature; and this is apparently due to the diversified and changing nature of the conditions to which they have been subjected. In this respect the different races of man resemble domesticated animals, and so do the individuals of the same race, when inhabiting a very wide area, like that of America. We see the influence of diversified conditions in the more civilized nations; for the members belonging to different grades of rank, and following different occupations, present a greater range of character than do the members of barbarous nations. But the uniformity of savages has

[2] "Hereditary Genius: an Inquiry into its Laws and Consequences."

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often been exaggerated, and in some cases can hardly be said to exist.[3] It is, nevertheless, an error to speak of man, even if we look only to the conditions to which he has been exposed, as "far more domesticated" than any other animal. Some savage races, such as the Australians, are not exposed to more diversified conditions than are many species which have a wide range. In another and much more important respect, man differs widely from any strictly domesticated animal; for his breeding has never long been controlled, either by methodical or unconscious selection. No race or body of men has been so completely subjugated by other men, as that certain individuals should be preserved, and thus unconsciously selected, from somehow excelling in utility to their masters. Nor have certain male and female individuals been intentionally picked out and matched, except in the well-known case of the Prussian grenadiers; and in this case man obeyed, as might have been expected, the law of methodical selection; for it is asserted that many tall men were reared in the villages inhabited by the grenadiers and their tall wives. In Sparta, also, a form of selection was followed, for it was enacted that all children should be examined shortly after birth; the well-formed and vigorous being preserved, the others left to perish.[4]

[3] Mr. Bates remarks ("The Naturalist on the Amazons," 1863, vol. ii. p. 159), with respect to the Indians of the same South American tribe, "no two of them were at all similar in the shape of the head; one man had an oval visage with fine features, and another was quite Mongolian in breadth and prominence of cheek, spread of nostrils, and obliquity of eyes."

[4] Mitford's "History of Greece," vol. i. p. 282. It appears also from a passage in Xenophon's "Memorabilia," B. ii. 4 (to which my attention has been called by the Rev. J. N. Hoare), that it was a well recognized principle with the Greeks, that men ought to select their wives with a view to the health and vigor of their children. The Grecian poet, Theognis, who lived 550 B. C., clearly saw how important selection, if carefully applied, would be for the improvement of mankind. He saw, likewise, that wealth often checks the proper action of sexual selection. He thus writes:

"With kine and horses, Kurnus! we proceed
By reasonable rules, and choose a breed
For profit and increase, at any price;
Of a sound stock, without defect or vice.
But, in the daily matches that we make,
The price is everything: for money's sake,
Men marry: women are in marriage given
The churl or ruffian, that in wealth has thriven,
May match his offspring with the proudest race:
Thus everything is mix'd, noble and base!

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If we consider all the races of man as forming a single species, his range is enormous; but some separate races, as the Americans and Polynesians, have very wide ranges. It is a well-known law that widely-ranging species are much more variable than species with restricted ranges; and the variability of man may with more truth be compared with that of widely-ranging species, than with that of domesticated animals.

Not only does variability appear to be induced in man and the lower animals by the same general causes, but in both the same parts of the body are affected in a closely analogous manner. This has been proved in such full detail by Gondron and Quatrefages, that I need here only refer to their works. Monstrosities, which graduate into slight variations, are likewise so similar in man and the lower animals, that the same classification and the same terms can be used for both, as has been shown by Isidore Geoffroy St.-Hilaire. In my work on the variation of domestic animals, I have attempted to arrange in a rude fashion the laws of variation under the following heads:— The direct and definite action of changed conditions, as exhibited by all or nearly all the individuals of the same species, varying in the same manner under the same circumstances. The effects of the long-continued use or disuse of parts. The cohesion of homologous parts. The variability of multiple parts. Compensation of growth; but of this law I have found no good instance in the case of man. The effects of the mechanical pressure of one part on another; as of the pelvis on the cranium of the infant in the womb. Arrests of development, leading to the diminution or suppression of parts. The reappearance of long-lost characters through reversion. And lastly, correlated variation. All these so-called laws apply equally to man and the lower animals; and most of them even to plants. It would be superfluous here to discuss all of them;[5] but several are so important, that they must be treated at considerable length.

> If then in outward manner, form, and mind,
> You find us a degraded, motley kind,
> Wonder no more, my friend! the cause is plain,
> And to lament the consequence is vain."
> (The works of J. Hookham Frere, vol. ii. 1872, p. 334.)

[5] I have fully discussed these laws in my "Variation of Animals and Plants under Domestication," vol. ii. chap. xxii. and xxiii. M. J. P. Durand has published a valuable essay "De l'Influence des Milieux," etc. He lays much stress, in the case of plants, on the nature of the soil.

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The Direct and Definite Action of Changed Conditions.—this is a most perplexing subject. It cannot be denied that changed conditions produce some, and occasionally a considerable effect, on organisms of all kinds; and it seems at first probable that if sufficient time were allowed this would be the invariable result. But I have failed to obtain clear evidence in favor of this conclusion; and valid reasons may be urged on the other side, at least as far as the innumerable structures are concerned, which are adapted for special ends. There can, however, be no doubt that changed conditions induce an almost indefinite amount of fluctuating variability, by which the whole organization is rendered in some degree plastic.

In the United States, above 1,000,000 soldiers, who served in the late war, were measured, and the States in which they were born and reared were recorded. From this astonishing number of observations it is proved that local influences of some kind act directly on stature; and we further learn that "the States where the physical growth has in great measure taken place, and the State of birth, which indicates the ancestry, seem to exert a marked influence on the stature." For instance, it is established, "that residence in the Western States, during the years of growth, tends to produce increase of stature." On the other hand, it is certain that with sailors, their life delays growth, as shown "by the great difference between the statures of soldiers and sailors at the ages of seventeen and eighteen years." Mr. B. A. Gould endeavored to ascertain the nature of the influences which thus act on stature; but he arrived only at negative results, namely, that they did not relate to climate, the elevation of the land, soil, nor even "in any controlling degree" to the abundance or the need of the comforts of life. This latter conclusion is directly opposed to that arrived at by Villermé, from the statistics of the height of the conscripts in different parts of France. When we compare the differences in stature between the Polynesian chiefs and the lower orders within the same islands, or between the inhabitants of the fertile volcanic and low barren coral islands of the same ocean,[6] or again between

[6] For the Polynesians, see Prichard's "Physical Hist. of Mankind," vol. v. p. 145, 283. Also Godron, "De l'Espèce," tom. ii. p. 289. There is also a remarkable difference in appearance between the closely allied Hindoos inhabiting the Upper Ganges and Bengal; see Elphinstone's "History of India," vol. i. p. 324.

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the Fuegians on the eastern and western shores of their country, where the means of subsistence are very different, it is scarcely possible to avoid the conclusion that better food and greater comfort do influence stature. But the preceding statements show how difficult it is to arrive at any precise result. Dr. Beddoe has lately proved that, with the inhabitants of Britain, residence in towns and certain occupations have a deteriorating influence on height; and he infers that the result is to a certain extent inherited, as is likewise the case in the United States. Dr. Beddoe further believes that wherever a "race attains its maximum of physical development, it rises highest in energy and moral vigor."

Whether external conditions produce any other direct effect on man is not known. It might have been expected that differences of climate would have had a marked influence, inasmuch as the lungs and kidneys are brought into activity under a low temperature, and the liver and skin under a high one. It was formerly thought that the color of the skin and the character of the hair were determined by light or heat; and although it can hardly be denied that some effect is thus produced, almost all observers now agree that the effect has been very small, even after exposure during many ages. But this subject will be more properly discussed when we treat of the different races of mankind. With our domestic animals there are grounds for believing that cold and damp directly affect the growth of the hair; but I have not met with any evidence on this head in the case of man.

Effects of the increased Use and Disuse of Parts.— It is well known that use strengthens the muscles in the individual, and complete disuse, or the destruction of the proper nerve, weakens them. When the eye is destroyed, the optic nerve often becomes atrophied. When an artery is tied, the lateral channels increase not only in diameter, but in the thickness and strength of their coats. When one kidney ceases to act from disease, the other increases in size, and does double work. Bones increase not only in thickness, but in length, from carrying a greater weight. Different occupations, habitually followed, lead to changed proportions in various parts of the body. Thus it was ascertained by the United States Commission that the legs of the sailors employed in the late war were longer by 0.217 of an inch than those of the

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soldiers, though the sailors were on an average shorter men; whilst their arms were shorter by 1.09 of an inch, and therefore, out of proportion, shorter in relation to their lesser height. This shortness of the arms is apparently due to their greater use, and is an unexpected result: but sailors chiefly use their arms in pulling, and not in supporting weights. With sailors, the girth of the neck and the depth of the instep are greater, whilst the circumference of the chest, waist, and hips is less, than in soldiers.

Whether the several foregoing modifications would become hereditary, if the same habits of life were followed during many generations, is not known, but it is probable. Rengger attributes the thin legs and thick arms of the Payaguas Indians to successive generations having passed nearly their whole lives in canoes, with their lower extremities motionless. Other writers have come to a similar conclusion in analogous cases. According to Cranz, who lived for a long time with the Esquimaux, "the natives believe that ingenuity and dexterity in seal-catching (their highest art and virtue) is hereditary; there is really something in it, for the son of a celebrated seal-catcher will distinguish himself, though he lost his father in childhood." But in this case it is mental aptitude, quite as much as bodily structure, which appears to be inherited. It is asserted that the hands of English laborers are at birth larger than those of the gentry. From the correlation which exists, at least in some cases, between the development of the extremities and of the jaws, it is possible that in those classes which do not labor much with their hands and feet, the jaws would be reduced in size from this cause. That they are generally smaller in refined and civilized men than in hard-working men or savages, is certain. But with savages, as Mr. Herbert Spencer has remarked, the greater use of the jaws in chewing coarse, uncooked food, would act in a direct manner on the masticatory muscles, and on the bones to which they are attached. In infants, long before birth, the skin on the soles of the feet is thicker than on any other part of the body; and it can hardly be doubted that this is due to the inherited effects of pressure during a long series of generations.

It is familiar to every one that watchmakers and engravers are liable to be short-sighted, whilst men living much out of doors,

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and especially savages, are generally long-sighted.[7] Short-sight and long-sight certainly tend to be inherited. The inferiority of Europeans, in comparison with savages, in eyesight and in the other senses, is no doubt the accumulated and transmitted effect of lessened use during many generations; for Rengger[8] states that he has repeatedly observed Europeans, who had been brought up and spent their whole lives with the wild Indians, who nevertheless did not equal them in the sharpness of their senses. The same naturalist observes that the cavities in the skull for the reception of the several sense-organs are larger in the American aborigines than in Europeans; and this probably indicates a corresponding difference in the dimensions of the organs themselves. Blumenbach has also remarked on the large size of the nasal cavities in the skulls of the American aborigines, and connects this fact with their remarkably acute power of smell. The Mongolians of the plains of Northern Asia, according to Pallas, have wonderfully perfect senses; and Prichard believes that the great breadth of their skulls across the zygomas follows from their highly-developed sense-organs.

The Quechua Indians inhabit the lofty plateaus of Peru; and Alcide d'Orbigny states that, from continually breathing a highly rarefied atmosphere, they have acquired chests and lungs of extraordinary dimensions. The cells, also, of the lungs are larger and more numerous than in Europeans. These observations have been doubted; but Mr. D. Forbes carefully measured many Aymaras, an allied race, living at the height of between 10,000 and 15,000 feet; and he informs me that they differ conspicuously from the men of all other races seen by him in the circumference and length of their bodies. In his table of measurements, the stature of each man is taken at 1000, and the other measurements are reduced to this standard. It is here seen that the extended arms of the Aymaras are shorter than those of Europeans,

[7] It is a singular and unexpected fact that sailors are inferior to landsmen in their mean distance of distinct vision. Dr. B. A. Gould ("Sanitary Memoirs of the War of the Rebellion," 1869, p. 530), has proved this to be the case; and he accounts for it by the ordinary range of vision in sailors being "restricted to the length of the vessel and the height of the masts."

[8] "Säugethiere von Paraguay," s. 8, 10. I have had good opportunities for observing the extraordinary power of eyesight in the Fuegians. See also Lawrence ("Lectures on Physiology," etc., 1822, p. 404) on this same subject. Mr. Giraud-Teulon has recently collected ("Revue des Cours Scientifiques," 1870, p. 625) a large and valuable body of evidence proving that the cause of short-sight, "*C'est le travail assidu, de près.*"

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and much shorter than those of Negroes. The legs are likewise shorter; and they present this remarkable peculiarity, that in every Aymara measured, the femur is actually shorter than the tibia. On an average, the length of the femur to that of the tibia is as 211 to 252; whilst in two Europeans, measured at the same time, the femora to the tibiæ were as 244 to 230; and in three Negroes as 258 to 241. The humerus is likewise shorter relatively to the forearm. This shortening of that part of the limb which is nearest to the body, appears to be, as suggested to me by Mr. Forbes, a case of compensation in relation with the greatly increased length of the trunk. The Aymaras present some other singular points of structure, for instance, the very small projection of the heel.

These men are so thoroughly acclimatized to their cold and lofty abode, that when formerly carried down by the Spaniards to the low eastern plains, and when now tempted down by high wages to the gold-washings, they suffer a frightful rate of mortality. Nevertheless Mr. Forbes found a few pure families which had survived during two generations: and he observed that they still inherited their characteristic peculiarities. But it was manifest, even without measurement, that these peculiarities had all decreased; and on measurement, their bodies were found not to be so much elongated as those of the men on the high plateau; whilst their femora had become somewhat lengthened, as had their tibiæ, although in a less degree. The actual measurements may be seen by consulting Mr. Forbes's memoir. From these observations, there can, I think, be no doubt that residence during many generations at a great elevation tends, both directly and indirectly, to induce inherited modifications in the proportions of the body.[9]

Although man may not have been much modified during the latter stages of his existence through the increased or decreased use of parts, the facts now given show that his liability in this respect has not been lost; and we positively know that the same law holds good with the lower animals. Consequently we may infer that when at a remote epoch the progenitors of man were in a transitional state, and were changing from quadrupeds into bi-

[9] Dr. Wilckens ("Landwirthschaft. Wochenblatt," No. 10, 1869) has lately published an interesting Essay showing how domestic animals, which live in mountainous regions, have their frames modified.

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peds, natural selection would probably have been greatly aided by the inherited effects of the increased or diminished use of the different parts of the body.

Arrests of Development.— There is a difference between arrested development and arrested growth, for parts in the former state continue to grow whilst still retaining their early condition. Various monstrosities come under this head; and some, as a cleft-palate, are known to be occasionally inherited. It will suffice for our purpose to refer to the arrested brain-development of microcephalous idiots, as described in Vogt's memoir. Their skulls are smaller, and the convolutions of the brain are less complex than in normal men. The frontal sinus, or the projection over the eyebrows, is largely developed, and the jaws are prognathous to an "*effrayant*" degree; so that these idiots somewhat resemble the lower types of mankind. Their intelligence, and most of their mental faculties, are extremely feeble. They cannot acquire the power of speech, and are wholly incapable of prolonged attention, but are much given to imitation. They are strong and remarkably active, continually gamboling and jumping about, and making grimaces. They often ascend stairs on all-fours; and are curiously fond of climbing up furniture or trees. We are thus reminded of the delight shown by almost all boys in climbing trees; and this again reminds us how lambs and kids, originally alpine animals, delight to frisk on any hillock, however small. Idiots also resemble the lower animals in some other respects; thus several cases are recorded of their carefully smelling every mouthful of food before eating it. One idiot is described as often using his mouth in aid of his hands whilst hunting for lice. They are often filthy in their habits, and have no sense of decency; and several cases have been published of their bodies being remarkably hairy.[10]

Reversion.— Many of the cases to be here given, might have been introduced under the last heading. When a structure is arrested in its development, but still continues growing, until it

[10] Prof. Laycock sums up the character of brute-like idiots by calling them *theroid;* "Journal of Mental Science," July, 1863. Dr. Scott ("The Deaf and Dumb," 2nd edit., 1870, p. 10) has often observed the imbecile smelling their food. See, on this same subject, and on the hairiness of idiots, Dr. Maudsley, "Body and Mind," pp. 46–51. Pinel has also given a striking case of hairiness in an idiot.

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closely resembles a corresponding structure in some lower and adult member of the same group, it may in one sense be considered as a case of reversion. The lower members in a group give us some idea how the common progenitor was probably constructed; and it is hardly credible that a complex part, arrested at an early phase of embryonic development, should go on growing so as ultimately to perform its proper function, unless it had acquired such power during some earlier state of existence, when the present exceptional or arrested structure was normal. The simple brain of a microcephalous idiot, in as far as it resembles that of an ape, may in this sense be said to offer a case of reversion.[11] There are other cases which come more strictly under our

[11] In my "Variation of Animals under Domestication" (vol. ii. p. 57), I attributed the not very rare cases of supernumerary mammæ in women to reversion. I was led to this as a probable conclusion, by the additional mammæ being generally placed symmetrically on the breast; and more especially from one case, in which a single efficient mamma occurred in the inguinal region of a woman, the daughter of another woman with supernumerary mammæ. But I now find that *mammæ erraticæ* occur in other situations, as on the back, in the armpit, and on the thigh; the mammæ in this latter instance having given so much milk that the child was thus nourished. The probability that the additional mammæ are due to reversion is thus much weakened; nevertheless, it still seems to me probable, because two pairs are often found symmetrically on the breast; and of this I myself received information in several cases. It is well known that some Lemurs normally have two pairs of mammæ on the breast. Five cases have been recorded of the presence of more than a pair of mammæ (of course rudimentary) in the male sex of mankind; see "Journal of Anat. and Physiology," 1872, p. 56, for a case given by Dr. Handyside, in which two brothers exhibited this peculiarity; see also a paper by Dr. Bartels, in "Reichert's and du Bois-Reymond's Archiv.," 1872, p. 304. In one of the cases alluded to by Dr. Bartels, a man bore five mammæ, one being medial and placed above the navel; Meckel von Hemsbach thinks that this latter case is illustrated by a medial mamma occurring in certain Cheiroptera. On the whole, we may well doubt if additional mammæ would ever have been developed in both sexes of mankind, had not his early progenitors been provided with more than a single pair.

In the above work (vol. ii. p. 12), I also attributed, though with much hesitation, the frequent cases of polydactylism in men and various animals to reversion. I was partly led to this through Prof. Owen's statement, that some of the Ichthyopterygia possess more than five digits, and therefore, as I supposed, had retained a primordial condition; but Prof. Gegenbaur ("Jenaischen Zeitschrift," B. v. Heft 3, s. 341), disputes Owen's conclusion. On the other hand, according to the opinion lately advanced by Dr. Günther, on the paddle of Ceratodus, which is provided with articulated bony rays on both sides of a central chain of bones, there seems no great difficulty in admitting that six or more digits on one side, or on both sides, might reappear through reversion. I am informed by Dr. Zouteveen that there is a case on record of a man having twenty-four fingers and twenty-four toes! I was chiefly led to the conclusion that the presence of supernumerary digits might be due to reversion from the fact that such digits, not only are strongly inherited, but, as I then believed, had the power of regrowth after amputation, like the normal digits of the lower vertebrata. But I have explained in the

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present head of reversion. Certain structures, regularly occurring in the lower members of the group to which man belongs, occasionally make their appearance in him, though not found in the normal human embryo; or, if normally present in the human embryo, they become abnormally developed, although in a manner which is normal in the lower members of the group. These remarks will be rendered clearer by the following illustrations.

In various mammals the uterus graduates from a double organ with two distinct orifices and two passages, as in the marsupials, into a single organ, which is in no way double except from having a slight internal fold, as in the higher apes and man. The rodents exhibit a perfect series of gradations between these two extreme states. In all mammals the uterus is developed from two simple primitive tubes, the inferior portions of which form the cornua; and it is in the words of Dr. Farre, "by the coalescence of the two cornua at their lower extremities that the body of the uterus is formed in man; while in those animals in which no middle portion or body exists, the cornua remain ununited. As the development of the uterus proceeds, the two cornua become gradually shorter, until at length they are lost, or, as it were, absorbed into the body of the uterus." The angles of the uterus are still produced into cornua, even in animals as high up in the scale as the lower apes and lemurs.

Now in women, anomalous cases are not very infrequent, in which the mature uterus is furnished with cornua, or is partially divided into two organs; and such cases, according to Owen, repeat "the grade of concentrative development," attained by certain rodents. Here perhaps we have an instance of a simple arrest of embryonic development, with subsequent growth and perfect functional development; for either side of the partially double uterus is capable of performing the proper office of gestation. In other and rarer cases, two distinct uterine cavities are formed, each having its proper orifice and passage. No such

Second Edition of my Variation under Domestication why I now place little reliance on the recorded cases of such regrowth. Nevertheless it deserves notice, inasmuch as arrested development and reversion are intimately related processes; that various structures in an embryonic or arrested condition, such as a cleft palate, bifid uterus, etc., are frequently accompanied by polydactylism. This has been strongly insisted on by Meckel and Isidore Geoffroy St.-Hilaire. But at present it is the safest course to give up altogether the idea that there is any relation between the development of supernumerary digits and reversion to some lowly organized progenitor of man.

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stage is passed through during the ordinary development of the embryo; and it is difficult to believe, though perhaps not impossible, that the two simple, minute, primitive tubes should know how (if such an expression may be used) to grow into two distinct uteri, each with a well-constructed orifice and passage, and each furnished with numerous muscles, nerves, glands and vessels, if they had not formerly passed through a similar course of development, as in the case of existing marsupials. No one will pretend that so perfect a structure as the abnormal double uterus in woman could be the result of mere chance. But the principle of reversion, by which a long-lost structure is called back into existence, might serve as the guide for its full development, even after the lapse of an enormous interval of time.

Professor Canestrini, after discussing the foregoing and various analogous cases, arrives at the same conclusion as that just given. He adduces another instance, in the case of the malar bone,[12] which, in some of the Quadrumana and other mammals, normally consists of two portions. This is its condition in the human fœtus when two months old; and through arrested development, it sometimes remains thus in man when adult, more especially in the lower prognathous races. Hence Canestrini concludes that some ancient progenitor of man must have had this bone normally divided into two portions, which afterwards became fused together. In man the frontal bone consists of a single piece, but in the embryo, and in children, and in almost all the lower mammals, it consists of two pieces separated by a distinct suture. This suture occasionally persists more or less distinctly in man after maturity; and more frequently in ancient than in recent crania, especially, as Canestrini has observed, in those ex-

[12] "Annuario della Soc. dei Naturalisti in Modena," 1867, p. 83. Prof. Canestrini gives extracts on this subject from various authorities. Laurillard remarks, that as he has found a complete similarity in the form, proportions, and connection of the two malar bones in several human subjects and in certain apes, he cannot consider this disposition of the parts as simply accidental. Another paper on this same anomaly has been published by Dr. Saviotti in the "Gazetta delle Cliniche," Turin, 1871, where he says that traces of the division may be detected in about two per cent. of adult skulls; he also remarks that it more frequently occurs in prognathous skulls, not of the Aryan race, than in others. See also G. Delorenzi on the same subject; "Tre nuovi casi d'anomalia dell' osso malare," Torino, 1872. Also, E. Morselli, "Sopra una rara anomalia dell' osso malare," Modena, 1872. Still more recently Gruber has written a pamphlet on the division of this bone. I give these references because a reviewer, without any grounds or scruples, has thrown doubts on my statements.

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humed from the Drift, and belonging to the brachycephalic type. Here again he comes to the same conclusion as in the analogous case of the malar bones. In this, and other instances presently to be given, the cause of ancient races approaching the lower animals in certain characters more frequently than do the modern races, appears to be, that the latter stand at a somewhat greater distance in the long line of descent from their early semi-human progenitors.

Various other anomalies in man, more or less analogous to the foregoing, have been advanced by different authors, as cases of reversion; but these seem not a little doubtful, for we have to descend extremely low in the mammalian series, before we find such structures normally present.[13]

In man, the canine teeth are perfectly efficient instruments for mastication. But their true canine character, as Owen remarks, "is indicated by the conical form of the crown, which terminates in an obtuse point, is convex outward and flat or subconcave within, at the base of which surface there is a feeble prominence. The conical form is best expressed in the Melanian races, especially the Australian. The canine is more deeply implanted, and by a stronger fang than the incisors." Nevertheless, this tooth no longer serves man as a special weapon for tearing his enemies or prey; it may, therefore, as far as its proper function is concerned, be considered as rudimentary. In every large collection of human skulls some may be found, as Häckel observes, with the canine teeth projecting considerably beyond the others in the same manner as in the anthropomorphous apes, but in a less degree. In these cases, open spaces between the teeth in the one jaw are left for the reception of the canines of the opposite jaw. An interspace of this kind in a Kaffir skull, figured by Wagner, is surprisingly wide. Considering how few are the an-

[13] A whole series of cases is given by Isid. Geoffroy St. Hilaire, "Hist. des Anomalies," tom. iii. p. 437. A reviewer ("Journal of Anat. and Physiology," 1871, p. 366) blames me much for not having discussed the numerous cases, which have been recorded, of various parts arrested in their development. He says that, according to my theory, "every transient condition of an organ, during its development, is not only a means to an end, but once was an end in itself." This does not seem to me necessarily to hold good. Why should not variations occur during an early period of development, having no relation to reversion; yet such variations might be preserved and accumulated, if in any way serviceable, for instance, in shortening and simplifying the course of development? And again, why should not injurious abnormalities, such as atrophied or hypertrophied parts, which have no relation to a former state of existence, occur at an early period, as well as during maturity?

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cient skulls which have been examined, compared to recent skulls, it is an interesting fact that in at least three cases the canines project largely; and in the Naulette jaw they are spoken of as enormous.

Of the anthropomorphous apes the males alone have their canines fully developed; but in the female gorilla, and in a less degree in the female orang, these teeth project considerably beyond the others; therefore the fact, of which I have been assured, that women sometimes have considerably projecting canines, is no serious objection to the belief that their occasional great development in man is a case of reversion to an ape-like progenitor. He who rejects with scorn the belief that the shape of his own canines, and their occasional great development in other men, are due to our early forefathers having been provided with these formidable weapons, will probably reveal, by sneering, the line of his descent. For though he no longer intends, nor has the power, to use these teeth as weapons, he will unconsciously retract his "snarling muscles" (thus named by Sir C. Bell), so as to expose them ready for action, like a dog prepared to fight.

Many muscles are occasionally developed in man, which are proper to the Quadrumana or other mammals. Professor Vlacovich examined forty male subjects, and found a muscle, called by him the ischio-pubic, in nineteen of them; in three others there was a ligament which represented this muscle; and in the remaining eighteen no trace of it. In only two out of thirty female subjects was this muscle developed on both sides, but in three others the rudimentary ligament was present. This muscle, therefore, appears to be much more common in the male than in the female sex; and on the belief in the descent of man from some lower form, the fact is intelligible; for it has been detected in several of the lower animals, and in all of these it serves exclusively to aid the male in the act of reproduction.

Mr. J. Wood, in his valuable series of papers,[14] has minutely

[14] These papers deserve careful study by any one who desires to learn how frequently our muscles vary, and in varying come to resemble those of the Quadrumana. The following references relate to the few points touched on in my text: "Proc. Royal Soc." vol. xiv. pp. 379–384; vol. xv., pp. 241, 242; vol. xv., p. 544; vol. xvi., p. 524. I may here add that Dr. Murie and Mr. St. George Mivart have shown in their Memoir on the Lemuroidea ("Transact. Zoolog. Soc." vol. vii., p. 96), how extraordinarily variable some of the muscles are in these animals, the lowest members of the Primates. Gradations, also, in the muscles leading to structures found in animals still lower in the scale, are numerous in the Lemuroidea.

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described a vast number of muscular variations in man, which resemble normal structures in the lower animals. The muscles which closely resemble those regularly present in our nearest allies, the Quadrumana, are too numerous to be here even specified. In a single male subject, having a strong bodily frame, and well-formed skull, no less than seven muscular variations were observed, all of which plainly represented muscles proper to various kinds of apes. This man, for instance, had on both sides of his neck a true and powerful "*levator claviculæ*," such as is found in all kinds of apes, and which is said to occur in about one out of sixty human subjects. Again, this man had "a special abductor of the metatarsal bone of the fifth digit, such as Professor Huxley and Mr. Flower have shown to exist uniformly in the higher and lower apes." I will give only two additional cases; the *acromio-basilar* muscle is found in all mammals below man, and seems to be correlated with a quadrupedal gait, and it occurs in about one out of sixty human subjects. In the lower extremities Mr. Bradley found an *abductor ossis metatarsi quinti* in both feet of man; this muscle had not up to that time been recorded in mankind, but is always present in the anthropomorphous apes. The muscles of the hands and arms — parts which are so eminently characteristic of man — are extremely liable to vary, so as to resemble the corresponding muscles in the lower animals.[15] Such resemblances are either perfect or imperfect; yet in the latter case they are manifestly of a transitional nature. Certain variations are more common in man, and others in woman, without our being able to assign any reason. Mr. Wood, after describing numerous variations, makes the following pregnant remark: "Notable departures from the ordinary type of the muscular structures run in grooves or directions, which must be taken to indicate some unknown factor, of much importance to a comprehensive knowledge of general and scientific anatomy." [16]

[15] Prof. Macalister has tabulated his observations, and finds that muscular abnormalities are most frequent in the fore-arms, secondly, in the face, thirdly, in the foot, etc.

[16] The Rev. Dr. Haughton, after giving ("Proc. R. Irish Academy," June 27, 1864, p. 715) a remarkable case of variation in the human *flexor pollicis longus*, adds, "This remarkable example shows that man may sometimes possess the arrangement of tendons of thumb and fingers characteristic of the macaque; but whether such a case should be regarded as a macaque passing upwards into a man, or a man passing downwards

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That this unknown factor is reversion to a former state of existence may be admitted as in the highest degree probable.[17] It is quite incredible that a man should through mere accident abnormally resemble certain apes in no less than seven of his muscles, if there had been no genetic connection between them. On the other hand, if man is descended from some ape-like creature, no valid reason can be assigned why certain muscles should not suddenly reappear after an interval of many thousand generations, in the same manner as with horses, asses, and mules, dark-colored stripes suddenly reappear on the legs, and shoulders, after an interval of hundreds, or more probably of thousands of generations.

These various cases of reversion are so closely related to those of rudimentary organs given in the first chapter, that many of them might have been indifferently introduced either there or here. Thus a human uterus furnished with cornua may be said to represent, in a rudimentary condition, the same organ in its normal state in certain mammals. Some parts which are rudimentary in man, as the os coccyx in both sexes, and the mammæ in the male sex, are always present; whilst others, such as the supra-condyloid foramen, only occasionally appear, and therefore might have been introduced under the head of reversion. These several reversionary structures, as well as the strictly rudimentary ones, reveal the descent of man from some lower form in an unmistakable manner.

Correlated Variation.— In man, as in the lower animals, many structures are so intimately related, that when one part varies

into a macaque, or as a congenital freak of nature, I cannot undertake to say." It is satisfactory to hear so capable an anatomist, and so embittered an opponent of evolutionism, admitting even the possibility of either of his first propositions. Prof. Macalister has also described ("Proc. R. Irish Acad." vol. x. 1864, p. 138) variations in the *flexor pollicis longus*, remarkable from their relations to the same muscle in the Quadrumana.

[17] Since the first edition of this book appeared, Mr. Wood has published another memoir in the "Phil. Transactions," 1870, p. 83, on the varieties of the muscles of the human neck, shoulder, and chest. He here shows how extremely variable these muscles are, and how often and how closely the variations resemble the normal muscles of the lower animals. He sums up by remarking, "It will be enough for my purpose if I have succeeded in showing the more important forms which, when occurring as varieties in the human subject, tend to exhibit in a sufficiently marked manner what may be considered as proofs and examples of the Darwinian principle of reversion, or law of inheritance, in this department of anatomical science."

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so does another, without our being able, in most cases, to assign any reason. We cannot say whether the one part governs the other, or whether both are governed by some earlier developed part. Various monstrosities, as I. Geoffroy repeatedly insists, are thus intimately connected. Homologous structures are particularly liable to change together, as we see on the opposite sides of the body, and in the upper and lower extremities. Meckel long ago remarked, that when the muscles of the arm depart from their proper type, they almost always imitate those of the leg; and so, conversely, with the muscles of the legs. The organs of sight and hearing, the teeth and hair, the color of the skin and of the hair, color and constitution, are more or less correlated. Professor Schaaffhausen first drew attention to the relation apparently existing between a muscular frame and the strongly-pronounced supra-orbital ridges, which are so characteristic of the lower races of man.

Besides the variations which can be grouped with more or less probability under the foregoing heads, there is a large class of variations which may be provisionally called spontaneous, for to our ignorance they appear to arise without any exciting cause. It can, however, he shown that such variations, whether consisting of slight individual differences, or of strongly-marked and abrupt deviations of structure, depend much more on the constitution of the organism than on the nature of the conditions to which it has been subjected.

Rate of Increase.— Civilized populations have been known under favorable conditions, as in the United States, to double their numbers in twenty-five years; and, according to a calculation, by Euler, this might occur in a little over twelve years. At the former rate, the present population of the United States (thirty millions), would in 657 years cover the whole terraqueous globe so thickly, that four men would have to stand on each square yard of surface. The primary or fundamental check to the continued increase of man is the difficulty of gaining subsistence, and of living in comfort. We may infer that this is the case from what we see, for instance, in the United States, where subsistence is easy, and there is plenty of room. If such means were suddenly doubled in Great Britain, our number would be quickly doubled. With civilized nations this primary check acts

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chiefly by restraining marriages. The greater death-rate of infants in the poorest classes is also very important; as well as the greater mortality, from various diseases, of the inhabitants of crowded and miserable houses, at all ages. The effects of severe epidemics and wars are soon counterbalanced, and more than counterbalanced, in nations placed under favorable conditions. Emigration also comes in aid as a temporary check, but, with the extremely poor classes, not to any great extent.

There is reason to suspect, as Malthus has remarked, that the reproductive power is actually less in barbarous, than in civilized races. We know nothing positively on this head, for with savages no census has been taken; but from the concurrent testimony of missionaries, and of others who have long resided with such people, it appears that their families are usually small, and large ones rare. This may be partly accounted for, as it is believed, by the women suckling their infants during a long time; but it is highly probable that savages, who often suffer much hardship, and who do not obtain so much nutritious food as civilized men, would be actually less prolific. I have shown in a former work, that all our domesticated quadrupeds and birds, and all our cultivated plants, are more fertile than the corresponding species in a state of nature. It is no valid objection to this conclusion that animals suddenly supplied with an excess of food, or when grown very fat; and that most plants on sudden removal from very poor to very rich soil, are rendered more or less sterile. We might, therefore, expect that civilized men, who in one sense are highly domesticated, would be more prolific than wild men. It is also probable that the increased fertility of civilized nations would become, as with our domestic animals, an inherited character: it is at least known that with mankind a tendency to produce twins runs in families.

Notwithstanding that savages appear to be less prolific than civilized people, they would no doubt rapidly increase if their numbers were not by some means rigidly kept down. The Santali, or hill-tribes of India, have recently afforded a good illustration of this fact; for, as shown by Mr. Hunter, they have increased at an extraordinary rate since vaccination has been introduced, other pestilences mitigated, and war sternly repressed. This increase, however, would not have been possible had not these rude people spread into the adjoining districts,

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and worked for hire. Savages almost always marry; yet there is some prudential restraint, for they do not commonly marry at the earliest possible age. The young men are often required to show that they can support a wife; and they generally have first to earn the price with which to purchase her from her parents. With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilized people, for all tribes periodically suffer from severe famines. At such times savages are forced to devour much bad food, and their health can hardly fail to be injured. Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines. They are then, also, compelled to wander much, and, as I was assured in Australia, their infants perish in large numbers. As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food. Savages, when hard pressed, encroach on each other's territories, and war is the result; but they are indeed almost always at war with their neighbors. They are liable to many accidents on land and water in their search for food; and in some countries they suffer much from the larger beasts of prey. Even in India, districts have been depopulated by the ravages of tigers.

Malthus has discussed these several checks, but he does not lay stress enough on what is probably the most important of all, namely infanticide, especially of female infants, and the habit of procuring abortion. These practices now prevail in many quarters of the world; and infanticide seems formerly to have prevailed, as Mr. M'Lennan has shown, on a still more extensive scale. These practices appear to have originated in savages recognizing the difficulty, or rather their impossibility of supporting all the infants that are born. Licentiousness may also be added to the foregoing checks; but this does not follow from failing means of subsistence; though there is reason to believe that in some cases (as in Japan) it has been intentionally encouraged as a means of keeping down the population.

If we look back to an extremely remote epoch, before man had arrived at the dignity of manhood, he would have been guided more by instinct and less by reason than are the lowest savages at the present time. Our early semi-human progenitors

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would not have practised infanticide or polyandry; for the instincts of the lower animals are never so perverted [18] as to lead them regularly to destroy their own offspring, or to be quite devoid of jealousy. There would have been no prudential restraint from marriage, and the sexes would have freely united at an early age. Hence the progenitors of man would have tended to increase rapidly; but checks of some kind, either periodical or constant, must have kept down their numbers, even more severely than with existing savages. What the precise nature of these checks were, we cannot say, any more than with most other animals. We know that horses and cattle, which are not extremely prolific animals, when first turned loose in South America, increased at an enormous rate. The elephant, the slowest breeder of all known animals, would in a few thousand years stock the whole world. The increase of every species of monkey must be checked by some means; but not, as Brehm remarks, by the attacks of beasts of prey. No one will assume that the actual power of reproduction in the wild horses and cattle of America, was at first in any sensible degree increased; or that, as each district became fully stocked, this same power was diminished. No doubt in this case, and in all others, many checks concur, and different checks under different circumstances; periodical dearths, depending on unfavorable seasons, being probably the most important of all. So it will have been with the early progenitors of man.

Natural Selection.— We have now seen that man is variable in body and mind; and that the variations are induced, either directly or indirectly, by the same general causes, and obey the same general laws, as with the lower animals. Man has spread widely over the face of the earth, and must have been exposed, during his incessant migration, to the most diversified conditions.

[18] A writer in the "Spectator" (March 12th, 1871, p. 320) comments as follows on this passage:—"Mr. Darwin finds himself compelled to reintroduce a new doctrine of the fall of man. He shows that the instincts of the higher animals are far nobler than the habits of savage races of men, and he finds himself, therefore, compelled to reintroduce,— in a form of the substantial orthodoxy of which he appears to be quite unconscious,— and to introduce as a scientific hypothesis the doctrine that man's gain of *knowledge* was the cause of a temporary but long-enduring moral deterioration, as indicated by the many foul customs, especially as to marriage, of savage tribes. What does the Jewish tradition of the moral degeneration of man through his snatching at a knowledge forbidden him by his highest instinct assert beyond this?"

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The inhabitants of Tierra del Fuego, the Cape of Good Hope, and Tasmania in the one hemisphere, and of the Arctic regions in the other, must have passed through many climates, and changed their habits many times, before they reached their present homes. The early progenitors of man must also have tended, like all other animals, to have increased beyond their means of subsistence; they must, therefore, occasionally have been exposed to a struggle for existence, and consequently to the rigid law of natural selection. Beneficial variations of all kinds will thus, either occasionally or habitually, have been preserved and injurious ones eliminated. I do not refer to strongly-marked deviations of structure, which occur only at long intervals of time, but to mere individual differences. We know, for instance, that the muscles of our hands and feet, which determine our powers of movement, are liable, like those of the lower animals,[19] to incessant variability. If then the progenitors of man inhabiting any district, especially one undergoing some change in its conditions, were divided into two equal bodies, the one half which included all the individuals best adapted by their powers of movement for gaining subsistence, or for defending themselves, would on an average survive in greater numbers, and procreate more offspring than the other and less well endowed half.

Man in the rudest state in which he now exists is the most dominant animal that has ever appeared on this earth. He has spread more widely than any other highly organized form; and all others have yielded before him. He manifestly owes this immense superiority to his intellectual faculties, to his social habits, which lead him to aid and defend his fellows, and to his corporeal structure. The supreme importance of these characters has been proved by the final arbitrament of the battle for life. Through his powers of intellect, articulate language has been evolved; and on this his wonderful advancement has mainly depended. As Mr. Chauncey Wright remarks: "A psychological analysis of the faculty of language shows, that even the smallest proficiency in it might require more brain power than the greatest proficiency in any other direction." He has invented and

[19] Messrs. Murie and Mivart in their "Anatomy of the Lemuroidea" ("Transact. Zoolog. Soc." vol. vii. 1869, pp. 96–98) say, "some muscles are so irregular in their distribution that they cannot be well classed in any of the above groups." These muscles differ even on the opposite sides of the same individual.

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is able to use various weapons, tools, traps, etc., with which he defends himself, kills or catches prey, and otherwise obtains food. He has made rafts or canoes for fishing or crossing over to neighboring fertile islands. He has discovered the art of making fire, by which hard and stringy roots can be rendered digestible, and poisonous roots or herbs innocuous. This discovery of fire, probably the greatest ever made by man, excepting language, dates from before the dawn of history. These several inventions, by which man in the rudest state has become so pre-eminent, are the direct results of the development of his powers of observation, memory, curiosity, imagination, and reason. I cannot, therefore, understand how it is that Mr. Wallace [20] maintains, that "natural selection could only have endowed the savage with a brain a little superior to that of an ape."

Although the intellectual powers and social habits of man are of paramount importance to him, we must not underrate the importance of his bodily structure, to which subject the remainder of this chapter will be devoted; the development of the intellectual and social or moral faculties being discussed in a later chapter.

Even to hammer with precision is no easy matter, as every one who has tried to learn carpentry will admit. To throw a stone with as true an aim as a Fuegian in defending himself, or in killing birds, requires the most consummate perfection in the correlated action of the muscles of the hand, arm, and shoulder, and, further, a fine sense of touch. In throwing a stone or spear, and in many other actions, a man must stand firmly on his feet; and this again demands the perfect co-adaptation of numerous muscles. To chip a flint into the rudest tool, or to form a barbed spear or hook from a bone, demands the use of a perfect hand; for, as a most capable judge, Mr. Schoolcraft,[21]

[20] The remark quoted in my text will surprise every one who has read Mr. Wallace's celebrated paper on "The Origin of Human Races deduced from the Theory of Natural Selection," originally published in the "Anthropological Review." I cannot here resist quoting a most just remark by Sir J. Lubbock ("Prehistoric Times," p. 479) in reference to this paper, namely, that Mr. Wallace, "with characteristic unselfishness, ascribes it (i. e. the idea of natural selection) unreservedly to Mr. Darwin, although, as is well known, he struck out the idea independently, and published it, though not with the same elaboration, at the same time."

[21] Quoted by Mr. Lawson Tait in his "Law of Natural Selection,"—"Dublin Quarterly Journal of Medical Science." Dr. Keller is likewise quoted to the same effect.

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remarks, the shaping fragments of stone into knives, lances, or arrow-heads, shows "extraordinary ability and long practice." This is to a great extent proved by the fact that primeval men practised a division of labor; each man did not manufacture his own flint tools or rude pottery, but certain individuals appear to have devoted themselves to such work, no doubt receiving in exchange the produce of the chase. Archæologists are convinced that an enormous interval of time elapsed before our ancestors thought of grinding chipped flints into smooth tools. One can hardly doubt, that a man-like animal who possessed a hand and arm sufficiently perfect to throw a stone with precision, or to form a flint into a rude tool, could, with sufficient practice, as far as mechanical skill alone is concerned, make almost anything which a civilized man can make. The structure of the hand in this respect may be compared with that of the vocal organs, which in the apes are used for uttering various signal-cries, or, as in one genus, musical cadences; but in man the closely similar vocal organs have become adapted through the inherited effects of use for the utterance of articulate language.

Turning now to the nearest allies of men, and therefore to the best representatives of our early progenitors, we find that the hands of the Quadrumana are constructed on the same general pattern as our own, but are far less perfectly adapted for diversified uses. Their hands do not serve for locomotion so well as the feet of a dog; as may be seen in such monkeys as the chimpanzee and orang, which walk on the outer margins of the palms, or on the knuckles. Their hands, however, are admirably adapted for climbing trees. Monkeys seize thin branches or ropes, with the thumb on one side and the fingers and palm on the other, in the same manner as we do. They can thus also lift rather large objects, such as the neck of a bottle, to their mouths. Baboons turn over stones, and scratch up roots with their hands. They seize nuts, insects, or other small objects with the thumb in opposition to the fingers, and no doubt they thus extract eggs and the young from the nests of birds. American monkeys beat the wild oranges on the branches until the rind is cracked, and then tear it off with the fingers of the two hands. In a wild state they break open hard fruits with stones. Other monkeys open mussel-shells with the two thumbs. With their fingers they pull out thorns and burs, and hunt for each other's parasites. They

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roll down stones, or throw them at their enemies: nevertheless, they are clumsy in these various actions, and, as I have myself seen, are quite unable to throw a stone with precision.

It seems to me far from true that because "objects are grasped clumsily" by monkeys, "a much less specialized organ of prehension" would have served them equally well with their present hands. On the contrary, I see no reason to doubt that more perfectly constructed hands would have been an advantage to them, provided that they were not thus rendered less fitted for climbing trees. We may suspect that a hand as perfect as that of man would have been disadvantageous for climbing; for the most arboreal monkeys in the world, namely, Ateles in America, Colobus in Africa, and Hylobates in Asia, are either thumbless, or their toes partially cohere, so that their limbs are converted into mere grasping hooks.[22]

As soon as some ancient member in the great series of the Primates came to be less arboreal, owing to a change in its manner of procuring subsistence, or to some change in the surrounding conditions, its habitual manner of progression would have been modified: and thus it would have been rendered more strictly quadrupedal or bipedal. Baboons frequent hilly and rocky districts, and only from necessity climb high trees; and they have acquired almost the gait of a dog. Man alone has become a biped; and we can, I think, partly see how he has come to assume his erect attitude, which forms one of his most conspicuous characters. Man could not have attained his present dominant position in the world without the use of his hands, which are so admirably adapted to act in obedience to his will. Sir C. Bell insists that "the hand supplies all instruments, and by its correspondence with the intellect gives him universal dominion." But the hands and arms could hardly have become perfect enough to have manufactured weapons, or to have hurled stones and spears with a true aim, as long as they were habitually used for locomotion and for supporting the whole weight of the body, or, as before remarked, so long as they were especially fitted for climb-

[22] In *Hylobates syndactylus*, as the name expresses, two of the toes regularly cohere; and this, as Mr. Blyth informs me, is occasionally the case with the toes of *H. agilis*, *lar*, and *leuciscus*. Colobus is strictly arboreal and extraordinarily active (Brehm, "Thierleben," B. i. s. 50), but whether a better climber than the species of the allied genera, I do not know. It deserves notice that the feet of the sloths, the most arboreal animals in the world, are wonderfully hook-like.

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ing trees. Such rough treatment would also have blunted the sense of touch, on which their delicate use largely depends. From these causes alone it would have been an advantage to man to become a biped; but for many actions it is indispensable that the arms and whole upper part of the body should be free; and he must for this end stand firmly on his feet. To gain this great advantage, the feet have been rendered flat; and the great toe has been peculiarly modified, though this has entailed the almost complete loss of its power of prehension. It accords with the principle of the division of physiological labor, prevailing throughout the animal kingdom, that as the hands became perfected for prehension, the feet should have become perfected for support and locomotion. With some savages, however, the foot has not altogether lost its prehensile power, as shown by their manner of climbing trees, and of using them in other ways.[23]

If it be an advantage to man to stand firmly on his feet and to have his hands and arms free, of which, from his pre-eminent success in the battle of life, there can be no doubt, then I can see no reason why it should not have been advantageous to the progenitors of man to have become more and more erect or bipedal. They would thus have been better able to defend themselves with stones or clubs, to attack their prey, or otherwise to obtain food. The best built individuals would in the long run have succeeded best, and have survived in larger numbers. If the gorilla and a few allied forms had become extinct, it might have been argued, with great force and apparent truth, that an animal could not have been gradually converted from a quadruped into a biped, as all the individuals in an intermediate condition would have been miserably ill-fitted for progression. But we know (and this is well worthy of reflection) that the anthropomorphous apes are now actually in an intermediate condition; and no one doubts that they are on the whole well adapted for their conditions of life. Thus the gorilla runs with a sidelong shambling gait, but more commonly progresses by resting on its bent hands. The long-armed apes occasionally use their arms

[23] Häckel has an excellent discussion on the steps by which man became a biped: "Natürliche Schöpfungsgeschichte," 1868, s. 507. Dr. Büchner ("Conférences sur la Théorie Darwinienne," 1869, p. 135) has given good cases of the use of the foot as a prehensile organ by man; and has also written on the manner of progression of the higher apes, to which I allude in the following paragraph: see also Owen ("Anatomy of Vertebrates," vol. iii. p. 71) on this latter subject.

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like crutches, swinging their bodies forward between them, and some kinds of Hylobates, without having been taught, can walk or run upright with tolerable quickness; yet they move awkwardly, and much less securely than man. We see, in short, in existing monkeys a manner of progression intermediate between that of a quadruped and a biped; but, as an unprejudiced judge insists, the anthropomorphous apes approach in structure more nearly to the bipedal than to the quadrupedal type.

As the progenitors of man became more and more erect, with their hands and arms more and more modified for prehension and other purposes, with their feet and legs at the same time transformed for firm support and progression, endless other changes of structure would have become necessary. The pelvis would have to be broadened, the spine peculiarly curved, and the head fixed in an altered position, all which changes have been attained by man. Prof. Schaaffhausen maintains that "the powerful mastoid processes of the human skull are the result of his erect position;" and these processes are absent in the orang, chimpanzee, etc., and are smaller in the gorilla than in man. Various other structures, which appear connected with man's erect position, might here have been added. It is very difficult to decide how far these correlated modifications are the result of natural selection, and how far of the inherited effects of the increased use of certain parts, or of the action of one part on another. No doubt these means of change often co-operate: thus when certain muscles, and the crests of bone to which they are attached, become enlarged by habitual use, this shows that certain actions are habitually performed and must be serviceable. Hence the individuals which performed them best, would tend to survive in greater numbers.

The free use of the arms and hands, partly the cause and partly the result of man's erect position, appears to have led in an indirect manner to other modifications of structure. The early male forefathers of man were, as previously stated, probably furnished with great canine teeth; but as they gradually acquired the habit of using stones, clubs, or other weapons, for fighting with their enemies or rivals, they would use their jaws and teeth less and less. In this case, the jaws, together with the teeth, would become reduced in size, as we may feel almost sure from innumerable analogous cases. In a future chapter we shall meet

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with a closely parallel case, in the reduction or complete disappearance of the canine teeth in male ruminants, apparently in relation with the development of their horns; and in horses, in relation to their habit of fighting with their incisor teeth and hoofs.

In the adult male anthropomorphous apes, as Rütimeyer, and others, have insisted, it is the effect on the skull of the great development of the jaw-muscles that causes it to differ so greatly in many respects from that of man, and has given to these animals "a truly frightful physiognomy." Therefore, as the jaws and teeth in man's progenitors gradually become reduced in size, the adult skull would have come to resemble more and more that of existing man. As we shall hereafter see, a great reduction of the canine teeth in the males would almost certainly affect the teeth of the females through inheritance.

As the various mental faculties gradually developed themselves the brain would almost certainly become larger. No one, I presume, doubts that the large proportion which the size of man's brain bears to his body, compared to the same proportion in the gorilla or orang, is closely connected with his higher mental powers. We meet with closely analogous facts with insects, for in ants the cerebral ganglia are of extraordinary dimensions, and in all the Hymenoptera these ganglia are many times larger than in the less intelligent orders, such as beetles.[24] On the other hand, no one supposes that the intellect of any two animals or of any two men can be accurately gauged by the cubic contents of their skulls. It is certain that there may be extraordinary mental activity with an extremely small absolute mass of nervous matter: thus the wonderfully diversified instincts, mental powers, and affections of ants are notorious, yet their cerebral ganglia are not so large as the quarter of a small pin's head. Under this point of view, the brain of an ant is one of the most marvelous atoms of matter in the world, perhaps more so than the brain of a man.

The belief that there exists in man some close relation between the size of the brain and the development of the intellectual faculties is supported by the comparison of the skulls of savage and civilized races, of ancient and modern people, and by the

[24] My son, Mr. F. Darwin, dissected for me the cerebral ganglia of the *Formica rufa*.

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analogy of the whole vertebrate series. Dr. J. Barnard Davis has proved, by many careful measurements, that the mean internal capacity of the skull in Europeans is 92.3 cubic inches; in Americans 87.5; in Asiatics 87.1; and in Australians only 81.9 cubic inches. Professor Broca found that the nineteenth century skulls from graves in Paris were larger than those from vaults of the twelfth century, in the proportion of 1484 to 1426; and that the increased size, as ascertained by measurements, was exclusively in the frontal part of the skull — the seat of the intellectual faculties. Prichard is persuaded that the present inhabitants of Britain have "much more capacious brain-cases" than the ancient inhabitants. Nevertheless, it must be admitted that some skulls of very high antiquity, such as the famous one of Neanderthal, are well developed and capacious.[25] With respect to the lower animals, M. E. Lartet, by comparing the crania of tertiary and recent mammals belonging to the same groups, has come to the remarkable conclusion that the brain is generally larger and the convolutions are more complex in the more recent forms. On the other hand, I have shown that the brains of domestic rabbits are considerably reduced in bulk, in comparison with those of the wild rabbit or hare; and this may be attributed to their having been closely confined during many generations, so that they have exerted their intellect, instincts, senses and voluntary movements but little.

The gradually increasing weight of the brain and skull in man must have influenced the development of the supporting spinal column, more especially whilst he was becoming erect. As this change of position was being brought about, the internal pressure of the brain will also have influenced the form of the skull; for many facts show how easily the skull is thus affected. Ethnologists believe that it is modified by the kind of cradle in which infants sleep. Habitual spasms of the muscles, and a cicatrix from a severe burn, have permanently modified the facial bones. In young persons whose heads have become fixed either sideways

[25] In the interesting article just referred to, Prof. Broca has well remarked, that in civilized nations, the average capacity of the skull must be lowered by the preservation of a considerable number of individuals, weak in mind and body, who would have been promptly eliminated in the savage state. On the other hand, with savages, the average includes only the more capable individuals, who have been able to survive under extremely hard conditions of life. Broca thus explains the otherwise inexplicable fact, that the mean capacity of the skull of the ancient Troglodytes of Lozère is greater than that of modern Frenchmen.

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or backwards, owing to disease, one of the two eyes has changed its position, and the shape of the skull has been altered apparently by the pressure of the brain in a new direction.[26] I have shown that with long-eared rabbits even so trifling a cause as the lopping forward of one ear drags forward almost every bone of the skull on that side; so that the bones on the opposite side no longer strictly correspond. Lastly, if any animal were to increase or diminish much in general size, without any change in its mental powers, or if the mental powers were to be much increased or diminished, without any great change in the size of the body, the shape of the skull would almost certainly be altered. I infer this from my observations on domestic rabbits, some kinds of which have become very much larger than the wild animal, whilst others have retained nearly the same size, but in both cases the brain has been much reduced relatively to the size of the body. Now I was at first much surprised on finding that in all these rabbits the skull had become elongated or dolichocephalic; for instance, of two skulls of nearly equal breadth, the one from a wild rabbit and the other from a large domestic kind, the former was 3.15 and the latter 4.3 inches in length. One of the most marked distinctions in different races of men is that the skull in some is elongated, and in others rounded; and here the explanation suggested by the case of the rabbits may hold good; for Welcker finds that short "men incline more to brachycephaly, and tall men to dolichocephaly;" and tall men may be compared with the larger and longer-bodied rabbits, all of which have elongated skulls, or are dolichocephalic.

From these several facts we can understand, to a certain extent, the means by which the great size and more or less rounded form of the skull have been acquired by man; and these are characters eminently distinctive of him in comparison with the lower animals.

Another most conspicuous difference between man and the lower animals is the nakedness of his skin. Whales and porpoises (Cetacea), dugongs (Sirenia) and the hippopotamus are

[26] Dr. Jarrold ("Anthropologia," pp. 115, 116) adduces from Camper and from his own observations, cases of the modification of the skull from the head being fixed in an unnatural position. He believes that in certain trades, such as that of a shoemaker, where the head is habitually held forward, the forehead becomes more rounded and prominent.

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naked; and this may be advantageous to them for gliding through the water; nor would it be injurious to them from the loss of warmth, as the species, which inhabit the colder regions, are protected by a thick layer of blubber, serving the same purpose as the fur of seals and otters. Elephants and rhinoceroses are almost hairless; and as certain extinct species, which formerly lived under an Arctic climate, were covered with long wool or hair, it would almost appear as if the existing species of both genera had lost their hairy covering from exposure to heat. This appears the more probable, as the elephants in India which live on elevated and cool districts are more hairy than those on the lowlands. May we then infer that man became divested of hair from having aboriginally inhabited some tropical land? That the hair is chiefly retained in the male sex on the chest and face, and in both sexes at the junction of all four limbs with the trunk, favors this inference — on the assumption that the hair was lost before man became erect; for the parts which now retain most hair would then have been most protected from the heat of the sun. The crown of the head, however, offers a curious exception, for at all times it must have been one of the most exposed parts, yet it is thickly clothed with hair. The fact, however, that the other members of the order Primates, to which man belongs, although inhabiting various hot regions, are well clothed with hair, generally thickest on the upper surface,[27] is opposed to the supposition that man became naked through the action of the sun. Mr. Belt believes [28] that within the tropics it is an advantage to man to be destitute of hair, as he is thus enabled to free himself of the multitude of ticks (acari) and other parasites, with which he is often infested, and which sometimes cause ulceration. But whether this evil is of sufficient magni-

[27] Isidore Geoffroy St.-Hilaire remarks ("Hist. Nat. Générale," tom. ii. 1859, pp. 215–217) on the head of man being covered with long hair; also on the upper surfaces of monkeys and of other mammals being more thickly clothed than the lower surfaces. This has likewise been observed by various authors. Prof. P. Gervais ("Hist. Nat. des Mammiféres," tom. i. 1854, p. 28), however, states that in the Gorilla the hair is thinner on the back, where it is partly rubbed off, than on the lower surface.

[28] The "Naturalist in Nicaragua," p. 209. As some confirmation of Mr. Belt's view, I may quote the following passage from Sir W. Denison ("Varieties of Vice-Regal Life," vol. i. p. 440): "It is said to be a practice with the Australians, when the vermin get troublesome, to singe themselves."

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tude to have led to the denudation of his body through natural selection, may be doubted, since none of the many quadrupeds inhabiting the tropics have, as far as I know, acquired any specialized means of relief. The view which seems to me the most probable is that man, or rather primarily woman, became divested of hair for ornamental purposes, as we shall see under Sexual Selection; and, according to this belief, it is not surprising that man should differ so greatly in hairiness from all other Primates, for characters, gained through sexual selection, often differ to an extraordinary degree in closely related forms.

According to a popular impression, the absence of a tail is eminently distinctive of man; but as those apes which come nearest to him are destitute of this organ, its disappearance does not relate exclusively to man. The tail often differs remarkably in length within the same genus: thus in some species of Macacus it is longer than the whole body, and is formed of twenty-four vertebræ; in others it consists of a scarcely visible stump, containing only three or four vertebræ. In some kinds of baboons there are twenty-five, whilst in the mandrill there are ten very small stunted caudal vertebræ, or, according to Cuvier, sometimes only five. The tail, whether it be long or short, almost always tapers towards the end; and this, I presume, results from the atrophy of the terminal muscles, together with their arteries and nerves, through disuse, leading to the atrophy of the terminal bones. But no explanation can at present be given of the great diversity which often occurs in its length. Here, however, we are more specially concerned with the complete external disappearance of the tail. Professor Broca has recently shown that the tail in all quadrupeds consists of two portions, generally separated abruptly from each other; the basal portion consists of vertebræ, more or less perfectly channeled and furnished with apophyses like ordinary vertebræ; whereas those of the terminal portion are not channeled, are almost smooth, and scarcely resemble true vertebræ. A tail, though not externally visible, is really present in man and the anthropomorphous apes, and is constructed on exactly the same pattern in both. In the terminal portion the vertebræ, constituting the os coccyx are quite rudimentary, being much reduced in size and number. In the basal portion, the vertebræ are likewise few, are united firmly together, and are arrested

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in development; but they have been rendered much broader and flatter than the corresponding vertebræ in the tails of other animals; they constitute what Broca calls the accessory sacral vertebræ. These are of functional importance by supporting certain internal parts and in other ways; and their modification is directly connected with the erect or semi-erect attitude of man and the anthropomorphous apes. This conclusion is the more trustworthy, as Broca formerly held a different view, which he has now abandoned. The modification, therefore, of the basal caudal vertebræ in man and the higher apes may have been effected, directly or indirectly, through natural selection.

But what are we to say about the rudimentary and variable vertebræ of the terminal portion of the tail, forming the os coccyx? A notion which has often been, and will no doubt again be ridiculed, namely, that friction has had something to do with the disappearance of the external portion of the tail, is not so ridiculous as it at first appears. Dr. Anderson states that the extremely short tail of *Macacus brunneus* is formed of eleven vertebræ, including the imbedded basal ones. The extremity is tendinous and contains no vertebræ; this is succeeded by five rudimentary ones, so minute that together they are only one line and a half in length, and these are permanently bent to one side in the shape of a hook. The free part of the tail, only a little above an inch in length, includes only four more small vertebræ. This short tail is carried erect; but about a quarter of its total length is doubled on to itself to the left; and this terminal part, which includes the hook-like portion, serves "to fill up the interspace between the upper divergent portion of the callosities"; so that the animal sits on it, and thus renders it rough and callous. Dr. Anderson thus sums up his observations: "These facts seem to me to have only one explanation; this tail, from its short size, is in the monkey's way when it sits down, and frequently becomes placed under the animal while it is in this attitude; and from the circumstance that it does not extend beyond the extremity of the ischial tuberosities, it seems as if the tail originally had been bent round by the will of the animal, into the interspace between the callosities, to escape being pressed between them and the ground, and that in time the curvature became per-

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manent, fitting in of itself when the organ hapens to be sat upon." Under these circumstances it is not surprising that the surface of the tail should have been roughened and rendered callous, and Dr. Murie, who carefully observed this species in the Zoological Gardens, as well as three other closely allied forms with slightly longer tails, says that when the animal sits down, the tail "is necessarily thrust to one side of the buttocks; and whether long or short its root is consequently liable to be rubbed or chafed." As we now have evidence that mutilations occasionally produce an inherited effect,[29] it is not very improbable that in short-tailed monkeys, the projecting part of the tail, being functionally useless, should after many generations have become rudimentary and distorted, from being continually rubbed and chafed. We see the projecting part in this condition in the *Macacus brunneus*, and absolutely aborted in the *M. ecaudatus* and in several of the higher apes. Finally, then, as far as we can judge, the tail has disappeared in man and the anthropomorphous apes, owing to the terminal portion having been injured by friction during a long lapse of time; the basal and embedded portion having been reduced and modified, so as to become suitable to the erect or semi-erect position.

I have now endeavored to show that some of the most distinctive characters of man have in all probability been acquired, either directly, or more commonly indirectly, through natural selection. We should bear in mind that modifications in structure or constitution which do not serve to adapt an organism to its habits of life, to the food which it consumes, or passively to the surrounding conditions, cannot have been thus acquired. We must not, however, be too confident in deciding what modifications are of service to each being: we should remember how little we know about the use of many parts, or what changes in the blood or tissues may serve to fit an organism for a new climate or new kinds of food. Nor must we forget the principle of correlation, by which, as Isidore Geoffroy has shown in the case of

[29] I allude to Dr. Brown-Séquard's observations on the transmitted effect of an operation causing epilepsy in guinea-pigs, and likewise more recently on the analogous effects of cutting the sympathetic nerve in the neck. I shall hereafter have occasion to refer to Mr. Salvin's interesting case of the apparently inherited effects of mot-mots biting off the barbs of their own tail-feathers. See also on the general subject "Variation of Animals and Plants under Domestication," vol. ii. pp. 22–24.

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man, many strange deviations of structure are tied together. Independently of correlation, a change in one part often leads, through the increased or decreased use of other parts, to other changes of a quite unexpected nature. It is also well to reflect on such facts, as the wonderful growth of galls on plants caused by the poison of an insect, and on the remarkable changes of color in the plumage of parrots when fed on certain fishes, or inoculated with the poison of toads; for we can thus see that the fluids of the system, if altered for some special purpose, might induce other changes. We should especially bear in mind that modifications acquired and continually used during past ages for some useful purpose, would probably become firmly fixed, and might be long inherited.

Thus a large yet undefined extension may safely be given to the direct and indirect results of natural selection; but I now admit, after reading the essay by Nägeli on plants, and the remarks by various authors with respect to animals, more especially those recently made by Professor Broca, that in the earlier editions of my "Origin of Species" I perhaps attributed too much to the action of natural selection or the survival of the fittest. I have altered the fifth edition of the "Origin" so as to confine my remarks to adaptive changes of structure; but I am convinced, from the light gained during even the last few years, that very many structures which now appear to us useless, will hereafter be proved to be useful, and will therefore come within the range of natural selection. Nevertheless, I did not formerly consider sufficiently the existence of structures, which, as far as we can at present judge, are neither beneficial nor injurious; and this I believe to be one of the greatest oversights as yet detected in my work. I may be permitted to say, as some excuse, that I had two distinct objects in view; firstly, to show that species had not been separately created, and secondly, that natural selection had been the chief agent of change, though largely aided by the inherited effects of habit, and slightly by the direct action of the surrounding conditions. I was not, however, able to annul the influence of my former belief, then almost universal, that each species had been purposely created; and this led to my tacit assumption that every detail of structure, excepting rudiments, was of some special, though unrecognized, service. Any one with this assumption in his mind

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would naturally extend too far the action of natural selection, either during past or present times. Some of those who admit the principle of evolution, but reject natural selection, seem to forget, when criticising my book, that I had the above two objects in view; hence if I have erred in giving to natural selection great power, which I am very far from admitting, or in having exaggerated its power, which is in itself probable, I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.

It is, as I can now see, probable that all organic beings, including man, possess peculiarities of structure, which neither are now, nor were formerly of any service to them, and which, therefore, are of no physiological importance. We know not what produces the numberless slight differences between the individuals of each species, for reversion only carries the problem a few steps backwards, but each peculiarity must have had its efficient cause. If these causes, whatever they may be, were to act more uniformly and energetically during a lengthened period (and against this no reason can be assigned), the result would probably be not a mere slight individual difference, but a well-marked and constant modification, though one of no physiological importance. Changed structures, which are in no way beneficial, cannot be kept uniform through natural selection, though the injurious will be thus eliminated. Uniformity of character would, however, naturally follow from the assumed uniformity of the exciting causes, and likewise from the free intercrossing of many individuals. During successive periods, the same organism might in this manner acquire successive modifications, which would be transmitted in a nearly uniform state as long as the exciting causes remained the same and there was free intercrossing. With respect to the exciting causes we can only say, as when speaking of so-called spontaneous variations, that they relate much more closely to the constitution of the varying organism, than to the nature of the conditions to which it has been subjected.

Conclusion.— In this chapter we have seen that as man at the present day is liable, like every other animal, to multiform individual differences or slight variations, so no doubt were the early progenitors of man; the variations being formerly induced

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by the same general causes, and governed by the same general and complex laws as at present. As all animals tend to multiply beyond their means of subsistence, so it must have been with the progenitors of man; and this would inevitably lead to a struggle for existence and to natural selection. The latter process would be greatly aided by the inherited effects of the increased use of parts, and these two processes would incessantly react on each other. It appears, also, as we shall hereafter see, that various unimportant characters have been acquired by man through sexual selection. An unexplained residuum of change must be left to the assumed uniform action of those unknown agencies, which occasionally induce strongly marked and abrupt deviations of structure in our domestic productions.

Judging from the habits of savages and of the greater number of the Quadrumana, primeval men, and even their ape-like progenitors, probably lived in society. With strictly social animals, natural selection sometimes acts on the individual, through the preservation of variations which are beneficial to the community. A community which includes a large number of well-endowed individuals increases in number, and is victorious over other less favored ones; even although each separate member gains no advantage over the others of the same community. Associated insects have thus acquired many remarkable structures, which are of little or no service to the individual, such as the pollen-collecting apparatus, or the sting of the worker-bee, or the great jaws of soldier-ants. With the higher social animals, I am not aware that any structure has been modified solely for the good of the community, though some are of secondary service to it. For instance, the horns of ruminants and the great canine teeth of baboons appear to have been acquired by the males as weapons for sexual strife, but they are used in defense of the herd or troop. In regard to certain mental powers the case, as we shall see in the fifth chapter, is wholly different; for these faculties have been chiefly, or even exclusively, gained for the benefit of the community, and the individuals thereof have at the same time gained an advantage indirectly.

It has often been objected to such views as the foregoing, that man is one of the most helpless and defenseless creatures in the world; and that during his early and less well-developed condi-

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tion, he would have been still more helpless. The Duke of Argyll, for instance, insists that "the human frame has diverged from the structure of brutes, in the direction of greater physical helplessness and weakness. That is to say, it is a divergence which of all others it is most impossible to ascribe to mere natural selection." He adduces the naked and unprotected state of the body, the absence of great teeth or claws for defense, the small strength and speed of man, and his slight power of discovering food or of avoiding danger by smell. To these deficiencies there might be added one still more serious, namely, that he cannot climb quickly, and so escape from enemies. The loss of hair would not have been a great injury to the inhabitants of a warm country. For we know that the unclothed Fuegians can exist under a wretched climate. When we compare the defenseless state of man with that of apes, we must remember that the great canine teeth with which the latter are provided, are possessed in their full development by the males alone, and are chiefly used by them for fighting with their rivals; yet the females, which are not thus provided, manage to survive.

In regard to bodily size or strength, we do not know whether man is descended from some small species, like the chimpanzee, or from one as powerful as the gorilla; and, therefore, we cannot say whether man has become larger and stronger, or smaller and weaker, than his ancestors. We should, however, bear in mind that an animal possessing great size, strength, and ferocity, and which, like the gorilla, could defend itself from all enemies, would not perhaps have become social: and this would most effectually have checked the acquirement of the higher mental qualities, such as sympathy and the love of his fellows. Hence it might have been an immense advantage to man to have sprung from some comparatively weak creature.

The small strength and speed of man, his want of natural weapons, etc., are more than counterbalanced, firstly, by his intellectual powers, through which he has formed for himself weapons, tools, etc., though still remaining in a barbarous state, and, secondly, by his social qualities which lead him to give and receive aid from his fellow-men. No country in the world abounds in a greater degree with dangerous beasts than Southern Africa; no country presents more fearful physical hardships than the Arctic regions; yet one of the puniest of races, that of

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the Bushmen, maintains itself in Southern Africa, as do the dwarfed Esquimaux in the Arctic regions. The ancestors of man were, no doubt, inferior in intellect, and probably in social disposition, to the lowest existing savages; but it is quite conceivable that they might have existed, or even flourished, if they had advanced in intellect, whilst gradually losing their brute-like powers, such as that of climbing trees, etc. But these ancestors would not have been exposed to any special danger, even if far more helpless and defenseless than any existing savages, had they inhabited some warm continent or large island, such as Australia, New Guinea, or Borneo, which is now the home of the orang. And natural selection arising from the competition of tribe with tribe, in some such large area as one of these, together with the inherited effects of habit, would, under favorable conditions, have sufficed to raise man to his present high position in the organic scale.

CHAPTER III.

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS.

The difference in mental power between the highest ape and the lowest savage, immense — Certain instincts in common — The emotions — Curiosity — Imitation — Attention — Memory — Imagination — Reason — Progressive Improvement — Tools and weapons used by animals — Abstraction, self-consciousness — Language — Sense of Beauty — Belief in God, spiritual agencies, superstitions.

