N'P'A' is less than NPA. The amount grown would decrease from OM to OM'. The proceeds of the tax would be OM' times five shillings, and the consumers' surplus of enjoyment would have considerably diminished. This is all obvious enough if you look at the curves. But I want to ask whether, without a curve, you could have got all that so quickly by logical cogitation? I agree it could have been done by hard thought, but what a help the diagram has been in thinking it out. It is like drawing a genealogical tree when you are thinking out some complex problems of family relationship. A simple inspection of the figure also shows that an *ad valorem* tax on rent would not increase price or diminish production.

Again, what is a monopoly? A monopoly is simply

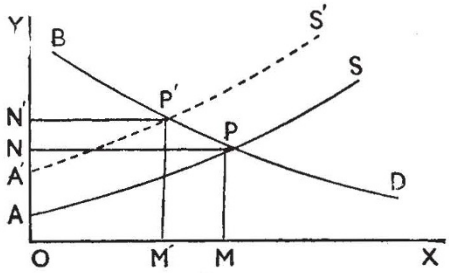

FIG. 7.

a power of stopping production at a point short of that which it would reach under conditions of free production, sale, and distribution. You can stop production by means of statutes regulating quantities produced, or by combinations to limit production, or to limit the supply of labour produced, or by statutes regulating the employment of capital, or by statutes fixing minima of wages, or in various other ways. If you exercise the power, then the state of things shown in Fig. 8 comes into play. The quantity produced is reduced to OM'. The price rises from PM to P'M', the surplus producers' profit (including rent) rises from ANP to AQP'N'. So that profits, interest, and wages increase, but the consumers' surplus enjoyment goes down from NPB to N'P'B. The limitation of output plays a far larger part in the regu-

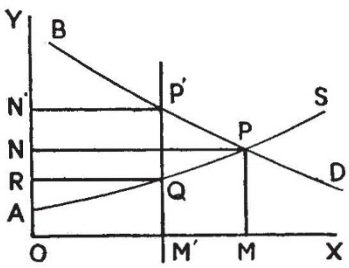

FIG. 8.

lation of prices than is commonly supposed. Those who are engaged in the manipulation of the meat trade, and the bread trade, and the petroleum industry, the supply of machinery or other articles, do not usually advertise the means they have taken to limit supply, nor do trade unions publicly descant upon the means they adopt to limit the labour of adults or apprentices. It is no part of our business here to discuss the necessity or the legitimate limits of such limitations. All that I am here to do is to show how useful diagrams are in explaining their effects.

The monopoly controller seeks, of course, to make the area AQP'N' a maximum, arranging his price just in the way a milliner would do who had to cut the biggest square she could out of a remnant of material. How much reduction of output and increase of price will the market bear? is the question that all monopolists present to themselves.

I could go on with these curves through a great variety of questions. They become especially interesting where applied to show the effects of tariffs upon export and import trade, but I must forbear.

My principal object has not been to introduce to the notice of the audience a subject already known to many of them, but rather to use it as an illustration of the truth that national economics is subject to laws —laws which, though complicated, are as exact and unfailing as the laws of physics, chemistry, or engineering, and which, if neglected by political engineers, will as certainly bring the State to ruin as the miscalculation of a mechanical engineer in designing a boiler, or of a civil engineer in designing a bridge. Whence, then, instead of consigning economics to Saturn, let us study it, not in a metaphysical or Aristotelian manner, using question-begging epithets, or, on the other hand, in the manner of some moderns, as, for example, Ruskin, by replacing reason by sentiment; but let us approach it in the spirit of positive science.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. G. ELLIOT SMITH, M.A., M.D., CH.M., F.R.S., PRESIDENT OF THE SECTION.[1]

The Evolution of Man.

AT the outset it is fitting that I should express our sense of the loss this section has sustained in the death of Mr. Andrew Lang. Meeting as we do so near to his home at St. Andrews, it was hoped at one time that his versatile scholarship and literary skill would have been available to add lustre to our deliberations. But early last winter we learned with deep regret that the state of his health would not permit him to accept the presidency of the section. In associating ourselves with those who are deploring the loss literature and history have sustained, we realise that our science also is the poorer to-day through the death of one of its most brilliant expositors.

The Scope of Evolution.

In a recent address Lord Morley referred to "evolution" as "the most overworked word in all the language of the day"; nevertheless, he was constrained to admit that, even when discussing such a theme as history and modern politics, "we cannot do without it." But to us in this section, concerned as we are with the problems of man's nature and the gradual emergence of human structure, customs, and institutions, the facts of evolution form the very fabric the threads of which we are endeavouring to disentangle; and in such studies ideas of evolution find more obvious expression than most of us can detect in modern politics. In such circumstances we are peculiarly liable to the risk of "overworking" not only the word evolution, but also the application of the idea of evolution to the material of our investigations.