We have seen in the last two chapters that man bears in his bodily structure clear traces of his descent from some lower form; but it may be urged that, as man differs so greatly in his mental power from all other animals, there must be some error in this conclusion. No doubt the difference in this respect is enormous, even if we compare the mind of one of the lowest savages, who has no words to express any number higher than four, and who uses hardly any abstract terms for common objects or for the affections, with that of the most highly organized ape. The difference would, no doubt, still remain immense, even

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if one of the higher apes had been improved, or civilized as much as a dog has been in comparison with its parent-form, the wolf or jackal. The Fuegians rank amongst the lowest barbarians; but I was continually struck with surprise how closely the three natives on board H. M. S. "Beagle," who had lived some years in England, and could talk a little English, resembled us in disposition and in most of our mental faculties. If no organic being excepting man had possessed any mental power, or if his powers had been of a wholly different nature from those of the lower animals, then we should never have been able to convince ourselves that our high faculties had been gradually developed. But it can be shown that there is no fundamental difference of this kind. We must also admit that there is a much wider interval in mental power between one of the lowest fishes, as a lamprey or lancelet, and one of the higher apes, than between an ape and man; yet this interval is filled up by numberless gradations.

Nor is the difference slight in moral disposition between a barbarian, such as the man described by the old navigator Byron, who dashed his child on the rocks for dropping a basket of sea-urchins, and a Howard or Clarkson; and in intellect, between a savage who uses hardly any abstract terms, and a Newton or Shakespeare. Differences of this kind between the highest men of the highest races and the lowest savages, are connected by the finest gradations. Therefore it is possible that they might pass and be developed into each other.

My object in this chapter is to show that there is no fundamental difference between man and the higher mammals in their mental faculties. Each division of the subject might have been extended into a separate essay, but must here be treated briefly. As no classification of the mental powers has been universally accepted, I shall arrange my remarks in the order most convenient for my purpose; and will select those facts which have struck me most, with the hope that they may produce some effect on the reader.

With respect to animals very low in the scale, I shall give some additional facts under Sexual Selection, showing that their mental powers are much higher than might have been expected. The variability of the faculties in the individuals of the same species is an important point for us, and some few illustrations

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will here be given. But it would be superfluous to enter into many details on this head, for I have found on frequent inquiry, that it is the unanimous opinion of all those who have long attended to animals of many kinds, including birds, that the individuals differ greatly in every mental characteristic. In what manner the mental powers were first developed in the lowest organisms, is as hopeless an inquiry as how life itself first originated. These are problems for the distant future, if they are ever to be solved by man.

As man possesses the same senses as the lower animals, his fundamental intuitions must be the same. Man has also some few instincts in common, as that of self-preservation, sexual love, the love of the mother for her new-born offspring, the desire possessed by the latter to suck, and so forth. But man, perhaps, has somewhat fewer instincts than those possessed by the animals which come next to him in the series. The orang in the Eastern islands, and the chimpanzee in Africa, build platforms on which they sleep; and, as both species follow the same habit, it might be argued that this was due to instinct, but we cannot feel sure that it is not the result of both animals having similar wants, and possessing similar powers of reasoning. These apes, as we may assume, avoid the many poisonous fruits of the tropics, and man has no such knowledge: but as our domestic animals, when taken to foreign lands, and when first turned out in the spring, often eat poisonous herbs, which they afterwards avoid, we cannot feel sure that the apes do not learn from their own experience or from that of their parents what fruits to select. It is, however, certain, as we shall presently see, that apes have an instinctive dread of serpents, and probably of other dangerous animals.

The fewness and the comparative simplicity of the instincts in the higher animals are remarkable in contrast with those of the lower animals. Cuvier maintained that instinct and intelligence stand in an inverse ratio to each other; and some have thought that the intellectual faculties of the higher animals have been gradually developed from their instincts. But Pouchet, in an interesting essay, has shewn that no such inverse ratio really exists. Those insects which possess the most wonderful instincts are certainly the most intelligent. In the vertebrate series, the least intelligent members, namely fishes and amphibians, do not

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possess complex instincts; and amongst mammals the animal most remarkable for its instincts, namely the beaver, is highly intelligent, as will be admitted by every one who has read Mr. Morgan's excellent work.

Although the first dawnings of intelligence, according to Mr. Herbert Spencer, have been developed through the multiplication and co-ordination of reflex actions, and although many of the simpler instincts graduate into reflex actions, and can hardly be distinguished from them, as in the case of young animals sucking, yet the more complex instincts seem to have originated independently of intelligence. I am, however, very far from wishing to deny that instinctive actions may lose their fixed and untaught character, and be replaced by others performed by the aid of the free will. On the other hand, some intelligent actions, after being performed during several generations, become converted into instincts and are inherited, as when birds on oceanic islands learn to avoid man. These actions may then be said to be degraded in character, for they are no longer performed through reason or from experience. But the greater number of the more complex instincts appear to have been gained in a wholly different manner, through the natural selection of variations of simpler instinctive actions. Such variations appear to arise from the same unknown causes acting on the cerebral organization, which induce slight variations or individual differences in other parts of the body; and these variations, owing to our ignorance, are often said to arise spontaneously. We can, I think, come to no other conclusion with respect to the origin of the more complex instincts, when we reflect on the marvelous instincts of sterile worker-ants and bees, which leave no offspring to inherit the effects of experience and of modified habits.

Although, as we learn from the above-mentioned insects and the beaver, a high degree of intelligence is certainly compatible with complex instincts, and although actions, at first learnt voluntarily can soon through habit be performed with the quickness and certainty of a reflex action, yet it is not improbable that there is a certain amount of interference between the development of free intelligence and of instinct,— which latter implies some inherited modification of the brain. Little is known about the functions of the brain, but we can perceive that as the intel-

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lectual powers become highly developed, the various parts of the brain must be connected by very intricate channels of the freest intercommunication; and as a consequence each separate part would perhaps tend to be less well fitted to answer to particular sensations or associations in a definite and inherited — that is instinctive — manner. There seems even to exist some relation between a low degree of intelligence and a strong tendency to the formation of fixed, though not inherited habits; for as a sagacious physician remarked to me, persons who are slightly imbecile tend to act in everything by routine or habit; and they are rendered much happier if this is encouraged.

I have thought this digression worth giving, because we may easily underrate the mental powers of the higher animals, and especially of man, when we compare their actions founded on the memory of past events, on foresight, reason, and imagination, with exactly similar actions instinctively performed by the lower animals; in this latter case the capacity of performing such actions has been gained, step by step, through the variability of the mental organs and natural selection, without any conscious intelligence on the part of the animal during each successive generation. No doubt, as Mr. Wallace has argued, much of the intelligent work done by man is due to imitation and not to reason; but there is this great difference between his actions and many of those performed by the lower animals, namely, that man cannot, on his first trial, make, for instance, a stone hatchet or a canoe, through his power of imitation. He has to learn his work by practice; a beaver, on the other hand, can make its dam or canal, and a bird its nest, as well, or nearly as well, and a spider its wonderful web, quite as well, the first time it tries as when old and experienced.

To return to our immediate subject; the lower animals, like man, manifestly feel pleasure and pain, happiness and misery. Happiness is never better exhibited than by young animals, such as puppies, kittens, lambs, etc., when playing together, like our own children. Even insects play together, as has been described by that excellent observer, P. Huber, who saw ants chasing and pretending to bite each other, like so many puppies.

The fact that the lower animals are excited by the same emotions as ourselves is so well established, that it will not be necessary to weary the reader by many details. Terror acts

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in the same manner on them as on us, causing the muscles to tremble, the heart to palpitate, the sphincters to be relaxed, and the hair to stand on end. Suspicion, the offspring of fear, is eminently characteristic of most wild animals. It is, I think, impossible to read the account given by Sir E. Tennent, of the behavior of the female elephants, used as decoys, without admitting that they intentionally practise deceit, and well know what they are about. Courage and timidity are extremely variable qualities in the individuals of the same species, as is plainly seen in our dogs. Some dogs and horses are ill-tempered, and easily turn sulky; others are good-tempered; and these qualities are certainly inherited. Every one knows how liable animals are to furious rage, and how plainly they show it. Many, and probably true, anecdotes have been published on the long-delayed and artful revenge of various animals. The accurate Rengger, and Brehm[1] state that the American and African monkeys which they kept tame, certainly revenged themselves. Sir Andrew Smith, a zoologist whose scrupulous accuracy was known to many persons, told me the following story of which he was himself an eye-witness; at the Cape of Good Hope an officer had often plagued a certain baboon, and the animal, seeing him approaching one Sunday for parade, poured water into a hole and hastily made some thick mud, which he skilfully dashed over the officer as he passed by, to the amusement of many bystanders. For long afterwards the baboon rejoiced and triumphed whenever he saw his victim.

The love of a dog for his master is notorious; as an old writer quaintly says, "A dog is the only thing on this earth that luvs you more than he luvs himself."

In the agony of death a dog has been known to caress his master, and every one has heard of the dog suffering under vivisection, who licked the hand of the operator; this man, unless the operation was fully justified by an increase of our knowledge, or unless he had a heart of stone, must have felt remorse to the last hour of his life.

As Whewell has well asked, "who that reads the touching instances of maternal affection, related so often of the women

[1] All the following statements, given on the authority of these two naturalists, are taken from Rengger's "Naturgesch. der Säugethiere von Paraguay," s. 41–57, and from Brehm's "Thierleben," B. i. s. 10–87.

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of all nations, and of the females of all animals, can doubt that the principle of action is the same in the two cases?" We see maternal affection exhibited in the most trifling details; thus Rengger observed an American monkey (a Cebus) carefully driving away the flies which plagued her infant; and Duvaucel saw a Hylobates washing the faces of her young ones in a stream. So intense is the grief of female monkeys for the loss of their young, that it invariably caused the death of certain kinds kept under confinement by Brehm in N. Africa. Orphan monkeys were always adopted and carefully guarded by the other monkeys, both males and females. One female baboon had so capacious a heart that she not only adopted young monkeys of other species, but stole young dogs and cats, which she continually carried about. Her kindness, however, did not go so far as to share her food with her adopted offspring, at which Brehm was surprised, as his monkeys always divided everything quite fairly with their own young ones. An adopted kitten scratched this affectionate baboon, who certainly had a fine intellect, for she was much astonished at being scratched, and immediately examined the kitten's feet, and without more ado bit off the claws.[2] In the Zoological Gardens, I heard from the keeper that an old baboon (*C. chacma*) had adopted a Rhesus monkey; but when a young drill and mandrill were placed in the cage, she seemed to perceive that these monkeys, though distinct species, were her nearer relatives, for she at once rejected the Rhesus and adopted both of them. The young Rhesus, as I saw, was greatly discontented at being thus rejected, and it would, like a naughty child, annoy and attack the young drill and mandrill whenever it could do so with safety; this conduct exciting great indignation in the old baboon. Monkeys will also, according to Brehm, defend their master when attacked by any one, as well as dogs to whom they are attached, from the attacks of other dogs. But we here trench on the subjects of sympathy and fidelity, to which I shall recur. Some of Brehm's monkeys took much delight in teasing a certain old dog whom they disliked, as well as other animals, in various ingenious ways.

[2] A critic, without any grounds, disputes the possibility of this act as described by Brehm, for the sake of discrediting my work. Therefore I tried, and found that I could readily seize with my own teeth the sharp little claws of a kitten nearly five weeks old.

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Most of the more complex emotions are common to the higher animals and ourselves. Every one has seen how jealous a dog is of his master's affection, if lavished on any other creature; and I have observed the same fact with monkeys. This shows that animals not only love, but have desire to be loved. Animals manifestly feel emulation. They love approbation or praise; and a dog carrying a basket for his master exhibits in a high degree self-complacency or pride. There can, I think, be no doubt that a dog feels shame, as distinct from fear, and something very like modesty when begging too often for food. A great dog scorns the snarling of a little dog, and this may be called magnanimity. Several observers have stated that monkeys certainly dislike being laughed at; and they sometimes invent imaginary offenses. In the Zoological Gardens I saw a baboon who always got into a furious rage when his keeper took out a letter or book and read it aloud to him; and his rage was so violent that, as I witnessed on one occasion, he bit his own leg till the blood flowed. Dogs show what may be fairly called a sense of humor, as distinct from mere play; if a bit of stick or other such object be thrown to one, he will often carry it away for a short distance; and then squatting down with it on the ground close before him, will wait until his master comes quite close to take it away. The dog will then seize it and rush away in triumph, repeating the same maneuver, and evidently enjoying the practical joke.

We will now turn to the more intellectual emotions and faculties, which are very important, as forming the basis for the development of the higher mental powers. Animals manifestly enjoy excitement, and suffer from ennui, as may be seen with dogs, and, according to Rengger, with monkeys. All animals feel *Wonder,* and many exhibit *Curiosity.* They sometimes suffer from this latter quality, as when the hunter plays antics and thus attracts them; I have witnessed this with deer, and so it is with the wary chamois, and with some kinds of wild-ducks. Brehm gives a curious account of the instinctive dread, which his monkeys exhibited, for snakes; but their curiosity was so great that they could not desist from occasionally satiating their horror in a most human fashion, by lifting up the lid of the box in which the snakes were kept. I was so much surprised at his account, that I took a stuffed and coiled-up

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snake into the monkey-house at the Zoological Gardens, and the excitement thus caused was one of the most curious spectacles which I ever beheld. Three species of Cercopithecus were the most alarmed; they dashed about their cages, and uttered sharp signal cries of danger, which were understood by the other monkeys. A few young monkeys and one old Anubis baboon alone took no notice of the snake. I then placed the stuffed specimen on the ground in one of the larger compartments. After a time all the monkeys collected round it in a large circle, and staring intently, presented a most ludicrous appearance. They became extremely nervous; so that when a wooden ball, with which they were familiar as a plaything, was accidentally moved in the straw, under which it was partly hidden, they all instantly started away. These monkeys behaved very differently when a dead fish, a mouse, a living turtle, and other new objects were placed in their cages; for though at first frightened, they soon approached, handled and examined them. I then placed a live snake in a paper bag, with the mouth loosely closed, in one of the larger compartments. One of the monkeys immediately approached, cautiously opened the bag a little, peeped in, and instantly dashed away. Then I witnessed what Brehm has described, for monkey after monkey, with head raised high and turned on one side, could not resist taking a momentary peep into the upright bag, at the dreadful object lying quietly at the bottom. It would almost appear as if monkeys had some notion of zoological affinities, for those kept by Brehm exhibited a strange, though mistaken, instinctive dread of innocent lizards and frogs. An orang, also, has been known to be much alarmed at the first sight of a turtle.

The principle of *Imitation* is strong in man, and especially, as I have myself observed, with savages. In certain morbid states of the brain this tendency is exaggerated to an extraordinary degree: some hemiplegic patients and others, at the commencement of inflammatory softening of the brain, unconsciously imitate every word which is uttered, whether in their own or in a foreign language, and every gesture or action which is performed near them. Desor has remarked that no animal voluntarily imitates an action performed by man, until in the ascending scale we come to monkeys, which are well known to be ridiculous mockers. Animals, however, sometimes imitate

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each other's actions: thus two species of wolves, which had been reared by dogs, learned to bark, as does sometimes the jackal, but whether this can be called voluntary imitation is another question. Birds imitate the songs of their parents, and sometimes of other birds; and parrots are notorious imitators of any sound which they often hear. Dureau de la Malle gives an account of a dog reared by a cat, who learnt to imitate the well-known action of a cat licking her paws, and thus washing her ears and face; this was also witnessed by the celebrated naturalist Audouin. I have received several confirmatory accounts; in one of these, a dog had not been suckled by a cat, but had been brought up with one, together with kittens, and had thus acquired the above habit, which he ever afterwards practised during his life of thirteen years. Dureau de la Malle's dog likewise learnt from the kittens to play with a ball by rolling it about with his fore paws, and springing on it. A correspondent assures me that a cat in his house used to put her paws into jugs of milk having too narrow a mouth for her head. A kitten of this cat soon learned the same trick, and practised it ever afterwards, whenever there was an opportunity.

The parents of many animals, trusting to the principle of imitation in their young, and more especially to their instinctive or inherited tendencies, may be said to educate them. We see this when a cat brings a live mouse to her kittens; and Dureau de la Malle has given a curious account (in the paper above quoted) of his observations on hawks which taught their young dexterity, as well as judgment of distances, by first dropping through the air dead mice and sparrows, which the young generally failed to catch, and then bringing them live birds and letting them loose.

Hardly any faculty is more important for the intellectual progress of man than *Attention*. Animals clearly manifest this power, as when a cat watches by a hole and prepares to spring on its prey. Wild animals sometimes become so absorbed when thus engaged, that they may be easily approached. Mr. Bartlett has given me a curious proof how variable this faculty is in monkeys. A man who trains monkeys to act in plays, used to purchase common kinds from the Zoological Society at the price of five pounds for each; but he offered to give double the price, if he might keep three or four of them for a few

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days, in order to select one. When asked how he could possibly learn so soon, whether a particular monkey would turn out a good actor, he answered that it all depended on their power of attention. If when he was talking and explaining anything to a monkey, its attention was easily distracted, as by a fly on the wall or other trifling object, the case was hopeless. If he tried by punishment to make an inattentive monkey act, it turned sulky. On the other hand, a monkey which carefully attended to him could always be trained.

It is almost superfluous to state that animals have excellent *Memories* for persons and places. A baboon at the Cape of Good Hope, as I have been informed by Sir Andrew Smith, recognized him with joy after an absence of nine months. I had a dog who was savage and averse to all strangers, and I purposely tried his memory after an absence of five years and two days. I went near the stable where he lived, and shouted to him in my old manner; he showed no joy, but instantly followed me out walking, and obeyed me, exactly as if I had parted with him only half an hour before. A train of old associations, dormant during five years, had thus been instantaneously awakened in his mind. Even ants, as P. Huber has clearly shown, recognized their fellow-ants belonging to the same community after a separation of four months. Animals can certainly by some means judge of the intervals of time between recurrent events.

The *Imagination* is one of the highest prerogatives of man. By this faculty he unites former images and ideas, independently of the will, and thus creates brilliant and novel results. A poet, as Jean Paul Richter remarks, "who must reflect whether he shall make a character say yes or no — to the devil with him; he is only a stupid corpse." Dreaming gives us the best notion of this power; as Jean Paul again says, "The dream is an involuntary art of poetry." The value of the products of our imagination depends of course on the number, accuracy, and clearness of our impressions, on our judgment and taste in selecting or rejecting the involuntary combinations, and to a certain extent on our power of voluntarily combining them. As dogs, cats, horses, and probably all the higher animals, even birds [3] have vivid dreams, and this is shown by their movements

[3] Houzeau says that his parokeets and canary-birds dreamt: "Facultés Mentales," tom. ii. p. 136.

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and the sounds uttered, we must admit that they possess some power of imagination. There must be something special, which causes dogs to howl in the night, and especially during moonlight, in that remarkable and melancholy manner called baying. All dogs do not do so; and, according to Houzeau, they do not then look at the moon, but at some fixed point near the horizon. Houzeau thinks that their imaginations are disturbed by the vague outlines of the surrounding objects, and conjure up before them fantastic images: if this be so, their feelings may almost be called superstitious.

Of all the faculties of the human mind, it will, I presume, be admitted that *Reason* stands at the summit. Only a few persons now dispute that animals possess some power of reasoning. Animals may constantly be seen to pause, deliberate, and resolve. It is a significant fact, that the more the habits of any particular animal are studied by a naturalist, the more he attributes to reason and the less to unlearnt instincts.[4] In future chapters we shall see that some animals extremely low in the scale apparently display a certain amount of reason. No doubt it is often difficult to distinguish between the power of reason and that of instinct. For instance, Dr. Hayes, in his work on "The Open Polar Sea," repeatedly remarks that his dogs, instead of continuing to draw the sledges in a compact body, diverged and separated when they came to thin ice, so that their weight might be more evenly distributed. This was often the first warning which the travelers received that the ice was becoming thin and dangerous. Now, did the dogs act thus from the experience of each individual, or from the example of the older and wiser dogs, or from an inherited habit, that is from instinct? This instinct may possibly have arisen since the time, long ago, when dogs were first employed by the natives in drawing their sledges; or the Arctic wolves, the parent-stock of the Esquimaux dog, may have acquired an instinct impelling them not to attack their prey in a close pack, when on thin ice.

We can only judge by the circumstances under which actions are performed, whether they are due to instinct, or to reason, or to the mere association of ideas: this latter principle, however, is intimately connected with reason. A curious case has been

[4] Mr. L. H. Morgan's work on "The American Beaver," 1868, offers a good illustration of this remark. I cannot help thinking, however, that he goes too far in underrating the power of instinct.

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given by Prof. Möbius, of a pike, separated by a plate of glass from an adjoining aquarium stocked with fish, and who often dashed himself with such violence against the glass in trying to catch the other fishes, that he was sometimes completely stunned. The pike went on thus for three months, but at last learnt caution, and ceased to do so. The plate of glass was then removed, but the pike would not attack these particular fishes, though he would devour others which were afterwards introduced; so strongly was the idea of a violent shock associated in his feeble mind with the attempt on his former neighbors. If a savage, who had never seen a large plate-glass window, were to dash himself even once against it, he would for a long time afterwards associate a shock with a window-frame; but very differently from the pike, he would probably reflect on the nature of the impediment, and be cautious under analogous circumstances. Now with monkeys, as we shall presently see, a painful or merely a disagreeable impression, from an action once performed, is sometimes sufficient to prevent the animal from repeating it. If we attribute this difference between the monkey and the pike solely to the association of ideas being so much stronger and more persistent in the one than the other, though the pike often received much the more severe injury, can we maintain in the case of man that a similar difference implies the possession of a fundamentally different mind?

Houzeau relates that, whilst crossing a wide and arid plain in Texas, his two dogs suffered greatly from thirst, and that between thirty and forty times they rushed down the hollows to search for water. These hollows were not valleys, and there were no trees in them, or any other difference in the vegetation, and as they were absolutely dry there could have been no smell of damp earth. The dogs behaved as if they knew that a dip in the ground offered them the best chance of finding water, and Houzeau has often witnessed the same behavior in other animals.

I have seen, as I dare say have others, that when a small object is thrown on the ground beyond the reach of one of the elephants in the Zoological Gardens, he blows through his trunk on the ground beyond the object, so that the current reflected on all sides may drive the object within his reach. Again a well-known ethnologist, Mr. Westropp, informs me that he ob-

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served in Vienna a bear deliberately making with his paw a current in some water, which was close to the bars of his cage, so as to draw a piece of floating bread within his reach. These actions of the elephant and bear can hardly be attributed to instinct or inherited habit, as they would be of little use to an animal in a state of nature. Now, what is the difference between such actions, when performed by an uncultivated man, and by one of the higher animals?

The savage and the dog have often found water at a low level, and the coincidence under such circumstances has become associated in their minds. A cultivated man would perhaps make some general proposition on the subject; but from all that we know of savages it is extremely doubtful whether they would do so, and a dog certainly would not. But a savage, as well as a dog, would search in the same way, though frequently disappointed; and in both it seems to be equally an act of reason, whether or not any general proposition on the subject is consciously placed before the mind.[5] The same would apply to the elephant and the bear making currents in the air or water. The savage would certainly neither know nor care by what law the desired movements were effected; yet his act would be guided by a rude process of reasoning, as surely as would a philosopher in his longest chain of deductions. There would no doubt be this difference between him and one of the higher animals, that he would take notice of much slighter circumstances and conditions, and would observe any connection between them after much less experience, and this would be of paramount importance. I kept a daily record of the actions of one of my infants, and when he was about eleven months old, and before he could speak a single word, I was continually struck with the greater quickness, with which all sorts of objects and sounds were associated together in his mind, compared with that of the most intelligent dogs I ever knew. But the higher animals differ in exactly the same way in this power of association from those low in the scale, such as the pike, as well as in that of drawing inferences and of observation.

The promptings of reason, after very short experience, are well shown by the following actions of American monkeys, which

[5] Prof. Huxley has analyzed with admirable clearness the mental steps by which a man, as well as a dog, arrives at a conclusion in a case analogous to that given in my text.

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stand low in their order. Rengger, a most careful observer, states that when he first gave eggs to his monkeys in Paraguay, they smashed them, and thus lost much of their contents; afterwards they gently hit one end against some hard body, and picked off the bits of shell with their fingers. After cutting themselves only *once* with any sharp tool, they would not touch it again, or would handle it with the greatest caution. Lumps of sugar were often given them wrapped up in paper; and Rengger sometimes put a live wasp in the paper, so that in hastily unfolding it they got stung; after this had *once* happened, they always first held the packet to their ears to detect any movement within.[6]

The following cases relate to dogs. Mr. Colquhoun winged two wild-ducks, which fell on the further side of a stream; his retriever tried to bring over both at once, but could not succeed; she then, though never before known to ruffle a feather, deliberately killed one, brought over the other, and returned for the dead bird. Col. Hutchinson relates that two partridges were shot at once, one being killed, the other wounded; the latter ran away, and was caught by the retriever, who on her return came across the dead bird; "she stopped, evidently greatly puzzled, and after one or two trials, finding she could not take it up without permitting the escape of the winged bird, she considered a moment, then deliberately murdered it by giving it a severe crunch, and afterwards brought away both together. This was the only known instance of her ever having wilfully injured any game." Here we have reason though not quite perfect, for the retriever might have brought the wounded bird first and then returned for the dead one, as in the case of the two wild-ducks. I give the above cases, as resting on the evidence of two independent witnesses, and because in both instances the retrievers, after deliberation, broke through a habit which is inherited by them (that of not killing the game retrieved), and because they show how strong their reasoning faculty must have been to overcome a fixed habit.

I will conclude by quoting a remark by the illustrious Humboldt. "The muleteers in S. America say, 'I will not give

[6] Mr. Belt, in his most interesting work, "The Naturalist in Nicaragua," 1874 (p. 119), likewise describes various actions of a tamed Cebus, which, I think, clearly show that this animal possessed some reasoning power.

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you the mule whose step is easiest, but *la mas racional,*— the one that reasons best;'" and as he adds, "this popular expression, dictated by long experience, combats the system of animated machines, better perhaps than all the arguments of speculative philosophy." Nevertheless some writers even yet deny that the higher animals possess a trace of reason; and they endeavor to explain away, by what appears to be mere verbiage,[7] all such facts as those above given.

It has, I think, now been shown that man and the higher animals, especially the Primates, have some few instincts in common. All have the same senses, intuitions, and sensations, — similar passions, affections, and emotions, even the more complex ones, such as jealousy, suspicion, emulation, gratitude, and magnanimity; they practise deceit and are revengeful; they are sometimes susceptible to ridicule, and even have a sense of humor; they feel wonder and curiosity; they possess the same faculties of imitation, attention, deliberation, choice, memory, imagination, the association of ideas, and reason, though in very different degrees. The individuals of the same species graduate in intellect from absolute imbecility to high excellence. They are also liable to insanity, though far less often than in the case of man. Nevertheless, many authors have insisted that man is divided by an insuperable barrier from all the lower animals in his mental faculties. I formerly made a collection of above a score of such aphorisms, but they are almost worthless, as their wide difference and number prove the difficulty, if not the impossibility, of the attempt. It has been asserted that man alone is capable of progressive improvement; that he alone makes use of tools or fire, domesticates other animals, or possesses property; that no animal has the power of abstraction, or of forming general concepts, is self-conscious and comprehends itself; that no animal employs language; that man alone has a sense of beauty, is liable to caprice, has the feeling of

[7] I am glad to find that so acute a reasoner as Mr. Leslie Stephen ("Darwinism and Divinity, Essays on Free-thinking," 1873, p. 80), in speaking of the supposed impassable barrier between the minds of man and the lower animals, says, "The distinctions, indeed, which have been drawn, seem to us to rest upon no better foundation than a great many other metaphysical distinctions; that is, the assumption that because you can give two things different names, they must therefore have different natures. It is difficult to understand how anybody who has ever kept a dog, or seen an elephant, can have any doubt as to an animal's power of performing the essential processes of reasoning."

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gratitude, mystery, &c.; believes in God, or is endowed with a conscience. I will hazard a few remarks on the more important and interesting of these points.

Archbishop Sumner formerly maintained that man alone is capable of progressive improvement. That he is capable of incomparably greater and more rapid improvement than is any other animal, admits of no dispute; and this is mainly due to his power of speaking and handing down his acquired knowledge. With animals, looking first to the individual, every one who has had any experience in setting traps, knows that young animals can be caught much more easily than old ones; and they can be much more easily approached by an enemy. Even with respect to old animals, it is impossible to catch many in the same place and in the same kind of trap, or to destroy them by the same kind of poison; yet it is improbable that all should have partaken of the poison, and impossible that all should have been caught in a trap. They must learn caution by seeing their brethren caught or poisoned. In North America, where the fur-bearing animals have long been pursued, they exhibit, according to the unanimous testimony of all observers, an almost incredible amount of sagacity, caution and cunning; but trapping has been there so long carried on, that inheritance may possibly have come into play. I have received several accounts that when telegraphs are first set up in any district, many birds kill themselves by flying against the wires, but that in the course of a very few years they learn to avoid this danger, by seeing, as it would appear, their comrades killed.

If we look to successive generations, or to the race, there is no doubt that birds and other animals gradually both acquire and lose caution in relation to man or other enemies; and this caution is certainly in chief part an inherited habit or instinct, but in part the result of individual experience. A good observer, Leroy, states, that in districts where foxes are much hunted, the young, on first leaving their burrows, are incontestably much more wary than the old ones in districts where they are not much disturbed.

Our domestic dogs are descended from wolves and jackals, and though they may not have gained in cunning, and may have lost in wariness and suspicion, yet they have progressed in certain moral qualities, such as in affection, trust-worthiness,

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temper, and probably in general intelligence. The common rat has conquered and beaten several other species throughout Europe, in parts of North America, New Zealand, and recently in Formosa, as well as on the mainland of China. Mr. Swinhoe, who describes these two latter cases, attributes the victory of the common rat over the large *Mus coninga* to its superior cunning; and this latter quality may probably be attributed to the habitual exercise of all its faculties in avoiding extirpation by man, as well as to nearly all the less cunning or weak-minded rats having been continuously destroyed by him. It is, however, possible that the success of the common rat may be due to its having possessed greater cunning than its fellow-species, before it became associated with man. To maintain, independently of any direct evidence, that no animal during the course of ages has progressed in intellect or other mental faculties, is to beg the question of the evolution of species. We have seen that, according to Lartet, existing mammals belonging to several orders have larger brains than their ancient tertiary prototypes.

It has often been said that no animal uses any tool; but the chimpanzee in a state of nature cracks a native fruit, somewhat like a walnut, with a stone. Rengger easily taught an American monkey thus to break open hard palm-nuts; and afterwards of its own accord, it used stones to open other kinds of nuts, as well as boxes. It thus also removed the soft rind of fruit that had a disagreeable flavor. Another monkey was taught to open the lid of a large box with a stick, and afterwards it used the stick as a lever to move heavy bodies; and I have myself seen a young orang put a stick into a crevice, slip his hand to the other end, and use it in the proper manner as a lever. The tamed elephants of India are well known to break off branches of trees and use them to drive away the flies; and this same act has been observed in an elephant in a state of nature. I have seen a young orang, when she thought she was going to be whipped, cover and protect herself with a blanket or straw. In these several cases stones and sticks were employed as implements; but they are likewise used as weapons. Brehm states, on the authority of the well-known traveler Schimper, that in Abyssinia when the baboons belonging to one species (*C. gelada*) descend in troops from the mountains to plunder the fields, they sometimes encounter troops of another species

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(*C. hamadryas*), and then a fight ensues. The Geladas roll down great stones, which the Hamadryas try to avoid, and then both species, making a great uproar, rush furiously against each other. Brehm, when, accompanying the Duke of Coburg-Gotha, aided in an attack with fire-arms on a troop of baboons in the pass of Mensa in Abyssinia. The baboons in return rolled so many stones down the mountain, some as large as a man's head, that the attackers had to beat a hasty retreat; and the pass was actually closed for a time against the caravan. It deserves notice that these baboons thus acted in concert. Mr. Wallace on three occasions saw female orangs, accompanied by their young, "breaking off branches and the great spiny fruit of the Durian tree, with every appearance of rage; causing such a shower of missiles as effectually kept us from approaching too near the tree." As I have repeatedly seen, a chimpanzee will throw any object at hand at a person who offends him; and the before-mentioned baboon at the Cape of Good Hope prepared mud for the purpose.

In the Zoological Gardens, a monkey, which had weak teeth, used to break open nuts with a stone; and I was assured by the keepers that after using the stone, he hid it in the straw, and would not let any other monkey touch it. Here, then, we have the idea of property; but this idea is common to every dog with a bone, and to most or all birds with their nests.

The Duke of Argyll remarks, that the fashioning of an implement for a special purpose is absolutely peculiar to man; and he considers that this forms an immeasurable gulf between him and the brutes. This is no doubt a very important distinction; but there appears to me much truth in Sir J. Lubbock's suggestion, that when primeval man first used flint-stones for any purpose, he would have accidentally splintered them, and would then have used the sharp fragments. From this step it would be a small one to break the flints on purpose, and not a very wide step to fashion them rudely. This latter advance, however, may have taken long ages, if we may judge by the immense interval of time which elapsed before the men of the neolithic period took to grinding and polishing their stone tools. In breaking the flints, as Sir J. Lubbock likewise remarks, sparks would have been emitted, and in grinding them heat would have been evolved: thus the two usual methods of

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"obtaining fire may have originated." The nature of fire would have been known in the many volcanic regions where lava occasionally flows through forests. The anthropomorphous apes, guided probably by instinct, build for themselves temporary platforms; but as many instincts are largely controlled by reason, the simpler ones, such as this of building a platform, might readily pass into a voluntary and conscious act. The orang is known to cover itself at night with the leaves of the Pandanus; and Brehm states that one of his baboons used to protect itself from the heat of the sun by throwing a straw-mat over its head. In these several habits, we probably see the first steps towards some of the simpler arts, such as rude architecture and dress, as they arose amongst the early progenitors of man.

Abstraction, General Conceptions, Self-consciousness, Mental Individuality.— It would be very difficult for any one with even much more knowledge than I possess, to determine how far animals exhibit any traces of these high mental powers. This difficulty arises from the impossibility of judging what passes through the mind of an animal; and again, the fact that writers differ to a great extent in the meaning which they attribute to the above terms, causes a further difficulty. If one may judge from various articles which have been published lately, the greatest stress seems to be laid on the supposed entire absence in animals of the power of abstraction, or of forming general concepts. But when a dog sees another dog at a distance, it is often clear that he perceives that it is a dog in the abstract; for when he gets nearer his whole manner suddenly changes, if the other dog be a friend. A recent writer remarks, that in all such cases it is a pure assumption to assert that the mental act is not essentially of the same nature in the animal as in man. If either refers what he perceives with his senses to a mental concept, then so do both. When I say to my terrier, in an eager voice (and I have made the trial many times), "Hi, hi, where is it?" she at once takes it as a sign that something is to be hunted, and generally first looks quickly all around, and then rushes into the nearest thicket, to scent for any game, but finding nothing, she looks up into any neighboring tree for a squirrel. Now do not these actions clearly show that she

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had in her mind a general idea or concept that some animal is to be discovered and hunted?

It may be freely admitted that no animal is self-conscious, if by this term it is implied that he reflects on such points, as whence he comes or whither he will go, or what is life and death, and so forth. But how can we feel sure that an old dog with an excellent memory and some power of imagination, as shown by his dreams, never reflects on his past pleasures or pains in the chase? And this would be a form of self-consciousness. On the other hand, as Büchner has remarked, how little can the hard-worked wife of a degraded Australian savage, who uses very few abstract words, and cannot count above four, exert her self-consciousness, or reflect on the nature of her own existence. It is generally admitted, that the higher animals possess memory, attention, association, and even some imagination and reason. If these powers, which differ much in different animals, are capable of improvement, there seems no great improbability in more complex faculties, such as the higher forms of abstraction, and self-consciousness, &c., having been evolved through the development and combination of the simpler ones. It has been urged against the views here maintained that it is impossible to say at what point in the ascending scale animals become capable of abstraction, &c.; but who can say at what age this occurs in our young children? We see at least that such powers are developed in children by imperceptible degrees.

That animals retain their mental individuality is unquestionable. When my voice awakened a train of old associations in the mind of the before-mentioned dog, he must have retained his mental individuality, although every atom of his brain had probably undergone change more than once during the interval of five years. This dog might have brought forward the argument lately advanced to crush all evolutionists, and said, "I abide amid all mental moods and all material changes. . . . The teaching that atoms leave their impressions as legacies to other atoms falling into the places they have vacated is contradictory of the utterance of consciousness, and is therefore false; but it is the teaching necessitated by evolutionism, consequently the hypothesis is a false one."

Language.— This faculty has justly been considered as one

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of the chief distinctions between man and the lower animals. But man, as a highly competent judge, Archbishop Whately remarks, "is not the only animal that can make use of language to express what is passing in his mind, and can understand, more or less, what is so expressed by another." In Paraguay the *Cebus azaræ* when excited utters at least six distinct sounds, which excite in other monkeys similar emotions. The movements of the features and gestures of monkeys are understood by us, and they partly understand ours, as Rengger and others declare. It is a more remarkable fact that the dog, since being domesticated, has learnt to bark in at least four or five distinct tones. Although barking is a new art, no doubt the wild parent-species of the dog expressed their feelings by cries of various kinds. With the domesticated dog we have the bark of eagerness, as in the chase; that of anger, as well as growling; the yelp or howl of despair, as when shut up; the baying at night; the bark of joy, as when starting on a walk with his master; and the very distinct one of demand or supplication, as when wishing for a door or window to be opened. According to Houzeau, who paid particular attention to the subject, the domestic fowl utters at least a dozen significant sounds.

The habitual use of articulate language is, however, peculiar to man; but he uses, in common with the lower animals, inarticulate cries to express his meaning, aided by gestures and the movements of the muscles of the face. This especially holds good with the more simple and vivid feelings, which are but little connected with our higher intelligence. Our cries of pain, fear, surprise, anger, together with their appropriate actions, and the murmur of a mother to her beloved child, are more expressive than any words. That which distinguishes man from the lower animals is not the understanding of articulate sounds, for, as every one knows, dogs understand many words and sentences. In this respect they are at the same stage of development as infants, between the ages of ten and twelve months, who understand many words and short sentences, but cannot yet utter a single word. It is not the mere articulation which is our distinguishing character, for parrots and other birds possess this power. Nor is it the mere capacity of connecting definite sounds with definite ideas; for it is certain that some parrots, which have been taught to speak, connect

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unerringly words with things and persons with events.[8] The lower animals differ from man solely in his almost infinitely larger power of associating together the most diversified sounds and ideas; and this obviously depends on the high development of his mental powers.

As Horne Tooke, one of the founders of the noble science of philology, observes, language is an art, like brewing or baking; but writing would have been a better simile. It certainly is not a true instinct, for every language has to be learnt. It differs, however, widely from all ordinary arts, for man has an instinctive tendency to speak, as we see in the babble of our young children; whilst no child has an instinctive tendency to brew, bake, or write. Moreover, no philologist now supposes that any language has been deliberately invented; it has been slowly and unconsciously developed by many steps.[9] The sounds uttered by birds offer in several respects the nearest analogy to language, for all the members of the same species utter the same instinctive cries expressive of their emotions; and all the kinds which sing, exert their power instinctively; but the actual song, and even the call-notes, are learnt from their parents or foster-parents. These sounds, as Daines Barrington has proved, "are no more innate than language is in man." The first attempts to sing "may be compared to the imperfect endeavor in a child to babble." The young males continue practising, or as the bird-catchers say, "recording," for ten or eleven months. Their first essays shows hardly a rudiment of the future song;

[8] I have received several detailed accounts to this effect. Admiral Sir B. J. Sulivan, whom I know to be a careful observer, assures me that an African parrot, long kept in his father's house, invariably called certain persons of the household, as well as visitors, by their names. He said "good morning" to every one at breakfast, and "good night" to each as they left the room at night, and never reversed these salutations. To Sir B. J. Sulivan's father, he used to add to the "good morning," a short sentence, which was never once repeated after his father's death. He scolded violently a strange dog which came into the room through the open window; and he scolded another parrot (saying "you naughty polly") which had got out of its cage, and was eating apples on the kitchen table. See also, to the same effect, Houzeau on parrots, "Facultés Mentales," tom. ii. p. 309. Dr. A. Moschkau informs me that he knew a starling which never made a mistake in saying in German "good morning" to persons arriving, and "good bye, old fellow," to those departing. I could add several other such cases.

[9] Prof. Whitney, in his "Oriental and Linguistic Studies," p. 354, observes that the desire of communication between man is the living force, which, in the development of language, "works both consciously and unconsciously; consciously as regards the immediate end to be attained; unconsciously as regards the further consequences of the act."

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but as they grow older we can perceive what they are aiming at; and at last they are said "to sing their song round." Nestlings which have learnt the song of a distinct species, as with the canary-birds educated in the Tyrol, teach and transmit their new song to their offspring. The slight natural differences of song in the same species inhabiting different districts may be appositely compared, as Barrington remarks, "to provincial dialects"; and the songs of allied, though distinct species may be compared with the languages of distinct races of man. I have given the foregoing details to show that an instinctive tendency to acquire an art is not peculiar to man.

With respect to the origin of articulate language, after having read on the one side the highly interesting works of Mr. Hensleigh Wedgwood, the Rev. F. Farrar, and Prof. Schleicher, and the celebrated lectures of Prof. Max Müller on the other side, I cannot doubt that language owes its origin to the imitation and modification of various natural sounds, the voices of other animals, and man's own instinctive cries, aided by signs and gestures. When we treat of sexual selection we shall see that primeval man, or rather some early progenitor of man, probably first used his voice in producing true musical cadences, that is in singing, as do some of the gibbon-apes at the present day; and we may conclude from a widely-spread analogy, that this power would have been especially exerted during the courtship of the sexes,— would have expressed various emotions, such as love, jealousy, triumph,— and would have served as a challenge to rivals. It is, therefore, probable that the imitation of musical cries by articulate sounds may have given rise to words expressive of various complex emotions. The strong tendency in our nearest allies, the monkeys, in microcephalous idiots, and in the barbarous races of mankind, to imitate whatever they hear deserves notice, as bearing on the subject of imitation. Since monkeys certainly understand much that is said to them by man, and when wild, utter signal-cries of danger to their fellows; and since fowls give distinct warnings for danger on the ground, or in the sky from hawks (both, as well as a third cry, intelligible to dogs),[10] may not some unusually wise ape-like animal have imitated the growl of a beast of prey, and thus told his fellow-monkeys the nature of

[10] Houzeau gives a very curious account of his observations on this subject in his "Facultés Mentales des Animaux," tom. ii. p. 348.

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the expected danger? This would have been a first step in the formation of a language.

As the voice was used more and more, the vocal organs would have been strengthened and perfected through the principle of the inherited effects of use; and this would have reacted on the power of speech. But the relation between the continued use of language and the development of the brain, has no doubt been far more important. The mental powers in some early progenitor of man must have been more highly developed than in any existing ape, before even the most imperfect form of speech could have come into use; but we may confidently believe that the continued use and advancement of this power would have reacted on the mind itself, by enabling and encouraging it to carry on long trains of thought. A complex train of thought can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or algebra. It appears, also, that even an ordinary train of thought almost requires, or is greatly facilitated by some form of language, for the dumb, deaf, and blind girl, Laura Bridgman, was observed to use her fingers whilst dreaming. Nevertheless, a long succession of vivid and connected ideas may pass through the mind without the aid of any form of language, as we may infer from the movements of dogs during their dreams. We have, also, seen that animals are able to reason to a certain extent, manifestly without the aid of language. The intimate connection between the brain, as it is now developed in us, and the faculty of speech, is well shown by those curious cases of brain-disease in which speech is specially affected, as when the power to remember substantives is lost, whilst other words can be correctly used, or where substantives of a certain class, or all except the initial letters of substantives and proper names are forgotten.[11] There is no more improbability in the continued use of the mental and vocal organs leading to inherited changes in their structure and functions, than in the case of hand-writing, which depends partly on the form of the hand and partly on the disposition of the mind; and handwriting is certainly inherited.

Several writers, more especially Prof. Max Müller, have lately insisted that the use of language implies the power of forming

[11] Many curious cases have been recorded. See, for instance, Dr. Bateman "On Aphasia," p. 27, 31, 53, 100, &c.

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general concepts; and that as no animals are supposed to possess this power, an impassable barrier is formed between them and man.[12] With respect to animals, I have already endeavored to show that they have this power, at least in a rude and incipient degree. As far as concerns infants of from ten to eleven months old, and deaf-mutes, it seems to me incredible, that they should be able to connect certain sounds with certain general ideas as quickly as they do, unless such ideas were already formed in their minds. The same remark may be extended to the more intelligent animals; as Mr. Leslie Stephen observes, "A dog frames a general concept of cats or sheep, and knows the corresponding words as well as a philosopher. And the capacity to understand is as good a proof of vocal intelligence, though in an inferior degree, as the capacity to speak."

Why the organs now used for speech should have been originally perfected for this purpose, rather than any other organs, it is not difficult to see. Ants have considerable powers of intercommunication by means of their antennæ, as shown by Huber, who devotes a whole chapter to their language. We might have used our fingers as efficient instruments, for a person with practice can report to a deaf man every word of a speech rapidly delivered at a public meeting; but the loss of our hands, whilst thus employed, would have been a serious inconvenience. As all the higher mammals possess vocal organs, constructed on the same general plan as ours, and used as a means of communication, it was obviously probable that these same organs would be still further developed if the power of communication had to be improved; and this has been effected by the aid of adjoining and well adapted parts,

[12] The judgment of a distinguished philologist, such as Prof. Whitney, will have far more weight on this point than anything that I can say. He remarks ("Oriental and Linguistic Studies," p. 297), in speaking of Bleek's views: "Because on the grand scale language is the necessary auxiliary of thought, indispensable to the development of the power of thinking, to the distinctness and variety and complexity of cognitions to the full mastery of consciousness; therefore he would fain make thought absolutely impossible without speech, identifying the faculty with its instrument. He might just as reasonably assert that the human hand cannot act without a tool. With such a doctrine to start from, he cannot stop short of Müller's worst paradoxes, that an infant (*in fans*, not speaking) is not a human being, and that deaf-mutes do not become possessed of reason until they learn to twist their fingers into imitation of spoken words." Max Müller gives in italics ("Lectures on Mr. Darwin's Philosophy of Language," third lecture) the following aphorism: "There is no thought without words, as little as there are words without thought." What a strange definition must here be given to the word thought!

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namely the tongue and lips.[13] The fact of the higher apes not using their vocal organs for speech, no doubt depends on their intelligence not having been sufficiently advanced. The possession by them of organs, which with long-continued practice might have been used for speech, although not thus used, is paralleled by the case of many birds which possess organs fitted for singing, though they never sing. Thus, the nightingale and crow have vocal organs similarly constructed, these being used by the former for diversified song, and by the latter only for croaking.[14] If it be asked why apes have not had their intellects developed to the same degree as that of man, general causes only can be assigned in answer, and it is unreasonable to expect any thing more definite, considering our ignorance with respect to the successive stages of development through which each creature has passed.

The formation of different languages and of distinct species, and the proofs that both have been developed through a gradual process, are curiously parallel.[15] But we can trace the formation of many words further back than that of species, for we can perceive how they actually arose from the imitation of various sounds. We find in distinct languages striking homologies due to community of descent, and analogies due to a similar process of formation. The manner in which certain letters or sounds change when others change is very like correlated growth. We have in both cases the reduplication of parts, the effects of long-continued use, and so forth. The frequent presence of rudiments, both in languages and in species, is still more remarkable. The letter *m* in the word *am,* means *I;* so that in the expression *I am,* a superfluous and useless rudiment has been retained. In the spelling also of words, letters often remain as the rudiments of ancient forms of pronunciation. Languages, like organic beings, can be classed in groups under groups; and they

[13] See some good remarks to this effect by Dr. Maudsley, "The Physiology and Pathology of Mind," p. 199.

[14] An excellent observer, Mr. Blackwall, remarks that the magpie learns to pronounce single words, and even short sentences, more readily than almost any other British bird; yet, as he adds, after long and closely investigating its habits, he has never known it, in a state of nature, display any unusual capacity for imitation. "Researches in Zoology," p. 158.

[15] See the very interesting parallelism between the development of species and languages, given by Sir C. Lyell in "The Geolog. Evidences of the Antiquity of Man," chap. xxiii.

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can be classed either naturally according to descent, or artificially by other characters. Dominant languages and dialects spread widely, and lead to the gradual extinction of other tongues. A language, like a species, when once extinct, never, as Sir C. Lyell remarks, reappears. The same language never has two birth-places. Distinct languages may be crossed or blended together.[16] We see variability in every tongue, and new words are continually cropping up; but as there is a limit to the powers of the memory, single words, like whole languages, gradually become extinct. As Max Müller has well remarked:—"A struggle for life is constantly going on amongst the words and grammatical forms in each language. The better, the shorter, the easier forms are constantly gaining the upper hand, and they owe their success to their own inherent virtue." To these more important causes of the survival of certain words, mere novelty and fashion may be added; for there is in the mind of man a strong love for slight changes in all things. The survival or preservation of certain favored words in the struggle for existence is natural selection.

The perfectly regular and wonderfully complex construction of the languages of many barbarous nations has often been advanced as a proof, either of the divine origin of these languages, or of the high art and former civilization of their founders. Thus F. von Schlegel writes: "In those languages which appear to be at the lowest grade of intellectual culture, we frequently observe a very high and elaborate degree of art in their grammatical structure. This is especially the case with the Basque and the Lapponian, and many of the American languages. But it is assuredly an error to speak of any language as an art, in the sense of its having been elaborately and methodically formed. Philologists now admit that conjugations, declensions, &c., originally existed as distinct words, since joined together; and as such words express the most obvious relations between objects and persons, it is not surprising that they should have been used by the men of most races during the earliest ages. With respect to perfection, the following illustration will best show how easily we may err: a Crinoid sometimes consists of no less than 150,000 pieces of shell, all arranged with perfect

[16] See remarks to this effect by the Rev. F. W. Farrar, in an interesting article, entitled "Philology and Darwinism," in "Nature," March 24th, 1870, p. 528.

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symmetry in radiating lines; but a naturalist does not consider an animal of this kind as more perfect than a bilateral one with comparatively few parts, and with none of these parts alike, excepting on the opposite sides of the body. He justly considers the differentiation and specialization of organs as the test of perfection. So with languages: the most symmetrical and complex ought not to be ranked above irregular, abbreviated, and bastardized languages, which have borrowed expressive words and useful forms of construction from various conquering, conquered, or immigrant races.

From these few and imperfect remarks I conclude that the extremely complex and regular construction of many barbarous languages, is no proof that they owe their origin to a special act of creation. Nor, as we have seen, does the faculty of articulate speech in itself offer any insuperable objection to the belief that man has been developed from some lower form.

Sense of Beauty.— This sense has been declared to be peculiar to man. I refer here only to the pleasure given by certain colors, forms, and sounds, and which may fairly be called a sense of the beautiful; with cultivated men such sensations are, however, intimately associated with complex ideas and trains of thought. When we behold a male bird elaborately displaying his graceful plumes or splendid colors before the female, whilst other birds, not thus decorated, make no such display, it is impossible to doubt that she admires the beauty of her male partner. As women everywhere deck themselves with these plumes, the beauty of such ornaments cannot be disputed. As we shall see later, the nests of humming-birds, and the playing passages of bower-birds are tastefully ornamented with gayly-colored objects; and this shows that they must receive some kind of pleasure from the sight of such things. With the great majority of animals, however, the taste for the beautiful is confined, as far as we can judge, to the attractions of the opposite sex. The sweet strains poured forth by many male birds during the season of love, are certainly admired by the females, of which fact evidence will hereafter be given. If female birds had been incapable of appreciating the beautiful colors, the ornaments, and voices of their male partners, all the labor and anxiety exhibited by the latter in displaying their charms before the females would have been thrown away; and this it is impossible to admit. Why certain

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bright colors should excite pleasure cannot, I presume, be explained, any more than why certain flavors and scents are agreeable; but habit has something to do with the result, for that which is at first unpleasant to our senses, ultimately becomes pleasant, and habits are inherited. With respect to sounds, Helmholtz has explained to a certain extent on physiological principles, why harmonies and certain cadences are agreeable. But besides this, sounds frequently recurring at irregular intervals are highly disagreeable, as every one will admit who has listened at night to the irregular flapping of a rope on board ship. The same principle seems to come into play with vision, as the eye prefers symmetry or figures with some regular recurrence. Patterns of this kind are employed by even the lowest savages as ornaments; and they have been developed through sexual selection for the adornment of some male animals. Whether we can or not give any reason for the pleasure thus derived from vision and hearing, yet man and many of the lower animals are alike pleased by the same colors, graceful shading and forms, and the same sounds.

The taste for the beautiful, at least as far as female beauty is concerned, is not of a special nature in the human mind; for it differs widely in the different races of man, and is not quite the same even in the different nations of the same race. Judging from the hideous ornaments, and the equally hideous music admired by most savages, it might be urged that their æsthetic faculty was not so highly developed as in certain animals, for instance, as in birds. Obviously no animal would be capable of admiring such scenes as the heavens at night, a beautiful landscape, or refined music; but such high tastes are acquired through culture, and depend on complex associations; they are not enjoyed by barbarians or by uneducated persons.

Many of the faculties, which have been of inestimable service to man for his progressive advancement, such as the powers of the imagination, wonder, curiosity, an undefined sense of beauty, a tendency to imitation, and the love of excitement or novelty, could hardly fail to lead to capricious changes of customs and fashions. I have alluded to this point, because a recent writer has oddly fixed on Caprice "as one of the most remarkable and typical differences between savages and brutes." But not only can we partially understand how it is that man is

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from various conflicting influences rendered capricious, but that the lower animals are, as we shall hereafter see, likewise capricious in their affections, aversions, and sense of beauty. There is also reason to suspect that they love novelty, for its own sake.

Belief in God — Religion.— There is no evidence that man was aboriginally endowed with the ennobling belief in the existence of an Omnipotent God. On the contrary there is ample evidence, derived not from hasty travelers, but from men who have long resided with savages, that numerous races have existed, and still exist, who have no idea of one or more gods, and who have no words in their languages to express such an idea. The question is of course wholly distinct from that higher one, whether there exists a Creator and Ruler of the universe; and this has been answered in the affirmative by some of the highest intellects that have ever existed.

If, however, we include under the term "religion" the belief in unseen or spiritual agencies, the case is wholly different; for this belief seems to be universal with the less civilized races. Nor is it difficult to comprehend how it arose. As soon as the important faculties of the imagination, wonder, and curiosity, together with some power of reasoning, had become partially developed, man would naturally crave to understand what was passing around him, and would have vaguely speculated on his own existence. As Mr. M'Lennan has remarked, "Some explanation of the phenomena of life, a man must feign for himself, and to judge from the universality of it, the simplest hypothesis, and the first to occur to men, seems to have been that natural phenomena are ascribable to the presence in animals, plants, and things, and in the forces of nature, of such spirits prompting to action as men are conscious they themselves possess." It is also probable, as Mr. Taylor has shown, that dreams may have first given rise to the notion of spirits; for savages do not readily distinguish between subjective and objective impressions. When a savage dreams, the figures which appear before him are believed to have come from a distance, and to stand over him; or "the soul of the dreamer goes out on its travels, and comes home with a remembrance of what it has seen." [17] But until the

[17] Tylor, "Early History of Mankind," p. 6. See also the three striking chapters on the Development of Religion, in Lubbock's "Origin of

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faculties of imagination, curiosity, reason, &c., had been fairly well developed in the mind of man, his dreams would not have led him to believe in spirits, any more than in the case of a dog.

The tendency in savages to imagine that natural objects and agencies are animated by spiritual or living essences, is perhaps illustrated by a little fact which I once noticed: my dog, a full-grown and very sensible animal, was lying on the lawn during a hot and still day; but at a little distance a slight breeze occasionally moved an open parasol, which would have been wholly disregarded by the dog, had any one stood near it. As it was, every time that the parasol slightly moved, the dog growled fiercely and barked. He must, I think, have reasoned to himself in a rapid and unconscious manner, that movement without any apparent cause indicated the presence of some strange living agent, and that no stranger had a right to be on his territory.

The belief in spiritual agencies would easily pass into the belief in the existence of one or more gods. For savages would naturally attribute to spirits the same passions, the same love of vengeance or simplest form of justice, and the same affections which they themselves feel. The Fuegians appear to be in this respect in an intermediate condition, for when the surgeon on board the "Beagle" shot some young ducklings as specimens, York Minster declared in the most solemn manner, "Oh, Mr. Bynoe, much rain, much snow, blow much;" and this was evidently a retributive punishment for wasting human food. So again he related how, when his brother killed a "wild man," storms long raged, much rain and snow fell. Yet we could never discover that the Fuegians believed in what we should call a God, or practised any religious rites; and Jemmy Button, with justifiable pride, stoutly maintained that there was no devil in his

Civilization," 1870. In a like manner Mr. Herbert Spencer, in his ingenious essay in the "Fortnightly Review" (May 1st, 1870, p. 535), accounts for the earliest forms of religious belief throughout the world, by man being led through dreams, shadows, and other causes, to look at himself as a double essence, corporeal and spiritual. As the spiritual being is supposed to exist after death and to be powerful, it is propitiated by various gifts and ceremonies, and its aid invoked. He then further shows that names or nicknames given from some animal or other object, to the early progenitors or founders of a tribe, are supposed after a long interval to represent the real progenitor of the tribe; and such animal or object is then naturally believed still to exist as a spirit, is held sacred, and worshipped as a god. Nevertheless I cannot but suspect that there is a still earlier and ruder stage, when anything which manifests power or movement is thought to be endowed with some form of life, and with mental faculties analogous to our own.

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land. This latter assertion is the more remarkable, as with savages the belief in bad spirits is far more common than that in good ones.

The feeling of religious devotion is a highly complex one, consisting of love, complete submission to an exalted and mysterious superior, a strong sense of dependence, fear, reverence, gratitude, hope for the future, and perhaps other elements. No being could experience so complex an emotion until advanced in his intellectual and moral faculties to at least a moderately high level. Nevertheless, we see some distant approach to this state of mind in the deep love of a dog for his master, associated with complete submission, some fear, and perhaps other feelings. The behavior of a dog when returning to his master after an absence, and, as I may add, of a monkey to his beloved keeper, is widely different from that towards their fellows. In the latter case the transports of joy appear to be somewhat less, and the sense of equality is shown in every action. Professor Braubach goes so far as to maintain that a dog looks on his master as on a god.[18]

The same high mental faculties which first led man to believe in unseen spiritual agencies, then in fetishism, polytheism, and ultimately in monotheism, would infallibly lead him, as long as his reasoning powers remained poorly developed, to various strange superstitions and customs. Many of these are terrible to think of — such as the sacrifice of human beings to a blood-loving god; the trial of innocent persons by the ordeal of poison or fire; witchcraft, &c.— yet it is well occasionally to reflect on these superstitions, for they show us what an infinite debt of gratitude we owe to the improvement of our reason, to science, and to our accumulated knowledge. As Sir J. Lubbock has well observed, "It is not too much to say that the horrible dread of unknown evil hangs like a thick cloud over savage life, and embitters every pleasure." These miserable and indirect consequences of our highest faculties may be compared with the incidental and occasional mistakes of the instincts of the lower animals.

[18] It is said (Dr. W. Lauder Lindsay, "Journal of Mental Science," 1871, p. 43), that Bacon long ago, and the poet Burns, held the same notion.

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CHAPTER IV.

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS — *continued.*

The moral sense — Fundamental proposition — The qualities of social animals — Origin of sociability — Struggle between opposed instincts — Man a social animal — The more enduring social instincts conquer other less persistent instincts — The social virtues alone regarded by savages — The self-regarding virtues acquired at a later stage of development — The importance of the judgment of the members of the same community on conduct — Transmission of moral tendencies — Summary.

I FULLY subscribe to the judgment of those writers who maintain that of all the differences between man and the lower animals, the moral sense or conscience is by far the most important. This sense, as Mackintosh remarks, "has a rightful supremacy over every other principle of human action;" it is summed up in that short but imperious word *ought*, so full of high significance. It is the most noble of all the attributes of man, leading him without a moment's hesitation to risk his life for that of a fellow-creature; or after due deliberation, impelled simply by the deep feeling of right or duty, to sacrifice it in some great cause. Immanuel Kant exclaims, "Duty! Wondrous thought, that workest neither by fond insinuation, flattery nor by any threat, but merely by holding up thy naked law in the soul, and so extorting for thyself always reverence, if not always obedience; before whom all appetites are dumb, however secretly they rebel; whence thy original?"

This great question has been discussed by many writers of consummate ability; and my sole excuse for touching on it, is the impossibility of here passing it over; and because, as far as I know, no one has approached it exclusively from the side of natural history. The investigation possesses, also, some independent interest, as an attempt to see how far the study of the

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lower animals throws light on one of the highest psychical faculties of man.

The following proposition seems to me in a high degree probable — namely, that any animal whatever, endowed with well-marked social instincts,[1] the parental and filial affections being here included, would inevitably acquire a moral sense or conscience, as soon as its intellectual powers had become as well, or nearly as well developed, as in man. For, *firstly*, the social instincts lead an animal to take pleasure in the society of its fellows, to feel a certain amount of sympathy with them, and to perform various services for them. The services may be of a definite and evidently instinctive nature; or there may be only a wish and readiness, as with most of the higher social animals, to aid their fellows in certain general ways. But these feelings and services are by no means extended to all the individuals of the same species, only to those of the same association. *Secondly*, as soon as the mental faculties had became highly developed, images of all past actions and motives would be incessantly passing through the brain of each individual: and that feeling of dissatisfaction, or even misery, which invariably results, as we shall hereafter see, from any unsatisfied instinct, would arise, as often as it was perceived that the enduring and always present social instinct had yielded to some other instinct, at the time stronger, but neither enduring in its nature, nor leaving behind it a very vivid impression. It is clear that many instinctive desires,

[1] Sir B. Brodie, after observing that man is a social animal ("Psychological Inquiries," p. 192), asks the pregnant question, "ought not this to settle the disputed question as to the existence of a moral sense?" Similar ideas have probably occurred to many persons, as they did long ago to Marcus Aurelius. Mr. J. S. Mill speaks, in his celebrated work, "Utilitarianism," (pp. 45, 46), of the social feelings as a "powerful natural sentiment," and as "the natural basis of sentiment for utilitarian morality." Again he says, "Like the other acquired capacities above referred to, the moral faculty, if not a part of our nature, is a natural outgrowth from it; capable, like them, in a certain small degree of springing up spontaneously." But in opposition to all this, he also remarks, "if, as in my own belief, the moral feelings are not innate, but acquired, they are not for that reason less natural." It is with hesitation that I venture to differ at all from so profound a thinker, but it can hardly be disputed that the social feelings are instinctive or innate in the lower animals; and why should they not be so in man? Mr. Bain (see, for instance, "The Emotions and the Will," p. 481) and others believe that the moral sense is acquired by each individual during his lifetime. On the general theory of evolution this is at least extremely improbable. The ignoring of all transmitted mental qualities will, as it seems to me, be hereafter judged as a most serious blemish in the works of Mr. Mill.

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such as that of hunger, are in their nature of short duration; and after being satisfied, are not readily or vividly recalled. *Thirdly,* after the power of language had been acquired, and the wishes of the community could be expressed, the common opinion how each member ought to act for the public good, would naturally become in a paramount degree the guide to action. But it should be borne in mind that however great weight we may attribute to public opinion, our regard for the approbation and disapprobation of our fellows depends on sympathy, which, as we shall see, forms an essential part of the social instinct, and is indeed its foundation-stone. *Lastly,* habit in the individual would ultimately play a very important part in guiding the conduct of each member; for the social instinct, together with sympathy, is, like any other instinct, greatly strengthened by habit, and so consequently would be obedience to the wishes and judgment of the community. These several subordinate propositions must now be discussed, and some of them at considerable length.

It may be well first to premise that I do not wish to maintain that any strictly social animal, if its intellectual faculties were to become as active and as highly developed as in man, would acquire exactly the same moral sense as ours. In the same manner as various animals have some sense of beauty, though they admire widely different objects, so they might have a sense of right and wrong, though led by it to follow widely different lines of conduct. If, for instance, to take an extreme case, men were reared under precisely the same conditions as hive-bees, there can hardly be a doubt that our unmarried females would, like the worker-bees, think it a sacred duty to kill their brothers, and mothers would strive to kill their fertile daughters; and no one would think of interfering.[2] Nevertheless, the bee, or any other

[2] Mr. H. Sidgwick remarks, in an able discussion on this subject, "a superior bee, we may feel sure, would aspire to a milder solution of the popular question." Judging, however, from the habits of many or most savages, man solves the problem by female infanticide, polyandry and promiscuous intercourse; therefore it may well be doubted whether it would be by a milder method. Miss Cobbe, in commenting on the same illustration, says, the *principles* of social duty would be thus reversed; and by this, I presume, she means that the fulfilment of a social duty would tend to the injury of individuals; but she overlooks the fact, which she would doubtless admit, that the instincts of the bee have been acquired for the good of the community. She goes so far as to say that if the theory of ethics advocated in this chapter were ever generally accepted, "I cannot but believe that in the hour of their triumph would be sounded the knell of the virtue of mankind!" It is to be hoped that the

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social animal, would gain in our supposed case, as it appears to me, some feeling of right or wrong, or a conscience. For each individual would have an inward sense of possessing certain stronger or more enduring instincts, and others less strong or enduring; so that there would often be a struggle as to which impulse should be followed; and satisfaction, dissatisfaction, or even misery would be felt, as past impressions were compared during their incessant passage through the mind. In this case an inward monitor would tell the animal that it would have been better to have followed the one impulse rather than the other. The one course ought to have been followed, and the other ought not; the one would have been right and the other wrong; but to these terms I shall recur.

Sociability.— Animals of many kinds are social; we find even distinct species living together; for example, some American monkeys; and united flocks of rooks, jackdaws, and starlings. Man shows the same feeling in his strong love for the dog, which the dog returns with interest. Every one must have noticed how miserable horses, dogs, sheep, &c., are when separated from their companions, and what strong mutual affection the two former kinds, at least, show on their reunion. It is curious to speculate on the feelings of a dog, who will rest peacefully for hours in a room with his master or any of the family, without the least notice being taken of him; but if left for a short time by himself, barks or howls dismally. We will confine our attention to the higher social animals; and pass over insects, although some of these are social, and aid one another in many important ways. The most common mutual service in the higher animals is to warn one another of danger by means of the united senses of all. Every sportsman knows, as Dr. Jaeger remarks, how difficult it is to approach animals in a herd or troop. Wild horses and cattle do not, I believe, make any danger-signal; but the attitude of any one of them who first discovers an enemy, warns the others. Rabbits stamp loudly on the ground with their hind-feet as a signal: sheep and chamois do the same with their fore-feet, uttering likewise a whistle. Many birds, and some mammals, post sentinels, which in the case of seals are said generally to be the females. The leader of a troop of monkeys acts as the

belief in the permanence of virtue on this earth is not held by many persons on so weak a tenure.

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sentinel, and utters cries expressive both of danger and of safety.[3] Social animals perform many little services for each other: horses nibble, and cows lick each other, on any spot which itches: monkeys search each other for external parasites; and Brehm states that after a troop of the *Cercopithecus griseo-viridis* has rushed through a thorny brake, each monkey stretches itself on a branch, and another monkey sitting by, "conscientiously" examines its fur, and extracts every thorn or burr.

Animals also render more important services to one another: thus wolves and some other beasts of prey hunt in packs, and aid one another in attacking their victims. Pelicans fish in concert. The Hamadryas baboons turn over stones to find insects, &c.; and when they come to a large one, as many as can stand round, turn it over together and share the booty. Social animals mutually defend each other. Bull bisons in N. America, when there is danger, drive the cows and calves into the middle of the herd, whilst they defend the outside. I shall also in a future chapter give an account of two young wild bulls at Chillingham attacking an old one in concert, and of two stallions together trying to drive away a third stallion from a troop of mares. In Abyssinia, Brehm encountered a great troop of baboons who were crossing a valley: some had already ascended the opposite mountain, and some were still in the valley: the latter were attacked by the dogs, but the old males immediately hurried down from the rocks, and with mouths widely opened roared so fearfully that the dogs quickly drew back. They were again encouraged to the attack; but by this time all the baboons had reascended the heights, excepting a young one, about six months old, who, loudly calling for aid, climbed on a block of rock, and was surrounded. Now one of the largest males, a true hero, came down again from the mountain, slowly went to the young one, coaxed him, and triumphantly led him away — the dogs being too much astonished to make an attack. I cannot resist giving another scene which was witnessed by this same naturalist; an eagle seized a young Cercopithecus, which, by clinging to a branch, was not at once

[3] Brehm, "Thierleben," B. i. s. 52, 79. For the case of the monkeys extracting thorns from each other, see s. 54. With respect to the Hamadryas turning over stones, the fact is given (s. 76) on the evidence of Alvarez, whose observations Brehm thinks quite trustworthy. For the cases of the old male baboons attacking the dogs, see s. 79; and with respect to the eagle, s. 56.

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carried off; it cried loudly for assistance, upon which the other members of the troop, with much uproar, rushed to the rescue, surrounded the eagle, and pulled out so many feathers, that he no longer thought of his prey, but only how to escape. This eagle, as Brehm remarks, assuredly would never again attack a single monkey of a troop.[4]

It is certain that associated animals have a feeling of love for each other, which is not felt by non-social adult animals. How far in most cases they actually sympathize in the pains and pleasures of others, is more doubtful, especially with respect to pleasures. Mr. Buxton, however, who had excellent means of observation, states that his macaws, which lived free in Norfolk, took "an extravagant interest" in a pair with a nest; and whenever the female left it, she was surrounded by a troop "screaming horrible acclamations in her honor." It is often difficult to judge whether animals have any feeling for the sufferings of others of their kind. Who can say what cows feel, when they surround and stare intently on a dying or dead companion; apparently, however, as Houzeau remarks, they feel no pity. That animals sometimes are far from feeling any sympathy is too certain; for they will expel a wounded animal from the herd, or gore or worry it to death. This is almost the blackest fact in natural history, unless, indeed, the explanation which has been suggested is true, that their instinct or reason leads them to expel an injured companion, lest beasts of prey, including man, should be tempted to follow the troop. In this case their conduct is not much worse than that of the North American Indians, who leave their feeble comrades to perish on the plains; or the Fijians, who, when their parents get old, or fall ill, bury them alive.

Many animals, however, certainly sympathize with each other's distress or danger. This is the case even with birds. Captain Stansbury found on a salt lake in Utah an old and completely blind pelican, which was very fat, and must have been well

[4] Mr. Belt gives the case of a spider-monkey (Ateles) in Nicaragua, which was heard screaming for nearly two hours in the forest, and was found with an eagle perched close by it. The bird apparently feared to attack as long as it remained face to face; and Mr. Belt believes, from what he has seen of the habits of these monkeys, that they protect themselves from eagles by keeping two or three together. "The Naturalist in Nicaragua," p. 118.

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fed for a long time by his companions.[5] Mr. Blyth, as he informs me, saw Indian crows feeding two or three of their companions which were blind; and I have heard of an analogous case with the domestic cock. We may, if we choose, call these actions instinctive; but such cases are much too rare for the development of any special instinct.[6] I have myself seen a dog, who never passed a cat who lay sick in a basket, and was a great friend of his, without giving her a few licks with his tongue, the surest sign of kind feeling in a dog.

It must be called sympathy that leads a courageous dog to fly at any one who strikes his master, as he certainly will. I saw a person pretending to beat a lady, who had a very timid little dog on her lap, and the trial had never been made before; the little creature instantly jumped away, but after the pretended beating was over, it was really pathetic to see how perseveringly he tried to lick his mistress's face, and comfort her. Brehm states that when a baboon in confinement was pursued to be punished, the others tried to protect him. It must have been sympathy in the cases above given which led the baboons and Cercopitheci to defend their young comrades from the dogs and the eagle. I will give only one other instance of sympathetic and heroic conduct, in the case of a little American monkey. Several years ago a keeper at the Zoological Gardens showed me some deep and scarcely healed wounds on the nape of his own neck, inflicted on him, whilst kneeling on the floor, by a fierce baboon. The little American monkey, who was a warm friend of this keeper, lived in the same large compartment, and was dreadfully afraid of the great baboon. Nevertheless, as soon as he saw his friend in peril, he rushed to the rescue, and by screams and bites so distracted the baboon that the man was able to escape, after, as the surgeon thought, running great risk of his life.

Besides love and sympathy, animals exhibit other qualities connected with the social instincts, which in us would be called moral; and I agree with Agassiz that dogs possess something very like a conscience.

[5] Capt. Stansbury also gives an interesting account of the manner in which a very young pelican, carried away by a strong stream, was guided and encouraged in its attempts to reach the shore by half a dozen old birds.

[6] As Mr. Bain states, "effective aid to a sufferer springs from sympathy proper": "Mental and Moral Science," p. 245.

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Dogs possess some power of self-command, and this does not appear to be wholly the result of fear. As Braubach remarks, they will refrain from stealing food in the absence of their master. They have long been accepted as the very type of fidelity and obedience. But the elephant is likewise very faithful to his driver or keeper, and probably considers him as the leader of the herd. Dr. Hooker informs me that an elephant, which he was riding in India, became so deeply bogged that he remained stuck fast until the next day, when he was extricated by men with ropes. Under such circumstances elephants will seize with their trunks any object, dead or alive, to place under their knees, to prevent their sinking deeper in the mud; and the driver was dreadfully afraid lest the animal should have seized Dr. Hooker and crushed him to death. But the driver himself, as Dr. Hooker was assured, ran no risk. This forbearance under an emergency so dreadful for a heavy animal, is a wonderful proof of noble fidelity.

All animals living in a body, which defend themselves or attack their enemies in concert, must indeed be in some degree faithful to one another; and those that follow a leader must be in some degree obedient. When the baboons in Abyssinia plunder a garden, they silently follow their leader; and if an imprudent young animal makes a noise, he receives a slap from the others to teach him silence and obedience. Mr. Galton, who has had excellent opportunities for observing the half-wild cattle in S. Africa, says, that they cannot endure even a momentary separation from the herd. They are essentially slavish, and accept the common determination, seeking no better lot than to be led by any one ox who has enough self-reliance to accept the position. The men who break in these animals for harness, watch assiduously for those who, by grazing apart, show a self-reliant disposition, and these they train as fore-oxen. Mr. Galton adds that such animals are rare and valuable; and if many were born they would soon be eliminated, as lions are always on the look-out for the individuals which wander from the herd.

With respect to the impulse which leads certain animals to associate together, and to aid one another in many ways, we may infer that in most cases they are impelled by the same sense of satisfaction or pleasure which they experience in

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performing other instinctive actions; or by the same sense of dissatisfaction as when other instinctive actions are checked. We see this in innumerable instances, and it is illustrated in a striking manner by the acquired instincts of our domesticated animals; thus a young shepherd-dog delights in driving and running round a flock of sheep, but not in worrying them; a young fox-hound delights in hunting a fox, whilst some other kinds of dogs, as I have witnessed, utterly disregard foxes. What a strong feeling of inward satisfaction must impel a bird, so full of activity, to brood day after day over her eggs. Migratory birds are quite miserable if stopped from migrating; perhaps they enjoy starting on their long flight; but it is hard to believe that the poor pinioned goose, described by Audubon, which started on foot at the proper time for its journey of probably more than a thousand miles, could have felt any joy in doing so. Some instincts are determined solely by painful feelings, as by fear, which leads to self-preservation, and is in some cases directed towards special enemies. No one, I presume, can analyze the sensations of pleasure or pain. In many instances, however, it is probable that instincts are persistently followed from the mere force of inheritance, without the stimulus of either pleasure or pain. A young pointer, when it first scents game, apparently cannot help pointing. A squirrel in a cage who pats the nuts which it cannot eat, as if to bury them in the ground, can hardly be thought to act thus, either from pleasure or pain. Hence the common assumption that men must be impelled to every action by experiencing some pleasure or pain may be erroneous. Although a habit may be blindly and implicitly followed, independently of any pleasure or pain felt at the moment, yet if it be forcibly and abruptly checked, a vague sense of dissatisfaction is generally experienced.

It has often been assumed that animals were in the first place rendered social, and that they feel as a consequence uncomfortable when separated from each other, and comfortable whilst together; but it is a more probable view that these sensations were first developed, in order that those animals which would profit by living in society, should be induced to live together, in the same manner as the sense of hunger and the pleasure of eating were, no doubt, first acquired in order to induce animals to eat. The feeling of pleasure from society is probably an

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extension of the parental or filial affections, since the social instinct seems to be developed by the young remaining for a long time with their parents; and this extension may be attributed in part to habit, but chiefly to natural selection. With those animals which were benefited by living in close association, the individuals which took the greatest pleasure in society would best escape various dangers, whilst those that cared least for their comrades, and lived solitary, would perish in greater numbers. With respect to the origin of the parental and filial affections, which apparently lie at the base of the social instincts, we know not the steps by which they have been gained; but we may infer that it has been to a large extent through natural selection. So it has almost certainly been with the unusual and opposite feeling of hatred between the nearest relations, as with the worker-bees which kill their brother-drones, and with the queen-bees which kill their daughter-queens; the desire to destroy their nearest relations having been in this case of service to the community. Parental affection, or some feeling which replaces it, has been developed in certain animals extremely low in the scale, for example, in star-fishes and spiders. It is also occasionally present in a few members alone in a whole group of animals, as in the genus Forficula, or earwigs.

The all-important emotion of sympathy is distinct from that of love. A mother may passionately love her sleeping and passive infant, but she can hardly at such times be said to feel sympathy for it. The love of a man for his dog is distinct from sympathy; and so is that of a dog for his master. Adam Smith formerly argued, as has Mr. Bain recently, that the basis of sympathy lies in our strong retentiveness of former states of pain or pleasure. Hence, "the sight of another person enduring hunger, cold, fatigue, revives in us some recollection of these states, which are painful even in idea." We are thus impelled to relieve the sufferings of another, in order that our own painful feelings may be at the same time relieved. In like manner we are led to participate in the pleasures of others.[7] But

[7] See the first and striking chapter in Adam Smith's "Theory of Moral Sentiments." Also Mr. Bain's "Mental and Moral Science," 1868, p. 244, and 275–282. Mr. Bain states, that, "sympathy is, indirectly, a source of pleasure to the sympathizer;" and he accounts for this through reciprocity. He remarks that "the person benefited, or others in his stead, may make up, by sympathy and good offices returned, for all the sacrifice." But if, as appears to be the case, sympathy is strictly an instinct, its ex-

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I cannot see how this view explains the fact that sympathy is excited, in an immeasurably stronger degree, by a beloved, than by an indifferent person. The mere sight of suffering, independently of love, would suffice to call up in us vivid recollections and associations. The explanation may lie in the fact that, with all animals, sympathy is directed solely towards the members of the same community, and therefore towards known, and more or less beloved members, but not to all the individuals of the same species. This fact is not more surprising than that the fears of many animals should be directed against special enemies. Species which are not social, such as lions and tigers, no doubt feel sympathy for the suffering of their own young, but not for that of any other animal. With mankind, selfishness, experience, and imitation, probably add, as Mr. Bain has shown, to the power of sympathy; for we are led by the hope of receiving good in return to perform acts of sympathetic kindness to others; and sympathy is much strengthened by habit. In however complex a manner this feeling may have originated, as it is one of high importance to all those animals which aid and defend one another, it will have been increased through natural selection; for those communities, which included the greatest number of the most sympathetic members, would flourish best, and rear the greatest number of offspring.

It is, however, impossible to decide in many cases whether certain social instincts have been acquired through natural selection, or are the indirect result of other instincts and faculties, such as sympathy, reason, experience, and a tendency to imitation; or again, whether they are simply the result of long-continued habit. So remarkable an instinct as the placing sentinels to warn the community of danger, can hardly have been the indirect result of any of these faculties; it must, therefore, have been directly acquired. On the other hand, the habit followed by the males of some social animals of defending the community, and of attacking their enemies or their prey in concert, may perhaps have originated from mutual sympathy; but courage, and in most cases strength, must have been previously acquired, probably through natural selection.

Of the various instincts and habits, some are much stronger

ercise would give direct pleasure, in the same manner as the exercise, as before remarked, of almost every other instinct.

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than others; that is, some either give more pleasure in their performance, and more distress in their prevention, than others; or, which is probably quite as important, they are, through inheritance, more persistently followed, without exciting any special feeling of pleasure or pain. We are ourselves conscious that some habits are much more difficult to cure or change than others. Hence a struggle may often be observed in animals between different instincts, or between an instinct and some habitual disposition; as when a dog rushes after a hare, is rebuked, pauses, hesitates, pursues again, or returns ashamed to his master; or as between the love of a female dog for her young puppies and for her master,— for she may be seen to slink away to them, as if half ashamed of not accompanying her master. But the most curious instance known to me of one instinct getting the better of another, is the migratory instinct conquering the maternal instinct. The former is wonderfully strong; a confined bird will at the proper season beat her breast against the wires of her cage, until it is bare and bloody. It causes young salmon to leap out of the fresh water, in which they could continue to exist, and thus unintentionally to commit suicide. Every one knows how strong the maternal instinct is, leading even timid birds to face great danger, though with hesitation, and in opposition to the instinct of self-preservation. Nevertheless, the migratory instinct is so powerful, that late in the autumn swallows, house-martins, and swifts frequently desert their tender young, leaving them to perish miserably in their nests.[8]

We can perceive that an instinctive impulse, if it be in any way more beneficial to a species than some other or opposed instinct, would be rendered the more potent of the two through natural selection; for the individuals which had it most

[8] This fact, the Rev. L. Jenyns states (see his edition of "White's Nat. Hist. of Selborne," 1853, p. 204), was first recorded by the illustrious Jenner, in "Phil. Transact." 1824, and has since been confirmed by several observers, especially by Mr. Blackwall. This latter careful observer examined, late in the autumn, during two years, thirty-six nests; he found that twelve contained young dead birds, five contained eggs on the point of being hatched, and three, eggs not nearly hatched. Many birds, not yet old enough for a prolonged flight, are likewise deserted and left behind. See Blackwall, "Researches in Zoology," 1834, pp. 108, 118. For some additional evidence, although this is not wanted, see Leroy, "Lettres Phil." 1802, p. 217. For Swifts, Gould's "Introduction to the Birds of Great Britain," 1823, p. 5. Similar cases have been observed in Canada by Mr. Adams; "Pop. Science Review," July, 1873, p. 283.

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strongly developed would survive in larger numbers. Whether this is the case with the migratory in comparison with the maternal instinct, may be doubted. The great persistence, or steady action of the former at certain seasons of the year during the whole day, may give it for a time paramount force.

Man a social animal.— Every one will admit that man is a social being. We see this in his dislike of solitude, and in his wish for society beyond that of his own family. Solitary confinement is one of the severest punishments which can be inflicted. Some authors suppose that man primevally lived in single families; but at the present day, though single families, or only two or three together, roam the solitudes of some savage lands, they always, as far as I can discover, hold friendly relations with other families inhabiting the same district. Such families occasionally meet in council, and unite for their common defense. It is no argument against savage man being a social animal, that the tribes inhabiting adjacent districts are almost always at war with each other; for the social instincts never extend to all the individuals of the same species. Judging from the analogy of the majority of the Quadrumana, it is probable that the early ape-like progenitors of man were likewise social; but this is not of much importance for us. Although man, as he now exists, has few special instincts, having lost many which his early progenitors may have possessed, this is no reason why he should not have retained from an extremely remote period some degree of instinctive love and sympathy for his fellows. We are indeed all conscious that we do possess such sympathetic feelings;[9] but our consciousness does not tell us whether they are instinctive, having originated long ago in the same manner as with the lower animals, or whether they have been acquired by each of us during our early years. As man is a social animal, it is almost certain that he would inherit a tendency to be faithful to his comrades, and obedient to the leader of his tribe; for these qualities are common to most social animals. He would consequently possess some capacity for self-command. He would from an inherited tendency be

[9] Hume remarks ("An Inquiry Concerning the Principles of Morals," edit. of 1751, p. 132), "There seems a necessity for confessing that the happiness and misery of others are not spectacles altogether indifferent to us, but that the view of the former . . . communicates a secret joy; the appearance of the latter . . . throws a melancholy damp over the imagination."

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willing to defend, in concert with others, his fellow-men; and would be ready to aid them in any way, which did not too greatly interfere with his own welfare or his own strong desires.

The social animals which stand at the bottom of the scale are guided almost exclusively, and those which stand higher in the scale are largely guided, by special instincts in the aid which they give to the members of the same community; but they are likewise in part impelled by mutual love and sympathy, assisted apparently by some amount of reason. Although man, as just remarked, has no special instincts to tell him how to aid his fellow-men, he still has the impulse, and with his improved intellectual faculties would naturally be much guided in this respect by reason and experience. Instinctive sympathy would also cause him to value highly the approbation of his fellows; for, as Mr. Bain has clearly shown, the love of praise and the strong feeling of glory, and the still stronger horror of scorn and infamy, "are due to the workings of sympathy." Consequently man would be influenced in the highest degree by the wishes, approbation, and blame of his fellow-men, as expressed by their gestures and language. Thus the social instincts, which must have been acquired by man in a very rude state, and probably even by his early ape-like progenitors, still give the impulse to some of his best actions; but his actions are in a higher degree determined by the expressed wishes and judgment of his fellow-men, and unfortunately very often by his own strong selfish desires. But as love, sympathy and self-command become strengthened by habit, and as the power of reasoning becomes clearer, so that man can value justly the judgments of his fellows, he will feel himself impelled, apart from any transitory pleasure or pain, to certain lines of conduct. He might then declare — not that any barbarian or uncultivated man could thus think — I am the supreme judge of my own conduct, and in the words of Kant, I will not in my own person violate the dignity of humanity.

The more enduring Social Instincts conquer the less persistent Instincts.— We have not, however, as yet considered the main point, on which, from our present point of view, the whole question of the moral sense turns. Why should a man feel that he ought to obey one instinctive desire rather than another? Why is he bitterly regretful, if he has yielded to a strong sense

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of self-preservation, and has not risked his life to save that of a fellow-creature? or why does he regret having stolen food from hunger?

It is evident in the first place, that with mankind the instinctive impulses have different degrees of strength; a savage will risk his own life to save that of a member of the same community, but will be wholly indifferent about a stranger: a young and timid mother urged by the maternal instinct will, without a moment's hesitation, run the greatest danger for her own infant, but not for a mere fellow-creature. Nevertheless many a civilized man, or even boy, who never before risked his life for another, but full of courage and sympathy, has disregarded the instinct of self-preservation, and plunged at once into a torrent to save a drowning man, though a stranger. In this case man is impelled by the same instinctive motive, which made the heroic little American monkey, formerly described, save his keeper, by attacking the great and dreaded baboon. Such actions as the above appear to be the simple result of the greater strength of the social or maternal instincts than that of any other instinct or motive; for they are performed too instantaneously for reflection, or for pleasure or pain to be felt at the time; though, if prevented by any cause, distress or even misery might be felt. In a timid man, on the other hand, the instinct of self-preservation might be so strong, that he would be unable to force himself to run any such risk, perhaps not even for his own child.

I am aware that some persons maintain that actions performed impulsively, as in the above cases, do not come under the dominion of the moral sense, and cannot be called moral. They confine this term to actions done deliberately, after a victory over opposing desires, or when prompted by some exalted motive. But it appears scarcely possible to draw any clear line of distinction of this kind.[10] As far as exalted motives are concerned, many instances have been recorded of savages, destitute of any feeling of general benevolence towards mankind, and not guided by any religious motive, who have deliberately sacrificed

[10] I refer here to the distinction between what has been called *material* and *formal* morality. I am glad to find that Professor Huxley ("Critiques and Addresses," 1873, p. 287) takes the same view on this subject as I do. Mr. Leslie Stephen remarks ("Essays on Freethinking and Plain Speaking," 1873, p. 83), "the metaphysical distinction between material and formal morality is as irrelevant as other such distinctions."

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their lives as prisoners,[11] rather than betray their comrades; and surely their conduct ought to be considered as moral. As far as deliberation, and the victory over opposing motives are concerned, animals may be seen doubting between opposed instincts, in rescuing their offspring or comrades from danger; yet their actions, though done for the good of others, are not called moral. Moreover, anything performed very often by us, will at last be done without deliberation or hesitation, and can then hardly be distinguished from an instinct; yet surely no one will pretend that such an action ceases to be moral. On the contrary, we all feel that an act cannot be considered as perfect, or as performed in the most noble manner, unless it be done impulsively, without deliberation or effort, in the same manner as by a man in whom the requisite qualities are innate. He who is forced to overcome his fear or want of sympathy before he acts, deserves, however, in one way higher credit than the man whose innate disposition leads him to a good act without effort. As we cannot distinguish between motives, we rank all actions of a certain class as moral, if performed by a moral being. A moral being is one who is capable of comparing his past and future actions or motives, and of approving or disapproving of them. We have no reason to suppose that any of the lower animals have this capacity; therefore, when a Newfoundland dog drags a child out of the water, or a monkey faces danger to rescue its comrade, or takes charge of an orphan monkey, we do not call its conduct moral. But in the case of man, who alone can with certainty be ranked as a moral being, actions of a certain class are called moral, whether performed deliberately, after a struggle with opposing motives, or impulsively through instinct, or from the effects of slowly-gained habit.

But to return to our more immediate subject. Although some instincts are more powerful than others, and thus lead to corresponding actions, yet it is untenable, that in man the social instincts (including the love of praise and fear of blame) possess greater strength, or have, through long habit, acquired greater strength than the instincts of self-preservation, hunger, lust, vengeance, &c. Why then does man regret, even though trying to banish such regret, that he has followed the one nat-

[11] I have given one such case, namely of three Patagonian Indians who preferred being shot, one after the other, to betraying the plans of their companions in war ("Journal of Researches," 1845, p. 103).

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ural impulse rather than the other; and why does he further feel that he ought to regret his conduct? Man in this respect differs profoundly from the lower animals. Nevertheless we can, I think, see with some degree of clearness the reason of this difference.

Man, from the activity of his mental faculties, cannot avoid reflection: past impressions and images are incessantly and clearly passing through his mind. Now with those animals which live permanently in a body, the social instincts are ever present and persistent. Such animals are always ready to utter the danger-signal, to defend the community, and to give aid to their fellows in accordance with their habits; they feel at all times, without the stimulus of any special passion or desire, some degree of love and sympathy for them; they are unhappy if long separated from them, and always happy to be again in their company. So it is with ourselves. Even when we are quite alone, how often do we think with pleasure or pain of what others think of us,— of their imagined approbation or disapprobation; and this all follows from sympathy, a fundamental element of the social instincts. A man who possessed no trace of such instincts would be an unnatural monster. On the other hand, the desire to satisfy hunger, or any passion such as vengeance, is in its nature temporary, and can for a time be fully satisfied. Nor is it easy, perhaps hardly possible, to call up with complete vividness the feeling, for instance, of hunger; nor indeed, as has often been remarked, of any suffering. The instinct of self-preservation is not felt except in the presence of danger; and many a coward has thought himself brave until he has met his enemy face to face. The wish for another man's property is perhaps as persistent a desire as any that can be named; but even in this case the satisfaction of actual possession is generally a weaker feeling than the desire: many a thief, if not a habitual one, after success has wondered why he stole some article.[12]

[12] Enmity or hatred seems also to be a highly persistent feeling, perhaps more so than any other that can be named. Envy is defined as hatred of another for some excellence or success; and Bacon insists (Essay ix.), "Of all other affections envy is the most importune and continual." Dogs are very apt to hate both strange men and strange dogs, especially if they live near at hand, but do not belong to the same family, tribe, or clan; this feeling would thus seem to be innate, and is certainly a most persistent one. It seems to be the complement and converse of the true social instinct. From what we hear of savages, it would appear that something of the same kind holds good with them. If this be so, it would be a small

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A man cannot prevent past impressions often repassing through his mind; he will thus be driven to make a comparison between the impressions of past hunger, vengeance satisfied, or danger shunned at other men's cost, with the almost ever-present instinct of sympathy, and with his early knowledge of what others consider as praiseworthy or blamable. This knowledge cannot be banished from his mind, and from instinctive sympathy is esteemed of great moment. He will then feel as if he had been balked in following a present instinct or habit, and this with all animals causes dissatisfaction, or even misery.

The above case of the swallow affords an illustration, though of a reversed nature, of a temporary though for the time strongly persistent instinct conquering another instinct, which is usually dominant over all others. At the proper season these birds seem all day long to be impressed with the desire to migrate; their habits change; they become restless, are noisy and congregate in flocks. Whilst the mother-bird is feeding, or brooding over her nestlings, the maternal instinct is probably stronger than the migratory; but the instinct which is the more persistent gains the victory, and at last, at a moment when her young ones are not in sight, she takes flight and deserts them. When arrived at the end of her long journey, and the migratory instinct has ceased to act, what an agony of remorse the bird would feel, if, from being endowed with great mental activity, she could not prevent the image constantly passing through her mind, of her young ones perishing in the bleak north from cold and hunger.

At the moment of action, man will no doubt be apt to follow the stronger impulse; and though this may occasionally prompt him to the noblest deeds, it will more commonly lead him to gratify his own desires at the expense of other men. But after their gratification when past and weaker impressions are judged by the ever-enduring social instinct, and by his deep regard for the good opinion of his fellows, retribution will surely come.

step in any one to transfer such feelings to any member of the same tribe if he had done him an injury and had become his enemy. Nor is it probable that the primitive conscience would reproach a man for injuring his enemy; rather it would reproach him, if he had not revenged himself. To do good in return for evil, to love your enemy, is a height of morality to which it may be doubted whether the social instincts would, by themselves, have ever led us. It is necessary that these instincts, together with sympathy, should have been highly cultivated and extended by the aid of reason, instruction, and the love or fear of God, before any such golden rule would ever be thought of and obeyed.

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He will then feel remorse, repentance, regret, or shame; this latter feeling, however, relates almost exclusively to the judgment of others. He will consequently resolve more or less firmly to act differently for the future; and this is conscience; for conscience looks backwards, and serves as a guide for the future.

The nature and strength of the feelings which we call regret, shame, repentance or remorse, depend apparently not only on the strength of the violated instinct, but partly on the strength of the temptation, and often still more on the judgment of our fellows. How far each man values the appreciation of others, depends on the strength of his innate or acquired feeling of sympathy; and on his own capacity for reasoning out the remote consequences of his acts. Another element is most important, although not necessary, the reverence or fear of the Gods, or Spirits believed in by each man: and this applies especially in cases of remorse. Several critics have objected that though some slight regret or repentance may be explained by the view advocated in this chapter, it is impossible thus to account for the soul-shaking feeling of remorse. But I can see little force in this objection. My critics do not define what they mean by remorse, and I can find no definition implying more than an overwhelming sense of repentance. Remorse seems to bear the same relation to repentance, as rage does to anger, or agony to pain. It is far from strange that an instinct so strong and so generally admired, as maternal love, should, if disobeyed, lead to the deepest misery, as soon as the impression of the past cause of disobedience is weakened. Even when an action is opposed to no special instinct, merely to know that our friends and equals despise us for it is enough to cause great misery. Who can doubt that the refusal to fight a duel through fear has caused many men an agony of shame? Many a Hindoo, it is said, has been stirred to the bottom of his soul by having partaken of unclean food. Here is another case of what must, I think, be called remorse. Dr. Landor acted as a magistrate in West Australia, and relates, that a native on his farm, after losing one of his wives from disease, came and said that "he was going to a distant tribe to spear a woman, to satisfy his sense of duty to his wife. I told him that if he did so, I would send him to prison for life. He remained about the farm for some months, but got exceedingly thin, and complained that he could not rest

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or eat, that his wife's spirit was haunting him, because he had not taken a life for hers. I was inexorable, and assured him that nothing should save him if he did." Nevertheless the man disappeared for more than a year, and then returned in high condition; and his other wife told Dr. Landor that her husband had taken the life of a woman belonging to a distant tribe; but it was impossible to obtain legal evidence of the act. The breach of a rule held sacred by the tribe, will thus, as it seems, give rise to the deepest feelings,— and this quite apart from the social instincts, excepting in so far as the rule is grounded on the judgment of the community. How so many strange superstitions have arisen throughout the world we know not; nor can we tell how some real and great crimes, such as incest, have come to be held in an abhorrence (which is not however quite universal) by the lowest savages. It is even doubtful whether in some tribes incest would be looked on with greater horror, than would the marriage of a man with a woman bearing the same name, though not a relation. "To violate this law is a crime which the Australians hold in the greatest abhorrence, in this agreeing exactly with certain tribes of North America. When the question is put in either district, is it worse to kill a girl of a foreign tribe, or to marry a girl of one's own, an answer just opposite to ours would be given without hesitation." We may, therefore, reject the belief, lately insisted on by some writers, that the abhorrence of incest is due to our possessing a special God-implanted conscience. On the whole it is intelligible, that a man urged by so powerful a sentiment as remorse, though arising as above explained, should be led to act in a manner, which he has been taught to believe serves as an expiation, such as delivering himself up to justice.

Man prompted by his conscience, will through long habit acquire such perfect self-command, that his desires and passions will at last yield instantly and without a struggle to his social sympathies and instincts, including his feeling for the judgment of his fellows. The still hungry, or the still revengeful man will not think of stealing food, or of wreaking his vengeance. It is possible, or as we shall hereafter see, even probable, that the habit of self-command may, like other habits, be inherited. Thus at last man comes to feel, through acquired and perhaps inherited habit, that it is best for him to obey his

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more persistent impulses. The imperious word *ought* seems merely to imply the consciousness of the existence of a rule of conduct, however it may have originated. Formerly it must have been often vehemently urged that an insulted gentleman *ought* to fight a duel. We even say that a pointer *ought* to point, and a retriever to retrieve game. If they fail to do so, they fail in their duty and act wrongly.

If any desire or instinct leading to an action opposed to the good of others still appears, when recalled to mind, as strong as, or stronger than, the social instinct, a man will feel no keen regret at having followed it; but he will be conscious that if his conduct were known to his fellows, it would meet with their disapprobation; and few are so destitute of sympathy as not to feel discomfort when this is realized. If he has no such sympathy, and if his desires leading to bad actions are at the time strong, and when recalled are not over-mastered by the persistent social instincts, and the judgment of others, then he is essentially a bad man;[13] and the sole restraining motive left is the fear of punishment, and the conviction that in the long run it would be best for his own selfish interests to regard the good of others rather than his own.

It is obvious that every one may with an easy conscience gratify his own desires, if they do not interfere with his social instincts, that is with the good of others; but in order to be quite free from self-reproach, or at least of anxiety, it is almost necessary for him to avoid the disapprobation, whether reasonable or not, of his fellow-men. Nor must he break through the fixed habits of his life, especially if these are supported by reason; for if he does, he will assuredly feel dissatisfaction. He must likewise avoid the reprobation of the one God or gods in whom, according to his knowledge or superstition, he may believe; but in this case the additional fear of divine punishment often supervenes.

The strictly Social Virtues at first alone regarded.— The above view of the origin and nature of the moral sense, which tells us what we ought to do, and of the conscience which reproves us if we disobey it, accords well with what we see of the early and

[13] Dr. Prosper Despine in his "Psychologie Naturelle," 1868 (tom. i. p. 243; tom. ii. p. 169) gives many curious cases of the worst criminals, who apparently have been entirely destitute of conscience.

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undeveloped condition of this faculty in mankind. The virtues which must be practised, at least generally, by rude men, so that they may associate in a body, are those which are still recognized as the most important. But they are practised almost exclusively in relation to the men of the same tribe; and their opposites are not regarded as crimes in relation to the men of other tribes. No tribe could hold together if murder, robbery, treachery, &c., were common; consequently such crimes within the limits of the same tribe "are branded with everlasting infamy"; but excite no such sentiment beyond these limits. A North-American Indian is well pleased with himself, and is honored by others, when he scalps a man of another tribe; and a Dyak cuts off the head of an unoffending person, and dries it as a trophy. The murder of infants has prevailed on the largest scale throughout the world,[14] and has met with no reproach; but infanticide, especially of females, has been thought to be good for the tribe, or at least not injurious. Suicide during former times was not generally considered as a crime,[15] but rather from the courage displayed, as an honorable act; and it is still practised by some semi-civilized and savage nations without reproach, for it does not obviously concern others of the tribe. It has been recorded that an Indian Thug conscientiously regretted that he had not robbed and strangled as many travelers as did his father before him. In a rude state of civilization the robbery of strangers is, indeed, generally considered as honorable.

Slavery, although in some ways beneficial during ancient times, is a great crime; yet it was not so regarded until quite recently, even by the most civilized nations. And this was especially the case, because the slaves belonged in general to a race different from that of their masters. As barbarians do not regard the opinion of their women, wives are commonly treated like slaves. Most savages are utterly indifferent to the suffer-

[14] The fullest account which I have met with is by Dr. Gerland, in his "Ueber dan Aussterben der Naturvölker," 1868: but I shall have to recur to the subject of infanticide in a future chapter.

[15] See the very interesting discussion on Suicide in Lecky's "History of European Morals," vol. i, 1869, p. 223. With respect to savages, Mr. Winwood Reade informs me that the negroes of West Africa often commit suicide. It is well known how common it was amongst the miserable aborigines of South America after the Spanish conquest. For New Zealand, see the voyage of the "Novara," and for the Aleutian Islands, Müller, as quoted by Houzeau, "Les Facultés Mentales," etc., tom. ii. p. 136.

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ings of strangers, or even delight in witnessing them. It is well known that the women and children of the North-American Indians aided in torturing their enemies. Some savages take a horrid pleasure in cruelty to animals, and humanity is an unknown virtue. Nevertheless, besides the family affections, kindness is common, especially during sickness, between the members of the same tribe, and is sometimes extended beyond these limits. Mungo Park's touching account of the kindness of the negro women of the interior to him is well known. Many instances could be given of the noble fidelity of savages towards each other, but not to strangers; common experience justifies the maxim of the Spaniard, "Never, never trust an Indian." There cannot be fidelity without truth; and this fundamental virtue is not rare between the members of the same tribe: thus Mungo Park heard the negro women teaching their young children to love the truth. This, again, is one of the virtues which becomes so deeply rooted in the mind, that it is sometimes practised by savages, even at a high cost, towards strangers; but to lie to your enemy has rarely been thought a sin, as the history of modern diplomacy too plainly shows. As soon as a tribe has a recognized leader, disobedience becomes a crime, and even abject submission is looked at as a sacred virtue.

As during rude times no man can be useful or faithful to his tribe without courage, this quality has universally been placed in the highest rank; and although in civilized countries a good yet timid man may be far more useful to the community than a brave one, we cannot help instinctively honoring the latter above a coward, however benevolent. Prudence, on the other hand, which does not concern the welfare of others, though a very useful virtue, has never been highly esteemed. As no man can practise the virtues necessary for the welfare of his tribe without self-sacrifice, self-command, and the power of endurance, these qualities have been at all times highly and most justly valued. The American savage voluntarily submits to the most horrid tortures without a groan, to prove and strengthen his fortitude and courage; and we cannot help admiring him, or even an Indian Fakir, who, from a foolish religious motive, swings suspended by a hook buried in his flesh.

The other so-called self-regarding virtues, which do not obviously, though they may really, affect the welfare of the tribe,

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have never been esteemed by savages, though now highly appreciated by civilized nations. The greatest intemperance is no reproach with savages. Utter licentiousness, and unnatural crimes, prevail to an astounding extent. As soon, however, as marriage, whether polygamous, or monogamous, becomes common, jealousy will lead to the inculcation of female virtue; and this, being honored, will tend to spread to the unmarried females. How slowly it spreads to the male sex, we see at the present day. Chastity eminently requires self-command; therefore it has been honored from a very early period in the moral history of civilized man. As a consequence of this, the senseless practice of celibacy has been ranked from a remote period as a virtue. The hatred of indecency, which appears to us so natural as to be thought innate, and which is so valuable an aid to chastity, is a modern virtue, appertaining exclusively, as Sir G. Staunton remarks, to civilized life. This is shown by the ancient religious rites of various nations, by the drawings on the walls of Pompeii, and by the practices of many savages.

We have now seen that actions are regarded by savages, and were probably so regarded by primeval man, as good or bad, solely as they obviously affect the welfare of the tribe,— not that of the species, nor that of an individual member of the tribe. This conclusion agrees well with the belief that the so-called moral sense is aboriginally derived from the social instincts, for both relate at first exclusively to the community.

The chief causes of the low morality of savages, as judged by our standard, are, firstly, the confinement of sympathy to the same tribe. Secondly, powers of reasoning insufficient to recognize the bearing of many virtues, especially of the self-regarding virtues, on the general welfare of the tribe. Savages, for instance, fail to trace the multiplied evils consequent on a want of temperance, chastity, &c. And, thirdly, weak power of self-command; for this power has not been strengthened through long-continued, perhaps inherited, habit, instruction and religion.

I have entered into the above details on the immorality of savages, because some authors have recently taken a high view of their moral nature, or have attributed most of their crimes to mistaken benevolence. These authors appear to rest their conclusion on savages possessing those virtues which are serviceable, or

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even necessary, for the existence of the family and of the tribe, — qualities which they undoubtedly do possess, and often in a high degree.

Concluding Remarks.— It was assumed formerly by philosophers of the derivative school of morals that the foundation of morality lay in a form of Selfishness; but more recently the "Greatest happiness principle" has been brought prominently forward. It is, however, more correct to speak of the latter principle as the standard, and not as the motive of conduct. Nevertheless, all the authors whose works I have consulted, with a few exceptions,[16] write as if there must be a distinct motive for every action, and that this must be associated with some pleasure or displeasure. But man seems often to act impulsively, that is from instinct or long habit, without any consciousness of pleasure, in the same manner as does probably a bee or ant, when it blindly follows its instincts. Under circumstances of extreme peril, as during a fire, when a man endeavors to save a fellow-creature without a moment's hesitation, he can hardly feel pleasure; and still less has he time to reflect on the dissatisfaction which he might subsequently experience if he did not make the attempt. Should he afterwards reflect over his own conduct, he would feel that there lies within him an impulsive power widely different from a search after pleasure or happiness; and this seems to be the deeply planted social instinct.

In the case of the lower animals it seems much more appropriate to speak of their social instincts, as having been developed

[16] Mill recognizes ("System of Logic," vol. ii. p. 422) in the clearest manner, that actions may be performed through habit without the anticipation of pleasure. Mr. H. Sidgwick also, in his Essay on Pleasure and Desire ("The Contemporary Review," April, 1872, p. 671), remarks: "To sum up, in contravention of the doctrine that our conscious active impulses are always directed towards the production of agreeable sensations in ourselves, I would maintain that we find everywhere in consciousness extra-regarding impulse, directed towards something that is not pleasure; that in many cases the impulse is so far incompatible with the self-regarding that the two do not easily co-exist in the same moment of consciousness." A dim feeling that our impulses do not by any means always arise from any contemporaneous or anticipated pleasure, has, I cannot but think, been one chief cause of the acceptance of the intuitive theory of morality, and of the rejection of the utilitarian or "Greatest happiness" theory. With respect to the latter theory the standard and the motive of conduct have no doubt often been confused, but they are really in some degree blended.

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for the general good rather than for the general happiness of the species. The term, general good, may be defined as the rearing of the greatest number of individuals in full vigor and health, with all their faculties perfect, under the conditions to which they are subjected. As the social instincts both of man and the lower animals have no doubt been developed by nearly the same steps, it would be advisable, if found practicable, to use the same definition in both cases, and to take as the standard of morality, the general good or welfare of the community, rather than the general happiness; but this definition would perhaps require some limitation on account of political ethics.

When a man risks his life to save that of a fellow-creature, it seems also more correct to say that he acts for the general good rather than for the general happiness of mankind. No doubt the welfare and the happiness of the individual usually coincide; and a contented, happy tribe will flourish better than one that is discontented and unhappy. We have seen that even at an early period in the history of man, the expressed wishes of the community will have naturally influenced to a large extent the conduct of each member; and as all wish for happiness, the "greatest happiness principle" will have become a most important secondary guide and object; the social instinct, however, together with sympathy (which leads to our regarding the approbation and disapprobation of others), having served as the primary impulse and guide. Thus the reproach is removed of laying the foundation of the noblest part of our nature in the base principle of selfishness; unless, indeed, the satisfaction which every animal feels, when it follows its proper instincts, and the dissatisfaction felt when prevented, be called selfish.

The wishes and opinions of the members of the same community, expressed at first orally, but later by writing also, either form the sole guides of our conduct, or greatly reinforce the social instincts; such opinions, however, have sometimes a tendency directly opposed to these instincts. This latter fact is well exemplified by the *Law of Honor,* that is, the law of the opinion of our equals, and not of all our countrymen. The breach of this law, even when the breach is known to be strictly accordant with true morality, has caused many a man more agony than a real crime. We recognize the same influence in the burning sense of shame which most of us have felt, even after

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the interval of years, when calling to mind some accidental breach of a trifling, though fixed, rule of etiquette. The judgment of the community will generally be guided by some rude experience of what is best in the long run for all the members; but this judgment will not rarely err from ignorance and weak powers of reasoning. Hence the strangest customs and superstitions, in complete opposition to the true welfare and happiness of mankind, have become all-powerful throughout the world. We see this in the horror felt by a Hindoo who breaks his caste, and in many other such cases. It would be difficult to distinguish between the remorse felt by a Hindoo who has yielded to the temptation of eating unclean food, from that felt after committing a theft; but the former would probably be the more severe.

How so many absurd rules of conduct, as well as so many absurd religious beliefs, have originated, we do not know; nor how it is that they have become, in all quarters of the world, so deeply impressed on the mind of men; but it is worthy of remark that a belief constantly inculcated during the early years of life, whilst the brain is impressible, appears to acquire almost the nature of an instinct; and the very essence of an instinct is that it is followed independently of reason. Neither can we say why certain admirable virtues, such as the love of truth, are much more highly appreciated by some savage tribes than by others; nor, again, why similar differences prevail even amongst highly civilized nations. Knowing how firmly fixed many strange customs and superstitions have become, we need feel no surprise that the self-regarding virtues, supported as they are by reason, should now appear to us so natural as to be thought innate, although they were not valued by man in his early condition.

Notwithstanding many sources of doubt, man can generally and readily distinguish between the higher and lower moral rules. The higher are founded on the social instincts, and relate to the welfare of others. They are supported by the approbation of our fellow-men and by reason. The lower rules, though some of them when implying self-sacrifice hardly deserve to be called lower, relate chiefly to self, and arise from public opinion, matured by experience and cultivation; for they are not practised by rude tribes.

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As man advances in civilization, and small tribes are united into larger communities, the simplest reason would tell each individual that he ought to extend his social instincts and sympathies to all the members of the same nation, though personally unknown to him. This point being once reached, there is only an artificial barrier to prevent his sympathies extending to the men of all nations and races. If, indeed, such men are separated from him by great differences in appearance or habits, experience unfortunately shows us how long it is, before we look at them as our fellow-creatures. Sympathy beyond the confines of man, that is, humanity to the lower animals, seems to be one of the latest moral acquisitions. It is apparently unfelt by savages, except towards their pets. How little the old Romans knew of it is shown by their abhorrent gladiatorial exhibitions. The very idea of humanity, as far as I could observe, was new to most of the Gauchos of the Pampas. This virtue, one of the noblest with which man is endowed, seems to arise incidentally from our sympathies becoming more tender and more widely diffused, until they are extended to all sentient beings. As soon as this virtue is honored and practised by some few men, it spreads through instruction and example to the young and eventually becomes incorporated in public opinion.

The highest possible stage in moral culture is when we recognize that we ought to control our thoughts, and "not even in inmost thought to think again the sins that made the past so pleasant to us." Whatever makes any bad action familiar to the mind, renders its performance by so much the easier. As Marcus Aurelius long ago said, "Such as are thy habitual thoughts, such also will be the character of thy mind; for the soul is dyed by the thoughts."

Our great philosopher, Herbert Spencer, has recently explained his views on the moral sense. He says, "I believe that the experiences of utility organized and consolidated through all past generations of the human race, have been producing corresponding modifications, which, by continued transmission and accumulation, have become in us certain faculties of moral intuition — certain emotions responding to right and wrong conduct, which have no apparent basis in the individual experiences of utility." There is not the least inherent improbability, as it seems to me, in virtuous tendencies being more or

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less strongly inherited; for, not to mention the various dispositions and habits transmitted by many of our domestic animals to their offspring, I have heard of authentic cases in which a desire to steal and a tendency to lie appeared to run in families of the upper ranks; and as stealing is a rare crime in the wealthy classes, we can hardly account by accidental coincidence for the tendency occurring in two or three members of the same family. If bad tendencies are transmitted, it is probable that good ones are likewise transmitted. That the state of the body by affecting the brain, has great influence on the moral tendencies is known to most of those who have suffered from chronic derangements of the digestion or liver. The same fact is likewise shown by the "perversion or destruction of the moral sense being often one of the earliest symptoms of mental derangement";[17] and insanity is notoriously often inherited. Except through the principle of the transmission of moral tendencies, we cannot understand the differences believed to exist in this respect between the various races of mankind.

Even the partial transmission of virtuous tendencies would be an immense assistance to the primary impulse derived directly and indirectly from the social instincts. Admitting for a moment that virtuous tendencies are inherited, it appears probable, at least in such cases as chastity, temperance, humanity to animals, &c., that they become first impressed on the mental organization through habit, instruction and example, continued during several generations in the same family, and in a quite subordinate degree, or not at all, by the individuals possessing such virtues having succeeded best in the struggle for life. My chief source of doubt with respect to any such inheritance, is that senseless customs, superstitions, and tastes, such as the horror of a Hindoo for unclean food, ought on the same principle to be transmitted. I have not met with any evidence in support of the transmission of superstitious customs or senseless habits, although in itself it is perhaps not less probable than that animals should acquire inherited tastes for certain kinds of food or fear of certain foes.

Finally the social instincts, which no doubt were acquired by man as by the lower animals for the good of the community,

[17] Maudsley, "Body and Mind," p. 60.

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will from the first have given to him some wish to aid his fellows, some feeling of sympathy, and have compelled him to regard their approbation and disapprobation. Such impulses will have served him at a very early period as a rude rule of right and wrong. But as man gradually advanced in intellectual power, and was enabled to trace the more remote consequences of his actions; as he acquired sufficient knowledge to reject baneful customs and superstitions; as he regarded more and more, not only the welfare, but the happiness of his fellow-men; as from habit, following on the beneficial experience, instruction and example, his sympathies became more tender and widely diffused, extending to men of all races, to the imbecile, maimed, and other useless members of society, and finally to the lower animals,— so would the standard of his morality rise higher and higher. And it is admitted by moralists of the derivative school and by some intuitionists, that the standard of morality has risen since an early period in the history of man.[18]

As a struggle may sometimes be seen going on between the various instincts of the lower animals, it is not surprising that there should be a struggle in man between his social instincts, with their derived virtues, and his lower, though momentarily stronger impulses or desires. This, as Mr. Galton[19] has remarked, is all the less surprising, as man has emerged from a state of barbarism within a comparatively recent period. After having yielded to some temptation we feel a sense of dissatisfaction, shame, repentance, or remorse, analogous to the feelings caused by other powerful instincts or desires, when left unsatisfied or balked. We compare the weakened impression of a past temptation with the ever present social instincts, or with habits, gained in early youth and strengthened during our whole lives, until they have become almost as strong as instincts. If with the temptation still before us we do not yield, it is because either the social instinct or some custom is at the moment predominant, or because we have learnt that it will appear to us hereafter the stronger, when compared with the weakened im-

[18] A writer in the "North British Review" (July, 1869, p. 531), well capable of forming a sound judgment, expresses himself strongly in favor of this conclusion. Mr. Lecky ("Hist. of Morals," vol. i. p. 143) seems to a certain extent to coincide therein.

[19] See his remarkable work on "Hereditary Genius," p. 349. The Duke of Argyll ("Primeval Man," p. 188) has some good remarks on the contest in man's nature between right and wrong.

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pression of the temptation, and we realize that its violation would cause us suffering. Looking to future generations, there is no cause to fear that the social instincts will grow weaker, and we may expect that virtuous habits will grow stronger, becoming perhaps fixed by inheritance. In this case the struggle between our higher and lower impulses will be less severe, and virtue will be triumphant.

Summary of the last two Chapters.— There can be no doubt that the difference between the mind of the lowest man and that of the highest animal is immense. An anthropomorphous ape, if he could take a dispassionate view of his own case, would admit that though he could form an artful plan to plunder a garden — though he could use stones for fighting or for breaking open nuts, yet that the thought of fashioning a stone into a tool was quite beyond his scope. Still less, as he would admit, could he follow out a train of metaphysical reasoning, or solve a mathematical problem, or reflect on God, or admire a grand natural scene. Some apes, however, would probably declare that they could and did admire the beauty of the colored skin and fur of their partners in marriage. They would admit, that though they could make other apes understand by cries some of their perceptions and simpler wants, the notion of expressing definite ideas by definite sounds had never crossed their minds. They might insist that they were ready to aid their fellow-apes of the same troop in many ways, to risk their lives for them, and to take charge of their orphans; but they would be forced to acknowledge that distinterested love for all living creatures, the most noble attribute of man, was quite beyond their comprehension.

Nevertheless the difference in mind between man and the higher animals, great as it is, certainly is one of degree and not of kind. We have seen that the senses and intuitions, the various emotions and faculties, such as love, memory, attention, curiosity, imitation, reason, &c., of which man boasts, may be found in an incipient, or even sometimes in a well-developed condition, in the lower animals. They are also capable of some inherited improvement, as we see in the domestic dog compared with the wolf or jackal. If it could be proved that certain high mental powers, such as the formation of general concepts,

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self-consciousness, &c., were absolutely peculiar to man, which seems extremely doubtful, it is not improbable that these qualities are merely the incidental results of other highly-advanced intellectual faculties; and these again mainly the result of the continued use of a perfect language. At what age does the new-born infant possess the power of abstraction, or become self-conscious, and reflect on its own existence? We cannot answer; nor can we answer in regard to the ascending organic scale. The half-art, half-instinct of language still bears the stamp of its gradual evolution. The ennobling belief in God is not universal with man; and the belief in spiritual agencies naturally follows from other mental powers. The moral sense perhaps affords the best and highest distinction between man and the lower animals; but I need say nothing on this head, as I have so lately endeavored to show that the social instincts,— the prime principle of man's moral constitution [20] — with the aid of active intellectual powers and the effects of habit, naturally lead to the golden rule, "As ye would that men should do to you, do ye to them likewise;" and this lies at the foundation of morality.

In the next chapter I shall make some few remarks on the probable steps and means by which the several mental and moral faculties of man have been gradually evolved. That such evolution is at least possible, ought not to be denied, for we daily see these faculties developing in every infant; and we may trace a perfect gradation from the mind of an utter idiot, lower than that of an animal low in the scale, to the mind of a Newton.

[20] "The Thoughts of Marcus Aurelius," &c., p. 139.

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CHAPTER V.

ON THE DEVELOPMENT OF THE INTELLECTUAL AND MORAL FACULTIES DURING PRIMEVAL AND CIVILIZED TIMES.

Advancement of the intellectual powers through natural selection — Importance of imitation — Social and moral faculties — Their development within the limits of the same tribe — Natural selection as affecting civilized nations — Evidence that civilized nations were once barbarous.

THE subjects to be discussed in this chapter are of the highest interest, but are treated by me in an imperfect and fragmentary manner. Mr. Wallace, in an admirable paper before referred to, argues that man, after he had partially acquired those intellectual and moral faculties which distinguish him from the lower animals, would have been but little liable to bodily modifications through natural selection or any other means. For man is enabled through his mental faculties "to keep with an unchanged body in harmony with the changing universe." He has great power of adapting his habits to new conditions of life. He invents weapons, tools, and various stratagems to procure food and to defend himself. When he migrates into a colder climate he uses clothes, builds sheds, and makes fires; and by the aid of fire cooks food otherwise indigestible. He aids his fellow-men in many ways, and anticipates future events. Even at a remote period he practised some division of labor.

The lower animals, on the other hand, must have their bodily structure modified in order to survive under greatly changed conditions. They must be rendered stronger, or acquire more effective teeth or claws, for defense against new enemies; or they must be reduced in size, so as to escape detection and danger. When they migrate into a colder climate, they must become clothed with thicker fur, or have their constitutions altered. If they fail to be thus modified, they will cease to exist.

The case, however, is widely different, as Mr. Wallace has

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with justice insisted, in relation to the intellectual and moral faculties of man. These faculties are variable; and we have every reason to believe that the variations tend to be inherited. Therefore, if they were formerly of high importance to primeval man and to his ape-like progenitors, they would have been perfected or advanced through natural selection. Of the high importance of the intellectual faculties there can be no doubt, for man mainly owes to them his predominant position in the world. We can see, that in the rudest state of society, the individuals who were the most sagacious, who invented and used the best weapons or traps, and who were best able to defend themselves, would rear the greatest number of offspring. The tribes, which included the largest number of men thus endowed, would increase in number and supplant other tribes. Numbers depend primarily on the means of subsistence, and this depends partly on the physical nature of the country, but in a much higher degree on the arts which are there practised. As a tribe increases and is victorious, it is often still further increased by the absorption of other tribes.[1] The stature and strength of the men of a tribe are likewise of some importance for its success, and these depend in part on the nature and amount of the food which can be obtained. In Europe the men of the Bronze period were supplanted by a race more powerful, and, judging from their sword-handles, with larger hands; but their success was probably still more due to their superiority in the arts.

All that we know about savages, or may infer from their traditions and from old monuments, the history of which is quite forgotten by the present inhabitants, show that from the remotest times successful tribes have supplanted other tribes. Relics of extinct or forgotten tribes have been discovered throughout the civilized regions of the earth, on the wild plains of America, and on the isolated islands in the Pacific Ocean. At the present day civilized nations are everywhere supplanting barbarous nations, excepting where the climate opposes a deadly barrier; and they succeed mainly, though not exclusively, through their arts, which are the products of the intellect. It is, there-

[1] After a time the members or tribes which are absorbed into another tribe assume, as Sir Henry Maine remarks ("Ancient Law," p. 131), that they are the co-descendants of the same ancestors.

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fore, highly probable that with mankind the intellectual faculties have been mainly and gradually perfected through natural selection; and this conclusion is sufficient for our purpose. Undoubtedly it would be interesting to trace the development of each separate faculty from the state in which it exists in the lower animals to that in which it exists in man; but neither my ability nor knowledge permits the attempt.

It deserves notice that, as soon as the progenitors of man became social (and this probably occurred at a very early period), the principle of imitation, and reason, and experience would have increased, and much modified the intellectual powers in a way, of which we see only traces in the lower animals. Apes are much given to imitation, as are the lowest savages; and the simple fact previously referred to, that after a time no animal can be caught in the same place by the same sort of trap, shows that animals learn by experience, and imitate the caution of others. Now, if some one man in a tribe, more sagacious than the others, invented a new snare or weapon, or other means of attack or defense, the plainest self-interest, without the assistanec of much reasoning power, would prompt the other members to imitate him; and all would thus profit. The habitual practice of each new art must likewise in some slight degree strengthen the intellect. If the new invention were an important one, the tribe would increase in number, spread, and supplant other tribes. In a tribe thus rendered more numerous there would always be a rather greater chance of the birth of other superior and inventive members. If such men left children to inherit their mental superiority, the chance of the birth of still more ingenious members would be somewhat better, and in a very small tribe decidedly better. Even if they left no children, the tribe would still include their blood-relations; and it has been ascertained by agriculturists that by preserving and breeding from the family of an animal, which when slaughtered was found to be valuable, the desired character has been obtained.

Turning now to the social and moral faculties. In order that primeval men, or the ape-like progenitors of man, should become social, they must have acquired the same instinctive feelings, which impel other animals to live in a body; and they no doubt

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exhibited the same general disposition. They would have felt uneasy when separated from their comrades, for whom they would have felt some degree of love; they would have warned each other of danger, and have given mutual aid in attack or defense. All this implies some degree of sympathy, fidelity, and courage. Such social qualities, the paramount importance of which to the lower animals is disputed by no one, were no doubt acquired by the progenitors of man in a similar manner, namely, through natural selection, aided by inherited habit. When two tribes of primeval man, living in the same country, came into competition, if (other circumstances being equal) the one tribe included a great number of courageous, sympathetic and faithful members, who were always ready to warn each other of danger, to aid and defend each other, this tribe would succeed better and conquer the other. Let it be borne in mind how all-important in the never-ceasing wars of savages, fidelity and courage must be. The advantage which disciplined soldiers have over undisciplined hordes follows chiefly from the confidence which each man feels in his comrades. Obedience, as Mr. Bagehot has well shown, is of the highest value, for any form of government is better than none. Selfish and contentious people will not cohere, and without coherence nothing can be effected. A tribe rich in the above qualities would spread and be victorious over other tribes: but in the course of time it would, judging from all past history, be in its turn overcome by some other tribe still more highly endowed. Thus the social and moral qualities would tend slowly to advance and be diffused throughout the world.

But it may be asked, how within the limits of the same tribe did a large number of members first become endowed with these social and moral qualities, and how was the standard of excellence raised? It is extremely doubtful whether the offspring of the more sympathetic and benevolent parents, or of those who were the most faithful to their comrades, would be reared in greater numbers than the children of selfish and treacherous parents belonging to the same tribe. He who was ready to sacrifice his life, as many a savage has been, rather than betray his comrades, would often leave no offspring to inherit his noble nature. The bravest men, who were always willing to come to the front in war, and who freely risked their lives for others, would on an average perish in larger numbers than other men.

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Therefore it hardly seems probable, that the number of men gifted with such virtues, or that the standard of their excellence, could be increased through natural selection, that is, by the survival of the fittest; for we are not here speaking of one tribe being victorious over another.

Although the circumstances, leading to an increase in the number of those thus endowed within the same tribe, are too complex to be clearly followed out, we can trace some of the probable steps. In the first place, as the reasoning powers and foresight of the members became improved, each man would soon learn that if he aided his fellow-men, he would commonly receive aid in return. From this low motive he might acquire the habit of aiding his fellows; and the habit of performing benevolent actions certainly strengthens the feeling of sympathy which gives the first impulse to benevolent actions. Habits, moreover, followed during many generations probably tend to be inherited.

But another and much more powerful stimulus to the development of the social virtues, is afforded by the praise and the blame of our fellow-men. To the instinct of sympathy, as we have already seen, it is primarily due, that we habitually bestow both praise and blame on others, whilst we love the former and dread the latter when applied to ourselves; and this instinct no doubt was originally acquired, like all the other social instincts, through natural selection. At how early a period the progenitors of man in the course of their development, became capable of feeling and being impelled by, the praise or blame of their fellow-creatures, we cannot of course say. But it appears that even dogs appreciate encouragement, praise, and blame. The rudest savages feel the sentiment of glory, as they clearly show by preserving the trophies of their prowess, by their habit of excessive boasting, and even by the extreme care which they take of their personal appearance and decorations; for unless they regarded the opinion of their comrades, such habits would be senseless.

They certainly feel shame at the breach of some of their lesser rules, and apparently remorse, as shown by the case of the Australian who grew thin and could not rest from having delayed to murder some other woman, so as to propitiate his dead wife's spirit. Though I have not met with any other recorded

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case, it is scarcely credible that a savage, who will sacrifice his life rather than betray his tribe, or one who will deliver himself up as a prisoner rather than break his parole, would not feel remorse in his inmost soul, if he had failed in a duty, which he held sacred.

We may therefore conclude that primeval man, at a very remote period, was influenced by the praise and blame of his fellows. It is obvious, that the members of the same tribe would approve of conduct which appeared to them to be for the general good, and would reprobate that which appeared evil. To do good unto others — to do unto others as ye would they should do unto you — is the foundation-stone of morality. It is, therefore, hardly possible to exaggerate the importance during rude times of the love of praise and the dread of blame. A man who was not impelled by any deep, instinctive feeling, to sacrifice his life for the good of others, yet was roused to such actions by a sense of glory, would by his example excite the same wish for glory in other men, and would strengthen by exercise the noble feeling of admiration. He might thus do far more good to his tribe than by begetting offspring with a tendency to inherit his own high character.

With increased experience and reason, man perceives the more remote consequences of his actions, and the self-regarding virtues, such as temperance, chastity, &c., which during early times are, as we have before seen, utterly disregarded, come to be highly esteemed or even held sacred. I need not, however, repeat what I have said on this head in the fourth chapter. Ultimately our moral sense or conscience becomes a highly complex sentiment — originating in the social instincts, largely guided by the approbation of our fellow-men, ruled by reason, self-interest, and in later times by deep religious feelings, and confirmed by instruction and habit.

It must not be forgotten that although a high standard of morality gives but a slight or no advantage to each individual man and his children over the other men of the same tribe, yet that an increase in the number of well-endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another. A tribe including many members who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy,

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were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection. At all times throughout the world tribes have supplanted other tribes; and as morality is one important element in their success, the standard of morality and the number of well-endowed men will thus everywhere tend to rise and increase.

It is, however, very difficult to form any judgment why one particular tribe and not another has been successful and has risen in the scale of civilization. Many savages are in the same condition as when first discovered several centuries ago. As Mr. Bagehot has remarked, we are apt to look at progress as normal in human society; but history refutes this. The ancients did not even entertain the idea, nor do the Oriental nations at the present day. According to another high authority, Sir Henry Maine, "the greatest part of mankind has never shown a particle of desire that its civil institutions should be improved." Progress seems to depend on many concurrent favorable conditions, far too complex to be followed out. But it has often been remarked, that a cool climate, from leading to industry and to the various arts, has been highly favorable thereto. The Esquimaux, pressed by hard necessity, have succeeded in many ingenious inventions, but their climate has been too severe for continued progress. Nomadic habits, whether over wide plains, or through the dense forests of the tropics, or along the shores of the sea, have in every case been highly detrimental. Whilst observing the barbarous inhabitants of Tierra del Fuego, it struck me that the possession of some property, a fixed abode, and the union of many families under a chief, were the indispensable requisites for civilization. Such habits almost necessitate the cultivation of the ground; and the first steps in cultivation would probably result, as I have elsewhere shown, from some such accident as the seeds of a fruit-tree falling on a heap of refuse, and producing an unusually fine variety. The problem, however, of the first advance of savages towards civilization is at present much too difficult to be solved.

Natural Selection as affecting Civilized Nations.— I have hitherto only considered the advancement of man from a semi-human condition to that of the modern savage. But some remarks on the action of natural selection on civilized nations may

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be worth adding. This subject has been ably discussed by Mr. W. R. Greg, and previously by Mr. Wallace and Mr. Galton. Most of my remarks are taken from these three authors. With savages, the weak in body or mind are soon eliminated; and those that survive commonly exhibit a vigorous state of health. We civilized men, on the other hand, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed, and the sick; we institute poor-laws; and our medical men exert their utmost skill to save the life of every one to the last moment. There is reason to believe that vaccination has preserved thousands, who from a weak constitution would formerly have succumbed to small-pox. Thus the weak members of civilized societies propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man. It is surprising how soon a want of care, or care wrongly directed, leads to the degeneration of a domestic race; but excepting in the case of man himself, hardly any one is so ignorant as to allow his worst animals to breed.

The aid which we feel impelled to give to the helpless is mainly an incidental result of the instinct of sympathy, which was originally acquired as part of the social instincts, but subsequently rendered, in the manner previously indicated, more tender and more widely diffused. Nor could we check our sympathy, even at the urging of hard reason, without deterioration in the noblest part of our nature. The surgeon may harden himself whilst performing an operation, for he knows that he is acting for the good of his patient; but if we were intentionally to neglect the weak and helpless, it could only be for a contingent benefit, with an overwhelming present evil. We must therefore bear the undoubtedly bad effects of the weak surviving and propagating their kind; but there appears to be at least one check in steady action, namely that the weaker and inferior members of society do not marry so freely as the sound; and this check might be indefinitely increased by the weak in body or mind refraining from marriage, though this is more to be hoped for than expected.

In every country in which a large standing army is kept up, the finest young men are taken by the conscription or are enlisted. They are thus exposed to early death during war, are often

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tempted into vice, and are prevented from marrying during the prime of life. On the other hand the shorter and feebler men, with poor constitutions, are left at home, and consequently have a much better chance of marrying and propagating their kind.

Man accumulates property and bequeaths it to his children, so that the children of the rich have an advantage over the poor in the race for success, independently of bodily or mental superiority. On the other hand, the children of parents who are short-lived, and are therefore on an average deficient in health and vigor, come into their property sooner than other children, and will be likely to marry earlier, and leave a larger number of offspring to inherit their inferior constitutions. But the inheritance of property by itself is very far from an evil; for without the accumulation of capital the arts could not progress; and it is chiefly through their power that the civilized races have extended, and are now everywhere extending their range, so as to take the place of the lower races. Nor does the moderate accumulation of wealth interfere with the process of selection. When a poor man becomes moderately rich, his children enter trades or professions in which there is struggle enough, so that the able in body and mind succeed best. The presence of a body of well-instructed men, who have not to labor for their daily bread, is important to a degree which cannot be over-estimated; as all high intellectual work is carried on by them, and on such work, material progress of all kinds mainly depends, not to mention other and higher advantages. No doubt wealth when very great tends to convert men into useless drones, but their number is never large; and some degree of elimination here occurs, for we daily see rich men, who happen to be fools or profligate, squandering away their wealth.

Primogeniture with entailed estates is a more direct evil, though it may formerly have been a great advantage by the creation of a dominant class, and any government is better than none. Most eldest sons, though they may be weak in body or mind, marry, whilst the younger sons, however superior in these respects, do not so generally marry. Nor can worthless eldest sons with entailed estates squander their wealth. But here, as elsewhere, the relations of civilized life are so complex that some compensatory checks intervene. The men who are rich through primogeniture are able to select generation after genera-

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tion the more beautiful and charming women; and these must generally be healthy in body and active in mind. The evil consequences, such as they may be, of the continued preservation of the same line of descent, without any selection, are checked by men of rank always wishing to increase their wealth and power; and this they effect by marrying heiresses. But the daughters of parents who have produced single children, are themselves, as Mr. Galton has shown, apt to be sterile; and thus noble families are continually cut off in the direct line, and their wealth flows into some side channel; but unfortunately this channel is not determined by superiority of any kind.

Although civilization thus checks in many ways the action of natural selection, it apparently favors the better development of the body, by means of good food and the freedom from occasional hardships. This may be inferred from civilized men having been found, wherever compared, to be physically stronger than savages. They appear also to have equal powers of endurance, as has been proved in many adventurous expeditions. Even the great luxury of the rich can be but little detrimental; for the expectation of life of our aristocracy, at all ages and of both sexes, is very little inferior to that of healthy English lives in the lower classes.

We will now look to the intellectual faculties. If in each grade of society the members were divided into two equal bodies, the one including the intellectually superior and the other the inferior, there can be little doubt that the former would succeed best in all occupations, and rear a greater number of children. Even in the lowest walks of life, skill and ability must be of some advantage; though in many occupations, owing to the great division of labor, a very small one. Hence in civilized nations there will be some tendency to an increase both in the number and in the standard of the intellectually able. But I do not wish to assert that this tendency may not be more than counterbalanced in other ways, as by the multiplication of the reckless and improvident; but even to such as these, ability must be some advantage.

It has often been objected to views like the foregoing, that the most eminent men who have ever lived have left no offspring to inherit their great intellect. Mr. Galton says, "I regret I am unable to solve the simple question whether, and how far,

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men and women who are prodigies of genius are infertile. I have, however, shown that men of eminence are by no means so." Great lawgivers, the founders of beneficent religions, great philosophers and discoverers in science, aid the progress of mankind in a far higher degree by their works than by leaving a numerous progeny. In the case of corporeal structures, it is the selection of the slightly better-endowed and the elimination of the slightly less well-endowed individuals, and not the preservation of strongly-marked and rare anomalies, that leads to the advancement of a species. So it will be with the intellectual faculties, since the somewhat abler men in each grade of society succeed rather better than the less able, and consequently increase in number, if not otherwise prevented. When in any nation the standard of intellect and the number of intellectual men have increased, we may expect from the law of the deviation from an average, that prodigies of genius will, as shown by Mr. Galton, appear somewhat more frequently than before.

In regard to the moral qualities, some elimination of the worst dispositions is always in progress even in the most civilized nations. Malefactors are executed, or imprisoned for long periods, so that they cannot freely transmit their bad qualities. Melancholic and insane persons are confined, or commit suicide. Violent and quarrelsome men often come to a bloody end. The restless who will not follow any steady occupation — and this relic of barbarism is a great check to civilization — emigrate to newly-settled countries, where they prove useful pioneers. Intemperance is so highly destructive, that the expectation of life of the intemperate, at the age of thirty for instance, is only 13.8 years; whilst for the rural laborers of England at the same age it is 40.59 years. Profligate women bear few children, and profligate men rarely marry; both suffer from disease. In the breeding of domestic animals, the elimination of those individuals, though few in number, which are in any marked manner inferior, is by no means an unimportant element towards success. This especially holds good with injurious characters which tend to reappear through reversion, such as blackness in sheep; and with mankind some of the worst dispositions, which occasionally without any assignable cause make their appearance in families, may perhaps be reversions to a savage state, from which we are not removed by very many generations. This view seems indeed

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recognized in the common expression that such men are the black sheep of the family.

With civilized nations, as far as an advanced standard of morality, and an increased number of fairly good men are concerned, natural selection apparently effects but little; though the fundamental social instincts were originally thus gained. But I have already said enough, whilst treating of the lower races, on the causes which lead to the advance of morality, namely, the approbation of our fellow-men — the strengthening of our sympathies of habit — example and imitation — reason — experience, and even self-interest — instruction during youth, and religious feelings.

A most important obstacle in civilized countries to an increase in the number of men of a superior class has been strongly insisted on by Mr. Greg and Mr. Galton, namely, the fact that the very poor and reckless, who are often degraded by vice, almost invariably marry early, whilst the careful and frugal, who are generally otherwise virtuous, marry late in life, so that they may be able to support themselves and their children in comfort. Those who marry early produce within a given period not only a greater number of generations, but, as shown by Dr. Duncan, they produce many more children. The children, moreover, that are born by mothers during the prime of life are heavier and larger, and therefore probably more vigorous, than those born at other periods. Thus the reckless, degraded, and often vicious members of society, tend to increase at a quicker rate than the provident and generally virtuous members. Or as Mr. Greg puts the case: "The careless, squalid, unaspiring Irishman multiplies like rabbits: the frugal, foreseeing, self-respecting, ambitious Scot, stern in his morality, spiritual in his faith, sagacious and disciplined in his intelligence, passes his best years in struggle and in celibacy, marries late, and leaves few behind him. Given a land originally peopled by a thousand Saxons and a thousand Celts — and in a dozen generations five-sixths of the population would be Celts, but five-sixths of the property, of the power, of the intellect, would belong to the one-sixth of Saxons that remained. In the eternal 'struggle for existence,' it would be the inferior and *less* favored race that had prevailed — and prevailed by virtue not of its good qualities but of its faults."

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There are, however, some checks to this downward tendency. We have seen that the intemperate suffer from a high rate of mortality, and the extremely profligate leave few offspring. The poorest classes crowd into towns, and it has been proved by Dr. Stark from the statistics of ten years in Scotland that at all ages the death-rate is higher in towns than in rural districts, "and during the first five years of life the town death-rate is almost exactly double that of the rural districts.". As these returns include both the rich and the poor, no doubt more than twice the number of births would be requisite to keep up the number of the very poor inhabitants in the towns, relatively to those in the country. With women, marriage at too early an age is highly injurious; for it has been found in France that, "twice as many wives under twenty die in the year, as died out of the same number of the unmarried." The mortality, also of husbands under twenty is "excessively high," [2] but what the cause of this may be, seems doubtful. Lastly, if the men who prudently delay marrying until they can bring up their families in comfort, were to select, as they often do, women in the prime of life, the rate of increase in the better class would be only slightly lessened.

It was established from an enormous body of statistics, taken during 1853, that the unmarried men throughout France, between the ages of twenty and eighty, die in a much larger proportion than the married: for instance, out of every 1000 unmarried men, between the ages of twenty and thirty, 11.3 annually died, whilst of the married only 6.5 died.[3] A similar law was proved to hold good, during the years 1863 and 1864, with the entire population above the age of twenty in Scotland: for instance, out of every 1000 unmarried men, between the ages of twenty and thirty, 14.97 annually died, whilst of the married only 7.24 died, that is less than half.[4] Dr. Stark remarks on this, "Bachelorhood is more destructive to life than the most unwholesome trades, or than residence in an unwhole-

[2] These quotations are taken from our highest authority on such questions, namely, Dr. Farr, in his paper "On the Influence of Marriage on the Mortality of the French People," read before the Nat. Assoc. for the Promotion of Social Science.

[3] Dr. Farr, ibid. The quotations given below are extracted from the same striking paper.

[4] I have taken the mean of the quinquennial means, given in "The Tenth Annual Report of Births, Deaths, &c., in Scotland."

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some house or district where there has never been the most distant attempt at sanitary improvement." He considers that the lessened mortality is the direct result of "marriage, and the more regular domestic habits which attend that state." He admits, however, that the intemperate, profligate, and criminal classes, whose duration of life is low, do not commonly marry; and it must likewise be admitted that men with a weak constitution, ill health, or any great infirmity in body or mind, will often not wish to marry, or will be rejected. Dr. Stark seems to have come to the conclusion that marriage in itself is a main cause of prolonged life, from finding that aged married men still have a considerable advantage in this respect over the unmarried of the same advanced age; but every one must have known instances of men, who with weak health during youth did not marry, and yet have survived to old age, though remaining weak, and therefore always with a lessened chance of life or of marrying. There is another remarkable circumstance which seems to support Dr. Stark's conclusion, namely, that widows and widowers in France suffer in comparison with the married a very heavy fate of mortality; but Dr. Farr attributes this to the poverty and evil habits consequent on the disruption of the family, and to grief. On the whole we may conclude with Dr. Farr that the lesser mortality of married than of unmarried men, which seems to be a general law, "is mainly due to the constant elimination of imperfect types, and to the skilful selection of the finest individuals out of each successive generation"; the selection relating only to the marriage state, and acting on all corporeal, intellectual, and moral qualities.[5] We may, therefore, infer that sound and good men who out of prudence remain for a time unmarried, do not suffer a high rate of mortality.

If the various checks specified in the two last paragraphs and perhaps others as yet unknown, do not prevent the reckless, the vicious and otherwise inferior members of society from increasing at a quicker rate than the better class of men, the nation will retrograde, as has too often occurred in the history of the world. We must remember that progress is no invariable

[5] Dr. Duncan remarks ("Fecundity, Fertility," &c., p. 334) on this subject: "At every age the healthy and beautiful go over from the unmarried side to the married, leaving the unmarried columns crowded with the sickly and unfortunate."

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rule. It is very difficult to say why one civilized nation rises, becomes more powerful, and spreads more widely, than another; or why the same nation progresses more quickly at one time than at another. We can only say that it depends on an increase in the actual number of the population, on the number of the men endowed with high intellectual and moral faculties, as well as on their standard of excellence. Corporeal structure appears to have little influence, except so far as vigor of body leads to vigor of mind.