My predecessor in the office of president of this section last year uttered a protest against the tendency, to which British anthropologists of the present generation seem to be peculiarly prone, to read evolutionary ideas into many events in man's history and the spread of his knowledge and culture in which careful in-

[1] This report represents the address as it was delivered at the meeting; it is a somewhat condensed and rearranged form of that appearing in the Association's Reports.

vestigation can detect no indubitable trace of any such influences having been at work.

I need offer no apology for repeating and emphasising some of the points brought forward in Dr. Rivers's deeply instructive address; for his lucid and convincing account of the circumstances that had compelled him to change his attitude toward the main problems of the history of human society in Melanesia first brought home to me the fact, which I had not clearly realised until then, that in my own experience, working in a very different domain of anthropology on the opposite side of the world, I had passed through phases precisely analogous to those described so graphically by Dr. Rivers. He told us that in his first attempts to trace out "the evolution of custom and institution" he started from the assumption that "where similarities are found in different parts of the world they are due to independent origin and development, which in turn is ascribed to the fundamental similarity of the workings of the human mind all over the world, so that, given similar conditions, similar customs and institutions will come into existence and develop on the same lines." But as he became more familiar with the materials of his research he found that such an attitude would not admit of an adequate explanation of the facts, and he was forced to confess that he "had ignored considerations arising from racial mixture and the blending of cultures."

I recall these statements to your recollection now, not merely for the purpose of emphasising the far-reaching significance of an address which is certain to be looked back upon as one of the most distinctive and influential utterances from this presidential chair, nor yet with the object of telling you how, in the course of my investigations upon the history of the people in the Nile Valley,[2] I also started out to search for evidences of evolution, but gradually came to realise that the facts of racial admixture and the blending of cultures were far more obtrusive and significant. My intention is rather to investigate the domain of anthropology in which unequivocal evolutionary factors have played a definite rôle; I refer to the study of man's genealogy, and the forces that determined the precise line of development his ancestors pursued and ultimately fashioned man himself.

I suppose it is inevitable in these days that one trained in biological ways of thought should approach the problems of anthropology with the idea of independent development as his guiding principle; but the conviction must be reached sooner or later, by everyone who conscientiously, and with an open mind, seeks to answer most of the questions relating to man's history and achievements—certainly the chapters in that history which come within the scope of the last sixty centuries—that evolution yields a surprisingly small contribution to the solution of the difficulties which present themselves. Most of the factors that call for investigation concerning the history of man and his works are unquestionably the direct effects of migrations and the intermingling of races and cultures.

But I would not have you misunderstand my meaning. Nothing could be further from my intention than to question the reality of evolution, as understood by Charles Darwin, and the tremendous influence it is still exerting upon mankind. In respect of certain perils man may, perhaps, have protected himself from "the general operation of that process of natural selection and survival of the fittest which, up to his appearance, had been the law of the living world" (Sir Ray Lankester); but it has been demonstrated quite definitely that man, in virtue of these very heightened powers, which, to some observers, seem to have secured him an immunity from what Sir Ray Lankester calls "nature's inexorable discipline of death," is constantly exposing himself to new conditions that favour the operations of natural selection, as well as other forms of "selection" which his increased powers of intelligent choice and his subjection to the influences of fashion expose him.

It is not, however, with such contentious matters as the precise mode of operation of evolution at the present day that I propose to deal; nor yet with the discussion of when and how the races of mankind became specialised and differentiated the one from the other. It is the much older story of the origin of man himself and the first glimmerings of human characteristics amidst even the remotest of his ancestors to which I invite you to give some consideration to-day.

In a recently published book[3] the statement is made that "the uncertainties as to man's pedigree and antiquity are still great, and it is undeniably difficult to discover the factors in his emergence and ascent." There is undoubtedly the widest divergence of opinion as to the precise pedigree; nevertheless, there seems to me to be ample evidence now available to justify us sketching the genealogy of man and confidently drawing up his pedigree as far back as Eocene times —a matter of a million years or so—with at least as much certainty of detail and completeness as in the case of any other recent mammal; and if all the factors in his emergence are not yet known, there is one unquestionable, tangible factor that we can seize hold of and examine—the steady and uniform development of the brain along a well-defined course throughout the primates right up to man—which must give us the fundamental reason for "man's emergence and ascent," whatever other factors may contribute toward that consummation.

What I propose to attempt is to put into serial order those vertebrates which we have reason to believe are the nearest relatives to man's ancestors now available for examination, and to determine what outstanding changes in the structure of the cerebral hemispheres have taken place at each upward step that may help to explain the gradual acquirement of the distinctively human mental faculties, which, by immeasurably increasing the power of adaptation to varying circumstances and modifying the process of sexual selection, have made man what he is at present.