It has been urged by several writers that as high intellectual powers are advantageous to a nation, the old Greeks, who stood some grades higher in intellect than any race that has ever existed, ought, if the power of natural selection were real, to have risen still higher in the scale, increased in number, and stocked the whole of Europe. Here we have the tacit assumption, so often made with respect to corporeal structures, that there is some innate tendency towards continued development in mind and body. But development of all kinds depends on many concurrent favorable circumstances. Natural selection acts only tentatively. Individuals and races may have acquired certain indisputable advantages, and yet have perished from failing in other characters. The Greeks may have retrograded from a want of coherence between the many small states, from the small size of their whole country, from the practice of slavery, or from extreme sensuality; for they did not succumb until "they were enervated and corrupt to the very core." The western nations of Europe, who now so immeasurably surpass their former savage progenitors, and stand at the summit of civilization, owe little or none of their superiority to direct inheritance from the old Greeks, though they owe much to the written works of that wonderful people.

Who can positively say why the Spanish nation, so dominant at one time, has been distanced in the race. The awakening of the nations of Europe from the dark ages is a still more perplexing problem. At that early period, as Mr. Galton has remarked, almost all the men of a gentle nature, those given to meditation or culture of the mind, had no refuge except in the bosom of a Church which demanded celibacy;[6] and this

[6] "Hereditary Genius," pp. 357–359. The Rev. F. W. Farrar ("Fraser's Mag.," Aug. 1870, p. 257) advances arguments on the other

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could hardly fail to have had a deteriorating influence on each successive generation. During this same period the Holy Inquisition selected with extreme care the freest and boldest men in order to burn or imprison them. In Spain alone some of the best men — those who doubted and questioned, and without doubting there can be no progress — were eliminated during three centuries at the rate of a thousand a year. The evil which the Catholic Church has thus effected is incalculable, though no doubt counterbalanced to a certain, perhaps to a large, extent in other ways; nevertheless, Europe has progressed at an unparalleled rate.

The remarkable success of the English as colonists, compared to other European nations, has been ascribed to their "daring and persistent energy"; a result which is well illustrated by comparing the progress of the Canadians of English and French extraction; but who can say how the English gained their energy? There is apparently much truth in the belief that the wonderful progress of the United States, as well as the character of the people, are the results of natural selection; for the more energetic, restless, and courageous men from all parts of Europe have emigrated during the last ten or twelve generations to that great country, and have there succeeded best. Looking to the distant future, I do not think that the Rev. Mr. Zincke takes an exaggerated view when he says: "All other series of events — as that which resulted in the culture of mind in Greece, and that which resulted in the empire of Rome — only appear to have purpose and value when viewed in connection with, or rather as subsidiary to . . . the great stream of Anglo-Saxon emigration to the west." Obscure as is the problem of the advance of civilization, we can at least see that a nation which produced during a lengthened period the greatest number of highly intellectual, energetic, brave, patriotic, and benevolent men, would generally prevail over less favored nations.

Natural selection follows from the struggle for existence; and this from a rapid rate of increase. It is impossible not to regret bitterly, but whether wisely is another question, the

side. Sir C. Lyell had already ("Principles of Geology," vol. ii. p. 489) in a striking passage called attention to the evil influence of the Holy Inquisition in having, through selection, lowered the general standard of intelligence in Europe.

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rate at which man tends to increase; for this leads in barbarous tribes to infanticide and many other evils, and in civilized nations to abject poverty, celibacy, and to the late marriages of the prudent. But as man suffers from the same physical evils as the lower animals, he has no right to expect an immunity from the evils consequent on the struggle for existence. Had he not been subjected during primeval times to natural selection, assuredly he would never have attained to his present rank. Since we see in many parts of the world enormous areas of the most fertile land capable of supporting numerous happy homes, but peopled only by a few wandering savages, it might be argued that the struggle for existence had not been sufficiently severe to force man upwards to his highest standard. Judging from all that we know of man and the lower animals, there has always been sufficient variability in their intellectual and moral faculties, for a steady advance through natural selection. No doubt such advance demands many favorable concurrent circumstances; but it may well be doubted whether the most favorable would have sufficed, had not the rate of increase been rapid, and the consequent struggle for existence extremely severe. It even appears from what we see, for instance, in parts of S. America, that a people which may be called civilized, such as the Spanish settlers, is liable to become indolent and to retrograde, when the conditions of life are very easy. With highly civilized nations continued progress depends in a subordinate degree on natural selection; for such nations do not supplant and exterminate one another as do savage tribes. Nevertheless the more intelligent members within the same community will succeed better in the long run than the inferior, and leave a more numerous progeny, and this is a form of natural selection. The more efficient causes of progress seem to consist of a good education during youth whilst the brain is impressible, and of a high standard of excellence, inculcated by the ablest and best men, embodied in the laws, customs and traditions of the nation, and enforced by public opinion. It should, however, be borne in mind, that the enforcement of public opinion depends on our appreciation of the approbation and disapprobation of others; and this appreciation is founded on our sympathy, which it can hardly be doubted was originally

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developed through natural selection as one of the most important elements of the social instincts.

On the Evidence that all Civilized Nations were Once Barbarous.— The present subject has been treated in so full and admirable a manner by Sir J. Lubbock, Mr. Tylor, Mr. M'Lennan, and others, that I need here give only the briefest summary of their results. The arguments recently advanced by the Duke of Argyll and formerly by Archbishop Whately, in favor of the belief that man came into the world as a civilized being, and that all savages have since undergone degradation, seem to me weak in comparison with those advanced on the other side. Many nations, no doubt, have fallen away in civilization, and some may have lapsed into utter barbarism, though on this latter head I have met with no evidence. The Fuegians were probably compelled by other conquering hordes to settle in their inhospitable country, and they may have become in consequence somewhat more degraded; but it would be difficult to prove that they have fallen much below the Botocudos, who inhabit the finest parts of Brazil.

The evidence that all civilized nations are the descendants of barbarians, consists, on the one side, of clear traces of their former low condition in still-existing customs, beliefs, language, &c.; and on the other side, of proofs that savages are independently able to raise themselves a few steps in the scale of civilization, and have actually thus risen. The evidence on the first head is extremely curious, but cannot be here given: I refer to such cases as that of the art of enumeration, which, as Mr. Tylor clearly shows by reference to the words still used in some places, originated in counting the fingers, first of one hand and then of the other, and lastly of the toes. We have traces of this in our own decimal system, and in the Roman numerals, where, after the V., which is supposed to be an abbreviated picture of a human hand, we pass on to VI., &c., when the other hand was no doubt used. So again, "when we speak of three-score and ten, we are counting by the vigesimal system, each score thus ideally made, standing for 20 — for 'one man,' as a Mexican or Carib would put it." [7] According

[7] "Royal Institution of Great Britain," March 15, 1867. Also, "Researches into the Early History of Mankind," 1865.

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to a large and increasing school of philologists, every language bears the marks of its slow and gradual evolution. So it is with the art of writing, for letters are rudiments of pictorial representations. It is hardly possible to read Mr. M'Lennan's work [8] and not admit that almost all civilized nations still retain traces of such rude habits as the forcible capture of wives. What ancient nation, as the same author asks, can be named that was originally monogamous? The primitive idea of justice, as shown by the law of battle and other customs of which vestiges still remain, was likewise most rude. Many existing superstitions are the remnants of former false religious beliefs. The highest form of religion — the grand idea of God hating sin and loving righteousness — was unknown during primeval times.

Turning to the other kind of evidence: Sir J. Lubbock has shown that some savages have recently improved a little in some of their simpler arts. From the extremely curious account which he gives of the weapons, tools, and arts, in use amongst savages in various parts of the world, it cannot be doubted that these have nearly all been independent discoveries, excepting perhaps the art of making fire. The Australian boomerang is a good instance of one such independent discovery. The Tahitians when first visited had advanced in many respects beyond the inhabitants of most of the other Polynesian islands. There are no just grounds for the belief that the high culture of the native Peruvians and Mexicans was derived from abroad; many native plants were there cultivated, and a few native animals domesticated. We should bear in mind that, judging from the small influence of most missionaries, a wandering crew from some semi-civilized land, if washed to the shores of America, would not have produced any marked effect on the natives, unless they had already become somewhat advanced. Looking to a very remote period in the history of the world, we find, to use Sir J. Lubbock's well-known terms, a paleolithic and neolithic period; and no one will pretend that the art of grinding rough flint tools was a borrowed one. In all parts of Europe, as far east as Greece, in Palestine, India, Japan, New Zealand, and Africa, including Egypt, flint tools

[8] "Primitive Marriage." See Prof. Schaaffhausen ("Anthropolog. Review," Oct. 1869, p. 373) remarks on "the vestiges of human sacrifices found both in Homer and the Old Testament."

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have been discovered in abundance; and of their use the existing inhabitants retain no tradition. There is also indirect evidence of their former use by the Chinese and ancient Jews. Hence there can hardly be a doubt that the inhabitants of these countries, which include nearly the whole civilized world, were once in a barbarous condition. To believe that man was aboriginally civilized and then suffered utter degradation in so many regions, is to take a pitiably low view of human nature. It is apparently a truer and more cheerful view that progress has been much more general than retrogression; that man has risen, though by slow and interrupted steps, from a lowly condition to the highest standard as yet attained by him in knowledge, morals and religion.

CHAPTER VI.

OF THE AFFINITIES AND GENEALOGY OF MAN.

Position of man in the animal series — The natural system genealogical — Adaptive characters of slight value — Various small points of resemblance between man and the Quadrumana — Rank of man in the natural system — Birthplace and antiquity of man — Absence of fossil connecting links — Lower stages in the genealogy of man, as inferred, firstly from his affinities and secondly from his structure — Early androgynous condition of the Vertebrata — Conclusion.

Even if it be granted that the difference between man and his nearest allies is as great in corporeal structure as some naturalists maintain, and although we must grant that the difference between them is immense is mental power, yet the facts given in the earlier chapters appear to declare, in the plainest manner, that man is descended from some lower form, notwithstanding that connecting-links have not hitherto been discovered.

Man is liable to numerous, slight, and diversified variations, which are induced by the same general causes, are governed and transmitted in accordance with the same general laws, as in the lower animals. Man has multiplied so rapidly, that he has necessarily been exposed to struggle for existence, and con-

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sequently to natural selection. He has given rise to many races, some of which differ so much from each other, that they have often been ranked by naturalists as distinct species. His body is constructed on the same homological plan as that of other mammals. He passes through the same phases of embryological development. He retains many rudimentary and useless structures, which no doubt were once serviceable. Characters occasionally make their reappearance in him, which we have reason to believe were possessed by his early progenitors. If the origin of man had been wholly different from that of all other animals, these various appearances would be mere empty deceptions; but such an admission is incredible. These appearances, on the other hand, are intelligible, at least to a large extent, if man is the co-descendant with other mammals of some unknown and lower form.

Some naturalists, from being deeply impressed with the mental and spiritual powers of man, have divided the whole organic world into three kingdoms, the Human, the Animal, and the Vegetable, thus giving to man a separate kingdom. Spiritual powers cannot be compared or classed by the naturalist: but he may endeavor to show, as I have done, that the mental faculties of man and the lower animals do not differ in kind, although immensely in degree. A difference in degree, however great, does not justify us in placing man in a distinct kingdom, as will perhaps be best illustrated by comparing the mental powers of two insects, namely, a coccus or scale-insect and an ant, which undoubtedly belong to the same class. The difference is here greater than, though of a somewhat different kind from, that between man and the highest mammal. The female coccus, whilst young, attaches itself by its proboscis to a plant; sucks the sap, but never moves again; is fertilized and lays eggs; and this is its whole history. On the other hand, to describe the habits and mental powers of worker-ants, would require, as Pierre Huber has shown, a large volume; I may, however, briefly specify a few points. Ants certainly communicate information to each other, and several unite for the same work, or for games of play. They recognize their fellow-ants after months of absence, and feel sympathy for each other. They build great edifices, keep them clean, close the doors in the evening, and post sentries. They make roads as well as

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tunnels under rivers, and temporary bridges over them, by clinging together. They collect food for the community, and when an object, too large for entrance, is brought to the nest, they enlarge the door, and afterwards build it up again. They store up seeds, of which they prevent the germination, and which, if damp, are brought up to the surface to dry. They keep aphides and other insects as milch-cows. They go out to battle in regular bands, and freely sacrifice their lives for the common weal. They emigrate according to a preconcerted plan. They capture slaves. They move the eggs of their aphides, as well as their own eggs and cocoons, into warm parts of the nest, in order that they may be quickly hatched; and endless similar facts could be given. On the whole, the difference in mental power between an ant and a coccus is immense; yet no one has ever dreamed of placing these insects in distinct classes, much less in distinct kingdoms. No doubt the difference is bridged over by other insects; and this is not the case with man and the higher apes. But we have every reason to believe that the breaks in the series are simply the results of many forms having become extinct.

Professor Owen, relying chiefly on the structure of the brain, has divided the mammalian series into four sub-classes. One of these he devotes to man; in another he places both the Marsupials and the Monotremata; so that he makes man as distinct from all other mammals as are these two latter groups conjoined. This view has not been accepted, as far as I am aware, by any naturalist capable of forming an independent judgment, and therefore need not here be further considered.

We can understand why a classification founded on any single character or organ — even an organ so wonderfully complex and important as the brain — or on the high development of the mental faculties, is almost sure to prove unsatisfactory. This principle has indeed been tried with hymenopterous insects; but when thus classed by their habits or instincts, the arrangement proved thoroughly artificial. Classifications may, of course, be based on any character whatever, as on size, color, or the element inhabited; but naturalists have long felt a profound conviction that there is a natural system. This system, it is now generally admitted, must be, as far as possible, genealogical in arrangement,— that is the co-descendants of the same

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form must be kept together in one group, apart from the co-descendants of any other form; but if the parent-forms are related, so will be their descendants, and the two groups together will form a larger group. The amount of difference between the several groups — that is the amount of modification which each has undergone — is expressed by such terms as genera, families, orders, and classes. As we have no record of the lines of descent, the pedigree can be discovered only by observing the degrees of resemblance between the beings which are to be classed. For this object numerous points of resemblance are of much more importance than the amount of similarity or dissimilarity in a few points. If two languages were found to resemble each other in a multitude of words and points of construction, they would be universally recognized as having sprung from a common source, notwithstanding that they differed greatly in some few words or points of construction. But with organic beings the points of resemblance must not consist of adaptations to similar habits of life: two animals may, for instance, have had their whole frames modified for living in the water, and yet they will not be brought any nearer to each other in the natural system. Hence we can see how it is that resemblances in several unimportant structures, in useless and rudimentary organs, or not now functionally active, or in an embryological condition, are by far the most serviceable for classification; for they can hardly be due to adaptations within a late period; and thus they reveal the old lines of descent or of true affinity.

We can further see why a great amount of modification in some one character ought not to lead us to separate widely any two organisms. A part which already differs much from the same part in other allied forms has already, according to the theory of evolution, varied much; consequently it would (as long as the organism remained exposed to the same exciting conditions) be liable to further variations of the same kind; and these, if beneficial, would be preserved, and thus be continually augmented. In many cases the continued development of a part, for instance, of the beak of a bird, or of the teeth of a mammal, would not aid the species in gaining its food, or for any other object; but with man we can see no definite limit to the continued development of the brain and mental faculties,

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as far as advantage is concerned. Therefore in determining the position of man in the natural or genealogical system, the extreme development of his brain ought not to outweigh a multitude of resemblances in other less important or quite unimportant points.

The greater number of naturalists who have taken into consideration the whole structure of man, including his mental faculties, have followed Blumenbach and Cuvier, and have placed man in a separate Order, under the title of the Bimana, and therefore on an equality with the orders of the Quadrumana, Carnivora, &c. Recently many of our best naturalists have recurred to the view first propounded by Linnæus, so remarkable for his sagacity, and have placed man in the same Order with the Quadrumana, under the title of the Primates. The justice of this conclusion will be admitted: for in the first place, we must bear in mind the comparative insignificance for classification of the great development of the brain in man, and that the strongly-marked differences between the skulls of man and the Quadrumana (lately insisted upon by Bischoff, Aeby, and others) apparently follow from their differently developed brains. In the second place, we must remember that nearly all the other and more important differences between man and the Quadrumana are manifestly adaptive in their nature, and relate chiefly to the erect position of man; such as the structure of his hand, foot, and pelvis, the curvature of his spine, and the position of his head. The family of Seals offers a good illustration of the small importance of adaptive characters for classification. These animals differ from all other Carnivora in the form of their bodies and in the structure of their limbs, far more than does man from the higher apes; yet in most systems, from that of Cuvier to the most recent one by Mr. Flower, seals are ranked as a mere family in the Order of the Carnivora. If man had not been his own classifier, he would never have thought of founding a separate order for his own reception.

It would be beyond my limits, and quite beyond my knowledge, even to name the innumerable points of structure in which man agrees with the other Primates. Our great anatomist and philosopher, Prof. Huxley, has fully discussed this subject, and concludes that man in all parts of his organization differs

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less from the higher apes, than these do from the lower members of the same group. Consequently there "is no justification for placing man in a distinct order."

In an early part of this work I brought forward various facts, showing how closely man agrees in constitution with the higher mammals; and this agreement must depend on our close similarity in minute structure and chemical composition. I gave, as instances, our liability to the same diseases, and to the attacks of allied parasites; our tastes in common for the same stimulants, and the similar effects produced by them, as well as by various drugs, and other such facts.

As small unimportant points of resemblance between man and the Quadrumana are not commonly noticed in systematic works, and as, when numerous, they clearly reveal our relationship, I will specify a few such points. The relative position of our features is manifestly the same; and the various emotions are displayed by nearly similar movements of the muscles and skin, chiefly above the eyebrows and round the mouth. Some few expressions are, indeed, almost the same, as in the weeping of certain kinds of monkeys and in the laughing noise made by others, during which the corners of the mouth are drawn backwards, and the lower eyelids wrinkled. The external ears are curiously alike. In man the nose is much more prominent than in most monkeys; but we may trace the commencement of an aquiline curvature in the nose of the Hoolock Gibbon; and this in the *Semnopithecus nasica* is carried to a ridiculous extreme.

The faces of many monkeys are ornamented with beards, whiskers, or mustaches. The hair on the head grows to a great length in some species of Semnopithecus; and in the Bonnet monkey (*Macacus radiatus*) it radiates from a point on the crown, with a parting down the middle. It is commonly said that the forehead gives to man his noble and intellectual appearance; but the thick hair on the head of the Bonnet monkey terminates downwards abruptly, and is succeeded by hair so short and fine that at a little distance the forehead, with the exception of the eyebrows, appears quite naked. It has been erroneously asserted that eyebrows are not present in any monkey. In the species just named the degree of nakedness of the forehead differs in different individuals; and Eschricht states that in our chil-

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dren the limit between the hairy scalp and the naked forehead is sometimes not well defined; so that here we seem to have a trifling case of reversion to a progenitor, in whom the forehead had not as yet become quite naked.

It is well known that the hair on our arms tends to converge from above and below to a point at the elbow. This curious arrangement, so unlike that in most of the lower mammals, is common to the gorilla, chimpanzee, orang, some species of Hylobates, and even to some few American monkeys. But in *Hylobates agilis* the hair on the fore-arm is directed downwards or towards the wrist in the ordinary manner; and in *H. lar* it is nearly erect, with only a very slight forward inclination; so that in this latter species it is in a transitional state. It can hardly be doubted that with most mammals the thickness of the hair on the back and its direction, is adapted to throw off the rain; even the transverse hairs on the fore-legs of a dog may serve for this end when he is coiled up asleep. Mr. Wallace, who has carefully studied the habits of the orang, remarks that the convergence of the hair towards the elbow on the arms of the orang may be explained as serving to throw off the rain, for this animal during rainy weather sits with its arms bent, and with the hands clasped round a branch or over its head. According to Livingstone, the gorilla also "sits in pelting rain with his hands over his head." If the above explanation is correct, as seems probable, the direction of the hair on our own arms offers a curious record of our former state; for no one supposes that it is now of any use in throwing off the rain; nor, in our present erect condition, is it properly directed for this purpose.

It would, however, be rash to trust too much to the principle of adaptation in regard to the direction of the hair in man or his early progenitors; for it is impossible to study the figures given by Eschricht of the arrangement of the hair on the human fœtus (this being the same as in the adult) and not agree with this excellent observer that other and more complex causes have intervened. The points of convergence seem to stand in some relation to those points in the embryo which are last closed in during development. There appears, also, to exist some relation between the arrangement of the hair on the limbs, and the course of the medullary arteries.

It must not be supposed that the resemblances between man

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and certain apes in the above and in many other points — such as in having a naked forehead, long tresses on the head, &c.— are all necessarily the result of unbroken inheritance from a common progenitor, or of subsequent reversion. Many of these resemblances are more probably due to analogous variation, which follows, as I have elsewhere attempted to show, from co-descended organisms having a similar constitution, and having been acted on by like causes inducing similar modifications. With respect to the similar direction of the hair on the fore-arms of man and certain monkeys, as this character is common to almost all the anthropomorphous apes, it may probably be attributed to inheritance; but this is not certain, as some very distinct American monkeys are thus characterized.

Although, as we have now seen, man has no just right to form a separate Order for his own reception, he may perhaps claim a distinct Sub-order or Family. Prof. Huxley, in his last work, divides the Primates into three Sub-orders; namely, the Anthropidæ with man alone, the Simiadæ including monkeys of all kinds, and the Lemuridæ with the diversified genera of lemurs. As far as differences in certain important points of structure are concerned, man may no doubt rightly claim the rank of a Sub-order; and this rank is too low, if we look chiefly to his mental faculties. Nevertheless, from a genealogical point of view it appears that this rank is too high, and that man ought to form merely a Family, or possibly even only a Sub-family. If we imagine three lines of descent proceeding from a common stock, it is quite conceivable that two of them might after the lapse of ages be so slightly changed as still to remain as species of the same genus, whilst the third line might become so greatly modified as to deserve to rank as a distinct Sub-family, or even Order. But in this case it is almost certain that the third line would still retain through inheritance numerous small points of resemblance with the other two. Here, then, would occur the difficulty, at present insoluble, how much weight we ought to assign in our classifications to strongly-marked differences in some few points,— that is, to the amount of modification undergone; and how much to close resemblance in numerous unimportant points, as indicating the lines of descent or genealogy. To attach much weight to the few but strong differences is the most obvious and perhaps the safest course, though it appears more correct to pay

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great attention to the many small resemblances, as giving a truly natural classification.

In forming a judgment on this head with reference to man, we must glance at the classification of the Simiadæ. This family is divided by almost all naturalists into the Catarhine group, or Old World monkeys, all of which are characterized (as their name expresses) by the peculiar structure of their nostrils, and by having four premolars in each jaw; and into the Platyrhine group or New World monkeys (including two very distinct sub-groups), all of which are characterized by differently constructed nostrils, and by having six premolars in each jaw. Some other small differences might be mentioned. Now man unquestionably belongs in his dentition, in the structure of his nostrils, and some other respects, to the Catarhine or Old World division; nor does he resemble the Platyrhines more closely than the Catarhines in any characters, excepting in a few of not much importance and apparently of an adaptive nature. It is therefore against all probability that some New World species should have formerly varied and produced a man-like creature, with all the distinctive characters proper to the Old World division; losing at the same time all its own distinctive characters. There can, consequently, hardly be a doubt that man is an off-shoot from the Old World Simian stem; and that under a genealogical point of view he must be classed with the Catarhine division.[1]

The anthropomorphous apes, namely the gorilla, chimpanzee, orang, and hylobates, are by most naturalists separated from the other Old World monkeys, as a distinct sub-group. I am aware that Gratiolet, relying on the structure of the brain, does not admit the existence of this sub-group, and no doubt it is a broken one. Thus the orang, as Mr. St. G. Mivart remarks, "is one of the most peculiar and aberrant forms to be found in the Order." The remaining non-anthropomorphous Old World monkeys, are again divided by some naturalists into two or three smaller sub-groups; the genus Semnopithecus, with its peculiar sacculated stomach, being the type of one such sub-group. But it appears

[1] This is nearly the same classification as that provisionally adopted by Mr. St. George Mivart ("Transact. Philosoph. Soc." 1867, p. 300), who, after separating the Lemuridæ, divides the remainder of the Primates into the Hominidæ, the Simiadæ which answer to the Catarhines, the Cebidæ, and the Hapalidæ,— these two latter groups answering to the Platyrhines. Mr. Mivart still abides by the same view.

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from M. Gaudry's wonderful discoveries in Attica, that during the Miocene period a form existed there, which connected Semnopithecus and Macacus; and this probably illustrates the manner in which the other and higher groups were once blended together.

If the anthropomorphous apes be admitted to form a natural sub-group, then as man agrees with them, not only in all those characters which he possesses in common with the whole Catarhine group, but in other peculiar characters, such as the absence of a tail and of callosities, and in general appearance, we may infer that some ancient member of the anthropomorphous sub-group gave birth to man. It is not probable that through the law of analogous variation a member of one of the other lower sub-groups should have given rise to a man-like creature, resembling the higher anthropomorphous apes in so many respects. No doubt man, in comparison with most of his allies, has undergone an extraordinary amount of modification, chiefly in consequence of the great development of his brain and his erect position; nevertheless, we should bear in mind that he "is but one of several exceptional forms of Primates."

Every naturalist, who believes in the principle of evolution, will grant that the two main divisions of the Simiadæ, namely the Catarhine and Platyrhine monkeys, with their sub-groups, have all proceeded from some one extremely ancient progenitor. The early descendants of this progenitor, before they had diverged to any considerable extent from each other, would still have formed a single natural group; but some of the species or incipient genera would have already begun to indicate by their diverging characters the future distinctive marks of the Catarhine and Platyrhine divisions. Hence the members of this supposed ancient group would not have been so uniform in their dentition, or in the structure of their nostrils, as are the existing Catarhine monkeys in one way and the Platyrhines in another way, but would have resembled in this respect the allied Lemuridæ, which differ greatly from each other in the form of their muzzles, and to an extraordinary degree in their dentition.

The Catarhine and Platyrhine monkeys agree in a multitude of characters, as is shown by their unquestionably belonging to one and the same Order. The many characters which they possess in common can hardly have been independently acquired by so many distinct species; so that these characters must have

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been inherited. But a naturalist would undoubtedly have ranked as an ape or a monkey, an ancient form which possessed many characters common to the Catarhine and Platyrhine monkeys, other characters in an intermediate condition, and some few, perhaps, distinct from those now found in either group. And as man from a genealogical point of view belongs to the Catarhine or Old World stock, we must conclude, however much the conclusion may revolt our pride, that our early progenitors would have been properly thus designated.[2] But we must not fall into the error of supposing that the early progenitor of the whole Simian stock, including man, was identical with, or even closely resembled, any existing ape or monkey.

On the Birthplace and Antiquity of Man.— We are naturally led to inquire, where was the birthplace of man at that stage of descent when our progenitors diverged from the Catarhine stock? The fact that they belonged to this stock clearly shows that they inhabited the Old World; but not Australia nor any oceanic island, as we may infer from the laws of geographical distribution. In each great region of the world the living mammals are closely related to the extinct species of the same region. It is therefore probable that Africa was formerly inhabited by extinct apes closely allied to the gorilla and chimpanzee; and as these two species are now man's nearest allies, it is somewhat more probable that our early progenitors lived on the African continent than elsewhere. But it is useless to speculate on this subject; for two or three anthropomorphous apes, one the Dryopithecus of Lartet, nearly as large as a man, and closely allied to Hylobates, existed in Europe during the Miocene age; and since so remote a period the earth has certainly undergone many great revolutions, and there has been ample time for migration on the largest scale.

At the period and place, whenever and wherever it was, when man first lost his hairy covering, he probably inhabited a hot country; a circumstance favorable for the frugiferous diet on which, judging from analogy, he subsisted. We are far from knowing how long ago it was when man first diverged from the

[2] Häckel has come to this same conclusion. See "Ueber die Entstehung des Menschengeschlechts," in Virchow's "Sammlung. gemein. wissen. Vortrage," 1868, s. 61. Also his "Natürliche Schöpfungsgeschichte," 1868 in which he gives in detail his views on the genealogy of man.

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Catarhine stock; but it may have occurred at an epoch as remote as the Eocene period; for that the higher apes had diverged from the lower apes as early as the Upper Miocene period is shown by the existence of the Dryopithecus. We are also quite ignorant at how rapid a rate organisms, whether high or low in the scale, may be modified under favorable circumstances; we know, however, that some have retained the same form during an enormous lapse of time. From what we see going on under domestication, we learn that some of the co-descendants of the same species may be not at all, some a little, and some greatly changed, all within the same period. Thus it may have been with man, who has undergone a great amount of modification in certain characters in comparison with the higher apes.

The great break in the organic chain between man and his nearest allies, which cannot be bridged over by any extinct or living species, has often been advanced as a grave objection to the belief than man is descended from some lower form; but this objection will not appear of much weight to those who, from general reasons, believe in the general principle of evolution. Breaks often occur in all parts of the series, some being wide, sharp and defined, others less so in various degrees; as between the orang and its nearest allies — between the Tarsius and the other Lemuridæ — between the elephant, and in a more striking manner between the Ornithorhynchus or Echidna, and all other mammals. But these breaks depend merely on the number of related forms which have become extinct. At some future period, not very distant as measured by centuries, the civilized races of man will almost certainly exterminate, and replace, the savage races throughout the world. At the same time the anthropomorphous apes, as Professor Schaaffhausen has remarked, will no doubt be exterminated. The break between man and his nearest allies will then be wider, for it will intervene between man in a more civilized state, as we may hope, even than the Caucasian, and some ape as low as a baboon, instead of as now between the negro or Australian and the gorilla.

With respect to the absence of fossil remains, serving to connect man with his ape-like progenitors, no one will lay much stress on this fact who reads Sir C. Lyell's discussion, where he shows that in all the vertebrate classes the discovery of fossil remains has been a very slow and fortuitous process. Nor should

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it be forgotten that those regions which are the most likely to afford remains connecting man with some extinct ape-like creature, have not as yet been searched by geologists.

Lower Stages in the Genealogy of Man.— We have seen that man appears to have diverged from the Catarhine or Old World division of the Simiadæ, after these had diverged from the New World division. We will now endeavor to follow the remote traces of his genealogy, trusting principally to the mutual affinities between the various classes and orders, with some slight reference to the periods, as far as ascertained of their successive appearance on the earth. The Lemuridæ stand below and near to the Simiadæ, and constitute a very distinct family of the Primates, or, according to Häckel and others, a distinct Order. This group is diversified and broken to an extraordinary degree, and includes many aberrant forms. It has, therefore, probably suffered much extinction. Most of the remnants survive on islands, such as Madagascar and the Malayan archipelago, where they have not been exposed to so severe a competition as they would have been on well-stocked continents. This group likewise presents many gradations, leading, as Huxley remarks, "insensibly from the crown and summit of the animal creation down to creatures from which there is but a step, as it seems, to the lowest, smallest, and least intelligent of the placental mammalia." From these various considerations it is probable that the Simiadæ were originally developed from the progenitors of the existing Lemuridæ; and these in their turn from forms standing very low in the mammalian series.

The Marsupials stand in many important characters below the placental mammals. They appeared at an earlier geological period, and their range was formerly much more extensive than at present. Hence the Placentata are generally supposed to have been derived from the Implacentata or Marsupials; not, however, from forms closely resembling the existing Marsupials, but from their early progenitors. The Monotremata are plainly allied to the Marsupials, forming a third and still lower division in the great mammalian series. They are represented at the present day solely by the Ornithorhynchus and Echidna; and these two forms may be safely considered as relics of a much larger group, representatives of which have been preserved in

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Australia through some favorable concurrence of circumstances. The Monotremata are eminently interesting, as leading in several important points of structure towards the class of reptiles.

In attempting to trace the genealogy of the Mammalia, and therefore of man, lower down in the series, we become involved in greater and greater obscurity; but as a most capable judge, Mr. Parker, has remarked, we have good reason to believe, that no true bird or reptile intervenes in the direct line of descent. He who wishes to see what ingenuity and knowledge can effect, may consult Prof. Häckel's works.[3] I will content myself with a few general remarks. Every evolutionist will admit that the five great vertebrate classes, namely, mammals, birds, reptiles, amphibians, and fishes, are descended from some one prototype; for they have much in common, especially during their embryonic state. As the class of fishes is the most lowly organized, and appeared before the others, we may conclude that all the members of the vertebrate kingdom are derived from some fishlike animal. The belief that animals so distinct as a monkey, an elephant, a humming-bird, a snake, a frog, and a fish, &c., could all have sprung from the same parents, will appear monstrous to those who have not attended to the recent progress of natural history. For this belief implies the former existence of links binding closely together all these forms, now so utterly unlike.

Nevertheless, it is certain that groups of animals have existed, or do now exist, which serve to connect several of the great vertebrate classes more or less closely. We have seen that the Ornithorhynchus graduates towards reptiles; and Prof. Huxley has discovered, and is confirmed by Mr. Cope and others, that the Dinosaurians are in many important characters intermediate between certain reptiles and certain birds — the birds referred to being the ostrich-tribe (itself evidently a widely-diffused remnant of a larger group) and the Archeopteryx, that strange Secondary bird, with a long lizard-like tail. Again, according to Prof. Owen, the Ichthyosaurians — great sea-lizards furnished with paddles — present many affinities with fishes, or rather,

[3] Elaborate tables are given in his "Generelle Morphologie" (B. ii. s. cliii. and s. 425); and with more especial reference to man in his "Natürliche Schöpfungsgeschichte." Prof. Huxley, in reviewing this latter work says, that he considers the phylum or lines of descent of the Vertebrata to be admirably discussed by Häckel, although he differs on some points. He expresses, also, his high estimate of the general tenor and spirit of the whole work.

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according to Huxley, with amphibians; a class which, including in its highest division frogs and toads, is plainly allied to the Ganoid fishes. These latter fishes swarmed during the earlier geological periods, and were constructed on what is called a generalized type, that is, they presented diversified affinities with other groups of organisms. The Lepidosiren is also so closely allied to amphibians and fishes, that naturalists long disputed in which of these two classes to rank it; it, and also some few Ganoid fishes have been preserved from utter extinction by inhabiting rivers, which are harbors of refuge, and are related to the great waters of the ocean in the same way that islands are to continents.

Lastly, one single member of the immense and diversified class of fishes, namely, the lancelet or amphioxus, is so different from all other fishes, that Häckel maintains that it ought to form a distinct class in the vertebrate kingdom. This fish is remarkable for its negative characters; it can hardly be said to possess a brain, vertebral column, or heart, &c.; so that it was classed by the older naturalists amongst the worms. Many years ago Prof. Goodsir perceived that the lancelet presented some affinities with the Ascidians, which are invertebrate, hermaphrodite, marine creatures permanently attached to a support. They hardly appear like animals, and consist of a simple, tough, leathery sack, with two small projecting orifices. They belong to the Mulluscoida of Huxley — a lower division of the great kingdom of the Mollusca; but they have recently been placed by some naturalists amongst the Vermes or worms. Their larvæ somewhat resemble tadpoles in shape,[4] and have the power of swimming freely about. M. Kovalevsky has lately observed that the larvæ of Ascidians are related to the Vertebrata, in their manner of development, in the relative position of the nervous system, and in possessing a structure closely like the *chorda dorsalis* of vertebrate animals; and in this he has been since con-

[4] At the Falkland Islands I had the satisfaction of seeing, in April 1833, and therefore some years before any other naturalist, the locomotive larvæ of a compound Ascidian, closely allied to Synoicum, but apparently generically distinct from it. The tail was about five times as long as the oblong head, and terminated in a very fine filament. It was, as sketched by me under a simple microscope, plainly divided by transverse opaque partitions, which I presume represent the great cells figured by Kovalevsky. At an early stage of development the tail was closely coiled round the head of the larva.

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firmed by Prof. Kupffer. M. Kovalevsky writes to me from Naples, that he has now carried these observations yet further, and should his results be well established, the whole will form a discovery of the very greatest value. Thus, if we may rely on embryology, ever the safest guide in classification, it seems that we have at last gained a clew to the source whence the Vertebrata were derived.[5] We should then be justified in believing that at an extremely remote period a group of animals existed, resembling in many respects the larvæ of our present Ascidians, which diverged into two great branches — the one retrograding in development and producing the present class of Ascidians, the other rising to the crown and summit of the animal kingdom by giving birth to the Vertebrata.

We have thus far endeavored rudely to trace the genealogy of the Vertebrata by the aid of their mutual affinities. We will now look to man as he exists; and we shall, I think, be able partially to restore the structure of our early progenitors, during successive periods, but not in due order of time. This can be effected by means of the rudiments which man still retains, by the characters which occasionally make their appearance in him through reversion, and by the aid of the principles of morphology and embryology. The various facts, to which I shall here allude, have been given in the previous chapters.

The early progenitors of man must have been once covered with hair, both sexes having beards; their ears were probably pointed, and capable of movement; and their bodies were provided with a tail, having the proper muscles. Their limbs and bodies were also acted on by many muscles which now only occasionally reappear, but are normally present in the Quadrumana. At this or some earlier period, the great artery and nerve of the humerus ran through a supra-condyloid foramen. The intestine gave forth a much larger diverticulum or cæcum than that now existing. The foot was then prehensile, judging from

[5] But I am bound to add that some competent judges dispute this conclusion; for instance, Mr. Giard, in a series of papers in the "Archives de Zoologie Expérimentale," for 1872. Nevertheless, this naturalist remarks, "The organization of the Ascidian larvæ, apart from any theory or hypothesis, shows us how nature is able to produce the fundamental feature of the vertebrate type (the existence of a dorsal cord) in an invertebrate, by the sole vital condition of adaptation, and this simple possibility of a passage from one to the other abolishes the abyss between the two sub-kingdoms, even although we may remain in ignorance as to where the passage was in reality effected."

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the condition of the great toe in the fœtus; and our progenitors, no doubt, were arboreal in their habits, and frequented some warm, forest-clad land. The males had great canine teeth, which served them as formidable weapons. At a much earlier period the uterus was double; the excreta were voided through a cloaca; and the eye was protected by a third eyelid or nictitating membrane. At a still earlier period the progenitors of man must have been aquatic in their habits; for morphology plainly tells us that our lungs consist of a modified swim-bladder, which once served as a float. The clefts on the neck in the embryo of man show where the branchiæ once existed. In the lunar or weekly recurrent periods of some of our functions we apparently still retain traces of our primordial birthplace, a shore washed by the tides. At about this same early period the true kidneys were replaced by the corpora wolffiana. The heart existed as a simple pulsating vessel; and the chorda dorsalis took the place of a vertebral column. These early ancestors of man, thus seen in the dim recesses of time, must have been as simply, or even still more simply, organized than the lancelet or amphioxus.

There is one other point deserving a fuller notice. It has long been known that in the vertebrate kingdom one sex bears rudiments of various accessory parts, appertaining to the reproductive system, which properly belong to the opposite sex; and it has now been ascertained that at a very early embryonic period both sexes possess true male and female glands. Hence some remote progenitor of the whole vertebrate kingdom appears to have been hermaphrodite or androgynous.[6] But here we encounter a singular difficulty. In the mammalian class the males possess rudiments of a uterus with the adjacent passage, in their vesiculæ prostaticæ; they bear also rudiments of mammæ, and some male Marsupials have traces of a marsupial sack.[7] Other analogous facts could be added. Are we, then, to suppose that some extremely ancient mammal continued androgynous, after it had acquired

[6] This is the conclusion of Prof. Gegenbaur, one of the highest authorities in comparative anatomy; see "Grundzüge der vergleich. Anat." 1870, s. 876. The result has been arrived at chiefly from the study of the Amphibia; but it appears from the researches of Waldeyer (as quoted in "Journal of Anat. and Phys." 1869, p. 161), that the sexual organs of even "the higher vertebrata are, in their early condition, hermaphrodite." Similar views have long been held by some authors, though until recently without a firm basis.

[7] The male Thylacinus offers the best instance. Owen, "Anatomy of Vertebrates," vol. iii. p. 771.

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the chief distinctions of its class, and therefore after it had diverged from the lower classes of the vertebrate kingdom? This seems very improbable, for we have to look to fishes, the lowest of all the classes, to find any still existent androgynous forms.[8] That various accessory parts, proper to each sex, are found in a rudimentary condition in the opposite sex, may be explained by such organs having been gradually acquired by the one sex, and then transmitted in a more or less imperfect state to the other. When we treat of sexual selection, we shall meet with innumerable instances of this form of transmission,— as in the case of the spurs, plumes, and brilliant colors, acquired for battle or ornament by male birds, and inherited by the females in an imperfect or rudimentary condition.

The possession by male mammals of functionally imperfect mammary organs is, in some respects, especially curious. The Monotremata have the proper milk-secreting glands with orifices, but no nipples; and as these animals stand at the very base of the mammalian series, it is probable that the progenitors of the class also had milk-secreting glands, but no nipples. This conclusion is supported by what is known of their manner of development; for Professor Turner informs me, on the authority of Kölliker and Langer, that in the embryo the mammary glands can be distinctly traced before the nipples are in the least visible; and the development of successive parts in the individual generally represents and accords with the development of successive beings in the same line of descent. The Marsupials differ from the Monotremata by possessing nipples; so that probably these organs were first acquired by the Marsupials, after they had diverged from, and risen above, the Monotremata, and were then transmitted to the placental mammals.[9] No one will suppose that the

[8] Hermaphroditism has been observed in several species of Serranus, as well as in some other fishes, where it is either normal and symmetrical, or abnormal and unilateral. Dr. Zouteveen has given me references on this subject, more especially to a paper by Prof. Halbertsma, in the "Transact. of the Dutch Acad. of Sciences," vol. xvi. Dr. Günther doubts the fact, but it has now been recorded by too many good observers to be any longer disputed. Dr. M. Lessona writes to me, that he has verified the observations made by Cavolini on Serranus. Prof. Ercolani has recently shown ("Acad. delle Scienze," Bologna, Dec. 28, 1871) that eels are androgynous.

[9] Prof. Gegenbaur has shown ("Jenaische Zeitschrift," Bd. vii. p. 212) that two distinct types of nipples prevail throughout the several mammalian orders, but that it is quite intelligible how both could have been derived from the nipples of the Marsupials, and the latter from those of the Monotremata. See, also, a memoir by Dr. Max Huss, on the mammary glands, ibid. B. viii. p. 176.

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Marsupials still remained androgynous, after they had approximately acquired their present structure. How then are we to account for male mammals possessing mammæ? It is possible that they were first developed in the females and then transferred to the males, but from what follows this is hardly probable.

It may be suggested, as another view, that long after the progenitors of the whole mammalian class had ceased to be androgynous, both sexes yielded milk, and thus nourished their young; and in the case of the Marsupials, that both sexes carried their young in marsupial sacks. This will not appear altogether improbable, if we reflect that the males of existing syngnathous fishes receive the eggs of the females in their abdominal pouches, hatch them, and afterwards, as some believe, nourish the young;[10]— that certain other male fishes hatch the eggs within their mouths or branchial cavities;— that certain male toads take the chaplets of eggs from the females, and wind them round their own thighs, keeping them there until the tadpoles are born; — that certain male birds undertake the whole duty of incubation, and that male pigeons, as well as the females, feed their nestlings with a secretion from their crops. But the above suggestion first occurred to me from the mammary glands of male mammals being so much more perfectly developed than the rudiments of the other accessory reproductive parts, which are found in the one sex though proper to the other. The mammary glands and nipples, as they exist in male mammals, can indeed hardly be called rudimentary; they are merely not fully developed, and not functionally active. They are sympathetically affected under the influence of certain diseases, like the same organs in the female. They often secrete a few drops of milk at birth and at puberty: this latter fact occurred in the curious case, before referred to, where a young man possessed two pairs of mammæ. In man and some other male mammals these organs have been known occasionally to become so well developed during maturity as to yield a fair supply of milk. Now if we suppose that during

[10] Mr. Lockwood believes (as quoted in "Quart. Journal of Science," April 1868, p. 269), from what he has observed of the development of Hippocampus, that the walls of the abdominal pouch of the male in some way afford nourishment. On male fishes hatching the ova in their mouths, see a very interesting paper by Prof. Wyman, in "Proc. Boston Soc. of Nat. Hist." Sept. 15, 1857; also Prof. Turner, in "Journal of Anat. and Phys." Nov. 1, 1866, p. 78. Dr. Günther has likewise described similar cases.

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a former prolonged period male mammals aided the females in nursing their offspring,[11] and that afterwards from some cause (as from the production of a smaller number of young) the males ceased to give this aid, disuse of the organs during maturity would lead to their becoming inactive; and from two well-known principles of inheritance, this state of inactivity would probably be transmitted to the males at the corresponding age of maturity. But at an earlier age these organs would be left unaffected, so that they would be almost equally well developed in the young of both sexes.

Conclusion.— Von Baer has defined advancement or progress in the organic scale better than any one else, as resting on the amount of differentiation and specialization of the several parts of a being,— when arrived at maturity, as I should be inclined to add. Now as organisms have become slowly adapted to diversified lines of life by means of natural selection, their parts will have become more and more differentiated and specialized for various functions from the advantage gained by the division of physiological labor. The same part appears often to have been modified first for one purpose, and then long afterwards for some other and quite distinct purpose; and thus all the parts are rendered more and more complex. But each organism still retains the general type of structure of the progenitor from which it was aboriginally derived. In accordance with this view it seems, if we turn to geological evidence, that organization on the whole has advanced throughout the world by slow and interrupted steps. In the great kingdom of the Vertebrata it has culminated in man. It must not, however, be supposed that groups of organic beings are always supplanted, and disappear as soon as they have given birth to other and more perfect groups. The latter, though victorious over their predecessors, may not have become better adapted for all places in the economy of nature. Some old forms appear to have survived from inhabiting protected sites, where they have not been exposed to very severe competition; and these often aid us in constructing our genealogies, by giving us a fair idea of former and lost populations. But we must not fall into the error of looking at the existing

[11] Maddle. C. Royer has suggested a similar view in her "Origine de l'Homme," &c., 1870.

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members of any lowly-organized group as perfect representatives of their ancient predecessors.

The most ancient progenitors in the kingdom of the Vertebrata, at which we are able to obtain an obscure glance, apparently consisted of a group of marine animals,[12] resembling the larvæ of existing Ascidians. These animals probably gave rise to a group of fishes, as lowly organized as the lancelet; and from these the Ganoids, and other fishes like the Lepidosiren, must have been developed. From such fish a very small advance would carry us on to the Amphibians. We have seen that birds and reptiles were once intimately connected together; and the Monotremata now connect mammals with reptiles in a slight degree. But no one can at present say by what line of descent the three higher and related classes, namely, mammals, birds, and reptiles, were derived from the two lower vertebrate classes, namely, amphibians and fishes. In the class of mammals the steps are not difficult to conceive which led from the ancient Monotremata to the ancient Marsupials; and from these to the early progenitors of the placental mammals. We may thus ascend to the Lemuridæ; and the interval is not very wide from these to the Simiadæ. The Simiadæ then branched off into two great stems, the New World and Old World monkeys; and from the latter, at a remote period, Man, the wonder and glory of the Universe, proceeded.

[12] The inhabitants of the seashore must be greatly affected by the tides; animals living either about the *mean* high-water mark, or about the *mean* low-water mark, pass through a complete cycle of tidal changes in a fortnight. Consequently, their food supply will undergo marked changes week by week. The vital functions of such animals, living under these conditions for many generations, can hardly fail to run their course in regular weekly periods. Now it is a mysterious fact that in the higher and now terrestrial Vertebrata, as well as in other classes, many normal and abnormal processes have one or more whole weeks as their periods; this would be rendered intelligible if the Vertebrata are descended from an animal allied to the existing tidal Ascidians. Many instances of such periodic processes might be given, as the gestation of mammals, the duration of fevers, &c. The hatching of eggs affords also a good example, for, according to Mr. Bartlett ("Land and Water," Jan. 7, 1871), the eggs of the pigeon are hatched in two weeks; those of the fowl in three; those of the duck in four; those of the goose in five; and those of the ostrich in seven weeks. As far as we can judge, a recurrent period, if approximately of the right duration for any process or function, would not, when once gained, be liable to change; consequently it might be thus transmitted through almost any number of generations. But if the function changed, the period would have to change, and would be apt to change almost abruptly by a whole week. This conclusion, if sound, is highly remarkable; for the period of gestation in each mammal, and the hatching of each bird's eggs, and many other vital processes, thus betray to us the primordial birthplace of these animals.

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Thus we have given to man a pedigree of prodigious length, but not, it may be said, of noble quality. The world, it has often been remarked, appears as if it had long been preparing for the advent of man: and this, in one sense is strictly true, for he owes his birth to a long line of progenitors. If any single link in this chain had never existed, man would not have been exactly what he now is. Unless we wilfully close our eyes, we may, with our present knowledge, approximately recognize our parentage; nor need we feel ashamed of it. The most humble organism is something much higher than the inorganic dust under our feet; and no one with an unbiased mind can study any living creature, however humble, without being struck with enthusiasm at its marvelous structure and properties.

CHAPTER VII.

ON THE RACES OF MAN.

The nature and value of specific characters — Application to the races of man — Arguments in favour of, and opposed to, ranking the so-called races of man as distinct species — Sub-species — Monogenists and polygenists — Convergence of character — Numerous points of resemblance in body and mind between the most distinct races of man — The state of man when he first spread over the earth — Each race not descended from a single pair. The extinction of races — The formation of races — The effects of crossing — Slight influence of the direct action of the conditions of life — Slight or no influence of natural selection — Sexual selection.

It is not my intention here to describe the several so-called races of men; but I am about to enquire what is the value of the differences between them under a classificatory point of view, and how they have originated. In determining whether two or more allied forms ought to be ranked as species or varieties, naturalists are practically guided by the following considerations; namely, the amount of difference between them, and whether such differences relate to few or many points of structure, and whether they are of physiological importance; but more especially whether they are constant. Constancy of char-

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acter is what is chiefly valued and sought for by naturalists. Whenever it can be shown, or rendered probable, that the forms in question have remained distinct for a long period, this becomes an argument of much weight in favor of treating them as species. Even a slight degree of sterility between any two forms when first crossed, or in their offspring, is generally considered as a decisive test of their specific distinctness; and their continued persistence without blending within the same area, is usually accepted as sufficient evidence, either of some degree of mutual sterility, or in the case of animals of some mutual repugnance to pairing.

Independently of fusion from intercrossing, the complete absence, in a well-investigated region, of varieties linking together any two closely-allied forms, is probably the most important of all the criterions of their specific distinctness; and this is a somewhat different consideration from mere constancy of character, for two forms may be highly variable and yet not yield intermediate varieties. Geographical distribution is often brought into play unconsciously and sometimes consciously; so that forms living in two widely separated areas, in which most of the other inhabitants are specifically distinct, are themselves usually looked at as distinct; but in truth this affords no aid in distinguishing geographical races from so-called good or true species.

Now let us apply these generally-admitted principles to the races of man, viewing him in the same spirit as a naturalist would any other animal. In regard to the amount of difference between the races, we must make some allowance for our nice powers of discrimination gained by the long habit of observing ourselves. In India, as Elphinstone remarks, although a newly-arrived European cannot at first distinguish the various native races, yet they soon appear to him extremely dissimilar;[1] and the Hindoo cannot at first perceive any difference between the several European nations. Even the most distinct races of man are much more like each other in form than would at first be supposed; certain negro tribes must be excepted, whilst others, as Dr. Rohlfs writes to me, and as I have myself seen, have Caucasian features. This general similarity is well shown by the

[1] "History of India," vol. i. p. 323. Father Ripa makes exactly the same remark with respect to the Chinese.

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French photographs in the Collection Anthropologique du Muséum de Paris of the men belonging to various races, the greater number of which might pass for Europeans, as many persons to whom I have shown them have remarked. Nevertheless, these men, if seen alive, would undoubtedly appear very distinct, so that we are clearly much influenced in our judgment by the mere color of the skin and hair, by slight differences in the features, and by expression.

There is, however, no doubt that the various races, when carefully compared and measured, differ much from each other,— as in the texture of the hair, the relative proportions of all parts of the body,[2] the capacity of the lungs, the form and capacity of the skull, and even in the convolutions of the brain.[3] But it would be an endless task to specify the numerous points of difference. The races differ also in constitution, in acclimatization and in liability to certain diseases. Their mental characteristics are likewise very distinct, chiefly as it would appear in their emotional, but partly in their intellectual faculties. Every one who has had the opportunity of comparison, must have been struck with the contrast between the taciturn, even morose, aborigines of S. America and the light-hearted, talkative negroes. There is a nearly similar contrast between the Malays and the Papuans, who live under the same physical conditions, and are separated from each other only by a narrow space of sea.

We will first consider the arguments which may be advanced in favor of classing the races of man as distinct species, and then the arguments on the other side. If a naturalist, who had never before seen a Negro, Hottentot, Australian, or Mongolian, were to compare them, he would at once perceive that they differed in a multitude of characters, some of slight and some of considerable importance. On enquiry he would find that they were adapted to live under widely different climates, and that they differed somewhat in bodily constitution and mental disposition. If he were then told that hundreds of similar specimens could be brought from the same countries, he would assuredly declare that they were as good species as many to which he had been in

[2] A vast number of measurements of Whites, Blacks, and Indians, are given in the "Investigations in the Military and Anthropolog. Statistics of American Soldiers," by B. A. Gould, 1869, pp. 298–358; "On the capacity of the lungs," p. 471.

[3] See, for instance, Mr. Marshall's account of the brain of a Bushwoman, in "Phil. Transact." 1864, p. 519.

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the habit of affixing specific names. This conclusion would be greatly strengthened as soon as he had ascertained that these forms had all retained the same character for many centuries; and that negroes, apparently identical with existing negroes, had lived at least 4000 years ago.[4] He would also hear, on the authority of an excellent observer, Dr. Lund, that the human skulls found in the caves of Brazil, entombed with many extinct mammals, belonged to the same type as that now prevailing throughout the American Continent.

Our naturalist would then perhaps turn to geographical distribution, and he would probably declare that those forms must be distinct species, which differ not only in appearance, but are fitted for hot, as well as damp or dry countries, and for the Arctic regions. He might appeal to the fact that no species in the group next to man — namely, the Quadrumana, can resist a low temperature, or any considerable change of climate; and that the species which come nearest to man have never been reared to maturity, even under the temperate climate of Europe. He would be deeply impressed with the fact, first noticed by Agassiz, that the different races of man are distributed over the world in the same zoological provinces, as those inhabited by undoubtedly distinct species and genera of mammals. This is manifestly the case with the Australian, Mongolian, and Negro races of man; in a less well-marked manner with the Hottentots; but plainly with the Papuans and Malays, who are separated, as Mr. Wallace has shown, by nearly the same line which divides the great Malayan and Australian zoological provinces. The Aborigines of America range throughout the Continent; and this at first appears opposed to the above rule, for most of the produc-

[4] With respect to the figures in the famous Egyptian caves of Abou-Simbel; M. Pouchet says ("The Plurality of the Human Races," Eng. translat., 1864, p. 50), that he was far from finding recognizable representations of the dozen or more nations which some authors believe that they can recognize. Even some of the most strongly-marked races cannot be identified with that degree of unanimity which might have been expected from what has been written on the subject. Thus Messrs. Nott and Gliddon ("Types of Mankind," p. 148), state that Rameses II., or the Great, has features superbly European; whereas Knox, another firm believer in the specific distinctness of the races of man ("Races of Man," 1850, p. 201), speaking of young Memnon (the same as Rameses II., as I am informed by Mr. Birch), insists in the strongest manner that he is identical in character with the Jews of Antwerp. Again, when I looked at the statue of Amunoph III., I agreed with two officers of the establishment, both competent judges, that he had a strongly-marked negro type of features; but Messrs. Nott and Gliddon (ibid. p. 146, fig. 53), describe him as a hybrid, but not of "negro intermixture."

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tions of the Southern and Northern halves differ widely: yet some few living forms, as the opossum, range from the one into the other, as did formerly some of the gigantic Edentata. The Esquimaux, like other Arctic animals, extend round the whole polar regions. It should be observed that the amount of difference between the mammals of the several zoological provinces does not correspond with the degree of separation between the latter; so that it can hardly be considered as an anomaly that the Negro differs more, and the American much less from the other races of man, than do the mammals of the African and American continents from the mammals of the other provinces. Man, it may be added, does not appear to have aboriginally inhabited any oceanic island; and in this respect, he resembles the other members of his class.

In determining whether the supposed varieties of the same kind of domestic animal should be ranked as such, or as specifically distinct, that is, whether any of them are descended from distinct wild species, every naturalist would lay much stress on the fact of their external parasites being specifically distinct. All the more stress would be laid on this fact, as it would be an exceptional one; for I am informed by Mr. Denny that the most different kinds of dogs, fowls, and pigeons, in England, are infested by the same species of Pediculi or lice. Now Mr. A. Murray has carefully examined the Pediculi collected in different countries from the different races of man, and he finds that they differ, not only in color, but in the structure of their claws and limbs. In every case in which many specimens were obtained the differences were constant. The surgeon of a whaling ship in the Pacific assured me that when the Pediculi, with which some Sandwich Islanders on board swarmed, strayed on to the bodies of the English sailors, they died in the course of three or four days. These Pediculi were darker colored, and appeared different from those proper to the natives of Chiloe in South America, of which he gave me specimens. These, again, appeared larger and much softer than European lice. Mr. Murray procured four kinds from Africa, namely, from the Negroes of the Eastern and Western coasts, from the Hottentots and Kaffirs; two kinds from the natives of Australia; two from North and two from South America In these latter cases it may be presumed that the Pediculi came from natives inhabiting different

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districts. With insects slight structural differences, if constant, are generally esteemed of specific value: and the fact of the races of man being infested by parasites, which appear to be specifically distinct, might fairly be urged as an argument that the races themselves ought to be classed as distinct species.

Our supposed naturalist having proceeded thus far in his investigation, would next enquire whether the races of men, when crossed, were in any degree sterile. He might consult the work of Professor Broca, a cautious and philosophical observer, and in this he would find good evidence that some races were quite fertile together, but evidence of an opposite nature in regard to other races. Thus it has been asserted that the native women of Australia and Tasmania rarely produce children to European men; the evidence, however, on this head has now been shown to be almost valueless. The half-castes are killed by the pure blacks: and an account has lately been published of eleven half-caste youths murdered and burnt at the same time, whose remains were found by the police.[5] Again, it has often been said that when mulattoes intermarry, they produce few children; on the other hand, Dr. Bachman, of Charleston, positively asserts that he has known mulatto families which have intermarried for several generations, and have continued on an average as fertile as either pure whites or pure blacks. Inquiries formerly made by Sir C. Lyell on this subject led him, as he informs me, to the same conclusion.[6] In the United States the census for the year 1854 included, according to Dr. Bachman, 405,751 mulattoes; and this number, considering all the circumstances of the case, seems small; but it may partly be accounted for by the degraded and anomalous position of the class, and by the

[5] See the interesting letter by Mr. T. A. Murray, in the "Anthropolog. Review," April, 1868, p. liii. In this letter Count Strzelecki's statement that Australian women who have borne children to a white man, are afterwards sterile with their own race, is disproved. M. A. de Quatrefages has also collected ("Revue des Cours Scientifiques," March, 1869, p. 239), much evidence that Australians and Europeans are not sterile when crossed.

[6] Dr. Rohlfs writes to me that he found the mixed races in the Great Sahara, derived from Arabs, Berbers, and Negroes of three tribes, extraordinarily fertile. On the other hand, Mr. Winwood Reade informs me that the Negroes on the Gold Coast, though admiring white men and mulattoes, have a maxim that mulattoes should not intermarry, as the children are few and sickly. This belief, as Mr. Reade remarks, deserves attention, as white men have visited and resided on the Gold Coast for four hundred years, so that the natives have had ample time to gain knowledge through experience.

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profligacy of the women. A certain amount of absorption of mulattoes into negroes must always be in progress; and this would lead to an apparent diminution of the former. The inferior vitality of mulattoes is spoken of in a trustworthy work[7] as a well-known phenomenon; and this, although a different consideration from their lessened fertility, may perhaps be advanced as a proof of the specific distinctness of the parent races. No doubt both animal and vegetable hybrids, when produced from extremely distinct species, are liable to premature death; but the parents of mulattoes cannot be put under the category of extremely distinct species. The common Mule, so notorious for long life and vigor, and yet so sterile, shows how little necessary connection there is in hybrids between lessened fertility and vitality; other analogous cases could be cited.

Even if it should hereafter be proved that all the races of men were perfectly fertile together, he who was inclined from other reasons to rank them as distinct species, might with justice argue that fertility and sterility are not safe criterions of specific distinctness. We know that these qualities are easily affected by changed conditions of life, or by close inter-breeding, and that they are governed by highly complex laws, for instance, that of the unequal fertility of converse crosses between the same two species. With forms which must be ranked as undoubted species, a perfect series exists from those which are absolutely sterile when crossed, to those which are almost or completely fertile. The degrees of sterility do not coincide strictly with the degrees of difference between the parents in external structure or habits of life. Man in many respects may be compared with those animals which have long been domesticated, and a large body of evidence can be advanced in favor of the Pallasian doctrine,[8] that domestication tends to eliminate the

[7] "Military and Anthropolog. Statistics of American Soldiers," by B. A. Gould, 1869, p. 319.

[8] "The Variation of Animals and Plants under Domestication," vol. ii. p. 109. I may here remind the reader that the sterility of species when crossed is not a specially-acquired quality, but, like the incapacity of certain trees to be grafted together, is incidental on other acquired differences. The nature of these differences is unknown, but they relate more especially to the reproductive system, and much less so to external structure or to ordinary differences in constitution. One important element in the sterility of crossed species apparently lies in one or both having been long habituated to fixed conditions: for we know that changed conditions have a special influence on the reproductive system, and we have good reason to believe (as before remarked) that the fluctuating condi-

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sterility which is so general a result of the crossing of species in a state of nature. From these several considerations, it may be justly urged that the perfect fertility of the intercrossed races of man, if established, would not absolutely preclude us from ranking them as distinct species.

Independently of fertility, the characters presented by the offspring from a cross have been thought to indicate whether or not the parent-forms ought to be ranked as species or varieties; but after carefully studying the evidence, I have come to the conclusion that no general rules of this kind can be trusted. The ordinary result of a cross is the production of a blended or intermediate form; but in certain cases some of the offspring take closely after one parent-form, and some after the other. This is especially apt to occur when the parents differ in characters which first appeared as sudden variations or monstrosities. I refer to this point, because Dr. Rohlfs informs me that he has frequently seen in Africa the offspring of negroes crossed with members of other races, either completely black or completely white, or rarely piebald. On the other hand, it is notorious that in America mulattoes commonly present an intermediate appearance.

We have now seen that a naturalist might feel himself fully justified in ranking the races of man as distinct species; for he has found that they are distinguished by many differences in structure and constitution, some being of importance. These differences have, also, remained nearly constant for very long

tions of domestication tend to eliminate that sterility which is so general with species, in a natural state, when crossed. It has elsewhere been shown by me (ibid. vol. ii. p. 185, and "Origin of Species," 5th edit. p. 317) that the sterility of crossed species has not been acquired through natural selection: we can see that when two forms have already been rendered very sterile, it is scarcely possible that their sterility should be augmented by the preservation or survival of the more and more sterile individuals; for, as the sterility increases, fewer and fewer offspring will be produced from which to breed, and at last only single individuals will be produced at the rarest intervals. But there is even a higher grade of sterility than this. Both Gärtner and Kölreuter have proved that in genera of plants, including many species, a series can be formed from species which, when crossed, yield fewer and fewer seeds, to species which never produce a single seed, but yet are affected by the pollen of the other species, as shown by the swelling of the germen. It is here manifestly impossible to select the more sterile individuals, which have already ceased to yield seeds; so that the acme of sterility, when the germen alone is affected, cannot have been gained through selection. This acme, and no doubt the other grades of sterility, are the incidental results of certain unknown differences in the constitution of the reproductive system of the species which are crossed.

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periods of time. Our naturalist will have been in some degree influenced by the enormous range of man, which is a great anomaly in the class of mammals, if mankind be viewed as a single species. He will have been struck with the distribution of the several so-called races, which accords with that of other undoubtedly distinct species of mammals. Finally, he might urge that the mutual fertility of all the races has not as yet been fully proved, and even if proved would not be an absolute proof of their specific identity.

On the other side of the question, if our supposed naturalist were to inquire whether the forms of man keep distinct like ordinary species, when mingled together in large numbers in the same country, he would immediately discover that this was by no means the case. In Brazil he would behold an immense mongrel population of Negroes and Portuguese; in Chili, and other parts of South America, he would behold the whole population consisting of Indians and Spaniards blended in various degrees.[9] In many parts of the same continent he would meet with the most complex crosses between Negroes, Indians, and Europeans; and judging from the vegetable kingdom, such triple crosses afford the severest test of the mutual fertility of the parent forms. In one island of the Pacific he would find a small population of mingled Polynesian and English blood; and in the Fiji Archipelago a population of Polynesian and Negritos crossed in all degrees. Many analogous cases could be added; for instance, in Africa. Hence the races of man are not sufficiently distinct to inhabit the same country without fusion; and the absence of fusion affords the usual and best test of specific distinctness.

Our naturalist would likewise be much disturbed as soon as he perceived that the distinctive characters of all the races were highly variable. This fact strikes every one on first beholding the negro slaves in Brazil, who have been imported from all parts of Africa. The same remark holds good with the Polynesians, and with many other races. It may be doubted whether any character can be named which is distinctive of a race and is constant. Savages, even within the limits of the same tribe, are

[9] M. de Quatrefages has given ("Anthropolog. Review," Jan. 1869, p. 22), an interesting account of the success and energy of the Paulistas in Brazil, who are a much crossed race of Portuguese and Indians, with a mixture of the blood of other races.

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not nearly so uniform in character, as has been often asserted. Hottentot women offer certain peculiarities, more strongly marked than those occurring in any other race, but these are known not to be of constant occurrence. In the several American tribes, color and hairiness differ considerably; as does color to a certain degree, and the shape of the features greatly, in the Negroes of Africa. The shape of the skull varies much in some races;[10] and so it is with every other character. Now all naturalists have learnt by dearly bought experience, how rash it is to attempt to define species by the aid of inconstant characters.

But the most weighty of all the arguments against treating the races of man as distinct species, is that they graduate into each other, independently in many cases, as far as we can judge, of their having intercrossed. Man has been studied more carefully than any other animal, and yet there is the greatest possible diversity amongst capable judges whether he should be classed as a single species or race, or as two (Virey), as three (Jacquinot), as four (Kant), five (Blumenbach), six (Buffon), seven (Hunter), eight (Agassiz), eleven (Pickering), fifteen (Bory St. Vincent), sixteen (Desmoulins), twenty-two (Morton), sixty (Crawfurd), or as sixty-three, according to Burke. This diversity of judgment does not prove that the races ought not to be ranked as species, but it shows that they graduate into each other, and that it is hardly possible to discover clear distinctive characters between them.

Every naturalist who has had the misfortune to undertake the description of a group of highly varying organisms, has encountered cases (I speak after experience) precisely like that of man; and if of a cautious disposition, he will end by uniting all the forms which graduate into each other, under a single species; for he will say to himself that he has no right to give names to objects which he cannot define. Cases of this kind occur in the Order which includes man, namely in certain genera of monkeys; whilst in other genera, as in Cercopithecus, most of the species can be determined with certainty. In the American genus Cebus, the various forms are ranked by some naturalists as species, by others as mere geographical races. Now if numerous

[10] For instance, with the aborigines of America and Australia. Prof. Huxley says ("Transact. Internat. Congress of Prehist. Arch." 1868, p. 105), that the skulls of many South Germans and Swiss are "as short and as broad as those of the Tartars," &c.

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specimens of Cebus were collected from all parts of South America, and those forms which at present appear to be specifically distinct, were found to graduate into each other by close steps, they would usually be ranked as mere varieties or races; and this course has been followed by most naturalists with respect to the races of man. Nevertheless, it must be confessed that there are forms, at least in the vegetable kingdom,[11] which we cannot avoid naming as species, but which are connected together by numberless gradations, independently of intercrossing.

Some naturalists have lately employed the term "sub-species" to designate forms which possess many of the characteristics of true species, but which hardly deserve so high a rank. Now if we reflect on the weighty arguments above given, for raising the races of man to the dignity of species, and the insuperable difficulties on the other side in defining them, it seems that the term "sub-species" might here be used with propriety. But from long habit the term "race" will perhaps always be employed. The choice of terms is only so far important in that it is desirable to use, as far as possible, the same terms for the same degrees of difference. Unfortunately this can rarely be done: for the larger genera generally include closely-allied forms, which can be distinguished only with much difficulty, whilst the smaller genera within the same family include forms that are perfectly distinct; yet all must be ranked equally as species. So again, species within the same large genus by no means resemble each other to the same degree: on the contrary, some of them can generally be arranged in little groups round other species, like satellites round planets.

The question whether mankind consists of one or several species has of late years been much discussed by anthropologists, who are divided into the two schools of monogenists and polygenists. Those who do not admit the principle of evolution, must look at species as separate creations, or as in some manner as distinct entities; and they must decide what forms of man they will consider as species by the analogy of the method commonly pursued in ranking other organic beings as species. But

[11] Prof. Nägeli has carefully described several striking cases in his "Botanische Mittheilungen," B. ii. ss. 294–369. Prof. Asa Gray has made analogous remarks on some intermediate forms in the Compositæ of N. America.

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it is a hopeless endeavor to decide this point, until some definition of the term "species" is generally accepted; and the definition must not include an indeterminate element such as an act of creation. We might as well attempt without any definition to decide whether a certain number of houses should be called a village, town, or city. We have a practical illustration of the difficulty in the never-ending doubts whether many closely-allied mammals, birds, insects, and plants, which represent each other respectively in North America and Europe, should be ranked as species or geographical races; and the like holds true of the productions of many islands situated at some little distance from the nearest continent.

Those naturalists, on the other hand, who admit the principle of evolution, and this is now admitted by the majority of rising men, will feel no doubt that all the races of man are descended from a single primitive stock; whether or not they may think fit to designate the races as distinct species, for the sake of expressing their amount of difference. With our domestic animals the question whether the various races have arisen from one or more species is somewhat different. Although it may be admitted that all the races, as well as all the natural species within the same genus, have sprung from the same primitive stock, yet it is a fit subject for discussion, whether all the domestic races of the dog, for instance, have acquired their present amount of difference since some one species was first domesticated by man; or whether they owe some of their characters to inheritance from distinct species, which had already been differentiated in a state of nature. With man no such question can arise, for he cannot be said to have been domesticated at any particular period.

During an early stage in the divergence of the races of man from a common stock, the differences between the races and their number must have been small; consequently as far as their distinguishing characters are concerned, they then had less claim to rank as distinct species than the existing so-called races. Nevertheless, so arbitrary is the term of species, that such early races would perhaps have been ranked by some naturalists as distinct species, if their differences, although extremely slight, had been more constant than they are at present, and had not graduated into each other.

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It is however possible, though far from probable, that the early progenitors of man might formerly have diverged much in character, until they became more unlike each other than any now existing races; but that subsequently, as suggested by Vogt, they converge in character. When man selects the offspring of two distinct species for the same object, he sometimes induces a considerable amount of convergence, as far as general appearance is concerned. This is the case, as shown by Von Nathusius, with the improved breeds of the pig, which are descended from two distinct species; and in a less marked manner with the improved breeds of cattle. A great anatomist, Gratiolet, maintains that the anthropomorphous apes do not form a natural sub-group; but that the orang is a highly developed gibbon or semnopithecus, the chimpanzee a highly developed macacus, and the gorilla a highly developed mandrill. If this conclusion, which rests almost exclusively on brain-characters, be admitted, we should have a case of convergence at least in external characters, for the anthropomorphous apes are certainly more like each other in many points, than they are to other apes. All analogical resemblances, as of a whale to a fish, may indeed be said to be cases of convergence; but this term has never been applied to superficial and adaptive resemblances. It would, however, be extremely rash to attribute to convergence close similarity of character in many points of structure amongst the modified descendants of widely distinct beings. The form of a crystal is determined solely by the molecular forces, and it is not surprising that dissimilar substances should sometimes assume the same form; but with organic beings we should bear in mind that the form of each depends on an infinity of complex relations, namely on variations, due to causes far too intricate to be followed,— on the nature of the variations preserved, these depending on the physical conditions, and still more on the surrounding organisms which compete with each,— and lastly, on inheritance (in itself a fluctuating element) from innumerable progenitors, all of which have had their forms determined through equally complex relations. It appears incredible that the modified descendants of two organisms, if these differed from each other in a marked manner, should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organization. In the case of the convergent races

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of pigs above referred to, evidence of their descent from two primitive stocks is, according to Von Nathusius, still plainly retained, in certain bones of their skulls. If the races of man had descended, as is supposed by some naturalists, from two or more species, which differed from each other as much, or nearly as much, as does the orang from the gorilla, it can hardly be doubted that marked differences in the structure of certain bones would still be discoverable in man as he now exists

Although the existing races of man differ in many respects, as in color, hair, shape of skull, proportions of the body, etc., yet if their whole structure be taken into consideration they are found to resemble each other closely in a multitude of points. Many of these are of so unimportant or of so singular a nature, that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races. The same remark holds good with equal or greater force with respect to the numerous points of mental similarity between the most distinct races of man. The American aborigines, Negroes and Europeans are as different from each other in mind as any three races that can be named; yet I was incessantly struck, whilst living with the Fuegians on board the "Beagle," with the many little traits of character, showing how similar their minds were to ours; and so it was with a full-blooded negro with whom I hapħened once to be intimate.

He who will read Mr. Tyler's and Sir J. Lubbock's interesting works can hardly fail to be deeply impressed with the close similarity between the men of all races in tastes, dispositions and habits. This is shown by the pleasure which they all take in dancing, rude music, acting, painting, tattooing, and otherwise decorating themselves; in their mutual comprehension of gesture-language, by the same expression in their features, and by the same inarticulate cries, when excited by the same emotions. This similarity, or rather identity, is striking, when contrasted with the different expressions and cries made by distinct species of monkeys. There is good evidence that the art of shooting with bows and arrows has not been handed down from any common progenitor of mankind, yet as Westropp and Nilsson have remarked, the stone arrow-heads, brought from the most distant parts of the world, and manufactured at the most remote periods,

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are almost identical; and this fact can only be accounted for by the various races having similar inventive or mental powers. The same observation has been made by archæologists with respect to certain widely-prevalent ornaments, such as zig-zags, &c.; and with respect to various simple beliefs and customs, such as the burying of the dead under megalithic structures. I remember observing in South America, that there, as in so many other parts of the world, men have generally chosen the summits of lofty hills, to throw up piles of stones, either as a record of some remarkable event, or for burying their dead.

Now when naturalists observe a close agreement in numerous small details of habits, tastes, and dispositions between two or more domestic races, or between nearly-allied natural forms, they use this fact as an argument that they are descended from a common progenitor who was thus endowed; and consequently that all should be classed under the same species. The same argument may be applied with much force to the races of man.

As it is improbable that the numerous and unimportant points of resemblance between the several races of man in bodily structure and mental faculties (I do not here refer to similar customs) should all have been independently acquired, they must have been inherited from progenitors who had these same characters. We thus gain some insight into the early state of man, before he had spread step by step over the face of the earth. The spreading of man to regions widely separated by the sea, no doubt, preceded any great amount of divergence of character in the several races; for otherwise we should sometimes meet with the same race in distinct continents; and this is never the case. Sir J. Lubbock, after comparing the arts now practised by savages in all parts of the world, specifies those which man could not have known, when he first wandered from his original birthplace; for if once learnt they would never have been forgotten. He thus shows that "the spear, which is but a development of the knife-point, and the club, which is but a long hammer, are the only things left." He admits, however, that the art of making fire probably had been already discovered, for it is common to all the races now existing, and was known to the ancient cave-inhabitants of Europe. Perhaps the art of making rude canoes or rafts was likewise known; but as man existed at a remote epoch, when the land in many places stood

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at a very different level to what it does now, he would have been able, without the aid of canoes, to have spread widely. Sir J. Lubbock further remarks how improbable it is that our earliest ancestors could have "counted as high as ten, considering that so many races now in existence cannot get beyond four." Nevertheless, at this early period, the intellectual and social faculties of man could hardly have been inferior in any extreme degree to those possessed at present by the lowest savages; otherwise primeval man could not have been so eminently successful in the struggle for life, as proved by his early and wide diffusion.

From the fundamental differences between certain languages, some philologists have inferred that when man first became widely diffused, he was not a speaking animal; but it may be suspected that languages, far less perfect than any now spoken, aided by gestures, might have been used, and yet have left no traces on subsequent and more highly-developed tongues. Without the use of some language, however imperfect, it appears doubtful whether man's intellect could have risen to the standard implied by his dominant position at an early period.

Whether primeval man, when he possessed but few arts, and those of the rudest kind, and when his power of language was extremely imperfect, would have deserved to be called man, must depend on the definition which we employ. In a series of forms graduating insensibly from some ape-like creature to man as he now exists, it would be impossible to fix on any definite point when the term "man" ought to be used. But this is a matter of very little importance. So again, it is almost a matter of indifference whether the so-called races of man are thus designated, or are ranked as species or sub-species; but the latter term appears the more appropriate. Finally, we may conclude that when the principle of evolution is generally accepted, as it surely will be before long, the dispute between the monogenists and the polygenists will die a silent and unobserved death.

One other question ought not to be passed over without notice, namely, whether, as is sometimes assumed, each sub-species or race of man has sprung from a single pair of progenitors. With our domestic animals a new race can readily be formed by

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carefully matching the varying offspring from a single pair, or even from a single individual possessing some new character; but most of our races have been formed, not intentionally from a selected pair, but unconsciously by the preservation of many individuals which have varied, however slightly, in some useful or desired manner. If in one country stronger and heavier horses, and in another country lighter and fleeter ones, were habitually preferred, we may feel sure that two distinct sub-breeds would be produced in the course of time, without any one pair having been separated and bred from, in either country. Many races have been thus formed, and their manner of formation is closely analogous to that of natural species. We know, also, that the horses taken to the Falkland Islands have, during successive generations, become smaller and weaker, whilst those which have run wild on the Pampas have acquired larger and coarser heads; and such changes are manifestly due, not to any one pair, but to all the individuals having been subjected to the same conditions, aided, perhaps, by the principle of reversion. The new sub-breeds in such cases are not descended from any single pair, but from many individuals which have varied in different degrees, but in the same general manner; and we may conclude that the races of man have been similarly produced, the modifications being either the direct result of exposure to different conditions, or the indirect result of some form of selection. But to this latter subject we shall presently return.

On the Extinction of the Races of Man.—The partial or complete extinction of many races and sub-races of man is historically known. Humboldt saw in South America a parrot which was the sole living creature that could speak a word of the language of a lost tribe. Ancient monuments and stone implements found in all parts of the world, about which no tradition has been preserved by the present inhabitants, indicate much extinction. Some small and broken tribes, remnants of former races, still survive in isolated and generally mountainous districts. In Europe, the ancient races were all, according to Schaaffhausen, "lower in the scale than the rudest living savages"; they must therefore have differed, to a certain extent, from any existing race. The remains described by Professor

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Broca from Les Eyzies, though they unfortunately appear to have belonged to a single family, indicate a race with a most singular combination of low or simious, and of high characteristics. This race is "entirely different from any other, ancient or modern, that we have heard of." It differed, therefore, from the quaternary race of the caverns of Belgium.

Man can long resist conditions which appear extremely unfavorable for his existence. He has long lived in the extreme regions of the North, with no wood for his canoes or implements, and with only blubber as fuel, and melted snow as drink. In the southern extremity of America the Fuegians survive without the protection of clothes, or of any building worthy to be called a hovel. In South Africa the aborigines wander over arid plains, where dangerous beasts abound. Man can withstand the deadly influence of the Terai at the foot of the Himalaya, and the pestilential shores of tropical Africa.

Extinction follows chiefly from the competition of tribe with tribe, and race with race. Various checks are always in action, serving to keep down the numbers of each savage tribe,— such as periodical famines, nomadic habits and the consequent deaths of infants, prolonged suckling, wars, accidents, sickness, licentiousness, the stealing of women, infanticide, and especially lessened fertility. If any one of these checks increases in power, even slightly, the tribe thus affected tends to decrease; and when of two adjoining tribes one becomes less numerous and less powerful than the other, the contest is soon settled by war, slaughter, cannibalism, slavery, and absorption. Even when a weaker tribe is not thus abruptly swept away, if it once begins to decrease, it generally goes on decreasing until it becomes extinct.

When civilized nations come into contact with barbarians the struggle is short, except where a deadly climate gives its aid to the native race. Of the causes which lead to the victory of civilized nations, some are plain and simple, others complex and obscure. We can see that the cultivation of the land will be fatal in many ways to savages, for they cannot, or will not, change their habits. New diseases and vices have in some cases proved highly destructive; and it appears that a new disease often causes much death, until those who are most susceptible to its destructive influence are gradually weeded out; and so it may be with the evil effects from spirituous liquors, as well

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as with the unconquerably strong taste for them shown by so many savages. It further appears, mysterious as is the fact, that the first meeting of distinct and separated people generates disease. Mr. Sproat, who in Vancouver Island closely attended to the subject of extinction, believed that changed habits of life, consequent on the advent of Europeans, induces much ill health. He lays, also, great stress on the apparently trifling cause that the natives become "bewildered and dull by the new life around them; they lose the motives for exertion, and get no new ones in their place."

The grade of their civilization seems to be a most important element in the success of competing nations. A few centuries ago Europe feared the inroads of Eastern barbarians; now any such fear would be ridiculous. It is a more curious fact, as Mr. Bagehot has remarked, that savages did not formerly waste away before the classical nations, as they now do before modern civilized nations; had they done so, the old moralists would have mused over the event; but there is no lament in any writer of that period over the perishing barbarians. The most potent of all the causes of extinction, appears in many cases to be lessened fertility and ill-health, especially amongst the children, arising from changed conditions of life, notwithstanding that the new conditions may not be injurious in themselves. I am much indebted to Mr. H. H. Howorth for having called my attention to this subject, and for having given me information respecting it. I have collected the following cases.

When Tasmania was first colonized the natives were roughly estimated by some at 7000 and by others at 20,000. Their number was soon greatly reduced, chiefly by fighting with the English and with each other. After the famous hunt by all the colonists, when the remaining natives delivered themselves up to the government, they consisted only of 120 individuals, who were in 1832 transported to Flinders Island. This island, situated between Tasmania and Australia, is forty miles long, and from twelve to eighteen miles broad: it seems healthy, and the natives were well treated. Nevertheless, they suffered greatly in health. In 1834 they consisted (Bonwick, p. 250) of forty-seven adult males, forty-eight adult females, and sixteen children, or in all of 111 souls. In 1835 only one hundred were left. As they continued rapidly to decrease, and as they

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themselves thought that they should not perish so quickly elsewhere, they were removed in 1847 to Oyster Cove in the southern part of Tasmania. They then consisted (Dec. 20th, 1847) of fourteen men, twenty-two women and ten children. But the change of site did no good. Disease and death still pursued them, and in 1864 one man (who died in 1869), and three elderly women alone survived. The infertility of the women is even a more remarkable fact than the liability of all to ill-health and death. At the time when only nine women were left at Oyster Cove, they told Mr. Bonwick that only two had ever borne children: and these two had together produced only three children!

With respect to the cause of this extraordinary state of things, Dr. Story remarks that death followed the attempts to civilize the natives. "If left to themselves to roam as they were wont and undisturbed, they would have reared more children, and there would have been less mortality." Another careful observer of the natives, Mr. Davis, remarks, "The births have been few and the deaths numerous. This may have been in a great measure owing to their change of living and food; but more so to their banishment from the mainland of Van Diemen's Land, and consequent depression of spirits."

Similar facts have been observed in two widely different parts of Australia. The celebrated explorer, Mr. Gregory, told Mr. Bonwick, that in Queensland "the want of reproduction was being already felt with the blacks, even in the most recently settled parts, and that decay would set it." Of thirteen aborigines from Shark's Bay who visited Murchison River, twelve died of consumption within three months.

The decrease of the Maories of New Zealand has been carefully investigated by Mr. Fenton, in an admirable Report, from which all the following statements, with one exception, are taken. The decrease in number since 1830 is admitted by every one, including the natives themselves, and is still steadily progressing. Although it has hitherto been found impossible to take an actual census of the natives, their numbers were carefully estimated by residents in many districts. The result seems trustworthy, and shows that during the fourteen years, previous to 1858, the decrease was 19.42 per cent. Some of the tribes, thus carefully examined, lived above a hundred miles

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apart, some on the coast, some inland; and their means of subsistence and habits differed to a certain extent. The total number in 1858 was believed to be 53,700, and in 1872, after a second interval of fourteen years, another census was taken, and the number is given as only 36,359, showing a decrease of 32.29 per cent.! Mr. Fenton, after showing in detail the insufficiency of the various causes, usually assigned in explanation of this extraordinary decrease, such as new diseases, the profligacy of the women, drunkenness, wars, &c., concludes on weighty grounds that it depends chiefly on the unproductiveness of the women, and on the extraordinary mortality of the young children. In proof of this he shows that in 1844 there was one non-adult for every 2.57 adults; whereas in 1858 there was only one non-adult for every 3.27 adults. The mortality of the adults is also great. He adduces as a further cause of the decrease the inequality of the sexes; for fewer females are born than males. To this latter point, depending perhaps on a widely distinct cause, I shall return in a future chapter. Mr. Fenton contrasts with astonishment the decrease in New Zealand with the increase in Ireland; countries not very dissimilar in climate, and where the inhabitants now follow nearly similar habits. The Maories themselves "attribute their decadence, in some measure, to the introduction of new food and clothing, and the attendant change of habits"; and it will be seen, when we consider the influence of changed conditions on fertility, that they are probably right. The diminution began between the years 1830 and 1840; and Mr. Fenton shows that about 1830, the art of manufacturing putrid corn (maize), by long steeping in water, was discovered and largely practised; and this proves that a change of habits was beginning amongst the natives, even when New Zealand was only thinly inhabited by Europeans. When I visited the Bay of Islands in 1835, the dress and food of the inhabitants had already been much modified: they raised potatoes, maize, and other agricultural produce, and exchanged them for English manufactured goods and tobacco.

It is evident from many statements in the life of Bishop Patteson, that the Melanesians of the New Hebrides and neighboring archipelagoes, suffered to an extraordinary degree in health, and perished in large numbers, when they were

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removed to New Zealand, Norfolk Island, and other salubrious places, in order to be educated as missionaries.

The decrease of the native population of the Sandwich Islands is as notorious as that of New Zealand. It has been roughly estimated by those best capable of judging, that when Cook discovered the Islands in 1779, the population amounted to about 300,000. According to a loose census in 1823, the numbers then were 142,050. In 1832, and at several subsequent periods, an accurate census was officially taken, but I have been able to obtain only the following returns:

Year	Native Population. (Except during 1832 and 1836, when the few foreigners in the islands were included.)	Annual rate of decrease per cent., assuming it to have been uniform between the successive censuses; these censuses being taken at irregular intervals.
1832	130,313	
		4.46
1836	108,579	
		2.47
1853	71,019	
		0.81
1860	67,084	
		2.18
1966	58,765	
		2.17
1872	51,531	

We here see that in the interval of forty years, between 1832 and 1872, the population has decreased no less than sixty-eight per cent.! This has been attributed by most writers to the profligacy of the women, to former bloody wars, and to the severe labor imposed on conquered tribes and to newly introduced diseases, which have been on several occasions extremely destructive. No doubt these and other such causes have been highly efficient, and may account for the extraordinary rate of decrease between the years 1832 and 1836; but the most potent of all the causes seems to be lessened fertility. According to Dr. Ruschenberger of the U. S. Navy, who visited these islands between 1835 and 1837, in one district of Hawaii, only twenty-five men out of 1134, and in another district only ten out of 637, had a family with as many as three

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children. Of eighty married women, only thirty-nine had ever borne children; and "the official report gives an average of half a child to each married couple in the whole island." This is almost exactly the same average as with the Tasmanians at Oyster Cove. Jarves, who published his History in 1843, says that "families who have three children are freed from all taxes; those having more are rewarded by gifts of land and other encouragements." This unparalleled enactment by the government well shows how infertile the race had become. The Rev. A. Bishop stated in the Hawaiian "Spectator" in 1839, that a large proportion of the children die at early ages, and Bishop Staley informs me that this is still the case, just as in New Zealand. This has been attributed to the neglect of the children by the women, but it is probably in large part due to innate weakness of constitution in the children, in relation to the lessened fertility of their parents. There is, moreover, a further resemblance to the case of New Zealand, in the fact that there is a large excess of male over female births: the census of 1872 gives 31,650 males to 25,247 females of all ages, that is 125.36 males for every 100 females; whereas in all civilized countries the females exceed the males. No doubt the profligacy of the women may in part account for their small fertility; but their changed habits of life is a much more probable cause, and which will at the same time account for the increased mortality, especially of the children. The islands were visited by Cook in 1779, by Vancouver in 1794, and often subsequently by whalers. In 1819 missionaries arrived, and found that idolatry had been already abolished, and other changes effected by the king. After this period there was a rapid change in almost all the habits of life of the natives, and they soon became "the most civilized of the Pacific Islanders." One of my informants, Mr. Coan, who was born on the islands, remarks that the natives have undergone a greater change in their habits of life in the course of fifty years than Englishmen during a thousand years. From information received from Bishop Staley, it does not appear that the poorer classes have ever much changed their diet, although many new kinds of fruit have been introduced, and the sugar-cane is in universal use. Owing, however, to their passion for imitating Europeans, they altered their manner of dressing at

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an early period, and the use of alcoholic drinks became very general. Although these changes appear inconsiderable, I can well believe, from what is known with respect to animals, that they might suffice to lessen the fertility of the natives.

Lastly, Mr. Macnamara states that the low and degraded inhabitants of the Andaman Islands, on the eastern side of the Gulf of Bengal, are "eminently susceptible to any change of climate: in fact, take them away from their island homes, and they are almost certain to die, and that independently of diet or extraneous influences." He further states that the inhabitants of the Valley of Nepâl, which is extremely hot in summer, and also the various hill-tribes of India, suffer from dysentery and fever when on the plains; and they die if they attempt to pass the whole year there.

We thus see that many of the wilder races of man are apt to suffer much in health when subjected to changed conditions or habits of life, and not exclusively from being transported to a new climate. Mere alterations in habits, which do not appear injurious in themselves, seem to have this same effect; and in several cases the children are particularly liable to suffer. It has often been said, as Mr. Macnamara remarks, that man can resist with impunity the greatest diversities of climate and other changes; but this is true only of the civilized races. Man in his wild condition seems to be in this respect almost as susceptible as his nearest allies, the anthropoid apes, which have never yet survived long, when removed from their native country.

Lessened fertility from changed conditions, as in the case of the Tasmanians, Maories, Sandwich Islanders, and apparently the Australians, is still more interesting than their liability to ill-health and death; for even a slight degree of infertility, combined with those other causes which tend to check the increase of every population, would sooner or later lead to extinction. The diminution of fertility may be explained in some cases by the profligacy of the women (as until lately with the Tahitians), but Mr. Fenton has shown that this explanation by no means suffices with the New Zealanders, nor does it with the Tasmanians.

In the paper above quoted, Mr. Macnamara gives reasons for believing that the inhabitants of districts subject to malaria

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are apt to be sterile; but this cannot apply in several of the above cases. Some writers have suggested that the aborigines of islands have suffered in fertility and health from long continued inter-breeding; but in the above cases infertility has coincided too closely with the arrival of Europeans for us to admit this explanation. Nor have we at present any reason to believe that man is highly sensitive to the evil effects of inter-breeding, especially in areas so large as New Zealand, and the Sandwich archipelago with its diversified stations. On the contrary, it is known that the present inhabitants of Norfolk Island are nearly all cousins or near relations as are the Todas in India, and the inhabitants of some of the Western Islands of Scotland; and yet they seem not to have suffered in fertility.

A much more probable view is suggested by the analogy of the lower animals. The reproductive system can be shown to be susceptible to an extraordinary degree (though why we know not) to changed conditions of life; and this susceptibility leads both to beneficial and to evil results. A large collection of facts on this subject is given in chap. xviii. of vol. ii. of my "Variation of Animals and Plants under Domestication," I can here give only the briefest abstract; and every one interested in the subject may consult the above work. Very slight changes increase the health, vigor and fertility of most or all organic beings, whilst other changes are known to render a large number of animals sterile. One of the most familiar cases, is that of tamed elephants not breeding in India; though they often breed in Ava, where the females are allowed to roam about the forests to some extent, and are thus placed under more natural conditions. The case of various American monkeys, both sexes of which have been kept for many years together in their own countries, and yet have very rarely or never bred, is a more apposite instance, because of their relationship to man. It is remarkable how slight a change in the conditions often induces sterility in a wild animal when captured; and this is the more strange as all our domesticated animals have become more fertile than they were in a state of nature; and some of them can resist the most unnatural conditions with undiminished fertility. Certain groups of animals are much more liable than others to be affected by cap-

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tivity; and generally all the species of the same group are affected in the same manner. But sometimes a single species in a group is rendered sterile, whilst the others are not so; on the other hand, a single species may retain its fertility whilst most of the others fail to breed. The males and females of some species when confined, or when allowed to live almost, but not quite free, in their native country, never unite; others thus circumstanced frequently unite but never produce offspring; others again produce some offspring, but fewer than in a state of nature; and as bearing on the above cases of man, it is important to remark that the young are apt to be weak and sickly, or malformed, and to perish at an early age.

Seeing how general is this law of susceptibility of the reproductive system to changed conditions of life, and that it holds good with our nearest allies, the Quadrumana, I can hardly doubt that it applies to man in his primeval state. Hence if savages of any race are induced suddenly to change their habits of life, they become more or less sterile, and their young offspring suffer in health, in the same manner and from the same cause, as do the elephant and hunting-leopard in India, many monkeys in America, and a host of animals of all kinds, on removal from their natural conditions.

We can see why it is that aborigines, who have long inhabited islands, and who must have been long exposed to nearly uniform conditions, should be specially affected by any change in their habits, as seems to be the case. Civilized races can certainly resist changes of all kinds far better than savages; and in this respect they resemble domesticated animals, for though the latter sometimes suffer in health (for instance European dogs in India), yet they are rarely rendered sterile, though a few such instances have been recorded. The immunity of civilized races and domesticated animals is probably due to their having been subjected to a greater extent, and therefore having grown somewhat more accustomed, to diversified or varying conditions, than the majority of wild animals; and to their having formerly immigrated or been carried from country to country, and to different families or sub-races having inter-crossed. It appears that a cross with civilized races at once gives to an aboriginal race an immunity from the evil consequences of changed conditions. Thus the crossed offspring

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from the Tahitians and English, when settled in Pitcairn Island, increased so rapidly that the Island was soon overstocked; and in June 1856 they were removed to Norfolk Island. They then consisted of 60 married persons and 134 children, making a total of 194. Here they likewise increased so rapidly, that although sixteen of them returned to Pitcairn Island in 1859, they numbered in January 1868, 300 souls; the males and females being in exactly equal numbers. What a contrast does this case present with that of the Tasmanians; the Norfolk Islanders *increased* in only twelve and a half years from 194 to 300; whereas the Tasmanians *decreased* during fifteen years from 120 to 46, of which latter number only ten were children.[12]

So again in the interval between the census of 1866 and 1872 the natives of full blood in the Sandwich Islands decreased by 8081, whilst the half-castes, who are believed to be healthier, increased by 847; but I do not know whether the latter number includes the offspring from the half-castes, or only the half-castes of the first generation.

The cases which I have here given all relate to aborigines, who have been subjected to new conditions as the result of the immigration of civilized men. But sterility and ill-health would probably follow, if savages were compelled by any cause, such as the inroad of a conquering tribe, to desert their homes and to change their habits. It is an interesting circumstance that the chief check to wild animals becoming domesticated, which implies the power of their breeding freely when first captured, and one chief check to wild men, when brought into contact with civilization, surviving to form a civilized race, is the same, namely, sterility from changed conditions of life.

Finally, although the gradual decrease and ultimate extinction of the races of man is a highly complex problem, depending on many causes which differ in different places and at different times; it is the same problem as that presented by the extinction of one of the higher animals — of the fossil horse, for instance, which disappeared from South America, soon afterwards to be replaced, within the same districts, by countless troops of the

[12] These details are taken from "The Mutineers of the 'Bounty,'" by Lady Belcher, 1870; and from "Pitcairn Island," ordered to be printed by the House of Commons, May 29th, 1863. The following statements about the Sandwich Islanders are from the "Honolulu Gazette," and from Mr. Coan.

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Spanish horse. The New Zealander seems conscious of this parallelism, for he compares his future fate with that of the native rat now almost exterminated by the European rat. Though the difficulty is great to our imagination, and really great, if we wish to ascertain the precise causes and their manner of action, it ought not to be so to our reason, as long as we keep steadily in mind that the increase of each species and each race is constantly checked in various ways; so that if any new check, even a slight one, be superadded, the race will surely decrease in number; and decreasing numbers will sooner or later lead to extinction; the end, in most cases, being promptly determined by the inroads of conquering tribes.

On the Formation of the Races of Man.— In some cases the crossing of distinct races has led to the formation of a new race. The singular fact that the Europeans and Hindoos, who belong to the same Aryan stock, and speak a language fundamentally the same, differ widely in appearance, whilst Europeans differ but little from Jews, who belong to the Semitic stock, and speak quite another language, has been accounted for by Broca, through certain Aryan branches having been largely crossed by indigenous tribes during their wide diffusion. When two races in close contact cross, the first result is a heterogeneous mixture: thus Mr. Hunter, in describing the Santali or hill-tribes of India, says that hundreds of imperceptible gradations may be traced "from the black, squat tribes of the mountains to the tall olive-colored Brahman, with his intellectual brow, calm eyes, and high but narrow head"; so that it is necessary in courts of justice to ask the witnesses whether they are Santalis or Hindoos. Whether a heterogeneous people, such as the inhabitants of some of the Polynesian islands, formed by the crossing of two distinct races, with few or no pure members left, would ever become homogeneous, is not known from direct evidence. But as with our domesticated animals, a cross-breed can certainly be fixed and made uniform by careful selection in the course of a few generations, we may infer that the free intercrossing of a heterogeneous mixture during a long descent would supply the place of selection, and overcome any tendency to reversion; so that the crossed race would ultimately become homogeneous, though it might

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not partake in an equal degree of the characters of the two parent-races.

Of all the differences between the races of man, the color of the skin is the most conspicuous and one of the best marked. It was formerly thought that differences of this kind could be accounted for by long exposure to different climates; but Pallas first showed that this is not tenable, and he has since been followed by almost all anthropologists. This view has been rejected chiefly because the distribution of the variously colored races, most of whom must have long inhabited their present homes, does not coincide with corresponding differences of climate. Some little weight may be given to such cases as that of the Dutch families, who, as we hear on excellent authority, have not undergone the least change of color after residing for three centuries in South Africa. An argument on the same side may likewise be drawn from the uniform appearance in various parts of the world of gypsies and Jews, though the uniformity of the latter has been somewhat exaggerated. A very damp or a very dry atmosphere has been supposed to be more influential in modifying the color of the skin than mere heat; but as D'Orbigny in South America, and Livingstone in Africa, arrived at diametrically opposite conclusions with respect to dampness and dryness, any conclusion on this head must be considered as very doubtful.

Various facts, which I have given elsewhere, prove that the color of the skin and hair is sometimes correlated in a surprising manner with a complete immunity from the action of certain vegetable poisons, and from the attacks of certain parasites. Hence it occurred to me, that negroes and other dark races might have acquired their dark tints by the darker individuals escaping from the deadly influence of the miasma of their native countries, during a long series of generations.

I afterwards found that this same idea had long ago occurred to Dr. Wells. It has long been known that negroes, and even mulattoes, are almost completely exempt from the yellow-fever, so destructive in tropical America. They likewise escape to a large extent the fatal intermittent fevers, that prevail along at least 2600 miles of the shores of Africa, and which annually cause one-fifth of the white settlers to die, and another fifth to return home invalided. This immunity in the negro seems

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to be partly inherent, depending on some unknown peculiarity of constitution, and partly the result of acclimatization. Pouchet states that the negro regiments recruited near the Soudan, and borrowed from the Viceroy of Egypt for the Mexican war, escaped the yellow-fever almost equally with the negroes originally brought from various parts of Africa and accustomed to the climate of the West Indies. That acclimatization plays a part, is shown by the many cases in which negroes have become somewhat liable to tropical fevers, after having resided for some time in a colder climate. The nature of the climate under which the white races have long resided, likewise has some influence on them; for during the fearful epidemic of yellow fever in Demerara during 1837, Dr. Blair found that the death-rate of the immigrants was proportional to the latitude of the country whence they had come. With the negro the immunity, as far as it is the result of acclimatization, implies exposure during a prodigious length of time; for the aborigines of tropical America who have resided there from time immemorial, are not exempt from yellow fever; and the Rev. H. B. Tristram states, that there are districts in Northern Africa which the native inhabitants are compelled annually to leave, though the negroes can remain with safety.

That the immunity of the negro is in any degree correlated with the color of his skin is a mere conjecture: it may be correlated with some difference in his blood, nervous system, or other tissues. Nevertheless, from the facts above alluded to, and from some connection apparently existing between complexion and a tendency to consumption, the conjecture seemed to me not improbable. Consequently I endeavored, with but little success,[13] to ascertain how far it holds good. The late

[13] In the spring of 1862 I obtained permission from the Director-General of the Medical department of the Army, to transmit to the surgeons of the various regiments on foreign service a blank table, with the following appended remarks, but I have received no returns. "As several well-marked cases have been recorded with our domestic animals of a relation between the color of the dermal appendages and the constitution; and it being notorious that there is some limited degree of relation between the color of the races of man and the climate inhabited by them; the following investigation seems worth consideration. Namely, whether there is any relation in Europeans between the color of their hair, and their liability to the diseases of tropical countries. If the surgeons of the several regiments, when stationed in unhealthy tropical districts, would be so good as first to count, as a standard of comparison, how many men, in the force whence the sick are drawn, have dark and light-colored hair, and hair of intermediate or doubtful tints; and if a similar account were kept

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Dr. Daniell, who had long lived on the West Coast of Africa, told me that he did not believe in any such relation. He was himself unusually fair, and had withstood the climate in a wonderful manner. When he first arrived as a boy on the coast, an old and experienced negro chief predicted from his appearance that this would prove the case. Dr. Nicholson, of Antigua, after having attended to this subject, writes to me that dark-colored Europeans escape the yellow fever more than those that are light-colored. Mr. J. M. Harris altogether denies that Europeans with dark hair withstand a hot climate better than other men: on the contrary, experience has taught him in making a selection of men for service on the cast of Africa, to choose those with red hair.[14] As far, therefore, as these slight indications go, there seems no foundation for the hypothesis, that blackness has resulted from the darker and darker individuals having survived better during long exposure to fever-generating miasma.

Dr. Sharpe remarks, that a tropical sun, which burns and blisters a white skin, does not injure a black one at all; and, as he adds, this is not due to habit in the individual, for children only six or eight months old are often carried about naked, and are not affected. I have been assured by a medical man, that some years ago during each summer, but not during the winter, his hands became marked with light brown patches, like, although larger than freckles, and that these patches were

by the same medical gentlemen, of all the men who suffered from malarious and yellow fevers, or from dysentery, it would soon be apparent, after some thousand cases had been tabulated, whether there exists any relation between the color of the hair and constitutional liability to tropical diseases. Perhaps no such relation would be discovered, but the investigation is well worth making. In case any positive result were obtained, it might be of some practical use in selecting men for any particular service. Theoretically the result would be of high interest, as indicating one means by which a race of men inhabiting from a remote period an unhealthy tropical climate, might have become dark-colored by the better preservation of dark-haired or dark-complexioned individuals during a long succession of generations."

[14] Anthropological Review," Jan. 1866, p. xxi. Dr. Sharpe also says, with respect to India "('Man a Special Creation,' 1873, p. 118), that it has been noticed by some medical officers that Europeans with light hair and florid complexions suffer less from diseases of tropical countries than persons with dark hair and sallow complexions; and, so far as I know, there appear to be good grounds for this remark." On the other hand, Mr. Heddle, of Sierra Leone, "who has had more clerks killed under him than any other man," by the climate of the West African Coast (W. Reade, "African Sketch Book," vol. ii. p. 522), holds a directly opposite view, as does Capt. Burton.

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never affected by sun-burning, whilst the white parts of his skin have on several occasions been much inflamed and blistered. With the lower animals there is, also, a constitutional difference in liability to the action of the sun between those parts of the skin clothed with white hair and other parts. Whether the saving of the skin from being thus burnt is of sufficient importance to account for a dark tint having been gradually acquired by man through natural selection, I am unable to judge. If it be so, we should have to assume that the natives of tropical America have lived there for a much shorter time than the negroes in Africa, or the Papuans in the southern parts of the Malay archipelago, just as the lighter-colored Hindoos have resided in India for a shorter time than the darker aborigines of the central and southern parts of the peninsula.

Although with our present knowledge we cannot account for the differences of color in the races of man, through any advantage thus gained, or from the direct action of climate; yet we must not quite ignore the latter agency, for there is good reason to believe that some inherited effect is thus produced.[15]

We have seen in the second chapter that the conditions of life affect the development of the bodily frame in a direct manner, and that the effects are transmitted. Thus, as is generally admitted, the European settlers in the United States undergo a slight but extraordinary rapid change of appearance. Their bodies and limbs become elongated; and I hear from Col. Bernys that during the late war in the United States, good evidence was afforded of this fact by the ridiculous appearance presented by the German regiments, when dressed in ready-made clothes manufactured for the American market, and which were much too long for the men in every way. There is, also, a considerable body of evidence showing that in the Southern States the house-slaves of the third generation presented a markedly different appearance from the field-slaves.

[15] See, for instance, Quatrefages ("Revue des Cours Scientifiques," Oct. 10, 1868, p. 724) on the effects of residence in Abyssinia and Arabia, and other analogous cases. Dr. Rolle ("Der Mensch, seine Abstammung," &c., 1865, s. 99) states, on the authority of Khanikof, that the greater number of German families settled in Georgia, have acquired in the course of two generations dark hair and eyes. Mr. D. Forbes informs me that the Quichuas in the Andes vary greatly in color, according to the position of the valleys inhabited by them.

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If, however, we look to the races of man as distributed over the world, we must infer that their characteristic differences cannot be accounted for by the direct action of different conditions of life, even after exposure to them for an enormous period of time. The Esquimaux live exclusively on animal food; they are clothed in thick fur, and are exposed to intense cold and to prolonged darkness; yet they do not differ in any extreme degree from the inhabitants of Southern China, who live entirely on vegetable food, and are exposed almost naked to a hot, glaring climate. The unclothed Fuegians live on the marine productions of their inhospitable shores; the Botocudos of Brazil wander about the hot forests of the interior and live chiefly on vegetable productions; yet these tribes resemble each other so closely that the Fuegians on board the "Beagle" were mistaken by some Brazilians for Botocudos. The Botocudos again, as well as the other inhabitants of tropical America, are wholly different from the Negroes who inhabit the opposite shores of the Atlantic, are exposed to a nearly similar climate, and follow nearly the same habits of life.

Nor can the differences between the races of man be accounted for by the inherited effects of the increased or decreased use of parts, except to a quite insignificant degree. Men who habitually live in canoes, may have their legs somewhat stunted; those who inhabit lofty regions may have their chests enlarged; and those who constantly use certain sense-organs may have the cavities in which they are lodged somewhat increased in size, and their features consequently a little modified. With civilized nations, the reduced size of the jaws from lessened use — the habitual play of different muscles serving to express different emotions — and the increased size of the brain from greater intellectual activity, have together produced a considerable effect on their general appearance when compared with savages. Increased bodily stature, without any corresponding increase in the size of the brain, may (judging from the previously adduced case of rabbits), have given to some races an elongated skull of the dolichocephalic type.

Lastly, the little-understood principle of correlated development has sometimes come into action, as in the case of great muscular development and strongly projecting supra-orbital ridges. The color of the skin and hair are plainly correlated,

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as is the texture of the hair with its color in the Mandans of North America.[16] The color also of the skin, and the odor emitted by it, are likewise in some manner connected. With the breeds of sheep the number of hairs within a given space and the number of the excretory pores are related. If we may judge from the analogy of our domesticated animals, many modifications of structure in man probably come under this principle of correlated development.

We have now seen that the external characteristic differences between the races of man cannot be accounted for in a satisfactory manner by the direct action of the conditions of life, nor by the effects of the continued use of parts, nor through the principle of correlation. We are therefore led to inquire whether slight individual differences, to which man is eminently liable, may not have been preserved and augmented during a long series of generations through natural selection. But here we are at once met by the objection that beneficial variations alone can be thus preserved; and as far as we are enabled to judge, although always liable to err on this head, none of the differences between the races of man are of any direct or special service to him. The intellectual and moral or social faculties must of course be excepted from this remark. The great variability of all the external differences between the races of man, likewise indicates that they cannot be of much importance; for if important, they would long ago have been either fixed and preserved, or eliminated. In this respect man resembles those forms, called by naturalists protean or polymorphic, which have remained extremely variable, owing, as it seems, to such variations being of an indifferent nature, and to their having thus escaped the action of natural selection.

We have thus far been baffled in all our attempts to account for the differences between the races of man; but there remains one important agency, namely Sexual Selection, which appears to have acted powerfully on man, as on many other animals. I do not intend to assert that sexual selection will account for

[16] Mr. Catlin states ("N. American Indians," 3rd edit. 1842, vol. i. p. 49) that in the whole tribe of the Mandans, about one in ten or twelve of the members, of all ages and both sexes, have bright silvery gray hair, which is hereditary. Now this hair is as coarse and harsh as that of a horse's mane, whilst the hair of other colors is fine and soft.

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all the differences between the races. An unexplained residuum is left, about which we can only say, in our ignorance, that as individuals are continually born with, for instance, heads a little rounder or narrower, and with noses a little longer or shorter, such slight differences might become fixed and uniform, if the unknown agencies which induced them were to act in a more constant manner, aided by long-continued intercrossing. Such variations come under the provisional class, alluded to in our second chapter, which for the want of a better term are often called spontaneous. Nor do I pretend that the effects of sexual selection can be indicated with scientific precision; but it can be shown that it would be an inexplicable fact if man had not been modified by this agency, which appears to have acted powerfully on innumerable animals. It can further be shown that the differences between the races of man, as in color, hairiness, form of features, &c., are of a kind which might have been expected to come under the influence of sexual selection. But in order to treat this subject properly, I have found it necessary to pass the whole animal kingdom in review. I have therefore devoted to it the Second Part of this work. At the close I shall return to man, and, after attempting to show how far he has been modified through sexual selection, will give a brief summary of the chapters in this First Part.

Note on the Resemblances and Differences in the Structure and the Development of the Brain in Man and Apes. By Professor Huxley, F. R. S.

The controversy respecting the nature and the extent of the differences in the structure of the brain in man and the apes, which arose some fifteen years ago, has not yet come to an end, though the subject matter of the dispute is, at present, totally different from what it was formerly. It was originally asserted and re-asserted, with singular pertinacity, that the brain of all the apes, even the highest, differs from that of man, in the absence of such conspicuous structures as the posterior lobes of the cerebral hemispheres, with the posterior cornu of the lateral ventricle and the *hippocampus minor*, contained in those lobes, which are so obvious in man.

But the truth that the three structures in question are as well developed in apes' as in human brains, or even better; and that it is characteristic of all the *Primates* (if we exclude the Lemurs) to have these

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parts well developed, stands at present on as secure a basis as any proposition in comparative anatomy. Moreover, it is admitted by every one of the long series of anatomists who, of late years, have paid special attention to the arrangement of the complicated sulci and gyri which appear upon the surface of the cerebral hemispheres in man and the higher apes, that they are disposed after the very same pattern in him, as in them. Every principal gyrus and sulcus of a chimpanzee's brain is clearly represented in that of a man, so that the terminology which applies to the one answers for the other. On this point there is no difference of opinion. Some years since, Professor Bischoff published a memoir on the cerebral convolutions of man and apes; and as the purpose of my learned colleague was certainly not to diminish the value of the differences between apes and men in this respect, I am glad to make a citation from him.

"That the apes, and especially the orang, chimpanzee and gorilla, come very close to man in their organization, much nearer than to any other animal, is a well known fact, disputed by nobody. Looking at the matter from the point of view of organization alone, no one probably would ever have disputed the view of Linnæus, that man should be placed, merely as a peculiar species, at the head of the mammalia and of those apes. Both show, in all their organs, so close an affinity, that the most exact anatomical investigation is needed in order to demonstrate those differences which really exist. So it is with the brains. The brains of man, the orang, the chimpanzee, the gorilla, in spite of all the important differences which they present, come very close to one another."

There remains, then, no dispute as to the resemblance in fundamental characters, between the ape's brain and man's; nor any as to the wonderfully close similarity between the chimpanzee, orang and man, in even the details of the arrangement of the gyri and sulci of the cerebral hemispheres. Nor, turning to the differences between the brains of the highest apes and that of man, is there any serious question as to the nature and extent of these differences. It is admitted that the man's cerebral hemispheres are absolutely and relatively larger than those of the orang and chimpanzee; that his frontal lobes are less excavated by the upward protrusion of the roof of the orbits; that his gyri and sulci are, as a rule, less symmetrically disposed, and present a greater number of secondary plications. And it is admitted that, as a rule, in man, the temporo-occipital or "external perpendicular" fissure, which is usually so strongly marked a feature of the ape's brain is but faintly marked. But it is also clear, that none of these differences constitutes a sharp demarcation between the man's and the ape's brain. In respect to the external perpendicular fissure of Gratiolet, in the human brain for instance, Professor Turner remarks:

"In some brains it appears simply as an indentation of the margin of the hemisphere, but, in others, it extends for some distance more or less transversely outwards. I saw it in the right hemisphere of a female brain pass more than two inches outwards; and on another specimen, also the right hemisphere, it proceeded for four-tenths of an inch out-

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wards, and then extended downwards, as far as the lower margin of the outer surface of the hemisphere. The imperfect definition of this fissure in the majority of human brains, as compared with its remarkable distinctness in the brain of most Quadrumana, is owing to the presence, in the former, of certain superficial, well marked, secondary convolutions which bridge it over and connect the parietal with the occipital lobe. The closer the first of these bridging gyri lies to the longitudinal fissure, the shorter is the external parieto-occipital fissure."

The obliteration of the external perpendicular fissure of Gratiolet, therefore, is not a constant character of the human brain. On the other hand, its full development is not a constant character of the higher ape's brain. For, in the chimpanzee, the more or less extensive obliteration of the external perpendicular sulcus by "bridging convolutions," on one side or the other, has been noted over and over again by Prof. Rolleston, Mr. Marshall, M. Broca and Professor Turner. At the conclusion of a special paper on this subject the latter writes:

"The three specimens of the brain of a chimpanzee just described, prove, that the generalization which Gratiolet has attempted to draw of the complete absence of the first connecting convolution and the concealment of the second, as essentially characteristic features in the brain of this animal, is by no means universally applicable. In only one specimen did the brain, in these particulars, follow the law which Gratiolet has expressed. As regards the presence of the superior bridging convolution, I am inclined to think that it has existed in one hemisphere, at least, in a majority of the brains of this animal which have, up to this time, been figured or described. The superficial position of the second bridging convolution is evidently less frequent, and has as yet, I believe, only been seen in the brain (A) recorded in this communication. The asymmetrical arrangement in the convolutions of the two hemispheres, which previous observers have referred to in their descriptions, is also well illustrated in these specimens."

Even were the presence of the temporo-occipital, or external perpendicular, sulcus, a mark of distinction between the higher apes and man, the value of such a distinctive character would be rendered very doubtful by the structure of the brain in the Platyrhine apes. In fact, while the temporo-occipital is one of the most constant of sulci in the Catarhine, or Old World, apes, it is never very strongly developed in the New World apes; it is absent in the smaller Platyrhini; rudimentary in *Pithecia;* and more or less obliterated by bridging convolutions in *Ateles*.

A character which is thus variable within the limits of a single group can have no great taxonomic value.

It is further established, that the degree of asymmetry of the convolution of the two sides in the human brain is subject to much individual variation; and that, in those individuals of the Bushman race who have been examined, the gyri and sulci of the two hemispheres are considerably less complicated and more symmetrical than in the European brain, while, in some individuals of the chimpanzee, their complexity and asymmetry become notable. This is particularly the case in the brain of a

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young male chimpanzee figured by M. Broca. (" L'ordre des Primates," p. 165, fig. 11.)

Again, as respects the question of absolute size, it is established that the difference between the largest and the smallest healthy human brain is greater than the difference between the smallest healthy human brain and the largest chimpanzee's or orang's brain.

Moreover, there is one circumstance in which the orang's and chimpanzee's brains resemble man's, but in which they differ from the lower apes, and that is the presence of two corpora candicantia — the *Cynomorpha* having but one.

In view of these facts I do not hesitate to repeat and insist upon the proposition which I enunciated:[17]

" So far as cerebral structure goes, therefore, it is clear that man differs less from the chimpanzee or the orang, than these do even from the monkeys, and that the difference between the brain of the chimpanzee and of man is almost insignificant when compared with that between the chimpanzee brain and that of a Lemur."

In the paper to which I have referred, Professor Bischoff does not deny the second part of this statement, but he first makes the irrelevant remark that it is not wonderful if the brains of an orang and a Lemur are very different; and secondly, goes on to assert that, " If we successively compare the brain of a man with that of an orang; the brain of this with that of a chimpanzee; of this with that of a gorilla, and so on of a *Hylobates*, *Semnopithecus*, *Cynocephalus*, *Cercopithecus*, *Macacus*, *Cebus*, *Callithrix*, *Lemur*, *Stenops*, *Hapale*, we shall not meet with a greater, or even as great a break in the degree of development of the convolutions, as we find between the brain of a man and that of an orang or chimpanzee."

To which I reply, firstly, that whether this assertion be true or false, it has nothing whatever to do with the proposition enunciated in " Man's Place in Nature," which refers not to the development of the convolutions alone, but to the structure of the whole brain. If Professor Bischoff had taken the trouble to refer to the work he criticizes, in fact, he would have found the following passage: " And it is a remarkable circumstance that though, so far as our present knowledge extends, there *is* one true structural break in the series of forms of Simian brains, this hiatus does not lie between man and the manlike apes, but between the lower and the lowest Simians, or in other words, between the Old and New World apes and monkeys and the Lemurs. Every Lemur which has yet been examined, in fact, has its cerebellum partially visible from above; and its posterior lobe, with the contained posterior cornu and hippocampus minor, more or less rudimentary. Every marmoset, American monkey, Old World monkey, baboon or manlike ape, on the contrary, has its cerebellum entirely hidden, posteriorly, by the cerebral lobes, and possesses a large posterior cornu with a well-developed hippocampus minor."

This statement was a strictly accurate account of what was known

[17] " Man's Place in Nature."

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when it was made; and it does not appear to me to be more than apparently weakened by the subsequent discovery of the relatively small development of the posterior lobes in the Siamang and in the Howling monkey. Notwithstanding the exceptional brevity of the posterior lobes in these two species, no one will pretend that their brains, in the slightest degree, approach those of the Lemurs. And if, instead of putting *Hapale* out of its natural place, as Professor Bischoff most unaccountably does, we write the series of animals he has chosen to mention as follows: *Homo, Pithecus, Troglodytes, Hylobates, Semnopithecus, Cynocephalus, Cercopithecus, Macacus, Cebus, Callithrix, Hapale, Lemur, Stenops,* I venture to reaffirm that the great break in this series lies between *Hapale* and *Lemur*, and that this break is considerably greater than that between any other two terms of that series. Professor Bischoff ignores the fact that long before he wrote, Gratiolet had suggested the separation of the Lemurs from the other Primates on the very ground of the difference in their cerebral characters; and that Professor Flower had made the following observations in the course of his description of the brain of the Javan Loris:

"And it is especially remarkable that, in the development of the posterior lobes, there is no approximation to the Lemurine, short hemisphered brain, in those monkeys which are commonly supposed to approach this family in other respects, viz., the lower members of the Platyrhine group."

So far as the structure of the adult brain is concerned, then, the very considerable additions to our knowledge, which have been made by the researches of so many investigators, during the past ten years, fully justify the statement which I made in 1863. But it has been said, that, admitting the similarity between the adult brains of man and apes, they are nevertheless, in reality, widely different, because they exhibit fundamental differences in the mode of their development. No one would be more ready than I to admit the force of this argument, if such fundamental differences of development really exist. But I deny that they do exist. On the contrary, there is a fundamental agreement in the development of the brain in men and apes.

Gratiolet originated the statement that there is a fundamental difference in the development of the brains of apes and that of man — consisting in this; that, in the apes, the sulci which first make their appearance are situated on the posterior region of the cerebral hemispheres, while, in the human fœtus, the sulci first become visible on the frontal lobes.

This general statement is based upon two observations, the one of a Gibbon almost ready to be born, in which the posterior gyri were "well developed," while those of the frontal lobes were "hardly indicated" (l. c. p. 39), and the other of a human fœtus at the 22nd or 23rd week of uterogestation.

Three views of this brain are given in Plate II. firs. 1, 2, 3, of the work cited, showing the upper, lateral and inferior views of the hemispheres, but not the inner view. It is worthy of note that the figure by no means bears out Gratiolet's description, inasmuch as the fissure

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(antero-temporal) on the posterior half of the face of the hemisphere is more marked than any of those vaguely indicated in the anterior half. If the figure is correct, it in no way justifies Gratiolet's conclusion: "It follows that between these brains (those of a Calithrix and of a Gibbon) and that of a human fœtus there is a fundamental difference. That is that long before the temporal folds appeared in the latter the frontal folds showed signs of existence."

Since Gratiolet's time, however, the development of the gyri and sulci of the brain has been made the subject of renewed investigation by Schmidt, Bischoff, Pansch, and more particularly by Ecker, whose work is not only the latest, but by far the most complete, memoir on the subject.

The final results of their inquiries may be summed up as follows: —

1. In the human fœtus, the sylvian fissure is formed in the course of the third month of uterogestation. In this, and in the fourth month, the cerebral hemispheres are smooth and rounded (with the exception of the sylvian depression), and they project backwards far beyond the cerebellum.

2. The sulci, properly so called, begin to appear in the interval between the end of the fourth and the beginning of the sixth month of fœtal life, but Ecker is careful to point out that, not only the time, but the order, of their appearance is subject to considerable individual variation. In no case, however, are either the frontal or the temporal sulci the earliest.

The first which appears, in fact, lies on the inner face of the hemisphere (whence doubtless Gratiolet, who does not seem to have examined that face in his fœtus, overlooked it), and is either the internal perpendicular (occipito-parietal), or the calcarine sulcus, these two being close together and eventually running into one another. As a rule the occipito-parietal is the earlier of the two.

3. At the latter part of this period, another sulcus, the "posterio-parietal," or "Fissure of Rolando" is developed, and it is followed, in the course of the sixth month, by the other principal sulci of the frontal, parietal, temporal and occipital lobes. There is, however, no clear evidence that one of these constantly appears before the other; and it is remarkable that, in the brain at the period described and figured by Ecker (l. c. p. 212–13, Taf. II. figs. 1, 2, 3, 4), the antero-temporal sulcus (*scissure parallèle*), so characteristic of the ape's brain, is as well, if not better developed than the fissure of Rolando, and is much more marked than the proper frontal sulci.

Taking the facts as they now stand, it appears to me that the order of the appearance of the sulci and gyri in the fœtal human brain is in perfect harmony with the general doctrine of evolution, and with the view that man has been evolved from some ape-like form; though there can be no doubt that that form was, in many respects, different from any member of the Primates now living.

Von Baer taught us, half a century ago, that, in the course of their development, allied animals put on at first, the characters of the greater groups to which they belong, and, by degrees, assume those which restrict

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them within the limits of their family, genus, and species; and he proved, at the same time, that no developmental stage of a higher animal is precisely similar to the adult condition of any lower animal. It is quite correct to say that a frog passes through the condition of a fish, inasmuch as at one period of its life the tadpole has all the characters of a fish, and if it went no further, would have to be grouped among fishes. But it is equally true that a tadpole is very different from any known fish.

In like manner, the brain of a human fœtus, at the fifth month, may correctly be said to be, not only the brain of an ape, but that of an Arctopithecine or marmoset-like ape; for its hemispheres, with their great posterior lobster, and with no sulci but the sylvian and the calcarine, present the characteristics found only in the group of the Arctopithecine Primates. But it is equally true, as Gratiolet remarks, that, in its widely open sylvian fissure, it differs from the brain of any actual marmoset. No doubt it would be much more similar to the brain of an advanced fœtus of a marmoset. But we know nothing whatever of the development of the brain in the marmosets. In the Platyrhini proper, the only observation with which I am acquainted is due to Pansch, who found in the brain of a fœtal *Cebus Apella*, in addition to the sylvian fissure and the deep calcarine fissure, only a very shallow antero-temporal fissure (*scissure parallèle* of Gratiolet).

Now this fact, taken together with the circumstance that the antero-temporal sulcus is present in such Platyrhini as the Saimiri, which present mere traces of sulci on the anterior half of the exterior of the cerebral hemispheres, or none at all, undoubtedly, so far as it goes, affords fair evidence in favor of Gratiolet's hypothesis, that the posterior sulci appear before the anterior, in the brains of the *Platyrhini*. But, it by no means follows, that the rule which may hold good for the *Platyrhini* extends to the *Catarhini*. We have no information whatever respecting the development of the brain in the *Cynomorpha;* and, as regards the *Anthropomorpha*, nothing but the account of the brain of the Gibbon, near birth, already referred to. At the present moment there is not a shadow of evidence to show that the sulci of a chimpanzee's, or orang's, brain do not appear in the same order as a man's.

Gratiolet opens his preface with the aphorism: "It is dangerous in dealing with the sciences to be too quick in coming to a conclusion." I fear he must have forgotten this sound maxim by the time he had reached the discussion of the differences between men and apes, in the body of his work. No doubt, the excellent author of one of the most remarkable contributions to the just understanding of the mammalian brain which has ever been made, would have been the first to admit the insufficiency of his data had he lived to profit by the advance of inquiry. The misfortune is that his conclusions have been employed by persons incompetent to appreciate their foundation, as arguments in favor of obscurantism.

But it is important to remark that, whether Gratiolet was right or wrong in his hypothesis respecting the relative order of appearance of the temporal and frontal sulci, the fact remains; that, before either tem-

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poral or frontal sulci, appear, the fœtal brain of man presents characters which are found only in the lowest group of the *Primates* (leaving out the Lemurs) ; and that this is exactly what we should expect to be the case, if man has resulted from the gradual modification of the same form as that from which the other *Primates* have sprung.

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PART II.

SEXUAL SELECTION.

CHAPTER VIII.

PRINCIPLES OF SEXUAL SELECTION.

Secondary sexual characters — Sexual selection — Manner of action — Excess of males — Polygamy — The male alone generally modified through sexual selection — Eagerness of the male — Variability of the male — Choice exerted by the female — Sexual compared with natural selection — Inheritance, at corresponding periods of life, at corresponding seasons of the year, and as limited by sex — Relations between the several forms of inheritance — Causes why one sex and the young are not modified through sexual selection — Supplement on the proportional numbers of the two sexes throughout the animal kingdom — The proportion of the sexes in relation to natural selection.

WITH animals which have their sexes separated, the males necessarily differ from the females in their organs of reproduction; and these are the primary sexual characters. But the sexes often differ in what Hunter has called secondary sexual characters, which are not directly connected with the act of reproduction; for instance, the male possesses certain organs of sense or locomotion, of which the female is quite destitute, or has them more highly-developed, in order that he may readily find or reach her; or again the male has special organs of prehension for holding her securely. These latter organs, of infinitely diversified kinds, graduate into those which are commonly ranked as primary, and in some cases can hardly be distinguished from them; we see instances of this in the complex appendages at the apex of the abdomen in male insects. Unless indeed we confine the term "primary" to the reproductive glands, it is scarcely possible to decide which ought to be called primary and which secondary.

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The female often differs from the male in having organs for the nourishment or protection of her young, such as the mammary glands of mammals, and the abdominal sacks of the marsupials. In some few cases also the male possesses similar organs, which are wanting in the female, such as the receptacles for the ova in certain male fishes, and those temporarily developed in certain male frogs. The females of most bees are provided with a special apparatus for collecting and carrying pollen, and their ovipositor is modified into a sting for the defense of the larvæ and the community. Many similar cases could be given, but they do not here concern us. There are, however, other sexual differences quite unconnected with the primary reproductive organs, and it is with these that we are more especially concerned — such as the greater size, strength, and pugnacity of the male, his weapons of offense or means of defense against rivals, his gaudy coloring and various ornaments, his power of song, and other such characters.

Besides the primary and secondary sexual differences, such as the foregoing, the males and females of some animals differ in structures related to different habits of life, and not at all, or only indirectly, to the reproductive functions. Thus the females of certain flies (Culicidæ and Tabanidæ) are blood-suckers, whilst the males, living on flowers, have mouths destitute of mandibles. The males of certain moths and of some crustaceans (*e. g.* Tanais) have imperfect, closed mouths, and cannot feed. The complemental males of certain Cirripedes live like epiphytic plants either on the female or the hermaphrodite form, and are destitute of a mouth and of prehensile limbs. In these cases it is the male which has been modified, and has lost certain important organs, which the females possess. In other cases it is the female which has lost such parts; for instance, the female glow-worm is destitute of wings, as also are many female moths, some of which never leave their cocoons. Many female parasitic crustaceans have lost their natatory legs. In some weevil-beetles (Curculionidæ) there is a great difference between the male and female in the length of the rostrum or snout; but the meaning of this and of many analogous differences, is not at all understood. Differences of structure between the two sexes in relation to different habits of life are generally confined to the lower animals; but with some

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few birds the beak of the male differs from that of the female. In the Huia of New Zealand the difference is wonderfully great, and we hear from Dr. Buller that the male uses his strong beak in chiseling the larvæ of insects out of decayed wood, whilst the female probes the softer parts with her far longer, much curved and pliant beak: and thus they mutually aid each other. In most cases, differences of structure between the sexes are more or less directly connected with the propagation of the species: thus a female, which has to nourish a multitude of ova, requires more food than the male, and consequently requires special means for procuring it. A male animal, which lives for a very short time, might lose its organs for procuring food through disuse, without detriment; but he would retain his locomotive organs in a perfect state, so that he might reach the female. The female, on the other hand, might safely lose her organs for flying, swimming, or walking, if she gradually acquired habits which rendered such powers useless.

We are, however, here concerned only with sexual selection. This depends on the advantage which certain individuals have over others of the same sex and species solely in respect of reproduction. When, as in the cases above mentioned, the two sexes differ in structure in relation to different habits of life, they have no doubt been modified through natural selection, and by inheritance limited to one and the same sex. So again the primary sexual organs, and those for nourishing or protecting the young, come under the same influence; for those individuals which generated or nourished their offspring best, would leave, *cæteris paribus,* the greatest number to inherit their superiority; whilst those which generated or nourished their offspring badly, would leave but few to inherit their weaker powers. As the male has to find the female, he requires organs of sense and locomotion, but if these organs are necessary for the other purposes of life, as is generally the case, they will have been developed through natural selection. When the male has found the female, he sometimes absolutely requires prehensile organs to hold her; thus Dr. Wallace informs me that the males of certain moths cannot unite with the females if their tarsi or feet are broken. The males of many oceanic crustaceans, when adult, have their legs and antennæ modified in an extraordinary manner for the prehension of the female;

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hence we may suspect that it is because these animals are washed about by the waves of the open sea, that they require these organs in order to propagate their kind, and if so, their development has been the result of ordinary or natural selection. Some animals extremely low in the scale have been modified for this same purpose; thus the males of certain parasitic worms, when fully grown, have the lower surface of the terminal part of their bodies roughened like a rasp, and with this they coil round and permanently hold the females.[1]

When the two sexes follow exactly the same habits of life, and the male has the sensory or locomotive organs more highly developed than those of the female, it may be that the perfection of these is indispensable to the male for finding the female; but in the vast majority of cases, they serve only to give one male an advantage over another, for with sufficient time, the less well-endowed males would succeed in pairing with the females; and judging from the structure of the female, they would be in all other respects equally well adapted for their ordinary habits of life. Since in such cases the males have acquired their present structure, not from being better fitted to survive in the struggle for existence, but from having gained an advantage over other males, and from having transmitted this advantage to their male offspring alone, sexual selection must here have come into action. It was the importance of this distinction which led me to designate this form of selection as Sexual Selection. So again, if the chief service rendered to the male by his prehensile organs is to prevent the escape of the female before the arrival of other males, or when assaulted by them, these organs will have been perfected through sexual selection, that is by the advantage acquired by certain individuals over their rivals. But in most cases of this kind it is impossible to distinguish between the effects of natural and

[1] M. Perrier advances this case ("Revue Scientifique," Feb. 1, 1873, p. 865) as one fatal to the belief in sexual selection, inasmuch as he supposes that I attribute all the differences between the sexes to sexual selection. This distinguished naturalist, therefore, like so many other Frenchmen, has not taken the trouble to understand even the first principles of sexual selection. An English naturalist insists that the claspers of certain male animals could not have been developed through the choice of the female! Had I not met with this remark, I should not have thought it possible for any one to have read this chapter and to have imagined that I maintain that the choice of the female had anything to do with the development of the prehensile organs in the male.

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sexual selection. Whole chapters could be filled with details on the differences between the sexes in their sensory, locomotive, and prehensile organs. As, however, these structures are not more interesting than others adapted for the ordinary purposes of life, I shall pass them over almost entirely, giving only a few instances under each class.

There are many other structures and instincts which must have been developed through sexual selection — such as the weapons of offense and the means of defense — of the males for fighting with and driving away their rivals — their courage and pugnacity — their various ornaments — their contrivances for producing vocal or instrumental music — and their glands for emitting odors, most of these latter structures serving only to allure or excite the female. It is clear that these characters are the result of sexual and not of ordinary selection, since unarmed, unornamented, or unattractive males would succeed equally well in the battle for life and in leaving a numerous progeny, but for the presence of better endowed males. We may infer that this would be the case, because the females, which are unarmed and unornamented, are able to survive and procreate their kind. Secondary sexual characters of the kind just referred to, will be fully discussed in the following chapters, as being in many respects interesting, but especially as depending on the will, choice, and rivalry of the individuals of either sex. When we behold two males fighting for the possession of the female, or several male birds displaying their gorgeous plumage, and performing strange antics before an assembled body of females, we cannot doubt that, though led by instinct, they know what they are about, and consciously exert their mental and bodily powers.

Just as man can improve the breed of his game-cocks by the selection of those birds which are victorious in the cock-pit, so it appears that the strongest and most vigorous males, or those provided with the best weapons, have prevailed under nature, and have led to the improvement of the natural breed or species. A slight degree of variability leading to some advantage, however slight, in reiterated deadly contests would suffice for the work of sexual selection; and it is certain that secondary sexual characters are eminently variable. Just as man can give beauty, according to his standard of taste, to

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his male poultry, or more strictly can modify the beauty originally acquired by the parent species, can give to the Sebright bantam a new and elegant plumage, an erect and peculiar carriage — so it appears that female birds in a state of nature, have by a long selection of the more attractive males, added to their beauty or other attractive qualities. No doubt this implies powers of discrimination and taste on the part of the female which will at first appear extremely improbable; but by the facts to be adduced hereafter, I hope to be able to show that the females actually have these powers. When, however, it is said that the lower animals have a sense of beauty, it must not be supposed that such sense is comparable with that of a cultivated man, with his multiform and complex associated ideas. A more just comparison would be between the taste for the beautiful in animals, and that in the lowest savages, who admire and deck themselves with any brilliant, glittering, or curious object.

From our ignorance on several points, the precise manner in which sexual selection acts is somewhat uncertain. Nevertheless if those naturalists who already believe in the mutability of species, will read the following chapters, they will, I think, agree with me, that sexual selection has played an important part in the history of the organic world. It is certain that amongst almost all animals there is a struggle between the males for the possession of the female. This fact is so notorious that it would be superfluous to give instances. Hence the females have the opportunity of selecting one out of several males, on the supposition that their mental capacity suffices for the exertion of a choice. In many cases special circumstances tend to make the struggle between the males particularly severe. Thus the males of our migratory birds generally arrive at their places of breeding before the females, so that many males are ready to contend for each female. I am informed by Mr. Jenner Weir, that the bird-catchers assert that this is invariably the case with the nightingale and blackcap, and with respect to the latter he can himself confirm the statement.

Mr. Swaysland of Brighton has been in the habit, during the last forty years, of catching our migratory birds on their first arrival, and he has never known the females of any species to arrive before their males. During one spring he shot thirty-

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nine males of Ray's wagtail (*Budytes Raii*) before he saw a single female. Mr. Gould has ascertained by the dissection of those snipes which arrive the first in this country, that the males come before the females. And the like holds good with most of the migratory birds of the United States. The majority of the male salmon in our rivers, on coming up from the sea, are ready to breed before the females. So it appears to be with frogs and toads. Throughout the great class of insects the males almost always are the first to emerge from the pupal state, so that they generally abound for a time before any females can be seen.[2] The cause of this difference between the males and females in their periods of arrival and maturity is sufficiently obvious. Those males which annually first migrated into any country, or which in the spring were first ready to breed, or were the most eager, would leave the largest number of offspring; and these would tend to inherit similar instincts and constitutions. It must be borne in mind that it would have been impossible to change very materially the time of sexual maturity in the females, without at the same time interfering with the period of the production of the young — a period which must be determined by the seasons of the year. On the whole there can be no doubt that with almost all animals, in which the sexes are separate, there is a constantly recurrent struggle between the males for the possession of the females.

Our difficulty in regard to sexual selection lies in understanding how it is that the males which conquer other males, or those which prove the most attractive to the females, leave a greater number of offspring to inherit their superiority than their beaten and less attractive rivals. Unless this result does follow, the characters which give to certain males an advantage over others, could not be perfected and augmented through sexual selection. When the sexes exist in exactly equal numbers, the worst-endowed males will (except where polygamy prevails), ultimately find females, and leave as many offspring, as well fitted for their general habits of life, as the best-endowed males. From various

[2] Even with those plants in which the sexes are separate, the male flowers are generally mature before the female. As first shown by C. K. Sprengel, many hermaphrodite plants are dichogamous; that is, their male and female organs are not ready at the same time, so that they cannot be self-fertilised. Now in such flowers, the pollen is in general matured before the stigma, though there are exceptional cases in which the female organs are beforehand.

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facts and considerations, I formerly inferred that with most animals, in which secondary sexual characters are well developed, the males considerably exceeded the females in number; but this is not by any means always true. If the males were to the females as two to one, or as three to two, or even in a somewhat lower ratio, the whole affair would be simple; for the better-armed or more attractive males would leave the largest number of offspring. But after investigating, as far as possible, the numerical proportion of the sexes, I do not believe that any great inequality in number commonly exists. In most cases sexual selection appears to have been effective in the following manner.

Let us take any species, a bird for instance, and divide the females inhabiting a district into two equal bodies, the one consisting of the more vigorous and better-nourished individuals, and the other of the less vigorous and healthy. The former, there can be little doubt, would be ready to breed in the spring before the others; and this is the opinion of Mr. Jenner Weir, who has carefully attended to the habits of birds during many years. There can also be no doubt that the most vigorous, best-nourished and earliest breeders would on an average succeed in rearing the largest number of fine offspring.[3] The males, as we have seen, are generally ready to breed before the females; the strongest, and with some species the best armed of the males, drive away the weaker; and the former would then unite with the more vigorous and better-nourished females, because they are the first to breed.[4] Such vigorous pairs would surely rear a larger number of offspring than the retarded females, which would be compelled to unite with the conquered and less powerful males, supposing the sexes to be numerically equal; and this is all that is wanted to add, in the course of successive generations, to the size, strength and courage of the males, or to improve their weapons.

But in very many cases the males which conquer their rivals,

[3] Here is excellent evidence on the character of the offspring from an experienced ornithologist. Mr. J. A. Allen, in speaking ("Mammals and Winter Birds of E. Florida," p. 229) of the later broods, after the accidental destruction of the first, says, that these "are found to be smaller and paler-colored than those hatched earlier in the season. In cases where several broods are reared each year, as a general rule the birds of the earlier broods seem in all respects the most perfect and vigorous."

[4] Hermann Müller has come to this same conclusion with respect to those female bees which are the first to emerge from the pupa each year. See his remarkable essay, "Anwendung den Darwin'schen Lehre auf Bienen." "Verh. d. V. Jahrg." xxix. p. 45.

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do not obtain possession of the females, independently of the choice of the latter. The courtship of animals is by no means so simple and short an affair as might be thought. The females are most excited by, or prefer pairing with, the more ornamented males, or those which are the best songsters, or play the best antics; but it is obviously probable that they would at the same time prefer the more vigorous and lively males, and this has in some cases been confirmed by actual observation.[5] Thus the more vigorous females, which are the first to breed, will have the choice of many males; and though they may not always select the strongest or best armed, they will select those which are vigorous and well armed, and in other respects the most attractive. Both sexes, therefore, of such early pairs would as above explained, have an advantage over others in rearing offspring; and this apparently has sufficed during a long course of generations to add not only to the strength and fighting powers of the males, but likewise to their various ornaments or other attractions.

In the converse and much rarer case of the males selecting particular females, it is plain that those which were the most vigorous and had conquered others, would have the freest choice; and it is almost certain that they would select vigorous as well as attractive females. Such pairs would have an advantage in rearing offspring, more especially if the male had the power to defend the female during the pairing-season as occurs with some of the higher animals, or aided her in providing for the young. The same principles would apply if each sex preferred and selected certain individuals of the opposite sex; supposing that they selected not only the more attractive, but likewise the more vigorous individuals.

Numerical Proportion of the Two Sexes.— I have remarked that sexual selection would be a simple affair if the males were considerably more numerous than the females. Hence I was led to investigate, as far as I could, the proportions between the two sexes of as many animals as possible; but the materials are scanty. I will here give only a brief abstract of the results, retaining the details for a supplementary discussion, so as not to

[5] With respect to poultry, I have received information, hereafter to be given, to this effect. Even with birds, such as pigeons, which pair for life, the female, as I hear from Mr. Jenner Weir, will desert her mate if he is injured or grows weak.

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interfere with the course of my argument. Domesticated animals alone afford the means of ascertaining the proportional numbers at birth; but no records have been specially kept for this purpose. By indirect means, however, I have collected a considerable body of statistics, from which it appears that with most of our domestic animals the sexes are nearly equal at birth. Thus 25,560 births of race-horses have been recorded during twenty-one years, and the male births were to the female births as 99.7 to 100. In greyhounds the inequality is greater than with any other animal, for out of 6878 births during twelve years, the male births were to the female as 110.1 to 100. It is, however, in some degree doubtful whether it is safe to infer that the proportion would be the same under natural conditions as under domestication; for slight and unknown differences in the conditions affect the proportion of the sexes. Thus with mankind, the male births in England are as 104.5, in Russia as 108.9, and with the Jews of Livonia as 120, to 100 female births. But I shall recur to this curious point of the excess of male births in the supplement to this chapter. At the Cape of Good Hope, however, male children of European extraction have been born during several years in the proportion of between 90 and 99 to 100 female children.