The links in the chain of our ancestry supplied by palæontology are few, and of doubtful value, if considered apart from the illumination of comparative anatomy.

Psychologists have formulated certain definite phases through which the evolution of intelligence must have passed in the process of gradual building-up of the structure of the mind. The brain in a sense is the incarnation of this mental structure; and it seemed to me that it would be instructive, and perhaps useful, to employ the facts of the evolution of the brain as the cement to unite into one comprehensive story the accumulations of knowledge concerning the essential facts of man's pedigree, and the factors that have contributed to his emergence, which have been gathered by workers in such diverse departments of knowledge as zoology and comparative anatomy, geology and palæontology, and physiology and psychology.

For it was the evolution of the brain and the ability to profit by experience, which such perfecting of the cerebral mechanism made possible, that led to the emergence of mammals, as I attempted to demonstrate in opening the discussion on the origin of mammals at the Portsmouth meeting last year[4]; and from

[2] "The Ancient Egyptians," Harpers, 1911.

[3] J. A. Thomson and P. Geddes, "Evolution," 1912, p. 102.

[4] Discussion on the "Origin of Mammals" at the meetings of Section D (Brit. Assoc. Reports, 1911, p. 424).

the mammalia, by a continuation of this process of building-up the cerebral cortex, or, if you prefer it, the structure of the mind, was eventually formed that living creature which has attained the most extensive powers of profiting by individual experience.

The study of the brain and mind, therefore, should have been the first care of the investigator of human origins. Charles Darwin, with his usual perspicuity, fully realised this; but since his time the rôle of intelligence and its instruments has been almost wholly ignored in these discussions; or when invoked at all wholly irrelevant aspects of the problems have been considered.

There can be no doubt that this neglect of the evidence which the comparative anatomy of the brain supplies is in large measure due to the discredit cast upon this branch of knowledge by the singularly futile pretensions of some of the foremost anatomists who opposed Darwin's views in the discussions which took place at the meetings of the British Association and elsewhere more than forty years ago.

Many of you no doubt are familiar with Charles Kingsley's delightful ridicule of these learned discussions in the pages of "Water Babies." The controversy excited by Sir Richard Owen's contention that the great distinctive feature of the human brain was the possession of a structure that used to be called the hippocampus minor was not unjustly the mark of his scathing satire.

"The professor had even got up at the British Association and declared that apes had hippopotamus majors in their brains, just as men have. Which was a shocking thing to say; for, if it were so, what would become of the faith, hope, and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is only a child's fancy, my dear. Nothing is to be depended upon but the great hippopotamus test. If you have a hippopotamus major in your brain you are no ape, though you had four hands, no feet, and were more apeish than the apes of all aperies. Always remember that the one true, certain, final, and all-important difference between you and an ape is that you have a hippopotamus major in your brain and it has none. If a hippopotamus was discovered in an ape's brain, why, it would not be one, you know, but something else."

The measure of the futility of the contention thus held up to scorn can be more justly realised now; for some years ago I discovered that the feature referred to in Kingsley's burlesque phrase, "hippopotamus major," which Owen claimed to be distinctive of the human brain, and Huxley maintained was present also in apes, is quite a primitive characteristic, and the common property of the mammalia in general.

This illustration of the nature of the discussions which distracted attention from the real problems, although the most notorious one, is unfortunately characteristic of the state of affairs that prevailed when prejudice blinded men's eyes to the obvious facts that were calling so urgently for calm investigation.

Man's Pedigree.

No one who is familiar with the anatomy of man and the apes can refuse to admit that no hypothesis other than that of close kinship affords a reasonable or credible explanation of the extraordinarily exact identity of structure that obtains in most parts of the bodies of man and the gorilla. To deny the validity of this evidence of near kinship is tantamount to a confession of the utter uselessness of the facts of comparative anatomy as indications of genetic relationships, and a reversion to the obscurantism of the dark ages of biology. But if anyone still harbours an honest doubt in the face of this overwhelming testimony from mere structure, the reactions of the blood will confirm the teaching of anatomy; and the susceptibility of the anthropoid apes to the infection of human diseases, from which other apes and mammals in general are immune, should complete and clinch the proof for all who are willing to be convinced.

Nor can anyone who, with an open mind, applies similar tests to the gibbon refuse to admit that it is a true, if very primitive, anthropoid ape, nearly related to the common ancestor of man, the gorilla, and the chimpanzee. Moreover, its structure reveals indubitable evidence of its derivation from some primitive Old World or catarrhine monkey akin to the ancestor of the langur, the sacred monkey of India. It is equally certain that the catarrhine apes were derived from some primitive platyrrhine ape, the other, less modified, descendants of which we recognise in the South American monkeys of the present day; and that the common ancestor of all these primates was a lemuroid nearly akin to the curious litle spectral tarsier, which still haunts the forests of Borneo, Java, and the neighbouring islands, and awakens in the minds of the peoples of those lands a superstitious dread—a sort of instinctive horror at the sight of the ghost-like representative of their first primate ancestor.