For our present purpose we are concerned with the proportion of the sexes, not only at birth, but also at maturity, and this adds another element of doubt; for it is a well-ascertained fact that with man the number of males dying before or during birth, and during the first few years of infancy, is considerably larger than that of females. So it almost certainly is with male lambs, and probably with some other animals. The males of some species kill one another by fighting; or they drive one another about until they become greatly emaciated. They must also be often exposed to various dangers, whilst wandering about in eager search for the females. In many kinds of fish the males are much smaller than the females, and they are believed often to be devoured by the latter, or by other fishes. The females of some birds appear to die earlier than the males; they are also liable to be destroyed on their nests, or whilst in charge of their young. With insects the female larvæ are often larger than those of the males, and would consequently be more likely to be devoured. In some cases the mature females are less active and less rapid in

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their movements than the males, and could not escape so well from danger. Hence, with animals in a state of nature, we must rely on mere estimation, in order to judge of the proportions of the sexes at maturity; and this is but little trustworthy, except when the inequality is strongly marked. Nevertheless, as far as a judgment can be formed, we may conclude from the facts given in the supplement, that the males of some few mammals, of many birds, of some fish and insects, are considerably more numerous than the females.

The proportion between the sexes fluctuates slightly during successive years: thus with race-horses, for every 100 mares born the stallions varied from 107.1 in one year to 92.6 in another year, and with greyhounds from 116.3 to 95.3. But had larger numbers been tabulated throughout an area more extensive than England, these fluctuations would probably have disappeared; and such as they are, would hardly suffice to lead to effective sexual selection in a state of nature. Nevertheless, in the cases of some few wild animals, as shown in the supplement, the proportions seem to fluctuate either during different seasons or in different localities in a sufficient degree to lead to such selection. For it should be observed that any advantage, gained during certain years or in certain localities by those males which were able to conquer their rivals, or were the most attractive to the females, would probably be transmitted to the offspring, and would not subsequently be eliminated. During the succeeding seasons, when, from the equality of the sexes, every male was able to procure a female, the stronger or more attractive males previously produced would still have at least as good a chance of leaving offspring as the weaker or less attractive.

Polygamy.— The practice of polygamy leads to the same results as would follow from an actual inequality in the number of the sexes; for if each male secures two or more females, many males cannot pair; and the latter assuredly will be the weaker or less attractive individuals. Many mammals and some few birds are polygamous, but with animals belonging to the lower classes I have found no evidence of this habit. The intellectual powers of such animals are, perhaps, not sufficient to lead them to collect and guard a harem of females. That some relation exists between polygamy and the development of secondary sex-

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ual characters, appears nearly certain; and this supports the view that a numerical preponderance of males would be eminently favorable to the action of sexual selection. Nevertheless many animals, which are strictly monogamous, especially birds, display strongly-marked secondary sexual characters; whilst some few animals, which are polygamous, do not have such characters.

We will first briefly run through the mammals, and then turn to birds. The gorilla seems to be polygamous, and the male differs considerably from the female; so it is with some baboons, which live in herds containing twice as many adult females as males. In South America the *Mycetes caraya* presents well-marked sexual differences, in color, beard, and vocal organs; and the male generally lives with two or three wives: the male of the *Cebus capucinus* differs somewhat from the female, and appears to be polygamous. Little is known on this head with respect to most other monkeys, but some species are strictly monogamous. The ruminants are eminently polygamous, and they present sexual differences more frequently than almost any other group of mammals; this holds good, especially in their weapons, but also in other characters. Most deer, cattle, and sheep are polygamous; as are most antelopes, though some are monogamous. Sir Andrew Smith, in speaking of the antelopes of South Africa, says that in herds of about a dozen there was rarely more than one mature male. The Asiatic *Antilope saiga* appears to be the most inordinate polygamist in the world; for Pallas states that the male drives away all rivals, and collects a herd of about a hundred females and kids together; the female is hornless and has softer hair, but does not otherwise differ much from the male. The wild horse of the Falkland Islands and of the Western States of N. America is polygamous, but, except in his greater size and in the proportions of his body, differs but little from the mare. The wild boar presents well-marked sexual characters, in his great tusks and some other points. In Europe and in India he leads a solitary life, except during the breeding-season; but as is believed by Sir W. Elliot, who has had many opportunities in India of observing this animal, he consorts at this season with several females. Whether this holds good in Europe is doubtful, but it is supported by some evidence. The adult male Indian elephant, like the boar, passes much of his time in solitude; but as Dr. Campbell states, when with others, "it is rare to find

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more than one male with a whole herd of females;" the larger males expelling or killing the smaller and weaker ones. The male differs from the female in his immense tusks, greater size, strength, and endurance; so great is the difference in these respects, that the males when caught are valued at one-fifth more than the females. The sexes of other pachydermatous animals differ very little or not at all, and, as far as known, they are not polygamists. Nor have I heard of any species in the Orders of Cheiroptera, Edentata, Insectivora and Rodents being polygamous, excepting that amongst the Rodents, the common rat, according to some rat-catchers, lives with several females. Nevertheless the two sexes of some sloths (Edentata) differ in the character and color of certain patches of hair on their shoulders. And many kinds of bats (Cheiroptera) present well-marked sexual differences, chiefly in the males possessing odoriferous glands and pouches, and by their being of a lighter color. In the great order of Rodents, as far as I can learn, the sexes rarely differ, and when they do so, it is but slightly in the tint of the fur.

As I hear from Sir Andrew Smith, the lion in South Africa sometimes lives with a single female, but generally with more, and, in one case, was found with as many as five females; so that he is polygamous. As far as I can discover, he is the only polygamist amongst all the terrestrial Carnivora, and he alone presents well-marked sexual characters. If, however, we turn to the marine Carnivora, as we shall hereafter see, the case is widely different; for many species of seals offer extraordinary sexual differences, and they are eminently polygamous. Thus, according to Péron, the male sea-elephant of the Southern Ocean always possesses several females, and the sea-lion of Forster is said to be surrounded by from twenty to thirty females. In the North, the male sea-bear of Steller is accompanied by even a greater number of females. It is an interesting fact, as Dr. Gill remarks, that in the monogamous species, "or those living in small communities, there is little difference in size between the males and females; in the social species, or rather those of which the males have harems, the males are vastly larger than the females."

Amongst birds, many species, the sexes of which differ greatly from each other, are certainly monogamous. In Great Britain we see well-marked sexual differences, for instance, in the wild-duck which pairs with a single female, the common blackbird, and the

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bullfinch which is said to pair for life. I am informed by Mr. Wallace that the like is true of the Chatterers or Cotingidæ of South America, and of many other birds. In several groups I have not been able to discover whether the species are polygamous or monogamous. Lesson says that birds of paradise, so remarkable for their sexual differences, are polygamous, but Mr. Wallace doubts whether he had sufficient evidence. Mr. Salvin tells me he has been led to believe that humming-birds are polygamous. The male widow-bird, remarkable for his caudal plumes, certainly seems to be a polygamist.[6] I have been assured by Mr. Jenner Weir and by others, that it is somewhat common for three starlings to frequent the same nest; but whether this is a case of polygamy or polyandry has not been ascertained.

The Gallinaceæ exhibit almost as strongly marked sexual differences as birds of paradise or humming-birds, and many of the species are, as is well known, polygamous; others being strictly monogamous. What a contrast is presented between the sexes of the polygamous peacock or pheasant, and the monogamous guinea-fowl or partridge! Many similar cases could be given, as in the grouse tribe, in which the males of the polygamous capercailzie and black-cock differ greatly from the females; whilst the sexes of the monogamous red grouse and ptarmigan differ very little. In the Cursores, except amongst the bustards, few species offer strongly-marked sexual differences, and the great bustard (*Otis tarda*) is said to be polygamous. With the Grallatores, extremely few species differ sexually, but the ruff (*Machetes pugnax*) affords a marked exception, and this species is believed by Montagu to be a polygamist. Hence it appears that amongst birds there often exists a close relation between polygamy and the development of strongly-marked sexual differences. I asked Mr. Bartlett, of the Zoological Gardens, who has had very large experience with birds, whether the male tragopan (one of the Gallinaceæ) was polygamous, and I was struck by his answering, "I do not know, but should think so from his splendid colors."

It deserves notice that the instinct of pairing with a single female is easily lost under domestication. The wild-duck is

[6] "The Ibis," vol. iii. p. 133, on the Progne Widow-bird. See also on the *Vidua axillaris*, ibid. vol. ii. p. 211. On the polygamy of the Capercailzie and Great Bustard, see L. Lloyd, "Game Birds of Sweden," p. 19, and 182. Montagu and Selby speak of the Black Grouse as polygamous and of the Red Grouse as monogamous.

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strictly monogamous, the domestic-duck highly polygamous. The Rev. W. D. Fox informs me that out of some half-tamed wild-ducks, on a large pond in his neighborhood, so many mallards were shot by the game-keeper that only one was left for every seven or eight females; yet unusually large broods were reared. The guinea-fowl is strictly monogamous; but Mr. Fox finds that his birds succeed best when he keeps one cock to two or three hens. Canary-birds pair in a state of nature, but the breeders in England successfully put one male to four or five females. I have noticed these cases, as rendering it probable that wild monogamous species might readily become either temporarily or permanently polygamous.

Too little is known of the habits of reptiles and fishes to enable us to speak of their marriage arrangements. The stickleback (Gasterosteus), however, is said to be a polygamist; and the male during the breeding season differs conspicuously from the female.

To sum up on the means through which, as far as we can judge, sexual selection has led to the development of secondary sexual characters. It has been shown that the largest number of vigorous offspring will be reared from the pairing of the strongest and best-armed males, victorious in contests over other males, with the most vigorous and best-nourished females, which are the first to breed in the spring. If such females select the more attractive, and at the same time vigorous males, they will rear a larger number of offspring than the retarded females, which must pair with the less vigorous and less attractive males. So it will be if the more vigorous males select the more attractive and at the same time healthy and vigorous females; and this will especially hold good if the male defends the female, and aids in providing food for the young. The advantage thus gained by the more vigorous pairs in rearing a larger number of offspring has apparently sufficed to render sexual selection efficient. But a large numerical preponderance of males over females will be still more efficient; whether the preponderance is only occasional and local, or permanent; whether it occurs at birth, or afterwards from the greater destruction of the females; or whether it indirectly follows from the practice of polygamy.

The Male generally more modified than the Female.—

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Throughout the animal kingdom, when the sexes differ in external appearance, it is, with rare exceptions, the male which has been the more modified; for, generally, the female retains a closer resemblance to the young of her own species, and to other adult members of the same group. The cause of this seems to lie in the males of almost all animals having stronger passions than the females. Hence it is the males that fight together and sedulously display their charms before the females; and the victors transmit their superiority to their male offspring. Why both sexes do not thus acquire the characters of their fathers, will be considered hereafter. That the males of all mammals eagerly pursue the females is notorious to every one. So it is with birds; but many cock birds do not so much pursue the hen, as display their plumage, perform strange antics, and pour forth their song in her presence. The male in the few fish observed seems much more eager than the female; and the same is true of alligators, and apparently of Batrachians. Throughout the enormous class of insects, as Kirby remarks, "the law is, that the male shall seek the female." Two good authorities, Mr. Blackwall and Mr. C. Spence Bate, tell me that the males of spiders and crustaceans are more active and more erratic in their habits than the females. When the organs of sense or locomotion are present in the one sex of insects and crustaceans and absent in the other, or when, as is frequently the case, they are more highly developed in the one than in the other, it is, as far as I can discover, almost invariably the male which retains such organs, or has them most developed; and this shows that the male is the more active member in the courtship of the sexes.[7]

The female, on the other hand, with the rarest exceptions, is less eager than the male. As the illustrious Hunter long ago observed, she generally "requires to be courted;" she is coy, and may often be seen endeavoring for a long time to escape from the male. Every observer of the habits of animals will be able to call to mind instances of this kind. It is shown by various facts,

[7] One parasitic Hymenopterous insect (Westwood, "Modern Class. of Insects," vol. ii. p. 160) forms an exception to the rule, as the male has rudimentary wings, and never quits the cell in which it is born, whilst the female has well-developed wings. Audouin believes that the females of this species are impregnated by the males which are born in the same cells with them; but it is much more probable that the females visit other cells, so that close inter-breeding is thus avoided. We shall hereafter meet in various classes, with a few exceptional cases, in which the female, instead of the male, is the seeker and wooer.

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given hereafter, and by the results fairly attributable to sexual selection, that the female, though comparatively passive, generally exerts some choice and accepts one male in preference to others. Or she may accept, as appearances would sometimes lead us to believe, not the male which is the most attractive to her, but the one which is the least distasteful. The exertion of some choice on the part of the female seems a law almost as general as the eagerness of the male.

We are naturally led to inquire why the male, in so many and such distinct classes, has become more eager than the female, so that he searches for her, and plays the more active part in courtship. It would be no advantage and some loss of power if each sex searched for the other; but why should the male almost always be the seeker? The ovules of plants after fertilization have to be nourished for a time; hence the pollen is necessarily brought to the female organs — being placed on the stigma, by means of insects or the wind, or by the spontaneous movements of the stamens; and in the Algæ, &c., by the locomotive power of the antherozooids. With lowly-organized aquatic animals, permanently affixed to the same spot and having their sexes separate, the male element is invariably brought to the female; and of this we can see the reason, for even if the ova were detached before fertilization, and did not require subsequent nourishment or protection, there would yet be greater difficulty in transporting them than the male element, because, being larger than the latter, they are produced in far smaller numbers. So that many of the lower animals are, in this respect, analogous with plants. The males of affixed and aquatic animals having been led to emit their fertilizing element in this way, it is natural that any of their descendants, which rose in the scale and became locomotive, should retain the same habit; and they would approach the female as closely as possible, in order not to risk the loss of the fertilizing element in a long passage of it through the water. With some few of the lower animals, the females alone are fixed, and the males of these must be the seekers. But it is difficult to understand why the males of species, of which the progenitors were primordially free, should invariably have acquired the habit of approaching the females, instead of being approached by them. But in all cases, in order that the males should seek efficiently, it would be necessary that they should be endowed with strong

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passions; and the acquirement of such passions would naturally follow from the more eager leaving a larger number of offspring than the less eager.

The great eagerness of the males has thus indirectly led to their much more frequently developing secondary sexual characters than the females. But the development of such characters would be much aided, if the males were more liable to vary than the females — as I concluded they were — after a long study of domesticated animals. Von Nathusius, who has had very wide experience, is strongly of the same opinion. Good evidence also in favor of this conclusion can be produced by a comparison of the two sexes in mankind. During the Novara Expedition [8] a vast number of measurements was made of various parts of the body in different races, and the men were found in almost every case to present a greater range of variation than the women; but I shall have to recur to this subject in a future chapter. Mr. J. Wood, who has carefully attended to the variation of the muscles in man, puts in italics the conclusion that "the greatest number of abnormalities in each subject is found in the males." He had previously remarked that "altogether in 102 subjects, the varieties of redundancy were found to be half as many again as in females, contrasting widely with the greater frequency of deficiency in females before described." Professor Macalister likewise remarks that variations in the muscles "are probably more common in males than females." Certain muscles which are not normally present in mankind are also more frequently developed in the male than in the female sex, although exceptions to this rule are said to occur. Dr. Burt Wilder has tabulated the cases of 152 individuals with supernumerary digits, of which 86 were males, and 39, or less than half, females, the remaining 27 being of unknown sex. It should not, however, be overlooked that women would more frequently endeavor to conceal a deformity of this kind than men. Again, Dr. L. Meyer asserts that the ears of man are more variable in form than those of a woman. Lastly the temperature is more variable in man than in woman.

The cause of the greater general variability in the male sex, than in the female is unknown, except in so far as secondary sexual characters are extraordinarily variable, and are usually

[8] "Reise der Novara: Anthropolog. Theil," ss. 216–269. The results were calculated by Dr. Weisbach from measurements made by Drs. K. Scherzer and Schwarz.

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confined to the males; and, as we shall presently see, this fact is, to a certain extent, intelligible. Through the action of sexual and natural selection male animals have been rendered in very many instances widely different from their females; but independently of selection the two sexes, from differing constitutionally, tend to vary in a somewhat different manner. The female has to expend much organic matter in the formation of her ova, whereas the male expends much force in fierce contests with his rivals, in wandering about in search of the female, in exerting his voice, pouring out odoriferous secretions, &c.: and this expenditure is generally concentrated within a short period. The great vigor of the male during the season of love seems often to intensify his colors, independently of any marked difference from the female.[9] In mankind, and even as low down in the organic scale as in the Lepidoptera, the temperature of the body is higher in the male than in the female, accompanied in the case of man by a slower pulse. On the whole the expenditure of matter and force by the two sexes is probably nearly equal, though effected in very different ways and at different rates.

From the causes just specified the two sexes can hardly fail to differ somewhat in constitution, at least during the breeding season; and, although they may be subjected to exactly the same conditions, they will tend to vary in a different manner. If such variations are of no service to either sex, they will not be accumulated and increased by sexual or natural selection. Nevertheless, they may become permanent if the exciting cause acts permanently; and in accordance with a frequent form of inheritance they may be transmitted to that sex alone in which they first appeared. In this case the two sexes will come to present permanent, yet unimportant, differences of character. For instance, Mr. Allen shows that with a large number of birds inhabiting the northern and southern United States, the specimens from the south are darker-colored than those from the north; and this seems to be the direct result of the difference in temperature, light, &c., between the two regions. Now, in some few cases, the two sexes of the same species appear to have been differently

[9] Prof. Mantegazza is inclined to believe ("Lettera a Carlo Darwin," "Archivio per l'Anthropologia," 1871, p. 306) that the bright colors, common in so many male animals, are due to the presence and retention by them of the spermatic fluid; but this can hardly be the case: for many male birds, for instance young pheasants, become brightly colored in the autumn of their first year.

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affected; in the *Agelæus phœniceus* the males have had their colors greatly intensified in the south; whereas with *Cardinalis virginianus* it is the females which have been thus affected; with *Quiscalus major* the females have been rendered extremely variable in tint, whilst the males remain nearly uniform.

A few exceptional cases occur in various classes of animals, in which the females instead of the males have acquired well pronounced secondary sexual characters, such as brighter colors, greater size, strength, or pugnacity. With birds there has sometimes been a complete transposition of the ordinary characters proper to each sex; the females having become the more eager in courtship, the males remaining comparatively passive, but apparently selecting the more attractive females, as we may infer from the results. Certain hen birds have thus been rendered more highly colored or otherwise ornamented, as well as more powerful and pugnacious than the cocks; these characters being transmitted to the female offspring alone.

It may be suggested that in some cases a double process of selection has been carried on; that the males have selected the more attractive females, and the latter the more attractive males. This process, however, though it might lead to the modification of both sexes, would not make the one sex different from the other, unless indeed their tastes for the beautiful differed; but this is a supposition too improbable to be worth considering in the case of any animal, excepting man. There are, however, many animals in which the sexes resemble each other, both being furnished with the same ornaments, which analogy would lead us to attribute to the agency of sexual selection. In such cases it may be suggested with more plausibility, that there has been a double or mutual process of sexual selection; the more vigorous and precocious females selecting the more attractive and vigorous males, the latter rejecting all except the more attractive females. But from what we know of the habits of animals, this view is hardly probable, for the male is generally eager to pair with any female. It is more probable that the ornaments common to both sexes were acquired by one sex, generally the male, and then transmitted to the offspring of both sexes. If, indeed, during a lengthened period the males of any species were greatly to exceed the females in number, and then during another lengthened period, but under different conditions, the reverse were to occur,

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a double, but not simultaneous, process of sexual selection might easily be carried on, by which the two sexes might be rendered widely different.

We shall hereafter see that many animals exist, of which neither sex is brilliantly colored or provided with special ornaments, and yet the members of both sexes or of one alone have probably acquired simple colors, such as white or black, through sexual selection. The absence of bright tints or other ornaments may be the result of variations of the right kind never having occurred, or of the animals themselves having preferred plain black or white. Obscure tints have often been developed through natural selection for the sake of protection, and the acquirement through sexual selection of conspicuous colors, appears to have been sometimes checked from the danger thus incurred. But in other cases the males during long ages may have struggled together for the possession of the females, and yet no effect will have been produced, unless a larger number of offspring were left by the more successful males to inherit their superiority, than by the less successful: and this, as previously shown, depends on many complex contingencies.

Sexual selection acts in a less rigorous manner than natural selection. The latter produces its effects by the life or death at all ages of the more or less successful individuals. Death, indeed, not rarely ensues from the conflicts of rival males. But generally the less successful male merely fails to obtain a female, or obtains a retarded and less vigorous female later in the season, or, if polygamous, obtains fewer females; so that they leave fewer, less vigorous, or no offspring. In regard to structures acquired through ordinary or natural selection, there is in most cases, as long as the conditions of life remain the same, a limit to the amount of advantageous modification in relation to certain special purposes; but in regard to structures adapted to make one male victorious over another, either in fighting or in charming the female, there is no definite limit to the amount of advantageous modification; so that as long as the proper variations arise the work of sexual selection will go on. This circumstance may partly account for the frequent and extraordinary amount of variability presented by secondary sexual characters. Nevertheless, natural selection will determine that such characters shall not be acquired by the victorious males, if they

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would be highly injurious, either by expending too much of their vital powers, or by exposing them to any great danger. The development, however, of certain structures — of the horns, for instance, in certain stags — has been carried to a wonderful extreme; and in some cases to an extreme which, as far as the general conditions of life are concerned, must be slightly injurious to the male. From this fact we learn that the advantages which favored males derive from conquering other males in battle or courtship, and thus leaving a numerous progeny, are in the long run greater than those derived from rather more perfect adaptation to their conditions of life. We shall further see, and it could never have been anticipated, that the power to charm the female has sometimes been more important than the power to conquer other males in battle.

LAWS OF INHERITANCE.

In order to understand how sexual selection has acted on many animals of many classes, and in the course of ages has produced a conspicuous result, it is necessary to bear in mind the laws of inheritance, as far as they are known. Two distinct elements are included under the term "inheritance"— the transmission, and the development of characters; but as these generally go together, the distinction is often overlooked. We see this distinction in those characters which are transmitted through the early years of life, but are developed only at maturity or during old age. We see the same distinction more clearly with secondary sexual characters, for these are transmitted through both sexes, though developed in one alone. That they are present in both sexes, is manifest when two species, having strongly-marked sexual characters, are crossed, for each transmits the characters proper to its own male and female sex to the hybrid offspring of either sex. The same fact is likewise manifest, when characters proper to the male are occasionally developed in the female when she grows old or becomes diseased, as, for instance, when the common hen assumes the flowing tail-feathers, hackles, comb, spurs, voice, and even pugnacity of the cock. Conversely, the same thing is evident, more or less plainly, with castrated males. Again, independently of old age or disease, characters are occasionally transferred from the male to the female, as when, in cer-

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tain breeds of the fowl, spurs regularly appear in the young and healthy females. But in truth they are simply developed in the female; for in every breed each detail in the structure of the spur is transmitted through the female to her male offspring. Many cases will hereafter be given, where the female exhibits, more or less perfectly, characters proper to the male, in whom they must have been first developed, and then transferred to the female. The converse case of the first development of characters in the female and of transference to the male, is less frequent; it will therefore be well to give one striking instance. With bees the pollen-collecting apparatus is used by the female alone for gathering pollen for the larvæ, yet in most of the species it is partially developed in the males to whom it is quite useless, and it is perfectly developed in the males of Bombus or the humble-bee. As not a single other Hymenopterous insect, not even the wasp, which is closely allied to the bee, is provided with a pollen-collecting apparatus, we have no grounds for supposing that male bees primordially collected pollen as well as the females; although we have some reason to suspect that male mammals primordially suckled their young as well as the females. Lastly, in all cases of reversion, characters are transmitted through two, three, or many more generations, and are then developed under certain unknown favorable conditions. This important distinction between transmission and development will be best kept in mind by the aid of the hypothesis of pangenesis. According to this hypothesis, every unit or cell of the body throws off gemmules or undeveloped atoms, which are transmitted to the offspring of both sexes, and are multiplied by self-division. They may remain undeveloped during the early years of life or during successive generations; and their development into units or cells, like those from which they were derived, depends on their affinity for, and union with other units or cells previously developed in the due order of growth.

Inheritance at corresponding Periods of Life.— This tendency is well established. A new character, appearing in a young animal, whether it lasts throughout life or is only transient, will, in general, reappear in the offspring at the same age and last for the same time. If, on the other hand, a new character appears at maturity, or even during old age, it tends to reappear in the off-

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spring at the same advanced age. When deviations from this rule occur, the transmitted characters much oftener appear before, than after the corresponding age. As I have dwelt on this subject sufficiently in another work, I will here merely give two or three instances, for the sake of recalling the subject to the reader's mind. In several breeds of the Fowl, the down-covered chickens, the young birds in their first true plumage, and the adults differ greatly from one another, as well as from their common parent-form, the *Gallus bankiva;* and these characters are faithfully transmitted by each breed to their offspring at the corresponding periods of life. For instance, the chickens of spangled Hamburgs, whilst covered with down, have a few dark spots on the head and rump, but are not striped longitudinally, as in many other breeds; in their first true plumage, "they are beautifully penciled," that is, each feather is transversely marked by numerous dark bars; but in their second plumage the feathers all become spangled or tipped with a dark round spot.[10] Hence in this breed variations have occurred at, and been transmitted to, three distinct periods of life. The Pigeon offers a more remarkable case, because the aboriginal parent species does not undergo any change of plumage with advancing age, excepting that at maturity the breast becomes more iridescent; yet there are breeds which do not acquire their characteristic colors until they have molted two, three or four times; and these modifications of plumage are regularly transmitted.

Inheritance at corresponding Seasons of the Year.— With animals in a state of nature, innumerable instances occur of characters appearing periodically at different seasons. We see this in the horns of the stag, and in the fur of arctic animals which becomes thick and white during the winter. Many birds acquire bright colors and other decorations during the breeding-season alone. Pallas states that in Siberia domestic cattle and horses become lighter-colored during the winter; and I have myself observed, and heard of similar strongly marked changes of color, that is, from brownish cream-color or reddish-brown to a perfect white, in several ponies in England. Although I do not know that this tendency to change the color of the coat during different

[10] These facts are given on the high authority of a great breeder, Mr. Teebay; see Tegetmeier's "Poultry Book," p. 158.

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seasons is transmitted, yet it probably is so, as all shades of color are strongly inherited by the horse. Nor is this form of inheritance, as limited by the seasons, more remarkable than its limitation by age or sex.

Inheritance as Limited by Sex.— The equal transmission of characters to both sexes is the commonest form of inheritance, at least with those animals which do not present strongly-marked sexual differences, and indeed with many of these. But characters are somewhat commonly transferred exclusively to that sex, in which they first appear. Ample evidence on this head has been advanced in my work on "Variation under Domestication," but a few instances may here be given. There are breeds of the sheep and goat, in which the horns of the male differ greatly in shape from those of the female; and these differences, acquired under domestication, are regularly transmitted to the same sex. As a rule, it is the females alone in cats which are tortoise-shell, the corresponding color in the males being rusty-red. With most breeds of the fowl, the characters proper to each sex are transmitted to the same sex alone. So general is this form of transmission that it is an anomaly when variations in certain breeds are transmitted equally to both sexes. There are also certain sub-breeds of the fowl in which the males can hardly be distinguished from one another, whilst the females differ considerably in color. The sexes of the pigeon in the parent-species do not differ in any external character; nevertheless, in certain domesticated breeds the male is colored differently from the female. The wattle in the English Carrier pigeon, and the crop in the Pouter, are more highly developed in the male than in the female; and although these characters have been gained through long-continued selection by man, the slight differences between the sexes are wholly due to the form of inheritance which has prevailed; for they have arisen, not from, but rather in opposition to, the wish of the breeder.

Most of our domestic races have been formed by the accumulation of many slight variations; and as some of the successive steps have been transmitted to one sex alone, and some to both sexes, we find in the different breeds of the same species all gradations between great sexual dissimilarity and complete similarity. Instances have already been given with the breeds of the fowl and

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pigeon, and under nature analogous cases are common. With animals under domestication, but whether in nature I will not venture to say, one sex may lose characters proper to it, and may thus come somewhat to resemble the opposite sex; for instance, the males of some breeds of the fowl have lost their masculine tail-plumes and hackles. On the other hand, the differences between the sexes may be increased under domestication, as with merino sheep, in which the ewes have lost their horns. Again, characters proper to one sex may suddenly appear in the other sex; as in those sub-breeds of the fowl in which the hens acquire spurs whilst young; or, as in certain Polish sub-breeds, in which the females, as there is reason to believe, originally acquired a crest, and subsequently transferred it to the males. All these cases are intelligible on the hypothesis of pangenesis; for they depend on the gemmules of certain parts, although present in both sexes, becoming, through the influence of domestication, either dormant or developed in either sex.

There is one difficult question which it will be convenient to defer to a future chapter; namely, whether a character at first developed in both sexes, could through selection be limited in its development to one sex alone. If, for instance, a breeder observed that some of his pigeons (of which the characters are usually transferred in an equal degree to both sexes) varied into pale blue, could he by long-continued selection make a breed, in which the males alone should be of this tint, whilst the females remained unchanged? I will here only say, that this, though perhaps not impossible, would be extremely difficult; for the natural result of breeding from the pale-blue males would be to change the whole stock of both sexes to this tint. If, however, variations of the desired tint appeared, which were from the first limited in their development to the male sex, there would not be the least difficulty in making a breed with the two sexes of a different color, as indeed has been effected with a Belgian breed, in which the males alone are streaked with black. In a similar manner, if any variation appeared in a female pigeon, which was from the first sexually limited in its development to the females, it would be easy to make a breed with the females alone thus characterized; but if the variation was not thus orig-

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inally limited, the process would be extremely difficult, perhaps impossible.[11]

On the Relation between the Period of Development of a Character and its Transmission to one Sex or to both Sexes.— Why certain characters should be inherited by both sexes, and other characters by one sex alone, namely by that sex in which the character first appeared, is in most cases quite unknown. We cannot even conjecture why with certain sub-breeds of the pigeon, black striæ, though transmitted through the female, should be developed in the male alone, whilst every other character is equally transferred to both sexes. Why, again, with cats, the tortoise-shell color should, with rare exceptions, be developed in the female alone. The very same character, such as deficient or supernumerary digits, color-blindness, &c., may with mankind be inherited by the males alone of one family, and in another family by the females alone, though in both cases transmitted through the opposite as well as through the same sex. Although we are thus ignorant, the two following rules seem often to hold good — that variations which first appear in either sex at a late period of life, tend to be developed in the same sex alone; whilst variations which first appear early in life in either sex tend to be developed in both sexes. I am, however, far from supposing that this is the sole determining cause. As I have not elsewhere discussed this subject, and as it has an important bearing on sexual selection, I must here enter into lengthy and somewhat intricate details.

It is in itself probable that any character appearing at an early age would tend to be inherited equally by both sexes, for the sexes do not differ much in constitution before the power of reproduction is gained. On the other hand, after this power has been gained and the sexes have come to differ in constitution, the gemmules (if I may again use the language of pangenesis)

[11] Since the publication of the first edition of this work, it has been highly satisfactory to me to find the following remarks from so experienced a breeder as Mr. Tegetmeier. After describing some curious cases in pigeons, of the transmission of color by one sex alone, and the formation of a sub-breed with this character, he says: "It is a singular circumstance that Mr. Darwin should have suggested the possibility of modifying the sexual colors of birds by a course of artificial selection. When he did so, he was in ignorance of these facts that I have related; but it is remarkable how very closely he suggested the right method of procedure."

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which are cast off from each varying part in the one sex would be much more likely to possess the proper affinities for uniting with the tissues of the same sex, and thus becoming developed, than with those of the opposite sex.

I was first led to infer that a relation of this kind exists, from the fact that whenever and in whatever manner the adult male differs from the adult female, he differs in the same manner from the young of both sexes. The generality of this fact is quite remarkable: it holds good with almost all mammals, birds, amphibians, and fishes; also with many crustaceans, spiders, and some few insects, such as certain orthoptera and libellulæ. In all these cases the variations, through the accumulation of which the male acquired his proper masculine characters, must have occurred at a somewhat late period of life; otherwise the young males would have been similarly characterized; and conformably with our rule, the variations are transmitted to and developed in the adult males alone. When, on the other hand, the adult male closely resembles the young of both sexes (these, with rare exceptions, being alike), he generally resembles the adult female; and in most of these cases the variations through which the young and old acquired their present characters, probably occurred, according to our rule, during youth. But there is here room for doubt, for characters are sometimes transferred to the offspring at an earlier age than that at which they first appeared in the parents, so that the parents may have varied when adult, and have transferred their characters to their offspring whilst young. There are, moreover, many animals, in which the two sexes closely resemble each other, and yet both differ from their young; and here the characters of the adults must have been acquired late in life; nevertheless, these characters, in apparent contradiction to our rule, are transferred to both sexes. We must not, however, overlook the possibility or even probability of successive variations of the same nature occurring, under exposure to similar conditions, simultaneously in both sexes at a rather late period of life; and in this case the variations would be transferred to the offspring of both sexes at a corresponding late age; and there would then be no real contradiction to the rule that variations occurring late in life are transferred exclusively to the sex in which they first appeared. This latter rule seems to hold true more generally than the second one, namely, that variations

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which occur in either sex early in life tend to be transferred to both sexes. As it was obviously impossible even to estimate in how large a number of cases throughout the animal kingdom these two propositions held good, it occurred to me to investigate some striking or crucial instances, and to rely on the result.

An excellent case for investigation is afforded by the Deer family. In all the species, but one, the horns are developed only in the males, though certainly transmitted through the females, and capable of abnormal development in them. In the reindeer, on the other hand, the female is provided with horns; so that in this species, the horns ought, according to our rule, to appear early in life, long before the two sexes are mature and have come to differ much in constitution. In all the other species the horns ought to appear later in life, which would lead to their development in that sex alone, in which they first appeared in the progenitor of the whole Family. Now in seven species, belonging to distinct sections of the family and inhabiting different regions, in which the stags alone bear horns, I find that the horns first appear at periods, varying from nine months after birth in the roebuck to ten, twelve or even more months in the stags of the six other and larger species.[12] But with the reindeer the case is widely different; for, as I hear from Prof. Nilsson, who kindly made special enquiries for me in Lapland, the horns appear in the young animals within four or five weeks after birth, and at the same time in both sexes. So that here we have a structure, developed at a most unusually early age in one species of the family, and likewise common to both sexes in this one species alone.

In several kinds of antelopes, only the males are provided with horns, whilst in the greater number both sexes bear horns. With respect to the period of development, Mr. Blyth informs me that there was at one time in the Zoological Gardens a young koodoo (*Ant. strepsiceros*), of which the males alone are horned, and also the young of a closely-allied species, the eland (*Ant. oreas*),

[12] I am much obliged to Mr. Cupples for having made inquiries for me in regard to the Roebuck and Red Deer of Scotland from Mr. Robertson, the experienced head-forester to the Marquis of Breadalbane. In regard to Fallow-deer, I have to thank Mr. Eyton and others for information. For the *Cervus alces* of N. America, see "Land and Water," 1868, pp. 221 and 254; and for the *C. Virginianus* and *strongyloceros* of the same continent, see J. D. Caton, in "Ottawa Acad. of Nat. Sc." 1868, p. 13. For *Cervus Eldi* of Pegu, see Lieut. Beaven, "Proc. Zoolog. Soc." 1867, p. 762.

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in which both sexes are horned. Now it is in strict conformity with our rule, that in the young male koodoo, although ten months old, the horns were remarkably small, considering the size ultimately attained by them; whilst in the young male eland, although only three months old, the horns were already very much larger than in the koodoo. It is also a noticeable fact that in the prong-horned antelope, [13] only a few of the females, about one in five, have horns, and these are in a rudimentary state, though sometimes above four inches long; so that as far as concerns the possession of horns by the males alone, this species is in an intermediate condition, and the horns do not appear until about five or six months after birth. Therefore in comparison with what little we know of the development of the horns in other antelopes, and from what we do know with respect to the horns of deer, cattle, &c., those of the prog-horned antelope appear at an intermediate period of life,— that is, not very early, as in cattle and sheep, nor very late, as in the larger deer and antelopes. The horns of sheep, goats, and cattle, which are well developed in both sexes, though not quite equal in size, can be felt, or even seen, at birth or soon afterwards. [14] Our rule, however, seems to fail in some breeds of sheep, for instance merinos, in which the rams alone are horned; for I cannot find on inquiry [15] that the horns are developed later in life in this breed than in ordinary sheep in which both sexes are horned. But with domesticated sheep the presence or absence of horns is not a firmly fixed character; for a certain proportion of the merino ewes bear small horns, and some of the rams are hornless; and in most breeds hornless ewes are occasionally produced.

Dr. W. Marshall has lately made a special study of the pro-

[13] *Antilocapra Americana.* I have to thank Dr. Canfield for information with respect to the horns of the female.

[14] I have been assured that the horns of the sheep in North Wales can always be felt, and are sometimes even an inch in length, at birth. Youatt says ("Cattle," 1834, p. 277), that the prominence of the frontal bone in cattle penetrates the cutis at birth, and that the horny matter is soon formed over it.

[15] I am greatly indebted to Prof. Victor Carus for having made inquiries for me, from the highest authorities, with respect to the merino sheep of Saxony. On the Guinea coast of Africa there is, however, a breed of sheep in which, as with merinos, the rams alone bear horns; and Mr. Winwood Reade informs me that in one case observed by him, a young ram, born on Feb. 10th, first showed horns on March 6th, so that in this instance, in conformity with rule, the development of the horns occurred at a later period of life than in Welsh sheep, in which both sexes are horned.

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tuberances so common on the heads of birds, and he comes to the following conclusion:— that with those species in which they are confined to the males, they are developed late in life; whereas with those species in which they are common to the two sexes, they are developed at a very early period. This is certainly a striking confirmation of my two laws of inheritance.

In most of the species of the splendid family of the Pheasants, the males differ conspicuously from the females, and they acquire their ornaments at a rather late period of life. The eared pheasant (*Crossoptilon auritum*), however, offers a remarkable exception, for both sexes possess the final caudal plumes, the large ear-tufts and the crimson velvet about the head; I find that all these characters appear very early in life in accordance with rule. The adult male can, however, be distinguished from the adult female by the presence of spurs; and conformably with our rule, these do not begin to be developed before the age of six months, as I am assured by Mr. Bartlett, and even at this age, the two sexes can hardly be distinguished.[16] The male and female Peacock differ conspicuously from each other in almost every part of their plumage, except in the elegant head-crest, which is common to both sexes; and this is developed very early in life, long before the other ornaments, which are confined to the male. The wild-duck offers an analogous case, for the beautiful green speculum on the wings is common to both sexes, though duller and somewhat smaller in the female, and it is developed early in life, whilst the curled tail-feathers and other ornaments of the male are developed later.[17] Between such extreme cases of close

[16] In the common peacock (*Pavo cristatus*) the male alone possesses spurs, whilst both sexes of the Java Peacock (*P. muticus*) offer the unusual case of being furnished with spurs. Hence I fully expected that in the latter species they would have been developed earlier in life than in the common peacock; but M. Hegt of Amsterdam informs me, that with young birds of the previous year, of both species, compared on April 23rd, 1869, there was no difference in the development of the spurs. The spurs, however, were as yet represented merely by slight knobs or elevations. I presume that I should have been informed if any difference in the rate of development had been observed subsequently.

[17] In some other species of the Duck family the speculum differs in a greater degree in the two sexes; but I have not been able to discover whether its full development occurs later in life in the males of such species, than in the male of the common duck, as ought to be the case according to our rule. With the allied *Mergus cucullatus* we have, however, a case of this kind: the two sexes differ conspicuously in general plumage, and to a considerable degree in the speculum, which is pure white in the male and grayish-white in the female. Now the young males at first entirely resemble the females, and have a grayish-white speculum,

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sexual resemblance and wide dissimilarity, as those of the Crossoptilon and peacock, many intermediate ones could be given, in which the characters follow our two rules in their order of development.

As most insects emerge from the pupal state in a mature condition, it is doubtful whether the period of development can determine the transference of their characters to one or to both sexes. But we do not know that the colored scales, for instance, in two species of butterflies, in one of which the sexes differ in color, whilst in the other they are alike, are developed at the same relative age in the cocoon. Nor do we know whether all the scales are simultaneously developed on the wings of the same species of butterfly, in which certain colored marks are confined to one sex, whilst others are common to both sexes. A difference of this kind in the period of development is not so improbable as it may at first appear; for with the Orthoptera, which assume their adult state, not by a single metamorphosis, but by a succession of molts, the young males of some species at first resemble the females, and acquire their distinctive masculine characters only at a later molt. Strictly analogous cases occur at the successive molts of certain male crustaceans.

We have as yet considered the transference of characters, relatively to their period of development, only in species in a natural state; we will now turn to domesticated animals, and first touch on monstrosities and diseases. The presence of supernumerary digits, and the absence of certain phalanges, must be determined at an early embryonic period — the tendency to profuse bleeding is at least congenital, as is probably color-blindness — yet these peculiarities, and other similar ones, are often limited in their transmission to one sex; so that the rule that characters, developed at an early period, tend to be transmitted to both sexes, here wholly fails. But this rule, as before remarked, does not appear to be nearly so general as the converse one, namely, that characters which appear late in life in one sex are transmitted exclusively to the same sex. From the fact of the above abnormal peculiarities becoming attached to one sex, long before the sexual functions are active, we may infer that there must be some dif-

which becomes pure white at an earlier age than that at which the adult male acquires his other and more strongly-marked sexual differences: see Audubon, "Ornithological Biography," vol. iii. pp. 249–250.

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ference between the sexes at an extremely early age. With respect to sexually-limited diseases, we know too little of the period at which they originate, to draw any safe conclusion. Gout, however, seems to fall under our rule, for it is generally caused by intemperance during manhood, and is transmitted from the father to his sons in a much more marked manner than to his daughters.

In the various domestic breeds of sheep, goats, and cattle, the males differ from their respective females in the shape or development of their horns, forehead, mane, dewlap, tail, and hump on the shoulders; and these peculiarities, in accordance with our rule, are not fully developed until a rather late period of life. The sexes of dogs do not differ, except that in certain breeds, especially in the Scotch deer-hound, the male is much larger and heavier than the female; and, as we shall see in a future chapter, the male goes on increasing in size to an unusually late period of life, which, according to rule, will account for his increased size being transmitted to his male offspring alone. On the other hand, the tortoise-shell color, which is confined to female cats, is quite distinct at birth, and this case violates the rule. There is a breed of pigeons in which the males alone are streaked with black, and the streaks can be detected even in the nestlings; but they become more conspicuous at each successive molt, so that this case partly opposes and partly supports the rule. With the English Carrier and Pouter pigeons, the full development of the wattle and the crop occurs rather late in life, and conformably with the rule, these characters are transmitted in full perfection to the males alone. The following cases perhaps come within the class previously alluded to, in which both sexes have varied in the same manner at a rather late period of life, and have consequently transferred their new characters to both sexes at a corresponding late period; and if so, these cases are not opposed to our rule:—there exist sub-breeds of the pigeon, described by Neumeister, in which both sexes change their color during two or three molts (as is likewise the case with the Almond Tumbler), nevertheless, these changes, though occurring rather late in life, are common to both sexes. One variety of the Canary-bird, namely the London Prize, offers a nearly analogous case.

With the breeds of the Fowl the inheritance of various char-

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acters by one or both sexes, seems generally determined by the period at which such characters are developed. Thus in all the many breeds in which the adult male differs greatly in color from the female, as well as from the wild parent-species, he differs also from the young male, so that the newly-acquired characters must have appeared at a rather late period of life. On the other hand, in most of the breeds in which the two sexes resemble each other, the young are colored in nearly the same manner as their parents, and this renders it probable that their colors first appeared early in life. We have instances of this fact in all black and white breeds, in which the young and old of both sexes are alike; nor can it be maintained that there is something peculiar in a black or white plumage, which leads to its transference to both sexes; for the males alone of many natural species are either black or white, the females being differently colored. With the so-called Cuckoo sub-breeds of the fowl, in which the feathers are transversely penciled with dark stripes, both sexes and the chickens are colored in nearly the same manner. The laced plumage of the Sebright bantam is the same in both sexes, and in the young chickens the wing-feathers are distinctly, though imperfectly laced. Spangled Hamburgs, however, offer a partial exception; for the two sexes, though not quite alike, resemble each other more closely than do the sexes of the aboriginal parent-species; yet they acquire their characteristic plumage late in life, for the chickens are distinctly penciled. With respect to other characters besides color, in the wild-parent species and in most of the domestic breeds, the males alone possess a well-developed comb; but in the young of the Spanish fowl it is largely developed at a very early age, and, in accordance with this early development in the male, it is of unusual size in the adult female. In the Game breeds pugnacity is developed at a wonderfully early age, of which curious proofs could be given; and this character is transmitted to both sexes, so that the hens, from their extreme pugnacity, are now generally exhibited in separate pens. With the Polish breeds the bony protuberance of the skull which supports the crest is partially developed even before the chickens are hatched, and the crest itself soon begins to grow, though at first feebly; and in this breed the adults of both sexes are characterized by a great bony protuberance and an immense crest.

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Finally, from what we have now seen of the relation which exists in many natural species and domesticated races, between the period of the development of their characters and the manner of their transmission — for example, the striking fact of the early growth of the horns in the reindeer, in which both sexes bear horns, in comparison with their much later growth in the other species in which the male alone bears horns — we may conclude that one, though not the sole cause of characters being exclusively inherited by one sex, is their development at a late age. And secondly, that one, though apparently a less efficient cause of characters being inherited by both sexes, is their development at an early age, whilst the sexes differ but little in constitution. It appears, however, that some difference must exist between the sexes even during a very early embryonic period, for characters developed at this age not rarely become attached to one sex.

Summary and concluding remarks.— From the foregoing discussion on the various laws of inheritance, we learn that the characters of the parents often, or even generally, tend to become developed in the offspring of the same sex, at the same age, and periodically at the same season of the year, in which they first appeared in the parents. But these rules, owing to unknown causes, are far from being fixed. Hence during the modification of a species, the successive changes may readily be transmitted in different ways; some to one sex, and some to both; some to the offspring at one age, and some to the offspring at all ages. Not only are the laws of inheritance extremely complex, but so are the causes which induce and govern variability. The variations thus induced are preserved and accumulated by sexual selection, which is in itself an extremely complex affair, depending, as it does, on the ardor in love, the courage, and the rivalry of the males, as well as on the powers of perception, the taste, and will of the female. Sexual selection will also be largely dominated by natural selection tending towards the general welfare of the species. Hence the manner in which the individuals of either or both sexes have been affected through sexual selection cannot fail to be complex in the highest degree.

When variations occur late in life in one sex, and are transmitted to the same sex at the same age, the other sex and the young are left unmodified. When they occur late in life, but are

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transmitted to both sexes at the same age, the young alone are left unmodified. Variations, however, may occur at any period of life in one sex or in both, and be transmitted to both sexes at all ages, and then all the individuals of the species are similarly modified. In the following chapters it will be seen that all these cases frequently occur in nature.

Sexual selection can never act on any animal before the age for reproduction arrives. From the great eagerness of the male it has generally acted on this sex and not on the females. The males have thus become provided with weapons for fighting with their rivals, with organs for discovering and securely holding the female, and for exciting or charming her. When the sexes differ in these respects, it is also, as we have seen, an extremely general law that the adult male differs more or less from the young male; and we may conclude from this fact that the successive variations, by which the adult male became modified, did not generally occur much before the age for reproduction. Whenever some or many of the variations occurred early in life, the young males would partake more or less of the characters of the adult males; and differences of this kind between the old and young males may be observed in many species of animals.

It is probable that young male animals have often tended to vary in a manner which would not only have been of no use to them at an early age, but would have been actually injurious — as by acquiring bright colors, which would render them conspicuous to their enemies, or by acquiring structures, such as great horns, which would expend much vital force in their development. Variations of this kind occurring in the young males would almost certainly be eliminated through natural selection. With the adult and experienced males, on the other hand, the advantages derived from the acquisition of such characters, would more than counterbalance some exposure to danger, and some loss of vital force.

As variations which give to the male a better chance of conquering other males, or of finding, securing, or charming the opposite sex, would, if they happened to arise in the female, be of no service to her, they would not be preserved in her through sexual selection. We have also good evidence with domesticated animals, that variations of all kinds are, if not carefully selected, soon lost through intercrossing and accidental

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deaths. Consequently in a state of nature, if variations of the above kind chanced to arise in the female line, and to be transmitted exclusively in this line, they would be extremely liable to be lost. If, however, the females varied and transmitted their newly acquired characters to their offspring of both sexes, the characters which were advantageous to the males would be preserved by them through sexual selection, and the two sexes would in consequence be modified in the same manner, although such characters were of no use to the females: but I shall hereafter have to recur to these more intricate contingencies. Lastly, the females may acquire, and apparently have often acquired by transference, characters from the male sex.

As variations occurring late in life, and transmitted to one sex alone, have incessantly been taken advantage of and accumulated through sexual selection in relation to the reproduction of the species; therefore it appears, at first sight, an unaccountable fact that similar variations have not frequently been accumulated through natural selection, in relation to the ordinary habits of life. If this had occurred, the two sexes would often have been differently modified, for the sake, for instance, of capturing prey or of escaping from danger. Differences of this kind between the two sexes do occasionally occur, especially in the lower classes. But this implies that the two sexes follow different habits in their struggles for existence, which is a rare circumstance with the higher animals. The case, however, is widely different with the reproductive functions, in which respect the sexes necessarily differ. For variations in structure which are related to these functions, have often proved of value to one sex, and from having arisen at a late period of life, have been transmitted to one sex alone; and such variations, thus preserved and transmitted, have given rise to secondary sexual characters.

In the following chapters, I shall treat of the secondary sexual characters in animals of all classes, and shall endeavor in each case to apply the principles explained in the present chapter. The lowest classes will detain us for a very short time, but the higher animals, especially birds, must be treated at considerable length. It should be borne in mind that for reasons already assigned, I intend to give only a few illustrative instances of the innumerable structures by the aid of which the male finds

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the female, or, when found, holds her. On the other hand, all structures and instincts by the aid of which the male conquers other males and by which he allures or excites the female, will be fully discussed, as these are in many ways the most interesting.

Supplement on the proportional numbers of the two sexes in animals belonging to various classes.

As no one, as far as I can discover, has paid attention to the relative numbers of the two sexes throughout the animal kingdom, I will here give such materials as I have been able to collect, although they are extremely imperfect. They consist in only a few instances of actual enumeration, and the numbers are not very large. As the proportions are known with certainty only in mankind, I will first give them as a standard of comparison.

Man.— In England during ten years (from 1857 to 1866) the average number of children born alive yearly was 707,120, in the proportion of 104.5 males to 100 females. But in 1857 the male births throughout England were as 105.2, and in 1865 as 104.0 to 100. Looking to separate districts, in Buckinghamshire (where about 5000 children are annually born) the *mean* proportion of male to female births, during the whole period of the above ten years, was as 102.8 to 100; whilst in N. Wales (where the average annual births are 12,873) it was as high as 106.2 to 100. Taking a still smaller district, viz., Rutlandshire (where the annual births average only 739), in 1864 the male births were as 114.6, and in 1862 as only 97.0 to 100; but even in this small district the average of the 7385 births during the whole ten years, was as 104.5 to 100: that is in the same ratio as throughout England. The proportions are sometimes slightly disturbed by unknown causes; thus Prof. Faye states "that in some districts of Norway there has been during a decennial period a steady deficiency of boys, whilst in other the opposite condition has existed." In France during forty-four years the male to the female births have been as 106.2 to 100; but during this period it has occurred five times in one department, and six times in another, that the female births have exceeded the males. In Russia the average proportion is as high

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as 108.9, and in Philadelphia in the United States as 110.5 to 100. The average for Europe, deduced by Bickes from about seventy million births, is 106 males to 100 females. On the other hand, with white children born at the Cape of Good Hope, the proportion of males is so low as to fluctuate during successive years between 90 and 99 males for every 100 females. It is a singular fact that with Jews the proportion of male births is decidedly larger than with Christians: thus in Prussia the proportion is as 113, in Breslau as 114, and in Livonia as 120 to 100; the Christian births in these countries being the same as usual, for instance, in Livonia as 104 to 100.

Prof. Faye remarks that "a still greater preponderance of males would be met with, if death struck both sexes in equal proportion in the womb and during birth. But the fact is, that for every 100 still-born females, we have in several countries from 134.6 to 144.9 still-born males. During the first four or five years of life, also, more male children die than females, for example in England, during the first year, 126 boys die for every 100 girls — a proportion which in France is still more unfavorable."[18] Dr. Stockton-Hough accounts for these facts in part by the more frequent defective development of males than of females. We have before seen that the male sex is more variable in structure than the female; and variations in important organs would generally be injurious. But the size of the body, and especially of the head, being greater in male than female infants is another cause: for the males are thus more liable to be injured during parturition. Consequently the still-born males are more numerous; and, as a highly competent judge, Dr. Crichton Browne,[19] believes, male infants often suffer in health for some years after birth. Owing to this excess in the death-rate of male children, both at birth and for some time subsequently, and owing to the exposure of grown men to various

[18] Dr. Stark remarks ("Tenth Annual Reports of Births, Deaths, &c., in Scotland," p. xxviii.) that "These examples may suffice to show that, at almost every stage of life, the males in Scotland have a greater liability to death and a higher death-rate than the females. The fact, however, of this peculiarity being most strongly developed at that infantile period of life when the dress, food, and general treatment of both sexes are alike, seems to prove that the higher male death-rate is an impressed, natural, and constitutional peculiarity due to sex alone."

[19] "West Riding Lunatic Asylum Reports," vol. i. 1871, p. 8. Sir J. Simpson has proved that the head of the male infant exceeds that of the female by 3-8ths of an inch in circumference, and by 1-8th in transverse diameter. Quetelet has shown that woman is born smaller than man.

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dangers, and to their tendency to emigrate, the females in all old-settled countries, where statistical records have been kept,[20] are found to preponderate considerably over the males.

It seems at first sight a mysterious fact that in different nations, under different conditions and climates, in Naples, Prussia, Westphalia, Holland, France, England and the United States, the excess of male over female births is less when they are illegitimate than when legitimate. This has been explained by different writers in many different ways, as from the mothers being generally young, from the large proportion of first pregnancies, etc. But we have seen that male infants, from the large size of their heads, suffer more than female infants during parturition; and as the mothers of illegitimate children must be more liable than other women to undergo bad labors, from various causes, such as attempts at concealment by tight lacing, hard work, distress of mind, etc., their male infants would proportionably suffer. And this probably is the most efficient of all the causes of the proportion of males to females born alive being less amongst illegitimate children than amongst the legitimate. With most animals the greater size of the adult male than of the female, is due to the stronger males having conquered the weaker in their struggles for the possession of the females, and no doubt it is owing to this fact that the two sexes of at least some animals differ in size at birth. Thus we have the curious fact that we may attribute the more frequent deaths of male than female infants, especially amongst the illegitimate, at least in part to sexual selection.

It has often been supposed that the relative age of the two parents determines the sex of the offspring; and Prof. Leuckart has advanced what he considers sufficient evidence, with respect to man and certain domesticated animals, that this is one important though not the sole factor in the result. So again the period of impregnation relatively to the state of the female has been thought by some to be the efficient cause; but recent observations discountenance this belief. According to Dr. Stockton-Hough, the season of the year, the poverty or wealth of the parents, residence in the country or in cities, the crossing of foreign immigrants, etc., all influence the proportion of the

[20] With the savage Guaranys of Paraguay, according to the accurate Azara (" Voyages dans l'Amérique merid." tom. ii. 1809, p. 60, 179), the women are to the men in the proportion of 14 to 13.

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sexes. With mankind, polygamy has also been supposed to lead to the birth of a greater proportion of female infants; but Dr. J. Campbell carefully attended to this subject in the harems of Siam, and concludes that the proportion of male to female births is the same as from monogamous unions. Hardly any animal has been rendered so highly polygamous as the English race-horse, and we shall immediately see that his male and female offspring are almost exactly equal in number. I will now give the facts which I have collected with respect to the proportional numbers of the sexes of various animals; and will then briefly discuss how far selection has come into play in determining the result.

Horses.— Mr. Tegetmeier has been so kind as to tabulate for me from the "Racing Calendar" the births of race-horses during a period of twenty-one years, viz., from 1846 to 1867; 1849 being omitted, as no returns were that year published. The total births were 25,560,[21] consisting of 12,763 males and 12,797 females, or in the proportion of 99.7 males to 100 females. As these numbers are tolerably large, and as they are drawn from all parts of England, during several years, we may with much confidence conclude that with the domestic horse, or at least with the race-horse, the two sexes are produced in almost equal numbers. The fluctuations in the proportions during successive years are closely like those which occur with mankind, when a small and thinly-populated area is considered; thus in 1856 the male horses were as 107.1, and in 1867 as only 92.6 to 100 fèmales. In the tabulated returns the proportions vary in cycles, for the males exceeded the females during six successive years; and the females exceeded the males during two periods each of four years; this, however, may be accidental; at least I can detect nothing of the kind with man in the decennial table in the Registrar's Report for 1866.

Dogs.— During a period of twelve years, from 1857 to 1868, the births of a large number of greyhounds, throughout England, were sent to the "Field" newspaper; and I am again indebted to Mr. Tegetmeier for carefully tabulating the results. The recorded births were 6878, consisting of 3605 males and 3273 females, that is, in the proportion of 110.1 males to 100 females. The greatest fluctuations occurred in 1864, when the proportion was as 95.3 males, and in 1867, as 116.3 males to 100 females. The above average proportion of 110.1 to 100 is probably nearly correct in the case of the greyhound, but whether it would hold

[21] During eleven years a record was kept of the number of mares which proved barren or prematurely slipped their foals; and it deserves notice, as showing how infertile these highly-nurtured and rather closely-interbred animals have become, that not far from one-third of the mares failed to produce living foals. Thus during 1866, 809 male colts and 816 female colts were born, and 743 mares failed to produce offspring. During 1867, 836 males and 902 females were born, and 794 mares failed.

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with other domesticated breeds is in some degree doubtful. Mr. Cupples has inquired from several great breeders of dogs, and finds that all without exception believe that females are produced in excess; but he suggests that this belief may have arisen from females being less valued, and from the consequent disappointment producing a stronger impression on the mind.

Sheep.— The sexes of sheep are not ascertained by agriculturists until several months after birth, at the period when the males are castrated; so that the following returns do not give the proportions at birth. Moreover, I find that several great breeders in Scotland, who annually raise some thousand sheep, are firmly convinced that a larger proportion of males than of females die during the first year or two. Therefore the proportion of males would be somewhat larger at birth than at the age of castration. This is a remarkable coincidence with what, as we have seen, occurs with mankind, and both cases probably depend on the same cause. I have received returns from four gentlemen in England who have bred Lowland sheep, chiefly Leicesters, during the last ten to sixteen years; they amount altogether to 8965 births, consisting of 4407 males and 4558 females; that is in the proportion of 96.7 males to 100 females. With respect to Cheviot and black-faced sheep bred in Scotland, I have received returns from six breeders, two of them on a large scale, chiefly for the years 1867–1869, but some of the returns extend back to 1862. The total number recorded amounts to 50,685, consisting of 25,071 males and 25,614 females, or in the proportion of 97.9 males to 100 females. If we take the English and Scotch returns together, the total number amounts to 59,650, consisting of 29,478 males and 30,172 females, or as 97.7 to 100. So that with sheep at the age of castration the females are certainly in excess of the males, but probably this would not hold good at birth.[22]

Of *Cattle* I have received returns from nine gentlemen of 982 births, too few to be trusted; these consisted of 477 bull-calves and 505 cow-calves, i. e., in the proportion of 94.4 males to 100 females. The Rev. W. D. Fox informs me that in 1867 out of 34 calves born on a farm in Derbyshire only one was a bull. Mr. Harrison Weir has inquired from several breeders of *Pigs*, and most of them estimate the male to the female births as about 7 to 6. This same gentleman has bred *Rabbits* for many years, and has noticed that a far greater number of bucks are produced than does. But estimations are of little value.

Of mammalia in a state of nature I have been able to learn very little. In regard to the common rat, I have received conflicting statements. Mr. R. Elliot, of Laighwood, informs me that a rat-catcher assured him that he had always found the males in great excess, even with the young in the nest. In consequence of this, Mr. Elliot himself subsequently examined some hundred old ones, and found the state-

[22] I am much indebted to Mr. Cupples for having procured for me the above returns from Scotland, as well as some of the following returns on cattle. Mr. R. Elliot, of Laighwood, first called my attention to the premature deaths of the males,— a statement subsequently confirmed by Mr. Aitchison and others. To this latter gentleman, and to Mr. Payan, I owe my thanks for large returns as to sheep.

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ment true. Mr. F. Buckland has bred a large number of white rats, and he also believes that the males greatly exceed the females. In regard to Moles, it is said that "the males are much more numerous than the females"; and as the catching of these animals is a special occupation, the statement may perhaps be trusted. Sir A. Smith, in describing an antelope of S. Africa (*Kobus ellipsiprymnus*), remarks, that in the herds of this and other species, the males are few in number compared with the females: the natives believe that they are born in this proportion; others believe that the younger males are expelled from the herds, and Sir A. Smith says, that though he has himself never seen herds consisting of young males alone, others affirm that this does occur. It appears probable that the young when expelled from the herd, would often fall a prey to the many beasts of prey of the country.

BIRDS.

With respect to the *Fowl*, I have received only one account, namely, that out of 1001 chickens of a highly-bred stock of Cochins, reared during eight years by Mr. Stretch, 487 proved males and 514 females; i. e. as 94.7 to 100. In regard to domestic pigeons there is good evidence either that the males are produced in excess, or that they live longer; for these birds invariably pair, and single males, as Mr. Tegetmeier informs me, can always be purchased cheaper than females. Usually the two birds reared from the two eggs laid in the same nest are a male and a female; but Mr. Harrison Weir, who has been so large a breeder, says that he has often bred two cocks from the same nest, and seldom two hens; moreover, the hen is generally the weaker of the two, and more liable to perish.

With respect to birds in a state of nature, Mr. Gould and others are convinced that the males are generally the more numerous; and as the young males of many species resemble the females, the latter would naturally appear to be the more numerous. Large numbers of pheasants are reared by Mr. Baker of Leadenhall from eggs laid by wild birds, and he informs Mr. Jenner Weir that four or five males to one female are generally produced. An experienced observer remarks, that in Scandinavia the broods of the capercailzie and black-cock contain more males than females; and that with the Dal-ripa (a kind of ptarmigan) more males than females attend the *leks* or places of courtship; but this latter circumstance is accounted for by some observers by a greater number of hen birds being killed by vermin. From various facts given by White of Selborne, it seems clear that the males of the partridge must be in considerable excess in the south of England; and I have been assured that this is the case in Scotland. Mr. Weir on inquiring from the dealers, who receive at certain seasons large numbers of ruffs (*Machetes pugnax*), was told that the males are much the more numerous. This same naturalist has also inquired for me from the birdcatchers, who annually catch an astonishing number of various small species alive for the London market, and he was unhesitatingly answered by an old and trustworthy man, that with the chaffinch the males

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are in large excess: he thought as high as 2 males to 1 female, or at least as high as 5 to 3.[23] The males of the blackbird, he likewise maintained, were by far the more numerous, whether caught by traps or by netting at night. These statements may apparently be trusted, because this same man said that the sexes are about equal with the lark, the twite (*Linaria montana*), and goldfinch. On the other hand, he is certain that with the common linnet, the females preponderate greatly, but unequally during different years; during some years he has found the females to the males as four to one. It should, however, be borne in mind, that the chief season for catching birds does not begin till September, so that with some species partial migrations may have begun, and the flocks at this period often consist of hens alone. Mr. Salvin paid particular attention to the sexes of the humming-birds in Central America, and is convinced that with most of the species the males are in excess; thus one year he procured 204 specimens belonging to ten species, and these consisted of 166 males and of only 38 females. With two other species the females were in excess: but the proportions apparently vary either during different seasons or in different localities; for on one occasion the males of *Campylopterus hemileucurus* were to the females as 5 to 2, and on another occasion in exactly the reversed ratio. As bearing on this latter point, I may add, that Mr. Powys found in Corfu and Epirus the sexes of the chaffinch keeping apart, and "the females by far the most numerous"; whilst in Palestine Mr. Tristram found "the male flocks appearing greatly to exceed the female in number." So again with the *Quiscalus major*, Mr. G. Taylor says, that in Florida there were "very few females in proportion to the males," whilst in Honduras the proportion was the other way, the species there having the character of a polygamist.

FISH.

With Fish the proportional numbers of the sexes can be ascertained only by catching them in the adult or nearly adult state; and there are many difficulties in arriving at any just conclusion.[24] Infertile females might readily be mistaken for males, as Dr. Günther has remarked to me in regard to trout. With some species the males are believed to die soon after fertilizing the ova. With many species the males are of much smaller size than the females, so that a large number of males would escape from the same net by which the females were caught. M. Carbonnier, who has especially attended to the natural history of the pike (*Esox lucius*), states that many males, owing to their small size, are devoured by the larger females; and he believes that the males of almost all fish are exposed from this same cause to greater danger than

[23] Mr. Jenner Weir received similar information, on making inquiries during the following year. To show the number of living chaffinches caught, I may mention that in 1869 there was a match between two experts, and one man caught in a day 62, and another 40, male chaffinches. The greatest number ever caught by one man in a single day was 70.

[24] Leuckart quotes Bloch (Wagner, "Handwörterbuch der Phys.," B. iv. s. 775), that with fish there are twice as many males as females.

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the females. Nevertheless, in the few cases in which the proportional numbers have been actually observed, the males appear to be largely in excess. Thus Mr. R. Buist, the superintendent of the Stormontfield experiments, says that in 1865, out of 70 salmon first landed for the purpose of obtaining the ova, upwards of 60 were males. In 1867 he again "calls attention to the vast disproportion of the males to the females. We had at the outset at least ten males to one female." Afterwards females sufficient for obtaining ova were procured. He adds, "from the great proportion of the males, they are constantly fighting and tearing each other on the spawning-beds." This disproportion, no doubt, can be accounted for in part, but whether wholly is doubtful, by the males ascending the rivers before the females. Mr. F. Buckland remarks in regard to trout, that "it is a curious fact that the males preponderate very largely in number over the females. It *invariably* happens that when the first rush of fish is made to the net, there will be at least seven or eight males to one female found captive. I cannot quite account for this; either the males are more numerous than the females, or the latter seek safety by concealment rather than flight." He then adds, that by carefully searching the banks sufficient females for obtaining ova can be found. Mr. H. Lee informs me that out of 212 trout taken for this purpose in Lord Portsmouth's park, 150 were males and 62 females.

The males of the Cyprinidæ likewise seem to be in excess; but several members of this Family, viz., the crap, tench, bream and minnow, appear regularly to follow the practice, rare in the animal kingdom, of polyandry; for the female whilst spawning is always attended by two males, one on each side, and in the case of the bream by three or four males. This fact is so well known, that it is always recommended to stock a pond with two male tenches to one female, or at least with three males to two females. With the minnow, an excellent observer states, that on the spawning-beds the males are ten times as numerous as the females; when a female comes amongst the males, "she is immediately pressed closely by a male on each side; and when they have been in that situation for a time, are superseded by other two males."

INSECTS.

In this great Class, the Lepidoptera almost alone afford means for judging of the proportional numbers of the sexes; for they have been collected with special care by many good observers, and have been largely bred from the egg or caterpillar state. I had hoped that some breeders of silk-moths might have kept an exact record, but after writing to France and Italy, and consulting various treatises, I cannot find that this has ever been done. The general opinion appears to be that the sexes are nearly equal, but in Italy, as I hear from Professor Canestrini, many breeders are convinced that the females are produced in excess. This same naturalist, however, informs me, that in the two yearly broods of the Ailanthus silk-moth (*Bombyx cynthia*), the males greatly preponderate in the first, whilst in the second the two sexes are nearly equal, or the females rather in excess.

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In regard to Butterflies in a state of nature, several observers have been much struck by the apparently enormous preponderance of the males.[25] Thus Mr. Bates, in speaking of several species, about a hundred in number, which inhabit the Upper Amazons, says that the males are much more numerous than the females, even in the proportion of a hundred to one. In North America, Edwards, who had great experience, estimates in the genus Papilio the males to the females as four to one; and Mr. Walsh, who informs me of this statement, says that with *P. turnus* this is certainly the case. In South Africa, Mr. R. Trimen found the males in excess in 19 species; and in one of these, which swarms in open places, he estimated the number of males as fifty to one female. With another species, in which the males are numerous in certain localities, he collected only five females during seven years. In the island of Bourbon, M. Maillard states that the males of one species of Papilio are twenty times as numerous as the females. Mr. Trimen informs me that as far as he has himself seen, or heard from others, it is rare for the females of any butterfly to exceed the males in number; but three South African species perhaps offer an exception. Mr. Wallace states that the females of *Ornithoptera crœsus*, in the Malay archipelago, are more common and more easily caught than the males; but this is a rare butterfly. I may here add, that in Hyperythra, a genus of moths, Guenée says, that from four to five females are sent in collections from India for one male.

When this subject of the proportional numbers of the sexes of insects was brought before the Entomological Society, it was generally admitted that the males of most Lepidoptera, in the adult or imago state, are caught in greater numbers than the females: but this fact was attributed by various observers to the more retiring habits of the females, and to the males emerging earlier from the cocoon. This latter circumstance is well known to occur with most Lepidoptera, as well as with other insects. So that, as M. Personnat remarks, the males of the domesticated *Bombyx Yamamai* are useless at the beginning of the season, and the females at the end, from the want of mates. I cannot, however, persuade myself that these causes suffice to explain the great excess of males, in the above cases of certain butterflies which are extremely common in their native countries. Mr. Stainton, who has paid very close attention during many years to the smaller moths, informs me that when he collected them in the imago state, he thought that the males were ten times as numerous as the females, but that since he has reared them on a large scale from the caterpiller state, he is convinced that the females are the more numerous. Several entomologists concur in this view. Mr. Doubleday, however, and some others, take an opposite view, and are convinced that they have reared from the eggs and caterpillars a larger proportion of males than of females.

Besides the more active habits of the males, their earlier emergence from the cocoon, and in some cases their frequenting more open stations,

[25] Leuckart quotes Meinecke (Wagner, "Handwörterbuch der Phys." B. iv. s. 775) that the males of Butterflies are three or four times as numerous as the females

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other causes may be assigned for an apparent or real difference in the proportional numbers of the sexes of Lepidoptera, when captured in the imago state, and when reared from the egg or caterpillar state. I hear from Professor Canestrini, that it is believed by many breeders in Italy, that the female caterpillar of the silk-moth suffers more from the recent disease than the male; and Dr. Staudinger informs me that in rearing Lepidoptera more females die in the cocoon than males. With many species the female caterpillar is larger than the male, and a collector would naturally choose the finest specimens, and thus unintentionally collect a larger number of females. Three collectors have told me that this was their practice; but Dr. Wallace is sure that most collectors take all the specimens which they can find of the rarer kinds, which alone are worth the trouble of rearing. Birds when surrounded by caterpillars would probably devour the largest; and Professor Canestrini informs me that in Italy some breeders believe, though on insufficient evidence, that in the first broods of the Ailanthus silkmoth, the wasps destroy a larger number of the female than of the male caterpillars. Dr. Wallace further remarks that female caterpillars, from being larger than the males, require more time for their development, and consume more food and moisture: and thus they would be exposed during a longer time to danger from ichneumons, birds, &c., and in times of scarcity would perish in greater numbers. Hence it appears quite possible that in a state of nature, fewer female Lepidoptera may reach maturity than males; and for our special object we are concerned with their relative numbers at maturity, when the sexes are ready to propagate their kind.

The manner in which the males of certain moths congregate in extraordinary numbers round a single female, apparently indicates a great excess of males, though this fact may perhaps be accounted for by the earlier emergence of the males from their cocoons. Mr. Stainton informs me that from twelve to twenty males, may often be seen congregated round a female *Elachista rufocinerea*. It is well known that if a virgin *Lasiocampa quercus* or *Saturnia carpini* be exposed in a cage, vast numbers of males collect round her, and if confined in a room will even come down the chimney to her. Mr. Doubleday believes that he has seen from fifty to a hundred males of both these species attracted in the course of a single day by a female in confinement. In the Isle of Wight Mr. Trimen exposed a box in which a female of the Lasiocampa had been confined on the previous day, and five males soon endeavored to gain admittance. In Australia, M. Verreaux, having placed the female of a small Bombyx in a box in his pocket, was followed by a crowd of males, so that about 200 entered the house with him.

Mr. Doubleday has called my attention to M. Staudinger's list of Lepidoptera, which gives the prices of the males and females of 300 species or well-marked varieties of butterflies (Rhopalocera). The prices for both sexes of the very common species are of course the same; but in 114 of the rarer species they differ; the males being in all cases, excepting one, the cheaper. On an average of the prices of the 113 species, the price of the male to that of the female is as 100 to 149; and this apparently indicates that inversely the males exceed the females in the

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same proportion. About 2000 species or varieties of moths (Heterocera) are catalogued, those with wingless females being here excluded on account of the difference in habits between the two sexes: of these 2000 species, 141 differ in price according to sex, the males of 130 being cheaper, and those of only 11 being dearer than the females. The average price of the males of the 130 species, to that of the females, is as 100 to 143. With respect to the butterflies in this priced list, Mr. Doubleday thinks (and no man in England has had more experience) that there is nothing in the habits of the species which can account for the difference in the prices of the two sexes, and that it can be accounted for only by an excess in the number of the males. But I am bound to add that Dr. Staudinger informs me, that he is himself of a different opinion. He thinks that the less active habits of the females and the earlier emergence of the males will account for his collectors securing a larger number of males than of females, and consequently for the lower prices of the former. With respect to specimens reared from the caterpillar-state, Dr. Staudinger believes, as previously stated, that a greater number of females than of males die whilst confined in the cocoons. He adds that with certain species one sex seems to preponderate over the other during certain years.

Of direct observations on the sexes of Lepidoptera, reared either from eggs or caterpillars, I have received only the few following cases:—

	Males.	Females.
The Rev. J. Hellins[26] of Exeter reared, during 1868, imagos of 73 species, which consisted of........	153	137
Mr. Albert Jones of Eltham reared, during 1868, imagos of 9 species, which consisted of........	159	126
During 1869 he reared imagos from 4 species, consisting of..................................	114	112
Mr. Buckler of Emsworth, Hants, during 1869, reared imagos from 74 species, consisting of....	180	169
Dr. Wallace of Colchester reared from one brood of Bombyx cynthia..........................	52	48
Dr. Wallace raised, from cocoons of Bombyx Pernyi sent from China, during 1869.................	224	123
Dr. Wallace raised, during 1868 and 1869, from two lots of cocoons of Bombyx yama-mai.......	52	46
Total	934	761

So that in these eight lots of cocoons and eggs, males were produced in excess. Taken together the proportion of males is as 122.7 to 100 females. But the numbers are hardly large enough to be trustworthy.

[26] This naturalist has been so kind as to send me some results from former years, in which the females seemed to preponderate; but so many of the figures were estimates, that I found it impossible to tabulate them.

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On the whole, from these various sources of evidence, all pointing in the same direction, I infer that with most species of Lepidoptera, the mature males generally exceed the females in number, whatever the proportions may be at their first emergence from the egg.

With reference to the other Orders of insects, I have been able to collect very little reliable information. With the stag-beetle (*Lucanus cervus*) "the males appear to be much more numerous than the females"; but when, as Cornelius remarked during 1867, an unusual number of these beetles appeared in one part of Germany, the females appeared to exceed the males as six to one. With one of the Elateridæ, the males are said to be much more numerous than the females, and "two or three are often found united with one female; so that here polyandry seems to prevail." With Siagonium (Staphylinidæ), in which the males are furnished with horns, "the females are far more numerous than the opposite sex." Mr. Janson stated at the Entomological Society that the females of the bark-feeding *Tomicus villosus* are so common as to be a plague, whilst the males are so rare as to be hardly known.

It is hardly worth while saying anything about the proportion of the sexes in certain species and even groups of insects, for the males are unknown or very rare, and the females are parthenogenetic, that is, fertile without sexual union; examples of this are afforded by several of the Cynipidæ. In all the gall-making Cynipidæ known to Mr. Walsh, the females are four or five times as numerous as the males; and so it is, as he informs me, with the gall-making Cecidomyiidæ (Diptera). With some common species of Saw-flies (Tenthredinæ) Mr. F. Smith has reared hundreds of specimens from larvæ of all sizes, but has never reared a single male; on the other hand, Curtis says, that with certain species (Athalia), bred by him, the males were to the females as six to one; whilst exactly the reverse occurred with the mature insects of the same species caught in the fields. In the family of Bees, Hermann Müller, collected a large number of specimens of many species, and reared others from the cocoons, and counted the sexes. He found that the males of some species greatly exceeded the females in number; in others the reverse occurred; and in others the two sexes were nearly equal. But as in most cases the males emerge from the cocoons before the females, they are at the commencement of the breeding season practically in excess. Müller also observed that the relative number of the two sexes in some species differed much in different localities. But as H. Müller has himself remarked to me, these remarks must be received with some caution, as one sex might more easily escape observation than the other. Thus his brother Fritz Müller has noticed in Brazil that the two sexes of the same species of bee sometimes frequent different kinds of flowers. With respect to the Orthoptera, I know hardly anything about the relative number of the sexes: Körte, however, says that out of 500 locusts which he examined, the males were to the females as five to six. With the Neuroptera, Mr. Walsh states that in many, but by no means in all the species of the Odonatous group, there is a great overplus of males: in the genus Hetærina, also, the males are generally at least four times as numerous as the females. In certain species in

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the genus Gomphus the males are equally in excess, whilst in two other species, the females are twice or thrice as numerous as the males. In some European species of Psocus thousands of females may be collected without a single male, whilst with other species of the same genus both sexes are common. In England, Mr. MacLachlan has captured hundreds of the female *Apatania muliebris*, but has never seen the male; and of *Boreus hyemalis* only four or five males have been seen here. With most of these species (excepting the Tenthredinæ) there is at present no evidence that the females are subject to parthenogenesis; and thus we see how ignorant we are of the causes of the apparent discrepancy in the proportion of the two sexes.

In the other classes of the Articulata I have been able to collect still less information. With spiders, Mr. Blackwall, who has carefully attended to this class during many years, writes to me that the males from their more erratic habits are more commonly seen, and therefore appear more numerous. This is actually the case with a few species; but he mentions several species in six genera, in which the females appear to be much more numerous than the males.[27] The small size of the males in comparison with the females (a peculiarity which is sometimes carried to an extreme degree), and their widely different appearance, may account in some instances for their rarity in collections.

Some of the lower Crustaceans are able to propagate their kind sexually, and this will account for the extreme rarity of the males; thus Von Siebold carefully examined no less than 13,000 specimens of Apus from twenty-one localities, and amongst these he found only 319 males. With some other forms (as Tanais and Cypris), as Fritz Müller informs me, there is reason to believe that the males are much shorter-lived than the females; and this would explain their scarcity, supposing the two sexes to be at first equal in number. On the other hand, Müller has invariably taken far more males than females of the Diastylidæ and of Cypridina on the shores of Brazil: thus with a species in the latter genus, 63 specimens caught the same day included 57 males; but he suggests that this preponderance may be due to some unknown difference in the habits of the two sexes. With one of the higher Brazilian crabs, namely a Gelasimus, Fritz Müller found the males to be more numerous than the females. According to the large experience of Mr. C. Spence Bate, the reverse seems to be the case with six common British crabs, the names of which he has given me.

The proportion of the sexes in relation to natural selection.

There is reason to suspect that in some cases man has by selection indirectly influenced his own sex-producing powers. Certain women tend to produce during their whole lives more children of one sex than of the other: and the same holds good

[27] Another great authority with respect to this class, Prof. Thorell of Upsala ("On European Spiders," 1869–70, part i. p. 205), speaks as if female spiders were generally commoner than the males.

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of many animals, for instance, cows and horses; thus Mr. Wright of Yeldersley House informs me that one of his Arab mares, though put seven times to different horses, produced seven fillies. Though I have very little evidence on this head, analogy would lead to the belief, that the tendency to produce either sex would be inherited like almost every other peculiarity, for instance, that of producing twins; and concerning the above tendency a good authority, Mr. J. Downing, has communicated to me facts which seem to prove that this does occur in certain families of short-horn cattle. Col. Marshall has recently found on careful examination that the Todas, a hill-tribe of India, consist of 112 males and 84 females of all ages — that is in a ratio of 133.3 males to 100 females. The Todas, who are polyandrous in their marriages, during former times invariably practised female infanticide; but this practice has now been discontinued for a considerable period. Of the children born within late years, the males are more numerous than the females, in the proportion of 124 to 100. Colonel Marshall accounts for this fact in the following ingenious manner. "Let us for the purpose of illustration take three families as representing an average of the entire tribe; say that one mother gives birth to six daughters and no sons; a second mother has six sons only, whilst the third mother has three sons and three daughters. The first mother, following the tribal custom, destroys four daughters and preserves two. The second retains her six sons. The third kills two daughters and keeps one, as also her three sons. We have then from the three families, nine sons and three daughters, with which to continue to breed. But whilst the males belong to families in which the tendency to produce sons is great, the females are of those of a converse inclination. Thus the bias strengthens with each generation, until, as we find, families grow to have habitually more sons than daughters."

That this result would follow from the above form of infanticide seems almost certain; that is if we assume that a sex-producing tendency is inherited. But as the above numbers are so extremely scanty, I have searched for additional evidence, but cannot decide whether what I have found is trustworthy; nevertheless the facts are, perhaps, worth giving. The Maories of New Zealand have long practised infanticide: and Mr. Fen-

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ton [28] states that he "has met with instances of women who have destroyed four, six, and even seven children, mostly females. However, the universal testimony of those best qualified to judge, is conclusive that this custom has for many years been almost extinct. Probably the year 1835 may be named as the period of its ceasing to exist." Now amongst the New Zealanders, as with the Todas, male births are considerably in excess. Mr. Fenton remarks, "One fact is certain, although the exact period of the commencement of this singular condition of the disproportion of the sexes cannot be demonstratively fixed, it is quite clear that this course of decrease was in full operation during the years 1830 to 1844, when the non-adult population of 1844 was being produced, and has continued with great energy up to the present time." The following statements are taken from Mr. Fenton, but as the numbers are not large, and as the census was not accurate, uniform results cannot be expected. It should be borne in mind in this and the following cases, that the normal state of every population is an excess of women, at least in all civilized countries, chiefly owing to the greater mortality of the male sex during youth, and partly to accidents of all kinds later in life. In 1858, the native population of New Zealand was estimated as consisting of 31,667 males and 24,303 females of all ages, that is in the ratio of 130.3 males to 100 females. But during this same year, and in certain limited districts, the numbers were ascertained with much care, and the males of all ages were here 753 and the females 616; that is in the ratio of 122.2 males to 100 females. It is more important for us that during this same year of 1858, the *non-adult* males within the same district were found to be 178, and the *non-adult* females 142, that is in the ratio of 125.3 to 100. It may be added that in 1844, at which period female infanticide had only lately ceased, the *non-adult* males in one district were 281, and the *non-adult* females only 194, that is in the ratio of 144.8 males to 100 females.

In the Sandwich Islands, the males exceed the females in number. Infanticide was formerly practised there to a frightful extent, but was by no means confined to female infants, as is shown by Mr. Ellis, and as I have been informed by Bishop

[28] "Aboriginal Inhabitants of New Zealand; Government Report," 1859, p. 36.

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Staley and the Rev. Mr. Coan. Nevertheless, another apparently trustworthy writer, Mr. Jarves, whose observations apply to the whole archipelago, remarks:—"Numbers of women are to be found, who confess to the murder of from three to six or eight children," and he adds, "females from being considered less useful than males were more often destroyed." From what is known to occur in other parts of the world, this statement is probable; but must be received with much caution. The practice of infanticide ceased about the year 1819, when idolatry was abolished and missionaries settled in the Islands. A careful census in 1839 of the adult and taxable men and women in the island of Kauai and in one district of Oahu, gives 4,723 males and 3,776 females; that is in the ratio of 125.08 to 100. At the same time the number of males under fourteen years in Kauai and under eighteen in Oohu was 1,797, and of females of the same ages 1,429; and here we have the ratio of 125.75 males to 100 females.

In a census of all the islands in 1850, the males of all ages amount to 36,272, and the females to 33,128, or as 109.49 to 100. The males under seventeen years amounted to 10,773, and the females under the same age to 9,593, or as 112.3 to 100. From the census of 1872, the proportion of males of all ages (including half-castes) to females, is as 125.36 to 100. It must be borne in mind that all these returns for the Sandwich Islands give the proportion of living males to living females, and not of the births; and judging from all civilized countries the proportion of males would have been considerably higher if the numbers had referred to births.[29]

[29] Dr. Coulter, in describing ("Journal R. Geograph. Soc.," vol. v. 1835, p. 67) the state of California about the year 1830, says that the natives, reclaimed by the Spanish missionaries, have nearly all perished, or are perishing, although well treated, not driven from their native land, and kept from the use of spirits. He attributes this, in great part, to the undoubted fact that the men greatly exceed the women in number; but he does not know whether this is due to a failure of female offspring, or to more females dying during early youth. The latter alternative, according to all analogy, is very improbable. He adds that "infanticide, properly so called, is not common, though very frequent recourse is had to abortion." If Dr. Coulter is correct about infanticide, this case cannot be advanced in support of Colonel Marshall's view. From the rapid decrease of the reclaimed natives, we may suspect that, as in the cases lately given, their fertility has been diminished from changed habits of life.

I had hoped to gain some light on this subject from the breeding of dogs; inasmuch as in most breeds, with the exception, perhaps, of greyhounds, many more female puppies are destroyed than males, just as with the Toda infants. Mr. Cupples assures me that this is usual with

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From the several foregoing cases we have some reason to believe that infanticide practised in the manner above explained, tends to make a male-producing race; but I am far from supposing that this practice in the case of man, or some analogous process with other species, has been the sole determining cause of an excess of males. There may be some unknown law leading to this result in decreasing races, which have already become somewhat infertile. Besides the several causes previously alluded to, the greater facility of parturition amongst savages, and the less consequent injury to their male infants, would tend to increase the proportion of live-born males to females. There does not, however, seem to be any necessary connection between savage life and a marked excess of males; that is if we may judge by the character of the scanty offspring of the lately existing Tasmanians and of the crossed offspring of the Tahitians now inhabiting Norfolk Island.

As the males and females of many animals differ somewhat in habits and are exposed in different degrees to danger, it is probable that in many cases, more of one sex than of the other are habitually destroyed. But as far as I can trace out the complication of causes, an indiscriminate though large destruction of either sex would not tend to modify the sex-producing power of the species. With strictly social animals, such as bees or ants, which produce a vast number of sterile and fertile females in comparison with the males, and to whom this preponderance is of paramount importance, we can see that those communities would flourish best which contained females having a strong inherited tendency to produce more and more females; and in such cases an unequal sex-producing tendency would be ultimately gained through natural selection. With animals living in herds or troops, in which the males come to the front and defend

Scotch deerhounds. Unfortunately I know nothing of the proportion of the sexes in any breed, excepting greyhounds, and there the male births are to the females as 110.1 to 100. Now from inquiries made from many breeders, it seems that the females are in some respects more esteemed, though otherwise troublesome; and it does not appear that the female puppies of the best-bred dogs are systematically destroyed more than the males, though this does sometimes take place to a limited extent. Therefore I am unable to decide whether we can, on the above principles, account for the preponderance of male births in greyhounds. On the other hand, we have seen that with horses, cattle, and sheep, which are too valuable for the young of either sex to be destroyed, if there is any difference, the females are slightly in excess.

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the herd, as with the bisons of North America and certain baboons, it is conceivable that a male-producing tendency might be gained by natural selection; for the individuals of the better defended herds would leave more numerous descendants. In the case of mankind the advantage arising from having a preponderance of men in the tribe is supposed to be one chief cause of the practice of female infanticide.

In no case, as far as we can see, would an inherited tendency to produce both sexes in equal numbers or to produce one sex in excess, be a direct advantage or disadvantage to certain individuals more than to others; for instance, an individual with a tendency to produce more males than females would not succeed better in the battle for life than an individual with an opposite tendency; and therefore a tendency of this kind could not be gained through natural selection. Nevertheless, there are certain animals (for instance, fishes and cirripedes) in which two or more males appear to be necessary for the fertilization of the female; and the males accordingly largely preponderate, but it is by no means obvious how this male-producing tendency could have been acquired. I formerly thought that when a tendency to produce the two sexes in equal numbers was advantageous to the species, it would follow from natural selection, but I now see that the whole problem is so intricate that it is safer to leave its solution for the future.

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CHAPTER IX.

SECONDARY SEXUAL CHARACTERS IN THE LOWER CLASSES OF THE ANIMAL KINGDOM.

These characters absent in the lowest classes — Brilliant colors — Mollusca — Annelids — Crustacea, secondary sexual characters strongly developed; dimorphism; color; characters not acquired before maturity — Spiders, sexual colors of; stridulation by the males — Myriapoda.

WITH animals belonging to the lower classes, the two sexes are not rarely united in the same individual, and therefore secondary sexual characters cannot be developed. In many cases where the sexes are separate, both are permanently attached to some support, and the one cannot search or struggle for the other. Moreover it is almost certain that these animals have too imperfect senses and much too low mental powers, to appreciate each other's beauty or other attractions, or to feel rivalry.

Hence in these classes or sub-kingdoms, such as the Protozoa, Cœlenterata, Echinodermata, Scolecida, secondary sexual characters, of the kind which we have to consider, do not occur; and this fact agrees with the belief that such characters in the higher classes have been acquired through sexual selection, which depends on the will, desire, and choice of either sex. Nevertheless some few apparent exceptions occur; thus, as I hear from Dr. Baird, the males of certain Entozoa, or internal parasitic worms, differ slightly in color from the females; but we have no reason to suppose that such differences have been augmented through sexual selection. Contrivances by which the male holds the female, and which are indispensable for the propagation of the species, are independent of sexual selection, and have been acquired through ordinary selection.

Many of the lower animals, whether hermaphrodites or with separate sexes, are ornamented with the most brilliant tints, or are shaded and striped in an elegant manner; for instance,

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many corals and sea-anemones (Actiniæ), some jelly-fish (Medusæ, Porpita, &c.), some Planariæ, many star-fishes, Echini, Ascidians, &c.; but we may conclude from the reasons already indicated, namely, the union of the two sexes in some of these animals, the permanently affixed condition of others, and the low mental powers of all, that such colors do not serve as a sexual attraction, and have not been acquired through sexual selection. It should be borne in mind that in no case have we sufficient evidence that colors have been thus acquired, except where one sex is much more brilliantly or conspicuously colored than the other, and where there is no difference in habits between the sexes sufficient to account for their different colors. But the evidence is rendered as complete as it can ever be, only when the more ornamented individuals, almost always the males, voluntarily display their attractions before the other sex; for we cannot believe that such display is useless, and if it be advantageous, sexual selection will almost inevitably follow. We may, however, extend this conclusion to both sexes, when colored alike, if their colors are plainly analogous to those of one sex alone in certain other species of the same group.

How, then, are we to account for the beautiful or even gorgeous colors of many animals in the lowest classes? It appears doubtful whether such colors often serve as a protection; but that we may easily err on this head, will be admitted by every one who reads Mr. Wallace's excellent essay on this subject. It would not, for instance, at first occur to any one that the transparency of the Medusæ, or jelly-fish, is of the highest service to them as a protection; but when we are reminded by Häckel that not only the medusæ, but many floating mollusca, crustaceans, and even small oceanic fishes partake of this same glass-like appearance, often accompanied by prismatic colors, we can hardly doubt that they thus escape the notice of pelagic birds and other enemies. M. Giard is also convinced that the bright tints of certain sponges and ascidians serve as a protection. Conspicuous colors are likewise beneficial to many animals as a warning to their would-be devourers that they are distasteful, or that they possess some special means of defense; but this subject will be discussed more conveniently hereafter.

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We can, in our ignorance of most of the lowest animals, only say that their bright tints result either from the chemical nature or the minute structure of their tissues, independently of any benefit thus derived. Hardly any color is finer than that of arterial blood; but there is no reason to suppose that the color of the blood is in itself any advantage; and though it adds to the beauty of the maiden's cheek, no one will pretend that it has been acquired for this purpose. So again with many animals, especially the lower ones, the bile is richly colored; thus, as I am informed by Mr. Hancock, the extreme beauty of the Eolidæ (naked sea-slugs) is chiefly due to the biliary glands being seen through the translucent integuments — this beauty being probably of no service to these animals. The tints of the decaying leaves in an American forest are described by every one as gorgeous; yet no one supposes that these tints are of the least advantage to the trees. Bearing in mind how many substances closely analogous to natural organic compounds have been recently formed by chemists, and which exhibit the most splendid colors, it would have been a strange fact if substances similarly colored had not often originated, independently of any useful end thus gained, in the complex laboratory of living organisms.

The Sub-kingdom of the Mollusca.— Throughout this great division of the animal kingdom, as far as I can discover, secondary sexual characters, such as we are here considering, never occur. Nor could they be expected in the three lowest classes, namely, in the Ascidians, Polyzoa, and Brachiopods (constituting the Molluscoida of some authors), for most of these animals are permanently affixed to a support or have their sexes united in the same individual. In the Lamellibranchiata, or bivalve shells, hermaphroditism is not rare. In the next higher class of the Gasteropoda, or univalve shells, the sexes are either united or separate. But in the latter case the males never possess special organs for finding, securing, or charming the females, or for fighting with other males. As I am informed by Mr. Gwyn Jeffreys, the sole external difference between the sexes consists in the shell sometimes differing a little in form; for instance, the shell of the male periwinkle (*Littorina littorea*) is narrower and has a more elongated spire than that

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of the female. But differences of this nature, it may be presumed, are directly connected with the act of reproduction, or with the development of the ova.

The Gasteropoda, though capable of locomotion and furnished with imperfect eyes, do not appear to be endowed with sufficient mental powers for the members of the same sex to struggle together in rivalry, and thus to acquire secondary sexual characters. Nevertheless with the plumoniferous gasteropods, or land-snails, the pairing is preceded by courtship; for these animals, though hermaphrodites, are compelled by their structure to pair together. Agassiz remarks, "Whoever has occasion to observe the courtships of the snails will not raise any question as to the motive of the movements and allurements which bring about and accomplish the double sexual connection of these hermaphrodites."

These animals appear also susceptible of some degree of permanent attachment: an accurate observer, Mr. Lonsdale, informs me that he placed a pair of land-snails (*Helix pomatia*), one of which was weakly, into a small and ill-provided garden. After a short time the strong and healthy individual disappeared, and was traced by its track of slime over a wall into an adjoining well-stocked garden. Mr. Lonsdale concluded that it had deserted its sickly mate; but after an absence of twenty-four hours it returned, and apparently communicated the result of its successful exploration, for both then started along the same track and disappeared over the wall.

Even in the highest class of the Mollusca, the Cephalopoda or cuttlefishes, in which the sexes are separate, secondary sexual characters of the present kind do not, as far as I can discover, occur. This is a surprising circumstance, as these animals possess highly-developed sense-organs and have considerable mental powers, as will be admitted by every one who has watched their artful endeavors to escape from an enemy. Certain Cephalopoda, however, are characterized by one extraordinary sexual character, namely that the male element collects within one of the arms or tentacles, which is then cast off, and clinging by its sucking-discs to the female, lives for a time an independent life. So completely does the cast-off arm resemble a separate animal, that it was described by Cuvier as a parasitic worm under the name of Hectocotyle. But this marvelous struc-

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ture may be classed as a primary rather than as a secondary sexual character.

Although with the Mollusca sexual selection does not seem to have come into play; yet many univalve and bivalve shells, such as volutes, cones, scallops, &c., are beautifully colored and shaped. The colors do not appear in most cases to be of any use as a protection; they are probably the direct result, as in the lowest classes, of the nature of the tissues; the patterns and the sculpture of the shell depending on its manner of growth. The amount of light seems to be influential to a certain extent; for although, as repeatedly stated by Mr. Gwyn Jeffreys, the shells of some species living at a profound depth are brightly colored, yet we generally see the lower surfaces, as well as the parts covered by the mantle, less highly-colored than the upper and exposed surfaces.[1] In some cases, as with shells living amongst corals or brightly-tinted sea-weeds, the bright colors may serve as a protection. But that many of the nudibranch mollusca, or sea-slugs, are as beautifully colored as any shells, may be seen in Messrs. Alder and Hancock's magnificent work; and from information kindly given me by Mr. Hancock, it seems extremely doubtful whether these colors usually serve as a protection. With some species this may be the case, as with one kind which lives on the green leaves of algæ, and is itself bright-green. But many brightly-colored, white, or otherwise conspicuous species, do not seek concealment; whilst again some equally conspicuous species, as well as other dull-colored kinds, live under stones and in dark recesses. So that with these nudibranch molluscs, color apparently does not stand in any close relation to the nature of the places which they inhabit.

These naked sea-slugs are hermaphrodites, yet they pair together, as do land-snails, many of which have extremely pretty shells. It is conceivable that two hermaphrodites, attracted by each other's greater beauty, might unite and leave offspring which would inherit their parents' greater beauty. But with such lowly-organized creatures this is extremely improbable. Nor is it at all obvious how the offspring from the more beauti-

[1] I have given ("Geolog. Observations on Volcanic Islands," p. 53) a curious instance of the influence of light on the colors of a frondescent incrustation, deposited by the surf on the coast-rocks of Ascension, and formed by the solution of triturated sea-shells.

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ful pairs of hermaphrodites would have any advantage over the offspring of the less beautiful, so as to increase in number, unless indeed vigor and beauty generally coincided. We have not here the case of a number of males becoming mature before the females, with the more beautiful males selected by the more vigorous females. If, indeed, brilliant colors were beneficial to a hermaphrodite animal in relation to its general habits of life, the more brightly-tinted individuals would succeed best and would increase in number; but this would be a case of natural and not of sexual selection.

Sub-kingdom of the Vermes; Class, Annelida (*or Sea-worms*).— In this class, although the sexes, when separate sometimes differ from each other in characters of such importance that they have been placed under distinct genera or even families, yet the differences do not seem of the kind which can be safely attributed to sexual selection. These animals are often beautifully colored, but as the sexes do not differ in this respect, we are but little concerned with them. Even the Nemertians, though so lowly organized, "vie in beauty and variety of coloring with any other group in the invertebrate series"; yet Dr. McIntosh cannot discover that these colors are of any service. The sedentary annelids become duller-colored, according to M. Quatrefages, after the period of reproduction; and this I presume may be attributed to their less vigorous condition at that time. All these worm-like animals apparently stand too low in the scale for the individuals of either sex to exert any choice in selecting a partner, or for the individuals of the same sex to struggle together in rivalry.

Sub-kingdom of the Arthropoda; Class, *Crustacea.*— In this great class we first meet with undoubted secondary sexual characters, often developed in a remarkable manner. Unfortunately the habits of crustaceans are very imperfectly known, and we cannot explain the uses of many structures peculiar to one sex. With the lower parasitic species the males are of small size, and they alone are furnished with perfect swimming-legs, antennæ and sense-organs; the females being destitute of these organs, with their bodies often consisting of a mere distorted mass. But these extraordinary differences between the two

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sexes are no doubt related to their widely different habits of life, and consequently do not concern us. In various crustaceans, belonging to distinct families, the anterior antennæ are furnished with peculiar thread-like bodies, which are believed to act as smelling-organs, and these are much more numerous in the males than in the females. As the males, without any unusual development of their olfactory organs, would almost certainly be able sooner or later to find the females, the increased number of the smelling-threads has probably been acquired through sexual selection, by the better provided males having been the more successful in finding partners and in producing offspring. Fritz Müller has described a remarkable dimorphic species of Tanais, in which the male is represented by two distinct forms, which never graduate into each other. In the one form the male is furnished with more numerous smelling-threads, and in the other form with more powerful and more elongated chelæ or pincers, which serve to hold the female. Fritz Müller suggests that these differences between the two male forms of the same species may have originated in certain individuals having varied in the number of the smelling-threads, whilst other individuals varied in the shape and size of their chelæ; so that of the former, those which were best able to find the female, and of the latter, those which were best able to hold her, have left the greatest number of progeny to inherit their respective advantages.[2]

In some of the lower crustaceans, the right anterior antenna of the male differs greatly in structure from the left, the latter resembling in its simple tapering joints the antennæ of the female. In the male the modified antenna is either swollen in the middle or angularly bent, or converted (fig. 4) into an elegant, and sometimes wonderfully complex, prehensile organ. It serves, as I hear from Sir J. Lubbock, to hold the female, and for this same purpose one of the two posterior legs (*b*) on the same side of the body is converted into a forceps. In another family the inferior or posterior antennæ are "curiously zigzagged" in the males alone.

In the higher crustaceans the anterior legs are developed into

[2] "Facts and Arguments for Darwin," English translat., p. 20. See the previous discussion on the olfactory threads. Sars has described a somewhat analogous case (as quoted in "Nature," 1870, p. 455) in a Norwegian crustacean, the *Pontoporeia affinis*

chelæ or pincers; and these are generally larger in the male than in the female,— so much so that the market value of the male edible crab (*Cancer pagurus*), according to Mr. C. Spence Bate, is five times as great as that of the female. In many species the chelæ are of unequal size on the opposite side of the body, the right-hand one being, as I am informed by Mr. Bate, generally, though not invariably, the largest. This inequality is also often much greater in the male than in the female. The two chelæ of the male often differ in structure (figs. 5, 6, 7), the smaller one resembling that of the female. What advantage is gained by their inequality being much greater in the male than in the female; and why, when they are of equal size, both are often much larger in the male than in the female, is not known. As I hear from Mr. Bate, the chelæ are sometimes of such length and size that they cannot possibly be used for carrying food to the mouth. In the males of certain fresh-water prawns (Palæmon) the right leg is actually longer than the whole body. The great size of the one leg with its chelæ may aid the male in fighting with his rivals; but this will not account for their inequality in the female on the opposite sides of the body. In Gelasimus, according to a statement quoted by Milne-Edwards, the male and the female live in the same burrow, and this shows that they pair; the male closes the mouth of the burrow with one of its chelæ, which is enormously developed; so that here it indirectly serves as a means of defense. Their main use, however, is probably to seize and to secure the female, and this in some instances, as with Gammarus, is known to be the case. The male of the hermit or soldier crab (*Pagurus*) for weeks together, carries about the shell inhabited by the female. The sexes, however, of the

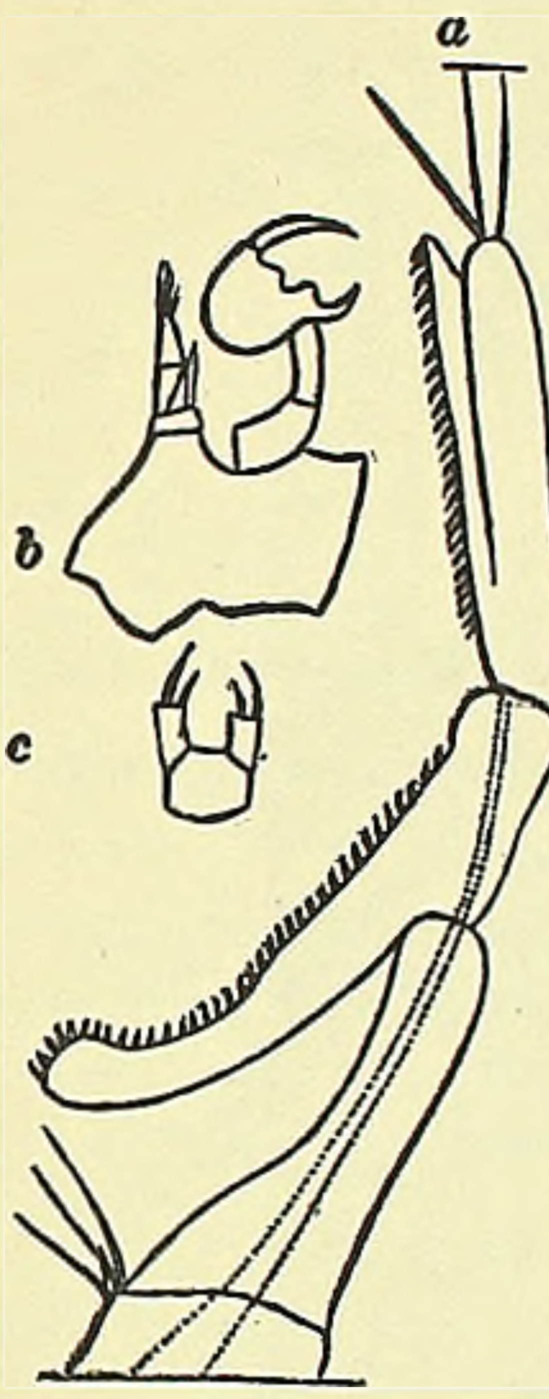

FIG. 4.— Labidocera Darwinii (from Lubbock).
a. Part of right anterior antenna of male, forming a prehensile organ.
b. Posterior pair of thoracic legs of male.
c. Ditto of female.

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common shore-crab (*Carcinus mænas*), as Mr. Bate informs me, unite directly after the female has molted her hard shell, when she is so soft that she would be injured if seized by the strong

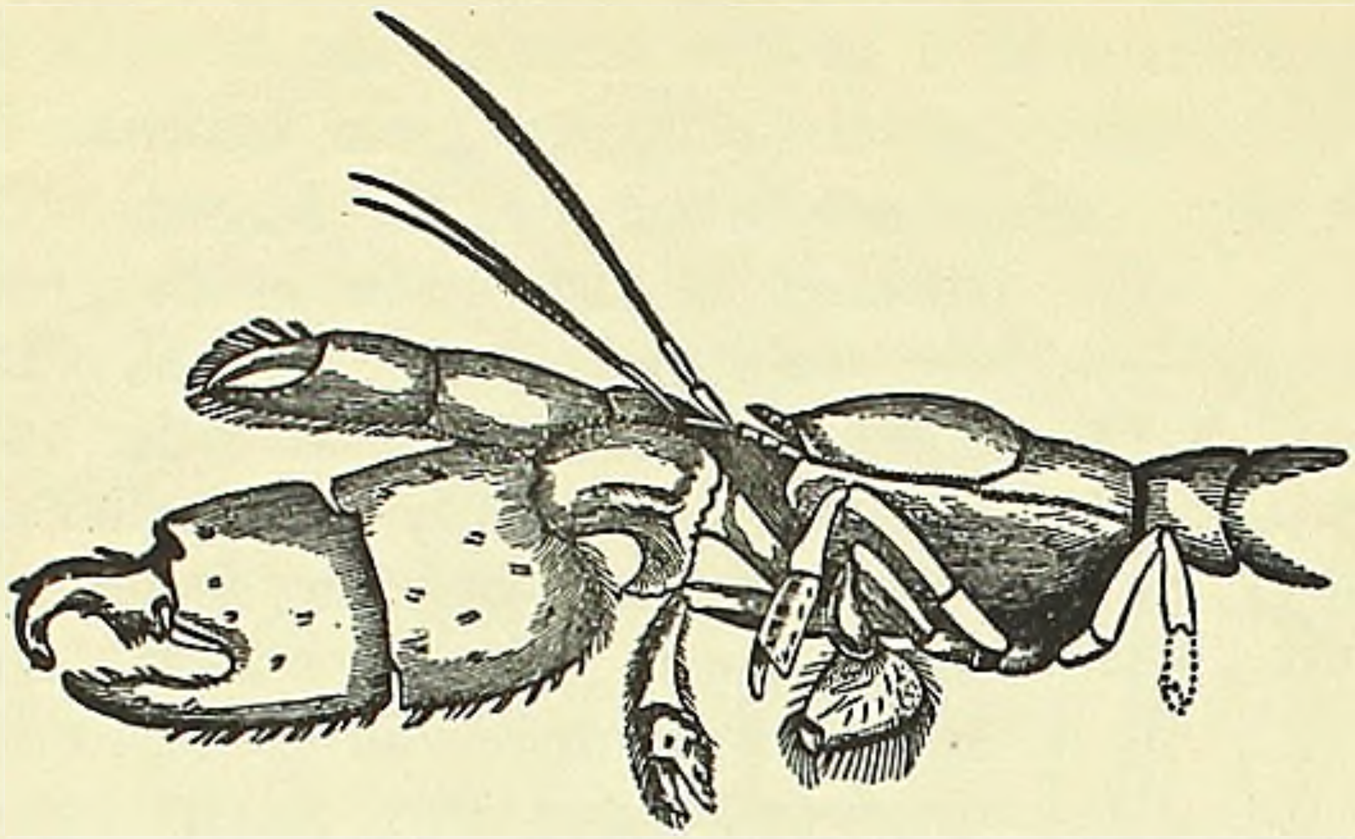

FIG. 5.— Anterior part of body of Callianassa (from Milne-Edwards), showing the unequal and differently-constructed right and left-hand chelæ of the male.
N. B.— The artist by mistake has reversed the drawing, and made the left-hand chela the largest.

pincers of the male; but as she is caught and carried about by the male before molting, she could then be seized with impunity.

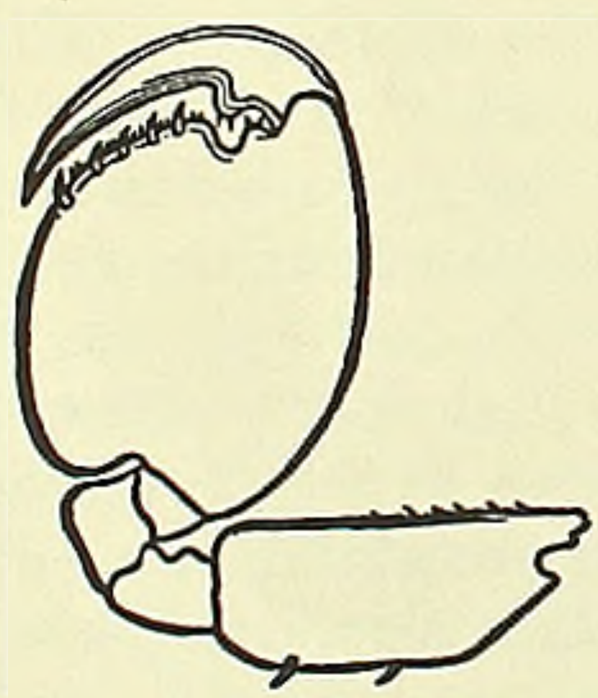

FIG. 6.

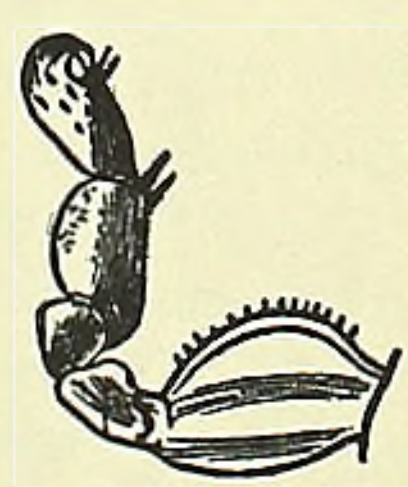

FIG. 7.

FIG. 6.— Second leg of male Orchestia Tucuratinga (from Fritz Müller).
FIG. 7.— Ditto of female.

Fritz Müller states that certain species of Melita are distinguished from all other amphipods by the females having "the coxal lamellæ of the penultimate pair of feet produced into hook-like processes, of which the males lay hold with the hands

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of the first pair." The development of these hook-like processes has probably followed from those females which were the most securely held during the act of reproduction, having left the largest number of offspring. Another Brazilian amphipod (*Orchestia Darwinii,* fig. 8) presents a case of dimorphism, like

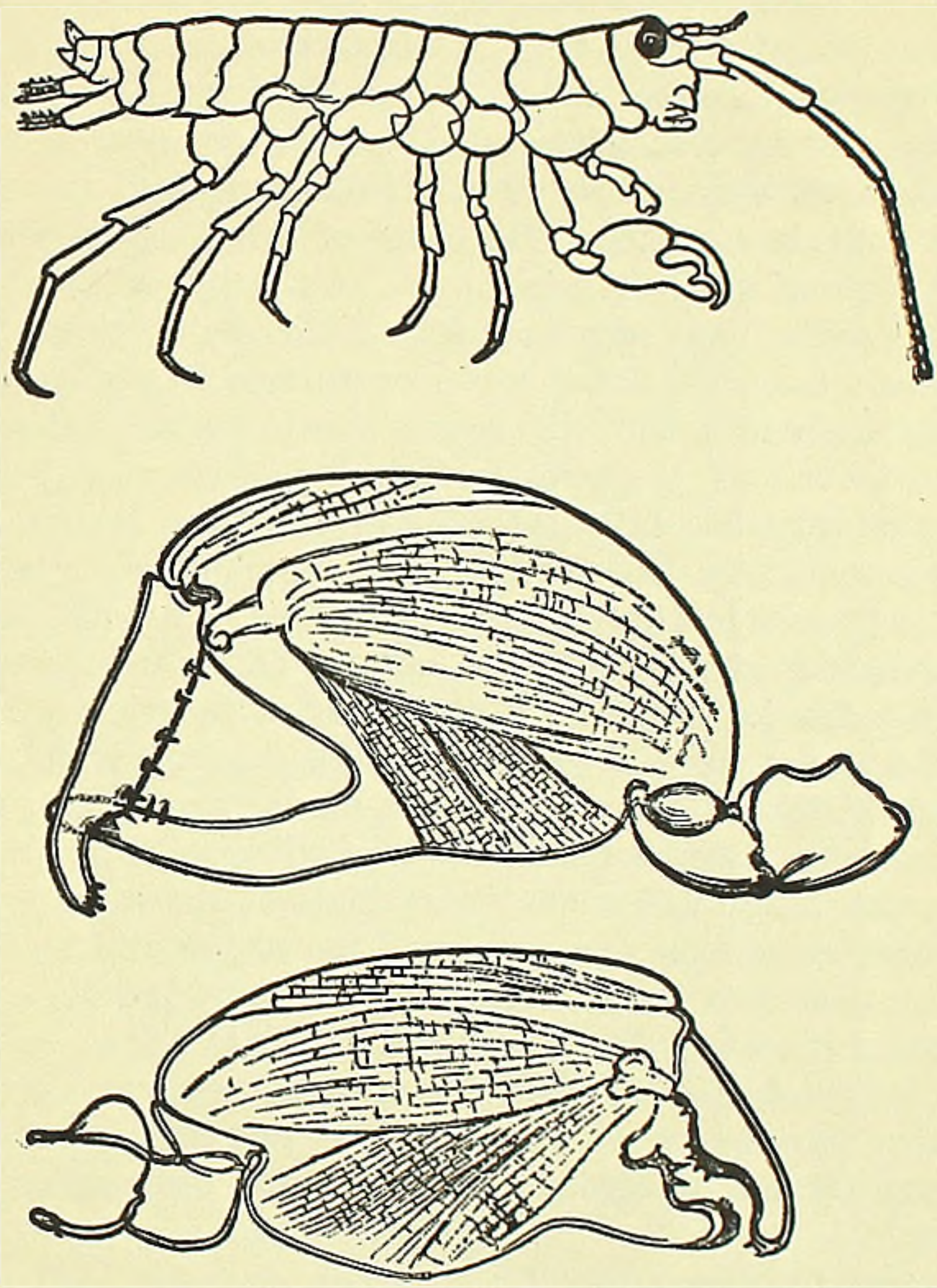

Fig. 8.—Orchestia Darwinnii (from Fritz Müller), showing the differently-constructed chelæ of the two male forms.

that of Tanais; for there are two male forms, which differ in the structure of their chelæ. As either chela would certainly suffice to hold the female,— for both are now used for this purpose, — the two male forms probably originated by some having varied in one manner and some in another; both forms having

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derived certain special, but nearly equal advantages, from their differently shaped organs.

It is not known that male crustaceans fight together for the possession of the females, but it is probably the case; for with most animals when the male is larger than the female, he seems to owe his greater size to his ancestors having fought with other males during many generations. In most of the orders, especially in the highest or the Brachyura, the male is larger than the female; the parasitic genera, however, in which the sexes follow different habits of life, and most of the Entomostraca must be excepted. The chelæ of many crustaceans are weapons well adapted for fighting. Thus when a Devil-crab (*Portunus puber*) was seen by a son of Mr. Bate fighting with a *Carcinus mœnas,* the latter was soon thrown on its back, and had every limb torn from its body. When several males of a Brazilian Gelasimus, a species furnished with immense pincers, were placed together in a glass vessel by Fritz Müller, they mutilated and killed one another. Mr. Bate put a large male *Carcinus mœnas* into a pan of water, inhabited by a female which was paired with a smaller male; but the latter was soon dispossessed. Mr. Bate adds, "if they fought, the victory was a bloodless one, for I saw no wounds." This same naturalist separated a male sand-skipper (so common on our sea-shores), *Gammarus marinus,* from its female, both of whom were imprisoned in the same vessel with many individuals of the same species. The female, when thus divorced, soon joined the others. After a time the male was put again into the same vessel; and he then, after swimming about for a time, dashed into the crowd, and without any fighting at once took away his wife. This fact shows that in the Amphipoda, an order low in the scale, the males and females recognize each other, and are mutually attached.

The mental powers of the Crustacea are probably higher than at first sight appears probable. Any one who tries to catch one of the shore-crabs, so common on tropical coasts, will perceive how wary and alert they are. There is a large crab (*Birgus latro*), found on coral islands, which makes a thick bed of the picked fibres of the cocoa-nut, at the bottom of a deep burrow. It feeds on the fallen fruit of this tree by tearing off the husk, fibre by fibre; and it always begins at that end where the three

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eye-like depressions are situated. It then breaks through one of these eyes by hammering with its heavy front pincers, and turning round, extracts the albuminous core with its narrow posterior pincers. But these actions are probably instinctive, so that they would be performed as well by a young animal as by an old one. The following case, however, can hardly be so considered: a trustworthy naturalist, Mr. Gardner, whilst watching a shore-crab (Gelasimus) making its burrow, threw some shells towards the hole. One rolled in, and three other shells remained within a few inches of the mouth. In about five minutes the crab brought out the shell which had fallen in, and carried it away to a distance of a foot; it then saw the three other shells lying near, and evidently thinking that they might likewise roll in, carried them to the spot where it had laid the first. It would, I think, be difficult to distinguish this act from one performed by man by the aid of reason.

Mr. Bate does not know of any well-marked case of difference of color in the two sexes of our British crustaceans, in which respect the sexes of the higher animals so often differ. In some cases, however, the males and females differ slightly in tint, but Mr. Bate thinks not more than may be accounted for by their different habits of life, such as by the male wandering more about, and being thus more exposed to the light. Dr. Power tried to distinguish by color the sexes of the several species which inhabit the Mauritius, but failed, except with one species of Squilla, probably *S. stylifera*, the male of which is described as being "of a beautiful bluish-green," with some of the appendages cherry-red, whilst the female is clouded with brown and gray, "with the red about her much less vivid than in the male." In this case, we may suspect the agency of sexual selection. From M. Bert's observations on Daphnia, when placed in a vessel illuminated by a prism, we have reason to believe that even the lowest crustaceans can distinguish colors. With Saphirina (an oceanic genus of Entomostraca), the males are furnished with minute shields or cell-like bodies, which exhibit beautiful changing colors; these are absent in the females, and in both sexes of one species. It would, however, be extremely rash to conclude that these curious organs serve to attract the females. I am informed by Fritz Müller, that in the female of a Brazilian species of Gelasimus, the whole body is of a nearly

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uniform grayish-brown. In the male the posterior part of the cephalo-thorax is pure white, with the anterior part of a rich green, shading into dark brown; and it is remarkable that these colors are liable to change in the course of a few minutes — the white becoming dirty gray or even black, the green "losing much of its brilliancy." It deserves especial notice that the males do not acquire their bright colors until they become mature. They appear to be much more numerous than the females; they differ also in the larger size of their chelæ. In some species of the genus, probably in all, the sexes pair and inhabit the same burrow. They are also, as we have seen, highly intelligent animals. From these various considerations it seems probable that the male in this species has become gayly ornamented in order to attract or excite the female.

It has just been stated that the male Gelasimus does not acquire his conspicuous colors until mature and nearly ready to breed. This seems a general rule in the whole class in respect to the many remarkable structural differences between the sexes. We shall hereafter find the same law prevailing throughout the great sub-kingdom of the Vertebrata; and in all cases it is eminently distinctive of characters which have been acquired through sexual selection. Fritz Müller gives some striking instances of this law; thus the male sand-hopper (Orchestia) does not, until nearly full grown, acquire his large claspers, which are very differently constructed from those of the female; whilst young, his claspers resemble those of the female.

Class, *Arachnida* (Spiders).— The sexes do not generally differ much in color, but the males are often darker than the females, as may be seen in Mr. Blackwall's magnificent work. In some species, however, the difference is conspicuous: thus the female of *Sparassus smaragdulus* is dullish green, whilst the adult male has the abdomen of a fine yellow, with three longitudinal stripes of rich red. In certain species of Thomisus the sexes closely resemble each other, in others they differ much; and analogous cases occur in many other genera. It is often difficult to say which of the two sexes departs most from the ordinary coloration of the genus to which the species belong; but Mr. Blackwall thinks that, as a general rule, it is the male; and Canestrini remarks that in certain genera the males can be specifically distinguished with ease, but the females with great

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difficulty. I am informed by Mr. Blackwall that the sexes whilst young usually resemble each other; and both often undergo great changes in color during their successive molts, before arriving at maturity. In other cases the male alone appears to change color. Thus the male of the above bright-colored Sparassus at first resembles the female, and acquires his peculiar tints only when nearly adult. Spiders are possessed of acute senses, and exhibit much intelligence; as is well known, the females often show the strongest affection for their eggs, which they carry about enveloped in a silken web. The males search eagerly for the females, and have been seen by Canestrini and others to fight for possession of them. This same author says that the union of the two sexes has been observed in about twenty species; and he asserts positively that the female rejects some of the males who court her, threatens them with open mandibles, and at last after long hesitation accepts the chosen one. From these several considerations, we may admit with some confidence that the well-marked differences in color between the sexes of certain species are the results of sexual selection; though we have not here the best kind of evidence,— the display by the male of his ornaments. From the extreme variability of color in the male of some species, for instance of *Theridion lineatum*, it would appear that these sexual characters of the males have not as yet become well fixed. Canestrini draws the same conclusion from the fact that the males of certain species present two forms, differing from each other in the size and length of their jaws; and this reminds us of the above cases of dimorphic crustaceans.

The male is generally much smaller than the female, sometimes to an extraordinary degree,[3] and he is forced to be extremely cautious in making his advances, as the female often carries her coyness to a dangerous pitch. De Greer saw a male that "in the midst of his preparatory caresses was seized by the object of his attentions, enveloped by her in a web and then devoured, a sight which, as he adds, filled him with horror and

[3] Aug. Vinson ("Aranéides des Iles de la Réunion," pl. vi. figs. 1 and 2) gives a good instance of the small size of the male, in *Epeira nigra*. In this species, as I may add, the male is testaceous and the female black with legs banded with red. Other even more striking cases of inequality in size between the sexes have been recorded ("Quarterly Journal of Science," 1868, July, p. 429); but I have not seen the original accounts.

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indignation." The Rev. O. P. Cambridge accounts in the following manner for the extreme smallness of the male in the genus Nephila. "M. Vinson gives a graphic account of the agile way in which the diminutive male escapes from the ferocity of the female, by gliding about and playing hide and seek over her body and along her gigantic limbs: in such a pursuit it is evident that the chances of escape would be in favor of the smallest males, while the larger ones would fall early victims; thus gradually a diminutive race of males would be selected, until at last they would dwindle to the smallest possible size compatible with the exercise of their generative functions,—in fact probably to the size we now see them, i. e., so small as to be a sort of parasite upon the female, and either beneath her notice, or too agile and too small for her to catch without great difficulty."

Westring has made the interesting discovery that the males of several species of Theridion have the power of making a stridulating sound, whilst the females are mute. The apparatus consists of a serrated ridge at the base of the abdomen, against which the hard hinder part of the thorax is rubbed; and of this structure not a trace can be detected in the females. It deserves notice that several writers, including the well-known arachnologist Walckenaer, have declared that spiders are attracted by music.[4] From the analogy of the Orthoptera and Homoptera, to be described in the next chapter, we may feel almost sure that the stridulation serves, as Westring also believes, to call or to excite the female; and this is the first case known to me in the ascending scale of the animal kingdom of sounds emitted for this purpose.[5]

Class, *Myriapoda.*—In neither of the two orders in this class, the millipedes and centipedes, can I find any well-marked instances of such sexual differences as more particularly concern us. In *Glomeris limbata,* however, and perhaps in some few other species, the males differ slightly in color from the females; but this Glomeris is a highly variable species. In the males of the Diplopoda, the legs belonging either to one of the anterior

[4] Dr. H. H. van Zouteveen, in his Dutch translation of this work (vol. i. p. 444), has collected several cases.

[5] Hilgendorf, however, has lately called attention to an analogous structure in some of the higher crustaceans, which seems adapted to produce sound; see "Zoological Record," 1869, page 603.

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or of the posterior segments of the body are modified into prehensile hooks which serve to secure the female. In some species of Iulus the tarsi of the male are furnished with membranous suckers for the same purpose. As we shall see when we treat of Insects, it is a much more unusual circumstance, that it is the female in Lithobius, which is furnished with prehensile appendages at the extremity of her body for holding the male.

CHAPTER X.

SECONDARY SEXUAL CHARACTERS OF INSECTS.

Diversified structures possessed by the males for seizing the females — Differences between the sexes, of which the meaning is not understood —Difference in size between the sexes — Thysanura — Diptera — Hemiptera — Homoptera, musical powers possessed by the males alone — Orthoptera, musical instruments of the males, much diversified in structure; pugnacity; colors — Neuroptera, sexual differences in color — Hymenoptera, pugnacity and colors — Coleoptera, colors; furnished with great horns, apparently as an ornament; battles; stridulating organs generally common to both sexes.

In the immense class of insects the sexes sometimes differ in their locomotive-organs, and often in their sense-organs, as in the pectinated and beautifully plumose antennæ of the males of many species. In Chloëon, one of the Ephemeræ, the male has great pillared eyes, of which the female is entirely destitute. The ocelli are absent in the females of certain insects, as in the Mutillidæ; and here the females are likewise wingless. But we are chiefly concerned with structures by which one male is enabled to conquer another, either in battle or courtship, through his strength, pugnacity, ornaments, or music. The innumerable contrivances, therefore, by which the male is able to seize the female, may be briefly passed over. Besides the complex structures at the apex of the abdomen, which ought perhaps to be ranked as primary organs,[1] "it is astonishing," as

[1] These organs in the male often differ in closely-allied species, and afford excellent specific characters. But their importance, from a functional point of view, as Mr. R. MacLachlan has remarked to me, has probably been overrated. It has been suggested, that slight differences in these organs would suffice to prevent the intercrossing of well-marked

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Mr. B. D. Walsh has remarked, "how many different organs are worked in by nature for the seemingly insignificant object of enabling the male to grasp the female firmly." The mandibles or jaws are sometimes used for this purpose; thus the male *Corydalis cornutus* (a neuropterous insect in some degree allied to the Dragon flies, &c.) has immense curved jaws, many times longer than those of the female; and they are smooth instead of being toothed, so that he is thus enabled to seize her without injury. One of the stag-beetles of North America (*Lucanus elaphus*) uses his jaws, which are much larger than those of the female, for the same purpose, but probably likewise for fighting. In one of the sand-wasps (*Ammophila*) the jaws in the two sexes are closely alike, but are used for widely different purposes: the males, as Professor Westwood observes, "are exceedingly ardent, seizing their partners round the neck with their sickle-shaped jaws;"[2] whilst the females use these organs for burrowing in sand-banks and making their nests.

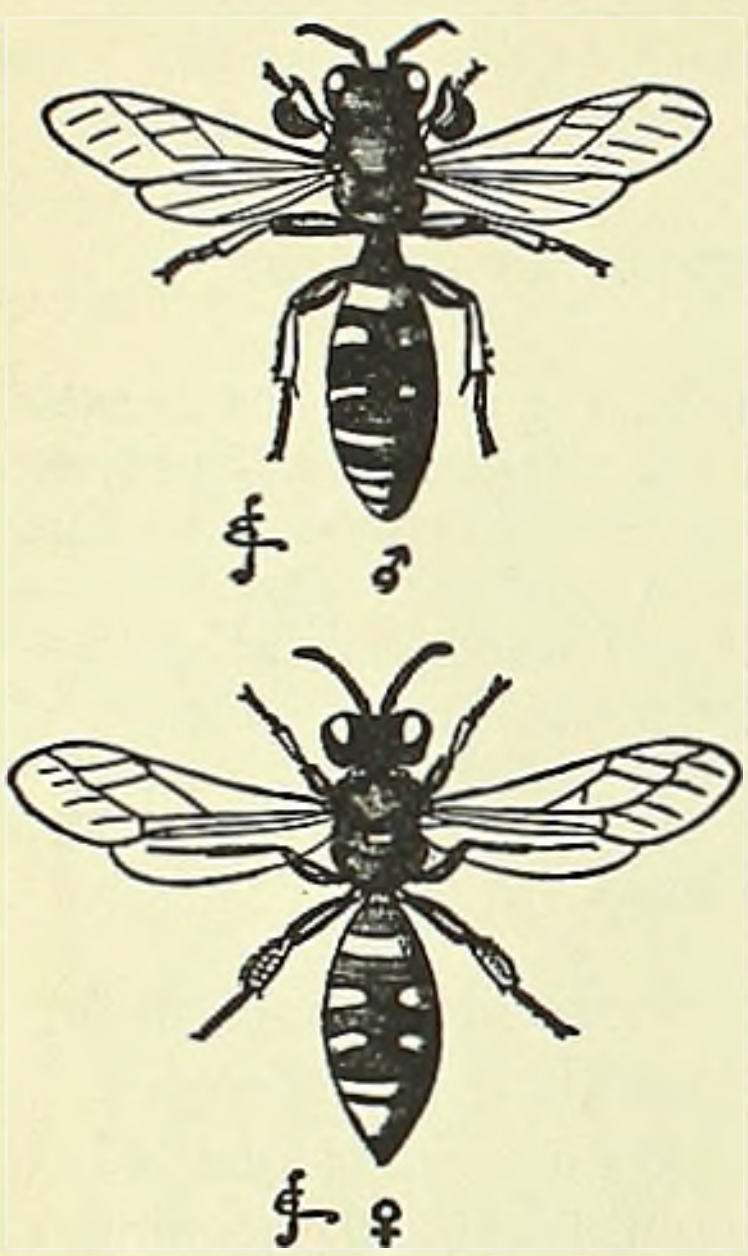

Fig. 9.—*Crabro cribrarius.* Upper figure, male; lower figure, female.

The tarsi of the front-legs are dilated in many male beetles, or are furnished with broad cushions of hairs; and in many genera of water-beetles they are armed with a round flat sucker, so that the male may adhere to the slippery body of the female. It is a much more unusual circumstance that the females of some water-

varieties or incipient species, and would thus aid in their development. That this can hardly be the case, we may infer from the many recorded cases (see, for instance, Bronn, "Geschichte der Natur," B. ii. 1843, s. 164; and Westwood, "Transact. Ent. Soc." vol. iii. 1842, p. 195) of distinct species having been observed in union. Mr. MacLachlan informs me (vide "Stett. Ent. Zeitung," 1867, s. 155) that when several species of Phryganidæ, which present strongly-pronounced differences of this kind, were confined together by Dr. Aug. Meyer, *they coupled*, and one pair produced fertile ova.

[2] "Modern Classification of Insects," vol. ii., pp. 205, 206. Mr. Walsh, who called my attention to the double use of the jaws, says that he has repeatedly observed this fact.

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beetles (Dytiscus) have their elytra deeply grooved, and in *Acilius sulcatus* thickly set with hairs, as an aid to the male. The females of some other water-beetles (Hydroporus) have their elytra punctured for the same purpose.[3] In the male of *Crabro cribrarius* (fig. 9), it is the tibia which is dilated into a broad horny plate, with minute membranous dots, giving to it a singular appearance like that of a riddle. In the male of Penthe (a genus of beetles) a few of the middle joints of the antennæ are dilated and furnished on the inferior surface with cushions of hair, exactly like those on the tarsi of the Carabidæ, "and obviously for the same end." In male dragon-flies, "the appendages at the tip of the tail are modified in an almost infinite variety of curious patterns to enable them to embrace the neck of the female." Lastly, in the males of many insects, the legs are furnished with peculiar spines, knobs or spurs; or the whole leg is bowed or thickened, but this is by no means invariably a sexual character; or one pair, or all three pairs are elongated, sometimes to an extravagant length.

The sexes of many species in all the orders present differences, of which the meaning is not understood. One curious case is that of a beetle (fig. 10), the male of which has the left mandible much enlarged; so that the mouth is greatly distorted. In another Carabidous beetle, Eurygnathus, we have the case, unique as far as known to Mr. Wollaston, of the head of the female being much broader and larger, though in a variable degree, than that of the male. Any number of such cases could be given. They abound in the Lepidoptera: one of the most extraordinary is that

Fig. 10.— Taphroderes distortus (much enlarged). Upper figure, male; lower figure, female.

[3] We have here a curious and inexplicable case of dimorphism, for some of the females of four European species of Dysticus, and of certain species of Hydroporus, have their elytra smooth; and no intermediate gradations between the sulcated or punctured, and the quite smooth elytra have been observed.

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certain male butterflies have their fore-legs more or less atrophied, with the tibiæ and tarsi reduced to mere rudimentary knobs. The wings, also, in the two sexes often differ in neuration,[4] and sometimes considerably in outline, as in the *Aricoris epitus,* which was shown to me in the British Museum by Mr. A. Butler. The males of certain South American butterflies have tufts of hair on the margins of the wings, and horny excrescences on the discs of the posterior pair. In several British butterflies, as shown by Mr. Wonfor, the males alone are in parts clothed with peculiar scales.

The use of the bright light of the female glow-worm has been subject to much discussion. The male is feebly luminous, as are the larvæ and even the eggs. It has been supposed by some authors that the light serves to frighten away enemies, and by others to guide the male to the female. At last, Mr. Belt appears to have solved the difficulty: he finds that all the Lampyridæ which he has tried are highly distasteful to insectivorous mammals and birds. Hence it is in accordance with Mr. Bates' view, hereafter to be explained, that many insects mimic the Lampyridæ closely, in order to be mistaken for them, and thus to escape destruction. He further believes that the luminous species profit by being at once recognized as unpalatable. It is probable that the same explanation may be extended to the Elaters, both sexes of which are highly luminous. It is not known why the wings of the female glow-worm have not been developed; but in her present state she closely resembles a larva, and as larvæ are so largely preyed on by many animals, we can understand why she has been rendered so much more luminous and conspicuous than the male; and why the larvæ themselves are likewise luminous.

Differences in Size between the Sexes.— With insects of all kinds the males are commonly smaller than the females; and this difference can often be detected even in the larval state. So considerable is the difference between the male and female cocoons of the silk-moth (*Bombyx mori*), that in France they are separated by a particular mode of weighing. In the lower classes of the animal kingdom, the greater size of the females seems gen-

[4] E Doubleday, "Annals and Mag. of Nat. Hist." vol. i. 1848, p. 379. I may add that the wings in certain Hymenoptera (see Shuckard, "Fossorial Hymenop." 1837, pp. 39-43) differ in neuration according to sex.

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erally to depend on their developing an enormous number of ova; and this may to a certain extent hold good with insects. But Dr. Wallace has suggested a much more probable explanation. He finds, after carefully attending to the development of the caterpillars of *Bombyx cynthia* and *yamamai,* and especially to that of some dwarfed caterpillars, reared from a second brood on unnatural food, "that in proportion as the individual moth is finer, so is the time required for its metamorphosis longer; and for this reason the female, which is the larger and heavier insect, from having to carry her numerous eggs, will be preceded by the male which is smaller and has less to mature." Now as most insects are short-lived, and as they are exposed to many dangers, it would manifestly be advantageous to the female to be impregnated as soon as possible. This end would be gained by the males being first matured in large numbers ready for the advent of the females; and this again would naturally follow, as Mr. A. R. Wallace has remarked, through natural selection; for the smaller males would be first matured, and thus would procreate a large number of offspring which would inherit the reduced size of their male parents, whilst the larger males from being matured later would leave fewer offspring.

There are, however, exceptions to the rule of male insects being smaller than the females; and some of these exceptions are intelligible. Size and strength would be an advantage to the males, which fight for the possession of the females; and in these cases, as with the stag-beetle (Lucanus), the males are larger than the females. There are, however, other beetles which are not known to fight together, of which the males exceed the females in size; and the meaning of this fact is not known; but in some of these cases, as with the huge Dynastes and Megasoma, we can at least see that there would be no necessity for the males to be smaller than the females, in order to be matured before them, for these beetles are not short-lived, and there would be ample time for the pairing of the sexes. So again, male dragon-flies (Libellulidæ) are sometimes sensibly larger, and never smaller, than the females; and as Mr. MacLachlan believes, they do not generally pair with the females until a week or fortnight has elapsed, and until they have assumed their proper masculine colors. But the most curious case, showing on what complex and easily-overlooked relations, so

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trifling a character as difference in size between the sexes may depend, is that of the aculeate Hymenoptera; for Mr. F. Smith informs me that throughout nearly the whole of this large group, the males, in accordance with the general rule, are smaller than the females, and emerge about a week before them; but amongst the Bees, the males of *Apis mellifica, Anthidium manicatum* and *Anthophora acervorum,* and amongst the Fossores, the males of the *Methoca ichneumonides,* are larger than the females. The explanation of this anomaly is that a marriage flight is absolutely necessary with these species, and the male requires great strength and size in order to carry the female through the air. Increased size has here been acquired in opposition to the usual relation between size and the period of development, for the males, though larger, emerge before the smaller females.

We will now review the several Orders, selecting such facts as more particularly concern us. The Lepidoptera (Butterflies and Moths) will be retained for a separate chapter.

Order, *Thysanura.*— The members of this lowly organized order are wingless, dull-colored, minute insects, with ugly, almost misshapen heads and bodies. Their sexes do not differ, but they are interesting as showing us that the males pay sedulous court to the females even low down in the animal scale. Sir J. Lubbock says: "It is very amusing to see these little creatures (*Smynthurus luteus*) coquetting together. The male, which is much smaller than the female, runs round her, and they butt one another, standing face to face and moving backward and forward like two playful lambs. Then the female pretends to run away and the male runs after her with a queer appearance of anger, gets in front and stands facing her again; then she turns coyly round, but he, quicker and more active, scuttles round too, and seems to whip her with his antennæ; then for a bit they stand face to face, play with their antennæ, and seem to be all in all to one another."

Order, *Diptera* (Flies).— The sexes differ little in color. The greatest difference, known to Mr. F. Walker, is in the genus Bibio, in which the males are blackish or quite black, and the females obscure brownish-orange. The genus Elaphomyia, discovered by Mr. Wallace in New Guinea, is highly remarkable,

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as the males are furnished with horns, of which the females are quite destitute. The horns spring from beneath the eyes, and curiously resemble those of a stag, being either branched or palmated. In one of the species, they equal the whole body in length. They might be thought to be adapted for fighting, but as in one species they are of a beautiful pink color, edged with black, with a pale central stripe, and as these insects have altogether a very elegant appearance, it is perhaps more probable that they serve as ornaments. That the males of some Diptera fight together is certain; Prof. Westwood has several times seen this with the Tipulæ. The males of other Diptera apparently try to win the females by their music: H. Müller watched for some time two males of an Eristalis courting a female; they hovered above her, and flew from side to side, making a high humming noise at the same time. Gnats and mosquitoes (Culicidæ) also seem to attract each other by humming; and Prof. Mayer has recently ascertained that the hairs on the antennæ of the male vibrate in unison with the notes of a tuning-fork, within the range of the sounds emitted by the funali. The longer hairs vibrate sympathetically with the graver notes, and the shorter hairs with the higher ones. Landois also asserts that he has repeatedly drawn down a whole swarm of gnats by uttering a particular note. It may be added that the mental faculties of the Diptera are probably higher than in most other insects, in accordance with their highly-developed nervous system.[5]

Order, *Hemiptera* (Field-Bugs).—Mr. J. W. Douglas, who has particularly attended to the British species, has kindly given me an account of their sexual differences. The males of some species are furnished with wings, whilst the females are wingless; the sexes differ in the form of their bodies, elytra, antennæ and tarsi; but as the signification of these differences are unknown, they may be here passed over. The females are generally larger and more robust than the males. With British, and, as far as Mr. Douglas knows, with exotic species, the sexes do not commonly differ much in color; but in about six British species the male is considerably darker than the female, and in

[5] See Mr. B. T. Lowne's interesting work, "On the Anatomy of the Blowfly, Musca vomitoria," p. 14. He remarks (p. 33) that, "the captured flies utter a peculiar plaintive note, and that this sound causes other flies to disappear."

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about four other species the female is darker than the male. Both sexes of some species are beautifully colored; and as these insects emit an extremely nauseous odor, their conspicuous colors may serve as a signal that they are unpalatable to insectivorous animals. In some few cases their colors appear to be directly protective: thus Prof. Hoffmann informs me that he could hardly distinguish a small pink and green species from the buds on the trunks of lime-trees, which this insect frequents.

Some species of Reduvidæ make a stridulating noise; and, in the case of *Pirates stridulus*, this is said to be effected by the movement of the neck within the prothoracic cavity. According to Westring, *Reduvius personatus* also stridulates. But I have no reason to suppose that this is a sexual character, excepting that with non-social insects there seems to be no use for sound-producing organs, unless it be as a sexual call.

Order, *Homoptera*.— Every one who has wandered in a tropical forest must have been astonished at the din made by the male Cicadæ. The females are mute; as the Grecian poet Xenarchus says, "Happy the Cicadas live, since they all have voiceless wives." The noise thus made could be plainly heard on board the "Beagle," when anchored at a quarter of a mile from the shore of Brazil; and Captain Hancock says it can be heard at the distance of a mile. The Greeks formerly kept, and the Chinese now keep, these insects in cages for the sake of their song, so that it must be pleasing to the ears of some men. The Cicadæ usually sing during the day, whilst the Fulgoridæ appear to be night-songsters. The sound, according to Landois, is produced by the vibration of the lips of the spiracles, which are set into motion by a current of air emitted from the tracheæ; but this view has lately been disputed. Dr. Powell appears to have proved that it is produced by the vibration of a membrane, set into action by a special muscle. In the living insect, whilst stridulating, this membrane can be seen to vibrate; and in the dead insect the proper sound is heard, if the muscle, when a little dried and hardened, is pulled with the point of a pin. In the female the whole complex musical apparatus is present, but is much less developed than in the male, and is never used for producing sound.

With respect to the object of the music, Dr. Hartman, in

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speaking of the *Cicada septemdecim* of the United States, says, "the drums are now (June 6th and 7th, 1851) heard in all directions. This I believe to be the marital summons from the males. Standing in thick chestnut sprouts about as high as my head, where hundreds were around me, I observed the females coming around the drumming males." He adds, "this season (Aug., 1868) a drawf pear-tree in my garden produced about fifty larvæ of *Cic. pruinosa;* and I several times noticed the females to alight near a male while he was uttering his clanging notes." Fritz Müller writes to me from S. Brazil that he has often listened to a musical contest between two or three males of a species with a particularly loud voice, seated at a considerable distance from each other: as soon as one had finished his song, another immediately began, and then another. As there is so much rivalry between the males, it is probable that the females not only find them by their sounds, but that, like female birds, they are excited or allured by the male with the most attractive voice.

I have not heard of any well-marked cases of ornamental differences between the sexes of the Homoptera. Mr. Douglas informs me that there are three British species, in which the male is black or marked with black bands, whilst the females are pale-colored or obscure.

Order, *Orthoptera* (Crickets and Grasshoppers).— The males in the three saltatorial families in this Order are remarkable for their musical powers, namely the Achetidæ or crickets, the Locustidæ for which there is no equivalent English name, and the Acridiidæ or grasshoppers. The stridulation produced by some of the Locustidæ is so loud that it can be heard during the night at the distance of a mile; and that made by certain species is not unmusical even to the human ear, so that the Indians on the Amazons keep them in wicker cages. All observers agree that the sounds serve either to call or excite the mute females. With respect to the migratory locusts of Russia, Körte has given [6] an interesting case of selection by the female of a male. The males of this species (*Pachytylus migratorius*) whilst coupled with the female stridulate from anger or jealousy,

[6] I state this on the authority of Köppen, "Ueber die Heuschrecken in Südrussland," p. 32, for I have in vain endeavoured to procure Körte's work.

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if approached by other males. The house-cricket when surprised at night uses its voice to warn its fellows. In North America the Katy-did (*Platyphyllum concavum,* one of the Locustidæ) is described as mounting on the upper branches of a tree, and in the evening beginning "his noisy babble, while rival notes issue from the neighboring trees, and the groves resound with the call of *Katy-did-she-did* the live-long night." Mr. Bates, in speaking of the European field-cricket (one of the Achetidæ), says "the male has been observed to place himself in the evening at the entrance of his burrow, and stridulate until a female approaches, when the louder notes are succeeded by a more subdued tone, whilst the successful musician caresses with his antennæ the mate he has won."[7] Dr. Scudder was able to excite one of these insects to answer him, by rubbing on a file with a quill. In both sexes a remarkable auditory apparatus has been discovered by Von Siebold, situated in the front legs.

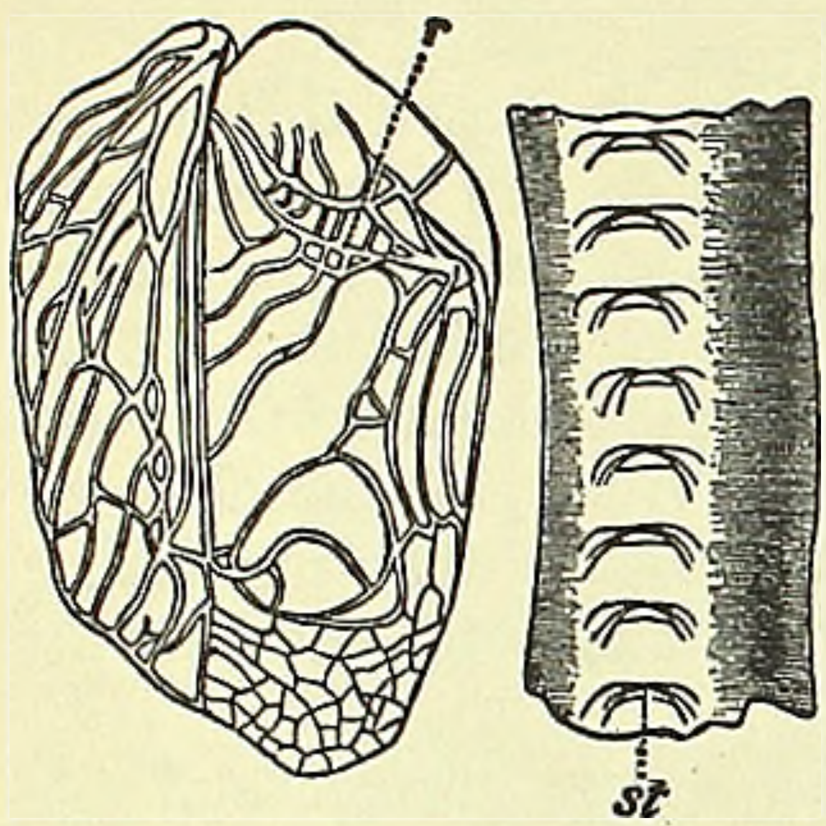

FIG. 11.—Gryllus campestris (from Landois).

Right-hand figure, under side of part of a wing-nervure, much magnified, showing the teeth (*st*). Left-hand figure, upper surface of wing-cover, with the projecting, smooth nervure, *r*, across which the teeth (*st*) are scraped.

In the three Families the sounds are differently produced. In the males of the Achetidæ both wing-covers have the same apparatus; and this in the field-cricket (*Gryllus Campestris,* fig. 11) consists, as described by Landois, of from 131 to 138 sharp, transverse ridges or teeth (*st*) on the under side of one of the nervures of the wing-cover. This toothed nervure is rapidly scraped across a projecting, smooth, hard nervure (*r*) on the upper surface of the opposite wing. First one wing is rubbed over the other, and then the movement is reversed. Both wings are raised a little at the same time, so as to increase the resonance. In some species the wing-covers of the males are furnished at the base with a talc-like plate. I here give a drawing

[7] "The Naturalist on the Amazons," vol. i., p. 252. Mr. Bates gives a very interesting discussion on the gradations in the musical apparatus of the three families.

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(fig. 12) of the teeth on the under side of the nervure of another species of Gryllus, viz., *G. domesticus.* With respect to the formation of these teeth, Dr. Gruber has shown that they have been developed by the aid of selection, from the minute scales and hairs with which the wings and body are covered, and I came to the same conclusion with respect to those of the Coleoptera. But Dr. Gruber further shows that their development is in part directly due to the stimulus from the friction of one wing over the other.

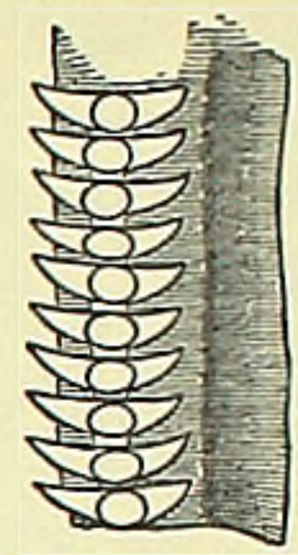

FIG. 12.—Teeth of Nervure of Gryllus domesticus from Landois).

In the Locustidæ the opposite wing-covers differ from each other in structure (fig. 13), and the action cannot, as in the last family, be reversed. The left wing, which acts as the bow, lies over the right wing which serves as the fiddle. One of the nervures (*a*) on the under surface of the former is finely serrated, and is scraped across the prominent nervures on the upper surface of the opposite or right wing. In our British *Phasgonura viridissima* it appeared to me that the serrated nervure is rubbed against the rounded hind-corner of the opposite wing, the edge of which is thickened, colored brown, and very sharp. In the right wing, but not in the left, there is a little plate, as transparent as talc, surrounded by nervures, and called the speculum. In *Ephippiger vitium,* a member of this same family, we have a curious subordinate modification; for the wing-covers are greatly reduced in size, but "the posterior part of the prothorax is elevated into a kind of dome over the wing-covers, and which has probably the effect of increasing the sound."

We thus see that the musical apparatus is more differentiated or specialized in the Locustidæ (which include, I believe, the most powerful performers in the Order), than in the Achetidæ, in which both wing-covers have the same structure and the same function. Landois, however, detected in one of the Locustidæ, namely, in Decticus, a short and narrow row of small teeth, mere rudiments, on the inferior surface of the right wing-cover, which underlies the other and is never used as the bow. I observed the same rudimentary structure on the under side of the right wing-cover in *Phasgonura viridissima.* Hence we may infer with confidence that the Locustidæ are descended from a

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form, in which, as in the existing Achetidæ, both wing-covers had serrated nervures on the under surface, and could be indifferently used as the bow; but that in the Locustidæ the two wing-covers gradually became differentiated and perfected, on the principle of the division of labor, the one to act exclusively as the bow, and the other as the fiddle. Dr. Gruber takes the same view, and has shown that rudimentary teeth are commonly found on the inferior surface of the right wing. By what steps the more simple apparatus in the Achetidæ originated, we do not know, but it is probable that the basal portions of the wing-

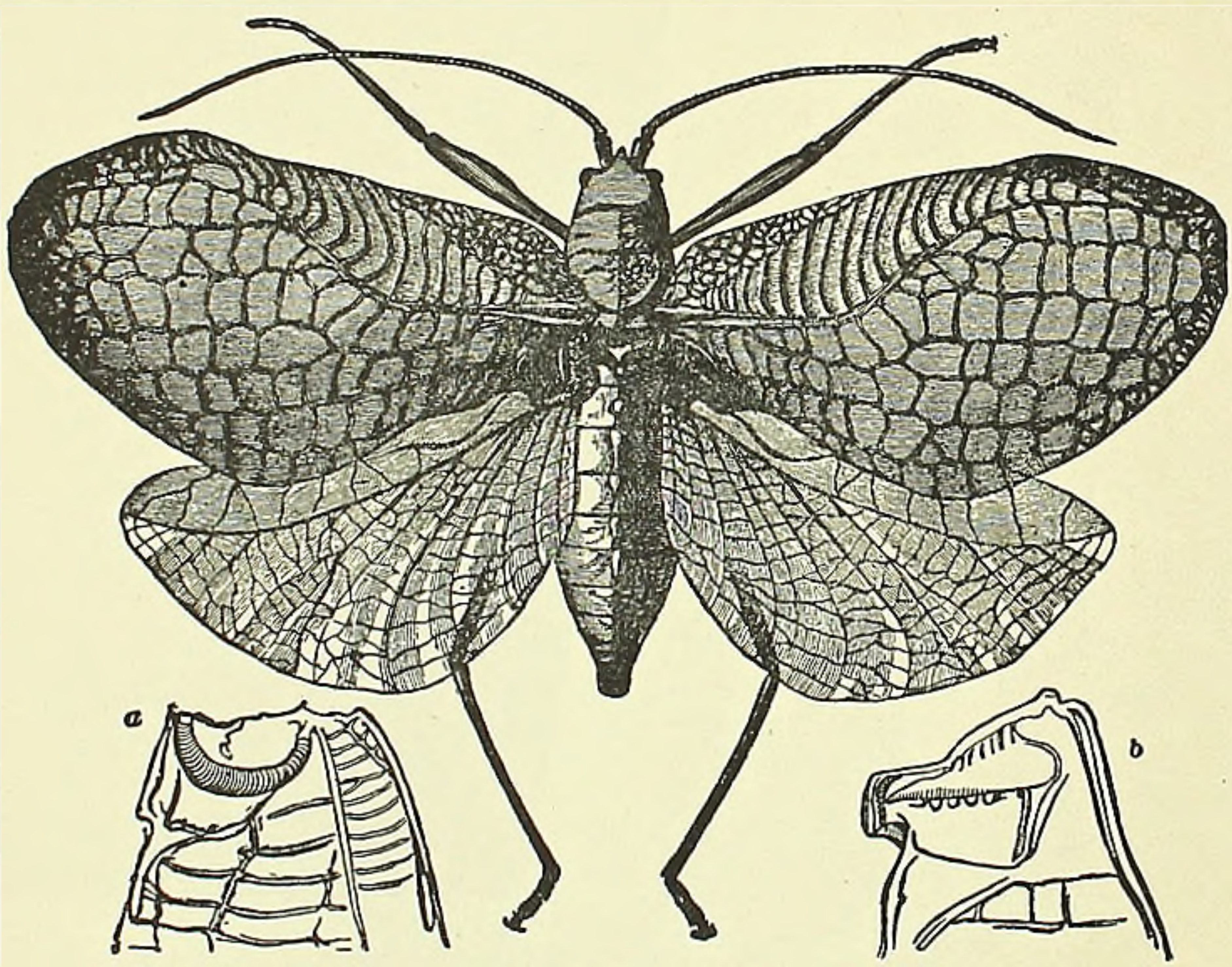

FIG. 13.—Chlorocœlus Tanana (from Bates). *a*, *b*, Lobes of opposite wing-covers.

covers originally overlapped each other as they do at present; and that the friction of the nervures produced a grating sound, as is now the case with the wing-covers of the females.[8] A grating sound thus occasionally and accidentally made by the males, if it served them ever so little as a love-call to the fe-

[8] Mr. Walsh also informs me that he has noticed that the female of the *Platyphyllum concavum*, "when captured makes a feeble grating noise by shuffling her wing-covers together."

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males, might readily have been intensified through sexual selection, by variations in the roughness of the nervures having been continually preserved.

In the last and third Family, namely, the Acridiidæ or grasshoppers, the stridulation is produced in a very different manner, and according to Dr. Scudder, is not so shrill as in the preceding Families. The inner surface of the femur (fig. 14, *r*) is furnished with a longitudinal row of minute, elegant, lancet-shaped, elastic teeth, from 85 to 93 in number; and these are scraped across the sharp projecting nervures on the wing-covers, which are thus made to vibrate and resound. Harris says that when one of the males begins to play, he first "bends the shank of the hind-leg beneath the thigh, where it is lodged in a furrow designed to receive it, and then draws the leg briskly up and down. He does not play both fiddles together, but alternately, first upon one and then on the other." In many species, the base of the abdomen is hollowed out into a great cavity which is believed to act as a resounding board. In Pneumora (fig. 15), a S. African genus belonging to the same family, we meet with a new and remarkable modification; in the males a small notched ridge projects obliquely from each side of the abdomen, against which the hind femora are rubbed. As the male is furnished with wings (the female being wingless), it is remarkable that the thighs are not rubbed in the usual manner against the wing-covers; but this may perhaps be accounted for by the unusually small size of the hind-legs. I have not been able to examine the inner surface of the thighs, which, judging from analogy, would be finely serrated. The species of Pneumora have been more profoundly modified for the sake of stridulation than any other orthopterous insect; for in the male the whole body has been converted into a musical instrument, being distended with air, like a great pellucid bladder, so as to increase the res-

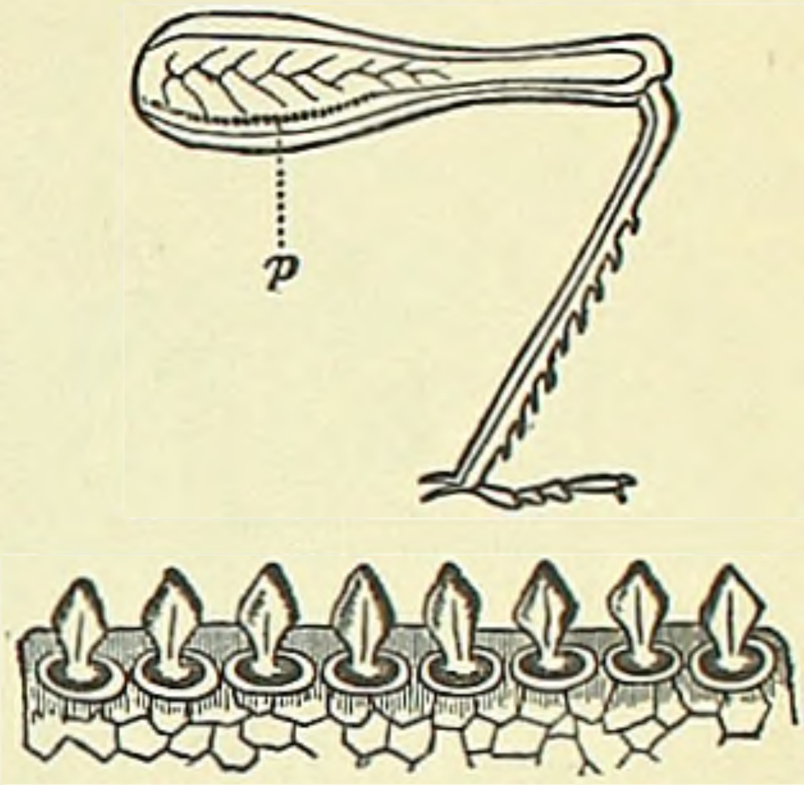

Fig. 14.— Hind-leg of Stenobothrus pratorum: *r*, the stridulating ridge; lower figure, the teeth forming the ridge, much magnified (from Landois).

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onance. Mr. Trimen informs me that at the Cape of Good Hope these insects make a wonderful noise during the night.

In the three foregoing families, the females are almost always destitute of an efficient musical apparatus. But there are a few exceptions to this rule, for Dr. Gruber has shown that both sexes of *Ephippiger vitium* are thus provided; though the organs differ

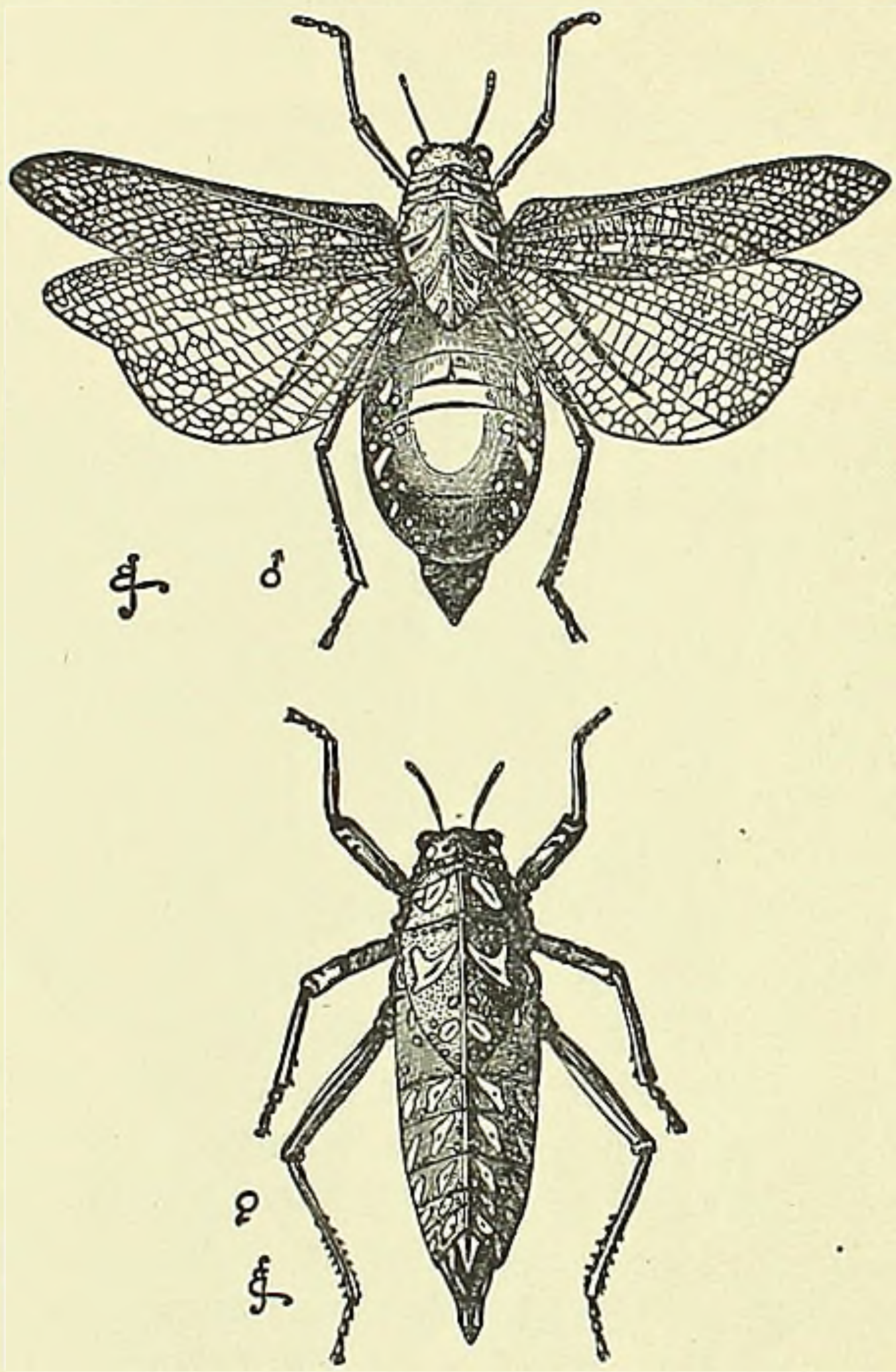

Fig. 15.—Pneumora (from specimens in the British Museum). Upper figure, male; lower figure, female.

in the male and female to a certain extent. Hence we cannot suppose that they have been transferred from the male to the female, as appears to have been the case with the secondary sexual characters of many other animals. They must have been independently developed in the two sexes, which no doubt mutually call to each other during the season of love. In most other Lo-

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custidæ (but not according to Landois in Decticus) the females have rudiments of the stridulatory organs proper to the male; from whom it is probable that these have been transferred. Landois also found such rudiments on the under surface of the wing-covers of the female Achetidæ, and on the femora of the female Acridiidæ. In the Homoptera, also, the females have the proper musical apparatus in a functionless state; and we shall hereafter meet in other divisions of the animal kingdom with many instances of structures proper to the male being present in a rudimentary condition in the female.

Landois has observed another important fact, namely, that in the females of the Acridiidæ, the stridulating teeth on the femora remain throughout life in the same condition in which they first appear during the larval state in both sexes. In the males, on the other hand, they become further developed, and acquire their perfect structure at the last molt, when the insect is mature and ready to breed.

From the facts now given, we see that the means by which the males of the Orthoptera produce their sounds are extremely diversified, and are altogether different from those employed by the Homoptera.[9] But throughout the animal kingdom we often find the same object gained by the most diversified means; this seems due to the whole organization having undergone multifarious changes in the course of ages, and as part after part varied different variations were taken advantage of for the same general purpose. The diversity of means for producing sound in the three families of the Orthoptera and in the Homoptera, impresses the mind with the high importance of these structures to the males, for the sake of calling or alluring the females. We need feel no surprise at the amount of modification which the Orthoptera have undergone in this respect, as we now know, from Dr. Scudder's remarkable discovery, that there has been more than ample time. This naturalist has lately found a fossil insect in the Devonian formation of New Brunswick, which is furnished with "the well-known tympanum or stridulating apparatus of the male Locustidæ." The insect, though in most respects related to the Neuroptera, appears, as is so often the

[9] Landois has recently found in certain Orthoptera rudimentary structures closely similar to the sound-producing organs in the Homoptera; and this is a surprising fact.

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case with very ancient forms, to connect the two related Orders of the Neuroptera and Orthoptera.

I have but little more to say on the Orthoptera. Some of the species are very pugnacious; when two male field-crickets (*Gryllus campestris*) are confined together, they fight till one kills the other; and the species of Mantis are described as maneuvering with their sword-like front-limbs, like hussars with their sabres. The Chinese keep these insects in little bamboo cages, and match them like game-cocks. With respect to color, some exotic locusts are beautifully ornamented; the posterior wings being marked with red, blue, and black; but as throughout the Order the sexes rarely differ much in color, it is not probable that they owe their bright tints to sexual selection. Conspicuous colors may be of use to these insects, by giving notice that they are unpalatable. Thus it has been observed that a bright-colored Indian locust was invariably rejected when offered to birds and lizards. Some cases, however, are known of sexual differences in color in this Order. The male of an American cricket [10] is described as being as white as ivory, whilst the female varies from almost white to greenish-yellow or dusky. Mr. Walsh informs me that the adult male of *Spectrum femoratum* (one of the Phasmidæ) "is of a shining brownish-yellow color; the adult female being of a dull, opaque, cinereous brown; the young of both sexes being green." Lastly, I may mention that the male of one curious kind of cricket is furnished with "a long membranous appendage, which falls over the face like a veil"; but what its use may be, is not known.

Order, *Neuroptera.*— Little need here be said, except as to color. In the Ephemeridæ the sexes often differ slightly in their obscure tints; but it is not probable that the males are thus rendered attractive to the females. The Libellulidæ, or dragon-flies, are ornamented with splendid green, blue, yellow, and vermilion metallic tints; and the sexes often differ. Thus, as Prof. Westwood remarks, the males of some of the Agrionidæ, "are of a rich blue with black wings, whilst the females are fine green with colorless wings." But in *Agrion Ramburii* these colors are exactly reversed in the two sexes. In the extensive N. American

[10] The *Œcanthus nivalis*. Harris, "Insects of New England," p. 124. The two sexes of *Œ. pellucidus* of Europe differ, as I hear from Victor Carus, in nearly the same manner.

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genus of Hetærina, the males alone have a beautiful carmine spot at the base of each wing. In *Anax junius* the basal part of the abdomen in the male is a vivid ultra-marine blue, and in the female grass-green. In the allied genus Gomphus, on the other hand, and in some other genera, the sexes differ but little in color. In closely-allied forms throughout the animal kingdom, similar cases of the sexes differing greatly, or very little, or not at all, are of frequent occurrence. Although there is so wide a difference in color between the sexes of many Libellulidæ, it is often difficult to say which is the more brilliant; and the ordinary coloration of the two sexes is reversed, as we have just seen, in one species of Agrion. It is not probable that their colors in any case have been gained as a protection. Mr. MacLachlan, who has closely attended to this family, writes to me that dragon-flies — the tyrants of the insect-world — are the least liable of any insect to be attacked by birds or other enemies, and he believes that their bright colors serve as a sexual attraction. Certain dragon-flies apparently are attracted by particular colors: Mr. Patterson observed that the Agrionidæ, of which the males are blue, settled in numbers on the blue float of a fishing line; whilst two other species were attracted by shining white colors.

It is an interesting fact, first noticed by Schelver, that, in several genera belonging to two sub-families, the males on first emergence from the pupal state, are colored exactly like the females; but that their bodies in a short time assume a conspicuous milky-blue tint, owing to the exudation of a kind of oil, soluble in ether and alcohol. Mr. MacLachlan believes that in the male of *Libellula depressa* this change of color does not occur until nearly a fortnight after the metamorphosis, when the sexes are ready to pair.

Certain species of Neurothemis present, according to Brauer, a curious case of dimorphism, some of the females having ordinary wings, whilst others have them "very richly netted, as in the males of the same species." Brauer "explains the phenomenon on Darwinian principles by the supposition that the close netting of the veins is a secondary sexual character in the males, which has been abruptly transferred to some of the females, instead of, as generally occurs, to all of them." Mr. MacLachlan informs me of another instance of dimorphism in several species of Agrion, in which some individuals are of an

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orange color, and these are invariably females. This is probably a case of reversion; for in the true Libellulæ, when the sexes differ in color, the females are orange or yellow; so that supposing Agrion to be descended from some primordial form which resembled the typical Libellulæ in its sexual characters, it would not be surprising that a tendency to vary in this manner should occur in the females alone.

Although many dragon-flies are large, powerful, and fierce insects, the males have not been observed by Mr. MacLachlan to fight together, excepting, as he believes, in some of the smaller species of Agrion. In another group in this Order, namely, the Termites or white ants, both sexes at the time of swarming may be seen running about, "the male after the female, sometimes two chasing one female, and contending with great eagerness who shall win the prize." The *Atropos pulsatorius* is said to make a noise with its jaws, which is answered by other individuals.

Order, *Hymenoptera.*—That inimitable observer, M. Fabre, in describing the habits of Cerceris, a wasp-like insect, remarks that "fights frequently ensue between the males for the possession of some particular female, who sits an apparently unconcerned beholder of the struggle for supremacy, and when the victory is decided, quietly flies away in company with the conqueror." Westwood says that the males of one of the saw-flies (Tenthredinæ) "have been found fighting together, with their mandibles locked." As M. Fabre speaks of the males of Cerceris striving to obtain a particular female, it may be well to bear in mind that insects belonging to this Order have the power of recognizing each other after long intervals of time, and are deeply attached. For instance, Pierre Huber, whose accuracy no one doubts, separated some ants, and when, after an interval of four months, they met others which had formerly belonged to the same community, they recognized and caressed one another with their antennæ. Had they been strangers they would have fought together. Again, when two communities engage in a battle, the ants on the same side sometimes attack each other in the general confusion, but they soon perceive their mistake, and the one ant soothes the other.

In this Order slight differences in color, according to sex,

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are common, but conspicuous differences are rare except in the family of Bees; yet both sexes of certain groups are so brilliantly colored — for instance in Chrysis, in which vermilion and metallic greens prevail — that we are tempted to attribute the result to sexual selection. In the Ichneumonidæ, according to Mr. Walsh, the males are almost universally lighter-colored than the females. On the other hand, in the Tenthredinidæ the males are generally darker than the females. In the Siricidæ the sexes frequently differ; thus the male of *Sirex juvencus* is banded with orange, whilst the female is dark purple; but it is difficult to say which sex is the more ornamented. In *Tremex columbæ* the female is much brighter colored than the male. I am informed by Mr. F. Smith, that the male ants of several species are black, the females being testaceous.

In the family of Bees, especially in the solitary species, as I hear from the same entomologist, the sexes often differ in color. The males are generally the brighter, and in Bombus as well as in Apathus, much more variable in color than the females. In *Anthophora retusa* the male is of a rich fulvous-brown, whilst the female is quite black: so are the females of several species of Xylocopa, the males being bright yellow. On the other hand the females of some species, as of *Andrœna fulva,* are much brighter colored than the males. Such differences in color can hardly be accounted for by the males being defenseless and thus requiring protection, whilst the females are well defended by their stings. H. Müller, who has particularly attended to the habits of bees, attributes these differences in color in chief part to sexual selection. That bees have a keen perception of color is certain. He says that the males search eagerly and fight for the possession of the females; and he accounts through such contests for the mandibles of the males being in certain species larger than those of the females. In some cases the males are far more numerous than the females, either early in the season, or at all times and places, or, locally; whereas the females in other cases are apparently in excess. In some species the more beautiful males appear to have been selected by the females; and in others the more beautiful females by the males. Consequently in certain genera the males of the several species differ much in appearance, whilst the females are almost indistinguishable; in other genera the reverse

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occurs. H. Müller believes that the colors gained by one sex through sexual selection have often been transferred in a variable degree to the other sex, just as the pollen-collecting apparatus of the female has often been transferred to the male, to whom it is absolutely useless.[11]

Mutilla Europæa makes a stridulating noise; and according to Goureau both sexes have this power. He attributes the sound to the friction of the third and preceding abdominal segments, and I find that these surfaces are marked with very fine concentric ridges; but so is the projecting thoracic collar into which the head articulates, and this collar, when scratched with the point of a needle, emits the proper sound. It is rather surprising that both sexes should have the power of stridulating, as the male is winged and the female wingless. It is notorious that Bees express certain emotions, as of anger, by the tone of their humming; and according to H. Müller, the males of some species make a peculiar singing noise whilst pursuing the females.

Order, *Coleoptera* (Beetles).— Many beetles are colored so as to resemble the surfaces which they habitually frequent, and they thus escape detection by their enemies. Other species, for instance diamond-beetles, are ornamented with splendid colors, which are often arranged in stripes, spots, crosses, and other elegant patterns. Such colors can hardly serve directly as a protection, except in the case of certain flower-feeding species; but they may serve as a warning or means of recognition, on the same principle as the phosphorescence of the glow-worm.

[11] M. Perrier in his article "la Sélection sexuelle d'après Darwin" ("Revue Scientifique," Feb. 1873, p. 868), without apparently having reflected much on the subject, objects that as the males of social bees are known to be produced from unfertilized ova, they could not transmit new characters to their male offspring. This is an extraordinary objection. A female bee fertilized by a male, which presented some character facilitating the union of the sexes, or rendering him more attractive to the female, would lay eggs which would produce only females; but these young females would next year produce males; and will it be pretended that such males would not inherit the characters of their male grandfathers? To take a case with ordinary animals as nearly parallel as possible: if a female of any white quadruped or bird were crossed by a male of a black breed, and the male and female offspring were paired together, will it be pretended that the grandchildren would not inherit a tendency to blackness from their male grandfather? The acquirement of new characters by the sterile worker-bees is a much more difficult case, but I have endeavoured to show in my "Origin of Species," how these sterile beings are subjected to the power of natural selection.

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As with beetles the colors of the two sexes are generally alike, we have no evidence that they have been gained through sexual selection; but this is at least possible, for they may have been developed in one sex and then transferred to the other; and this view is even in some degree probable in those groups which possess other well-marked secondary sexual characters. Blind beetles, which cannot of course behold each other's beauty, never, as I hear from Mr. Waterhouse, Jr., exhibit bright colors, though they often have polished coats; but the explanation of their obscurity may be that they generally inhabit caves and other obscure stations.

Some Longicorns, especially certain Prionidæ, offer an exception to the rule that the sexes of beetles do not differ in color. Most of these insects are large and splendidly colored. The males in the genus Pyrodes,[12] which I saw in Mr. Bates' collection, are generally redder but rather duller than the females, the latter being colored of a more or less splendid golden-green. On the other hand, in one species the male is golden-green, the female being richly tinted with red and purple. In the genus Esmeralda the sexes differ so greatly in color that they have been ranked as distinct species; in one species both are of a beautiful shining green, but the male has a red thorax. On the whole, as far as I could judge, the females of those Prionidæ, in which the sexes differ, are colored more richly than the males, and this does not accord with the common rule in regard to color, when acquired through sexual selection.

A most remarkable distinction between the sexes of many beetles is presented by the great horns which rise from the head, thorax, and clypeus of the males; and in some few cases from the under surface of the body. These horns, in the great

[12] *Pyrodes pulcherrimus*, in which the sexes differ conspicuously, has been described by Mr. Bates in "Transact. Ent. Soc." 1869, p. 50. I will specify the few other cases in which I have heard of a difference in color between the sexes of beetles. Kirby and Spence ("Introduct. to Entomology," vol. iii. p. 301) mention a Cantharis, Meloe, Rhagium, and the *Leptura testacea;* the male of the latter being testaceous, with a black thorax, and the female of a dull red all over. These two latter beetles belong to the family of Longicorns. Messrs. R. Trimen and Waterhouse, jun., inform me of two Lamellicorns, viz., a Peritrichia and Trichius, the male of the latter being more obscurely colored than the female. In *Tillus elongatus* the male is black, and the female always, as it is believed, of a dark blue color, with a red thorax. The male, also, of *Orsodacna atra*, as I hear from Mr. Walsh, is black, the female (the so-called *O. ruficollis*) having a rufous thorax.

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family of the Lamellicorns, resemble those of various quadrupeds, such as stags, rhinoceroses, &c., and are wonderful both from their size and diversified shapes. Instead of describing them, I have given figures of the males and females of some of the more remarkable forms. (Figs. 16 to 20.) The females generally exhibit rudiments of the horns in the form of small knobs or ridges; but some are destitute of even the slightest rudiment. On the other hand, the horns are nearly as well developed in the female as in the male of *Phanæus lancifer;* and only a little less well developed in the females of some

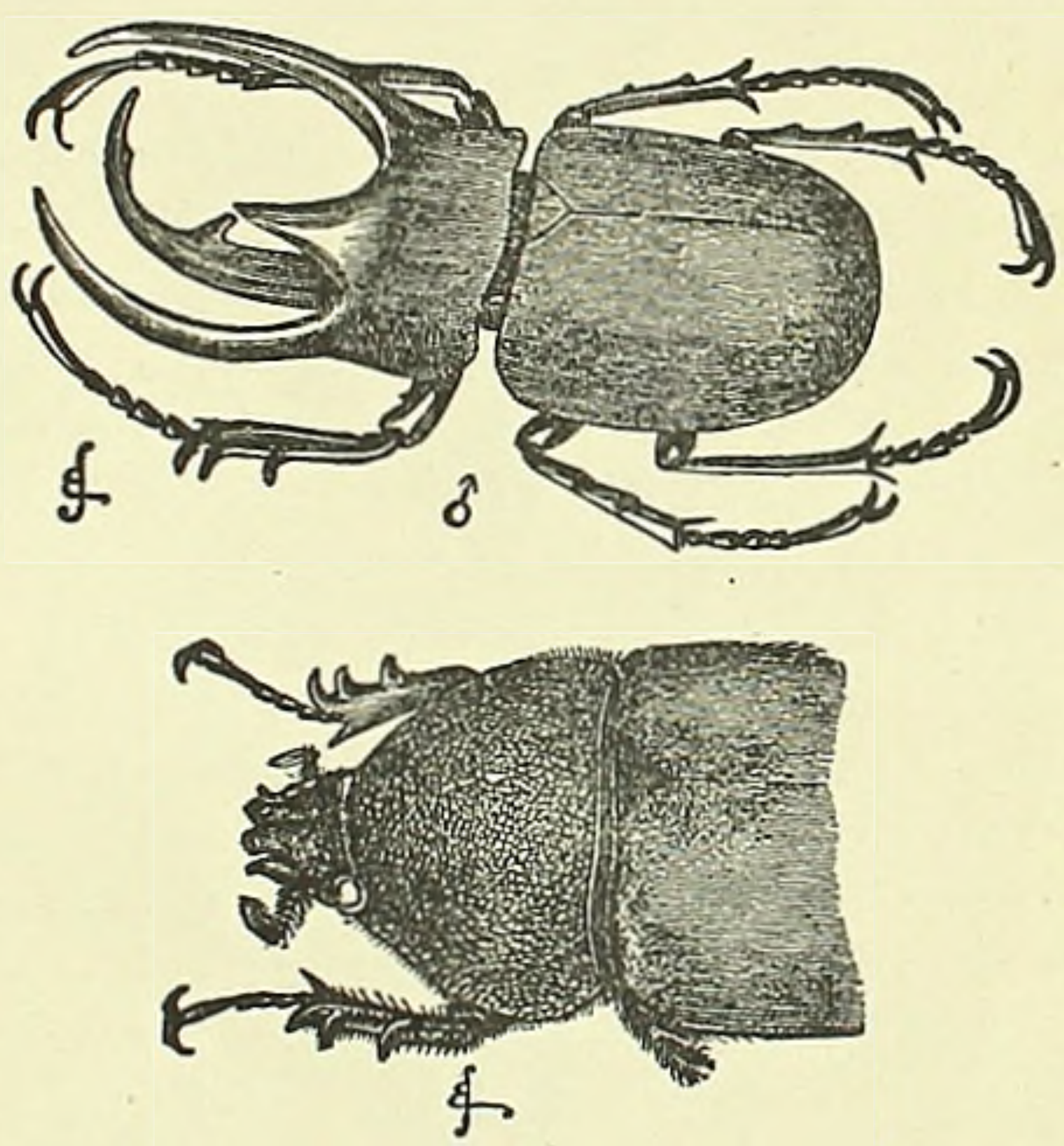

Fig. 16.— Chalcosoma atlas. Upper figure, male (reduced) ; lower figure, female (nat. size).

other species of this genus and of Copris. I am informed by Mr. Bates that the horns do not differ in any manner corresponding with the more important characteristic differences between the several subdivisions of the family: thus within the same section of the genus Onthophagus, there are species which have a single horn, and others which have two.

In almost all cases, the horns are remarkable from their excessive variability; so that a graduated series can be formed, from the most highly developed males to others so degenerate

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that they can barely be distinguished from the females. Mr. Walsh found that in *Phanæus carnifex* the horns were thrice as

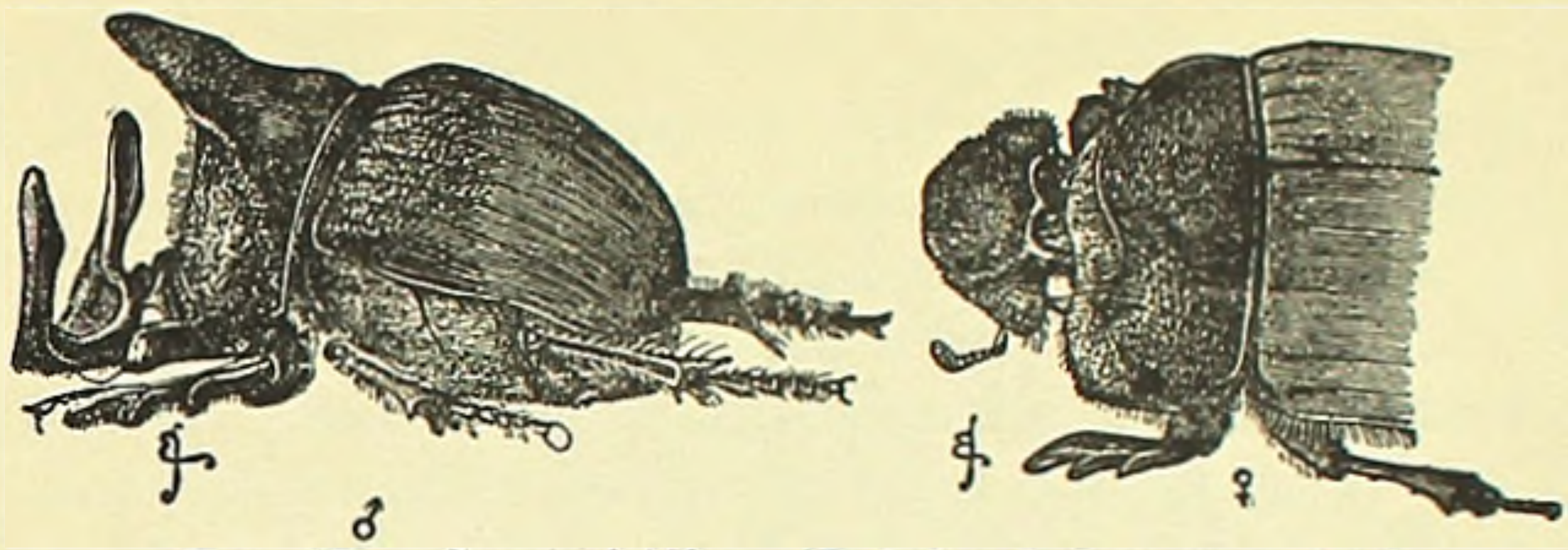

FIG. 17.— Copris isidis. (Left-hand figures, males.)

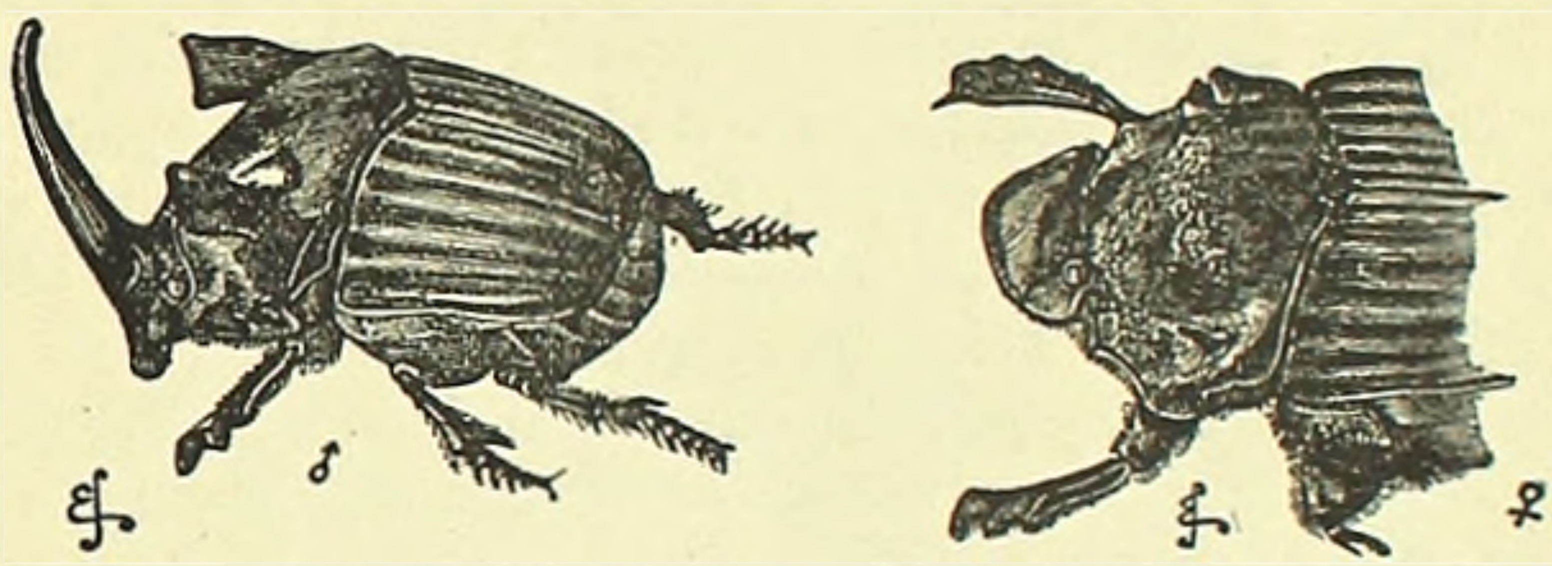

FIG. 18.— Phanæus faunus.

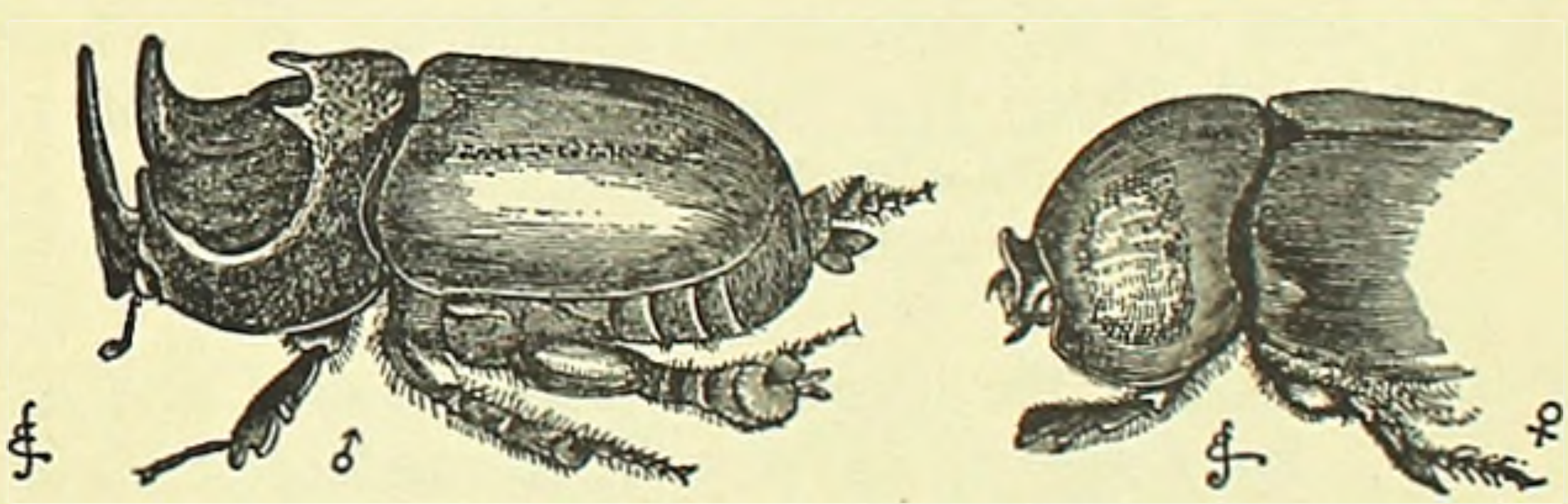

FIG. 19.— Dipelicus cantori.

FIG. 20.— Onthophagus rangifer, enlarged.

long in some males as in others. Mr. Bates, after examining above a hundred males of *Onthophagus rangifer* (fig. 20),

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thought that he had at last discovered a species in which the horns did not vary; but further research proved the contrary.

The extraordinary size of the horns, and their widely different structure in closely-allied forms, indicate that they have been formed for some purpose; but their excessive variability in the males of the same species leads to the inference that this purpose cannot be of a definite nature. The horns do not show marks of friction, as if used for any ordinary work. Some authors suppose that as the males wander about much more than the females, they require horns as a defense against their enemies; but as the horns are often blunt, they do not seem well adapted for defense. The most obvious conjecture is that they are used by the males for fighting together; but the males have never been observed to fight; nor could Mr. Bates, after a careful examination of numerous species, find any sufficient evidence, in their mutilated or broken condition, of their having been thus used. If the males had been habitual fighters, the size of their bodies would probably have been increased through sexual selection, so as to have exceeded that of the females; but Mr. Bates, after comparing the two sexes in above a hundred species of the Copridæ, did not find any marked difference in this respect amongst well-developed individuals. In Lethrus, moreover, a beetle belonging to the same great division of the Lamellicorns, the males are known to fight, but are not provided with horns, though their mandibles are much larger than those of the female.

The conclusion that the horns have been acquired as ornaments is that which best agrees with the fact of their having been so immensely, yet not fixedly, developed,— as shown by their extreme variability in the same species, and by their extreme diversity in closely-allied species. This view will at first appear extremely improbable; but we shall hereafter find with many animals standing much higher in the scale, namely fishes, amphibians, reptiles and birds, that various kinds of crests, knobs, horns and combs have been developed apparently for this sole purpose.

The males of *Onitis furcifer* (fig. 21), and of some other species of the genus, are furnished with singular projections on their anterior femora, and with a great fork or pair of horns on the lower surface of the thorax. Judging from other insects,

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these may aid the male in clinging to the female. Although the males have not even a trace of a horn on the upper surface of the body, yet the females plainly exhibit a rudiment of a single horn on the head (fig. 22, *a*), and of a crest (*b*) on the thorax. That the slight thoracic crest in the female is a rudiment of a projection proper to the male, though entirely absent in the male of this particular species, is clear: for the female of *Bubas bison* (a genus which comes next to Onitis) has a similar slight crest on the thorax, and the male bears a great projection in the same situation. So, again, there can hardly be a doubt that the little point (*a*) on the head of the female *Onitis furcifer,* as well as on the head of the females of two or three allied species, is a rudimentary representative of the cephalic horn,

Fig. 21.—Onitis furcifer, male, viewed from beneath.

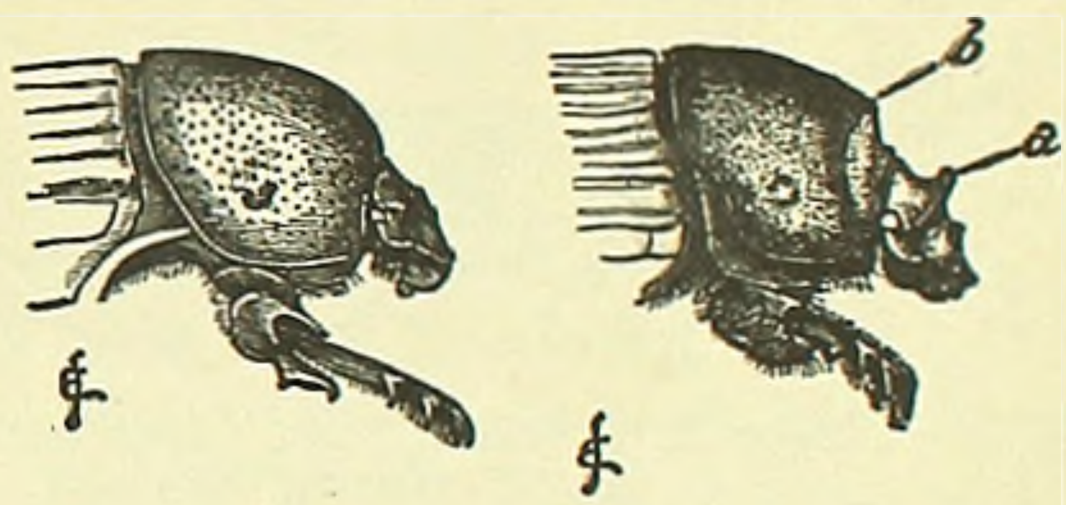

Fig. 22.—Left-hand figure, male of Onitis furcifer, viewed laterally. Right-hand figure, female. *a*. Rudiment of cephalic horn. *b*. Trace of thoracic horn or crest.

which is common to the males of so many Lamellicorn beetles, as in Phanæus (fig. 18).

The old belief that rudiments have been created to complete the scheme of nature is here so far from holding good, that we have a complete inversion of the ordinary state of things in the family. We may reasonably suspect that the males originally bore horns and transferred them to the females in a rudimentary condition, as in so many other Lamellicorns. Why the males subsequently lost their horns, we know not; but this may have been caused through the principle of compensation, owing to the development of the large horns and projections on the lower surface; and as these are confined to the males, the rudiments of the upper horns on the females would not have been thus obliterated.

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The cases hitherto given refer to the Lamellicorns, but the males of some few other beetles, belonging to two widely distinct groups, namely, the Curculionidæ and Staphylinidæ, are furnished with horns — in the former on the lower surface of the body, in the latter on the upper surface of the head and thorax. In the Staphylinidæ, the horns of the male are extraordinarily variable in the same species, just as we have seen with the Lamellicorns. In Siagonium we have a case of dimorphism, for the males can be divided into two sets, differing greatly in the size of their bodies and in the development of their horns, without intermediate gradations. In a species of Bledius (fig. 23), also belonging to the Staphylinidæ, Professor Westwood states that, "male specimens can be found in the same locality in which the central horn of the thorax is very large, but the

FIG. 23.— Bledius taurus, magnified. Left hand figure, male; right-hand figure, female.

horns of the head quite rudimental; and others, in which the thoracic horn is much shorter, whilst the protuberances on the head are long."[13] Here we apparently have a case of compensation, which throws light on that just given, of the supposed loss of the upper horns by the males of *Onitis*.

Law of Battle.— Some male beetles, which seem ill-fitted for fighting, nevertheless engage in conflicts for the possession of the females. Mr. Wallace saw two males of *Leptorhynchus angustatus*, a linear beetle with a much elongated rostrum, "fighting for a female, who stood close by busy at her boring. They pushed at each other with their rostra, and clawed and thumped, apparently in the greatest rage." The smaller male, however, "soon ran away, acknowledging himself vanquished." In some few cases male beetles are well adapted for fighting, by possessing great toothed mandibles, much larger than those of the females. This is the case with the common stag-beetle (*Lucanus*

[13] "Modern Classification of Insects," vol. i. p. 172: Siagonium, p. 172. In the British Museum I noticed one male specimen of Siagonium in an intermediate condition, so that the dimorphism is not strict.

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cervus), the males of which emerge from the pupal state about a week before the other sex, so that several may often be seen pursuing the same female. At this season they engage in fierce conflicts. When Mr. A. H. Davis enclosed two males with one female in a box, the larger male severely pinched the smaller one, until he resigned his pretensions. A friend informs me that when a boy he often put the males together to see them fight, and he noticed that they were much bolder and fiercer than the females, as with the higher animals. The males would seize hold of his finger, if held in front of them, but not so the females, although they have stronger jaws. The males of many of the Lucanidæ as well as of the above-mentioned Leptorhynchus, are larger and more powerful insects than the females. The two sexes of *Lethrus cephalotes* (one of the Lamellicorns) inhabit the same burrow; and the male has larger mandibles than the female. If, during the breeding season, a strange male attempts to enter the burrow, he is attacked; the female does not remain passive, but closes the mouth of the burrow, and encourages her mate by continually pushing him on from behind; and the battle lasts until the aggressor is killed or runs away. The two sexes of another Lamellicorn beetle, the *Ateuchus cicatricosus,* live in pairs, and seem much attached to each other; the male excites the female to roll the balls of dung in which the ova are deposited; and if she is removed, he becomes much agitated. If the male is removed the female ceases all work, and as M. Brulerie believes, would remain on the same spot until she died.

The great mandibles of the male Lucanidæ are extremely variable both in size and structure, and in this respect resemble the horns on the head and thorax of many male Lamellicorns and Staphylinidæ. A perfect series can be formed from the best-provided to the worst-provided or degenerate males. Although the mandibles of the common stag-beetle, and probably of many other species, are used as efficient weapons for fighting, it is doubtful whether their great size can thus be accounted for. We have seen that they are used by the *Lucanus elaphus* of N. America for seizing the female. As they are so conspicuous and so elegantly branched, and as owing to their great length they are not well adapted for pinching, the suspicion has crossed my mind that they may in addition serve as an orna-

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ment, like the horns on the head and thorax of the various species above described. The male *Chiasognathus Grantii* of S. Chile — a splendid beetle belonging to the same family — has enormously developed mandibles (fig. 24); he is bold and pugnacious; when threatened he faces round, opens his great jaws, and at the same time stridulates loudly. But the mandibles were not strong enough to pinch my finger so as to cause actual pain.

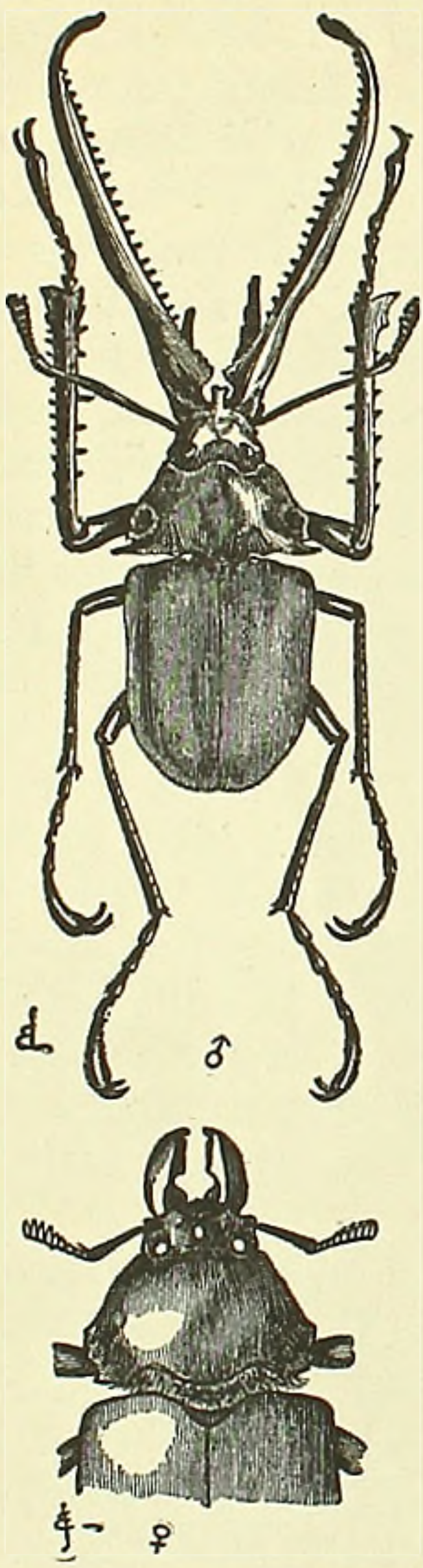

FIG. 24.— Chiasognathus Grantii, reduced. Upper figure, male; lower figure, female.

Sexual selection, which implies the possession of considerable perceptive powers and of strong passions, seems to have been more effective with the Lamellicorns than with any other family of beetles. With some species the males are provided with weapons for fighting; some live in pairs and show mutual affection; many have the power of stridulating when excited; many are furnished with the most extraordinary horns, apparently for the sake of ornament; and some, which are diurnal in their habits, are gorgeously colored. Lastly, several of the largest beetles in the world belong to this family, which was placed by Linnæus and Fabricius at the head of the Order.

Stridulating Organs.— Beetles belonging to many and widely distinct families possess these organs. The sound thus produced can sometimes be heard at the distance of several feet or even yards, but it is not comparable with that made by the Orthoptera. The rasp generally consists of a narrow, slightly-raised surface, crossed by very fine, parallel ribs, sometimes so fine as to cause iridescent colors, and having a very elegant appearance under the microscope. In some cases, as with Typhœus, minute, bristly

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or scale-like prominences, with which the whole surrounding surface is covered in approximately parallel lines, could be traced passing into the ribs of the rasp. The transition takes place by their becoming confluent and straight, and at the same time more prominent and smooth. A hard ridge on an adjoining part of the body serves as the scraper for the rasp, but this scraper in some cases has been specially modified for the purpose. It is rapidly moved across the rasp, or conversely the rasp across the scraper.

These organs are situated in widely different positions. In the carrion-beetles (Necrophorus) two parallel rasps (*r*, fig. 25) stand on the dorsal surface of the fifth abdominal segment, each rasp consisting of 126 to 140 fine ribs. These ribs are scraped against the posterior margins of the elytra, a small portion of which projects beyond the general outline. In many Crioceridæ,

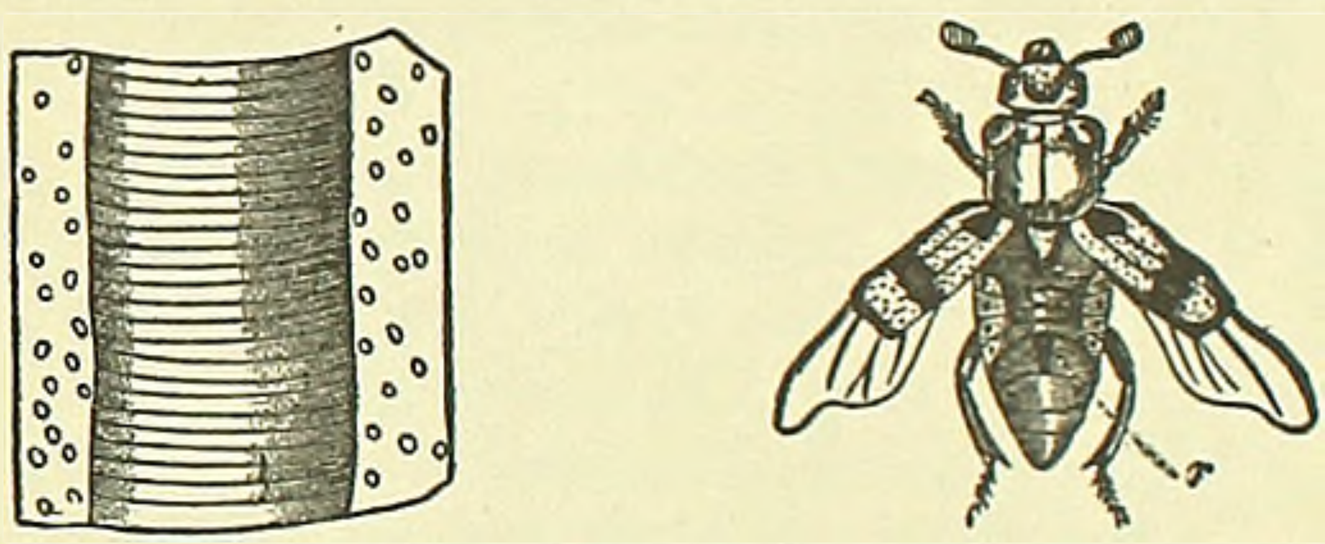

FIG. 25.—Necrophorus (from Landois). *r*. The two rasps. Left-hand figure, part of the rasp highly magnified.

and in *Clythra 4-punctata* (one of the Chrysomelidæ), and in some Tenebrionidæ, &c.,[14] the rasp is seated on the dorsal apex of the abdomen, on the pygidium or pro-pygidium, and is scraped in the same manner by the elytra. In Heterocerus, which belongs to another family, the rasps are placed on the sides of the first abdominal segment, and are scraped by ridges on the femora. In certain Curculionidæ and Carabidæ,[15] the parts are

[14] I am greatly indebted to Mr. G. R. Crotch for having sent me many prepared specimens of various beetles belonging to these three families and to others, as well as for valuable information. He believes that the power of stridulation in the Clythra has not been previously observed. I am also much indebted to Mr. E. W. Janson, for information and specimens. I may add that my son, Mr. F. Darwin, finds that *Dermestes murinus* stridulates, but he searched in vain for the apparatus. Scolytus has lately been described by Dr. Chapman as a stridulator, in the "Entomologist's Monthly Magazine," vol. vi. p. 130.

[15] Westring has described (Kroyer, "Naturhist. Tidskrift," B. ii. 1849, p. 334) the stridulating organs in these two, as well as in other families.

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completely reversed in position, for the rasps are seated on the inferior surface of the elytra, near their apices, or along their outer margins, and the edges of the abdominal segments serve as the scrapers. In *Pelobius Hermanni* (one of Dytiscidæ or water-beetles) a strong ridge runs parallel and near to the sutural margin of the elytra, and is crossed by ribs, coarse in the middle part, but becoming gradually finer at both ends, especially at the upper end; when this insect is held under water or in the air, stridulating noise is produced by the extreme horny margin of the abdomen being scraped against the rasps. In a great number of long-horned beetles (Longicornia) the organs are situated quite otherwise, the rasp being on the meso-thorax, which is rubbed against the pro-thorax; Landois counted 238 very fine ribs on the rasp of *Cerambyx heros.*

FIG. 26.—Hind-leg of Geotrupes stercorarius (from Landois). *r.* Rasp. *c.* Coxa. *f.* Femur. *t.* Tibia. *tr.* Tarsi.

Many Lamellicorns have the power of stridulating, and the organs differ greatly in position. Some species stridulate very loudly, so that when Mr. F. Smith caught a *Trox sabulosus,* a gamekeeper, who stood by, thought he had caught a mouse; but I failed to discover the proper organs in this beetle. In Geotrupes and Typhœus, a narrow ridge runs obliquely across (*r,* fig. 26) the coxa of each hind-leg (having in *G. stercorarius* 84 ribs), which is scraped by a specially projecting part of one of the abdominal segments. In the nearly allied *Copris lunaris,* an excessively narrow fine rasp runs along the sutural margin of the elytra, with another short rasp near the basal outer margin; but in some other Coprini the rasp is seated, according to Leconte, on the dorsal surface of the abdomen. In Oryctes it is seated on the pro-pygidium; and, according to the same entomologist, in some other Dynastini, on the under surface of the elytra. Lastly, Westring states that in *Omaloplia brunnea* the rasp is placed on the pro-sternum, and the scraper on the meta-

In the Carabidæ I have examined *Elaphrus uliginosus* and *Blethisa multipunctata,* sent to me by Mr. Crotch. In Blethisa the "transverse ridges on the furrowed border of the abdominal segment do not, as far as I could judge, come into play in scraping the rasps on the elytra.

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sternum, the parts thus occupying the under surface of the body, instead of the upper surface as in the Longicorns.

We thus see that in the different coleopterous families the stridulating organs are wonderfully diversified in position, but not much in structure. Within the same family some species are provided with these organs, and others are destitute of them. This diversity is intelligible, if we suppose that originally various beetles made a shuffling or hissing noise by the rubbing together of any hard and rough parts of their bodies, which happened to be in contact; and that from the noise thus produced being in some way useful, the rough surfaces were gradually developed into regular stridulating organs. Some beetles as they move, now produce, either intentionally or unintentionally, a shuffling noise, without possessing any proper organs for the purpose. Mr. Wallace informs me that the *Euchirus longimanus* (a Lamellicorn, with the anterior legs wonderfully elongated in the male) "makes, whilst moving, a low hissing sound by the protrusion and contraction of the abdomen; and when seized it produces a grating sound by rubbing its hind legs against the edges of the elytra." The hissing sound is clearly due to a narrow rasp running along the sutural margin of each elytron; and I could likewise make the grating sound by rubbing the shagreened surface of the femur against the granulated margin of the corresponding elytron; but I could not here detect any proper rasp; nor is it likely that I could have overlooked it in so large an insect. After examining Cychrus, and reading what Westring has written about this beetle, it seems very doubtful whether it possesses any true rasp, though it has the power of emitting a sound.

From the analogy of the Orthoptera and Homoptera, I expected to find the stridulating organs in the Coleoptera differing according to sex; but Landois, who has carefully examined several species, observed no such difference; nor did Westring; nor did Mr. G. R. Crotch in preparing the many specimens which he had the kindness to send me. Any difference in these organs, if slight, would, however, be difficult to detect, on account of their great variability. Thu, in the first pair of specimens of *Necrophorus humator* and of *Pelobius* which I examined, the rasp was considerably larger in the male than in the female; but not so with succeeding specimens. In *Geotrupes stercorarius*

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the rasp appeared to me thicker, opaquer, and more prominent in three males than in the same number of females; in order, therefore, to discover whether the sexes differed in their power of stridulating, my son, Mr. F. Darwin, collected fifty-seven living specimens, which he separated into two lots, according as they made a greater or less noise, when held in the same manner. He then examined all these specimens, and found that the males were very nearly in the same proportion to the females in both the lots. Mr. F. Smith has kept alive numerous specimens of *Monoynchus pseudacori* (Curculionidæ), and is convinced that both sexes stridulate, and apparently in an equal degree.

Nevertheless, the power of stridulating is certainly a sexual character in some few Coleoptera. Mr. Crotch discovered that the males alone of two species of Heliopathes (Tenebrionidæ) possess stridulating organs. I examined five males of *H. gibbus*, and in all these there was a well-developed rasp, partially divided into two, on the dorsal surface of the terminal abdominal segment; whilst in the same number of females there was not even a rudiment of the rasp, the membrane of this segment being transparent, and much thinner than in the male. In *H. cribrato-striatus* the male has a similar rasp, excepting that it is not partially divided into two portions, and the female is completely destitute of this organ; the male in addition has on the apical margins of the elytra, on each side of the suture, three or four short longitudinal ridges, which are crossed by extremely fine ribs, parallel to and resembling those on the abdominal rasp; whether these ridges serve as an independent rasp, or as a scraper for the abdominal rasp, I could not decide: the female exhibits no trace of this latter structure.

Again, in three species of the Lamellicorn genus Oryctes, we have a nearly parallel case. In the females of *O. gryphus* and *nasicornis* the ribs on the rasp of the pro-pygidium are less continuous and less distinct than in the males; but the chief difference is that the whole upper surface of this segment, when held in the proper light, is seen to be clothed with hairs, which are absent or are represented by excessively fine down in the males. It should be noticed that in all Coleoptera the effective part of the rasp is destitute of hairs. In *O. senegalensis* the difference between the sexes is more strongly marked, and this is best seen

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when the proper abdominal segment is cleaned and viewed as a transparent object. In the female the whole surface is covered with little separate crests, bearing spines; whilst in the male these crests in proceeding towards the apex, become more and more confluent, regular, and naked; so that three-fourths of the segment is covered with extremely fine parallel ribs, which are quite absent in the female. In the females, however, of all three species of Oryctes, a slight grating or stridulating sound is produced, when the abdomen of a softened specimen is pushed backwards and forwards.

In the case of the Heliopathes and Oryctes there can hardly be a doubt that the males stridulate in order to call or to excite the females; but with most beetles the stridulation apparently serves both sexes as a mutual call. Beetles stridulate under various emotions, in the same manner as birds use their voices for many purposes besides singing to their mates. The great Chiasognathus stridulates in anger or defiance; many species do the same from distress or fear, if held so that they cannot escape; by striking the hollow stems of trees in the Canary Islands, Messrs. Wollaston and Crotch were able to discover the presence of beetles belonging to the genus Acalles by their stridulation. Lastly, the male Ateuchus stridulates to encourage the female in her work, and from distress when she is removed. Some naturalists believe that beetles make this noise to frighten away their enemies; but I cannot think that a quadruped or bird, able to devour a large beetle, would be frightened by so slight a sound. The belief that the stridulation serves as a sexual call is supported by the fact that death-ticks (*Anobium tessellatum*) are well known to answer each other's ticking, and, as I have myself observed, a tapping noise artificially made. Mr. Doubleday also informs me that he has sometimes observed a female ticking,[16] and in an hour or two afterwards has found her united with a male, and on one occasion surrounded by several males. Finally, it is probable that the two sexes of many kinds of

[16] According to Mr. Doubleday, "the noise is produced by the insect raising itself on its legs as high as it can, and then striking its thorax five or six times, in rapid succession, against the substance upon which it is sitting." For references on this subject see Landois, "Zeitschrift für wissen. Zoolog." B. xvii. s. 181. Olivier says (as quoted by Kirby and Spence, "Introduct." vol. ii. p. 395) that the female of *Pimelia striata* produces a rather loud sound by striking her abdomen against any hard substance, "and that the male, obedient to this call, soon attends her, and they pair."

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beetles were at first enabled to find each other by the slight shuffling noise produced by the rubbing together of the adjoining hard parts of their bodies; and that as those males or females which made the greatest noise succeeded best in finding partners, rugosities on various parts of their bodies were gradually developed by means of sexual selection into true stridulating organs.

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