This much of man's pedigree will, I think, be admitted by the great majority of zoologists who are familiar with the facts; but I believe we can push the line of ancestry still further back, beyond the most primitive primate into Haeckel's suborder Menotyphla, which most zoologists regard as constituting two families of insectivora. I need not stop to give the evidence for this opinion, for most of the data and arguments in support of it have recently been summarised most excellently by Dr. W. K. Gregory.[5]

This group includes the Oriental tree-shrews and the African jumping-shrews. The latter (Macroscelididæ), living in the original South African home of the mammalia, present extraordinarily primitive features linking them by close bonds of affinity to the marsupials. The tree-shrews (Tupaiidæ), however, which range from India to Java, while presenting very definite evidence of kinship to their humble African cousins, also display in the structure of their bodies positive evidence of relationship to the stem of the aristocratic primate phylum.

Quite apart from the striking similarities produced by identical habits and habitats, there are many structural identities in the tree-shrews and lemuroids, not directly associated with such habits, which can be interpreted only as evidences of affinity.

The Neopallium and its Relation to the Ability of Learning by Experience.

Having now sketched the broad lines of man's pedigree right back to the most primitive mammals, let us next consider what were the outstanding factors that determined the course of his ancestors' progressive evolution.

The class mammalia, to which man belongs, is distinguished in structure from all other vertebrates mainly by the size and high development of the brain, and, as regards the behaviour of its members, by the fact that they are able, in immeasurably greater degree than all other animals, not excluding even birds, to profit by individual experience. The behaviour of most, or perhaps it would be more correct to say all, animals, however complex and nicely adapted to their

5 "The Orders of Mammals," Bull. Amer. Mus. Nat. Hist., vol. xxvii., 1910, p. 321.

circumstances it may seem, is essentially instinctive; and the main problem we have to solve, in attempting to explain the emergence of the distinctive attributes of the creature which in greater measure than any other has succeeded in subordinating its instincts to reason, is the means by which it has become possible for the effects of individual experience to be brought to bear upon conduct.

The ability to learn by experience necessarily implies the development, somewhere in the brain, of a something which can act not only as a receptive organ for impressions of the senses and a means for securing that their influence will find expression in modifying behaviour, but also serve in a sense as a recording apparatus for storing such impressions, so that they may be revived in memory at some future time in association with other impressions received simultaneously, the state of consciousness they evoked, and the response they called forth.

Such an organ of associative memory is actually found in the brain of mammals. It is the cortical area to which eleven years ago I applied the term "neopallium."[6] Into it pathways lead from all the sense organs; and each of its territories, which receives a definite kind of impression, visual, acoustic, tactile, or any other, is linked by the most intimate bonds with all the others. In spite of the disapproval of the psychologists, we can indeed regard this neopallium as fulfilling all the conditions of the *sensorium commune,* which Aristotle and many generations of philosophers have sought for twenty centuries; for it is unquestionably a "unitary organ the physical processes of which might be regarded as corresponding to the unity of consciousness" (Wm. MacDougall).

Nothing that happens in this area in the course of its enormous expansion and differentiation in the higher mammals materially affects this fundamental purpose of the neopallium, which continues to remain a unifying organ that acts as a whole, though each part is favourably placed to receive and transmit to the rest its special quota to the sum-total of what we may call the materials of conscious life.

The consciousness which resides, so to speak, in this neopallium, and is fed by the continual stream of sensory impressions pouring into it and awakening memories of past sensations, can express itself directly in the behaviour of the animal through the intermediation of a part of the neopallium itself, the so-called motor area, which is not only kept in intimate relation with the muscles, tendons, and skin by sensory impressions, but controls the voluntary responses of the muscles of the opposite side of the body.

The Differentiation of Mammals and the Effects of Specialisation.

The possession of this higher type of brain enormously widened the scope for the conscious and intelligent adaptation of the animal to varying surroundings; and in the exercise of this newly acquired ability to learn from individual experience, and so appreciate the possibilities of fresh sources of food supply and new modes of life, the way was opened for an infinite series of adaptations to varying environments, entailing structural modifications in which the enhanced plasticity of the new type of animal found expression.

Nature tried innumerable experiments with the new type of brain almost as soon as the humble Therapsid-like mammal felt the impetus of its new-found power of adaptation. In turn, the Prototherian and Metatherian types of brain were tried before the more adaptable scheme of the Eutherian brain was evolved.

[6] "The Natural Subdivision of the Cerebral Hemisphere," *Journ. Anat. and Phys.*, vol. xxxv., 1901, p 431: Arris and Gale Lectures on the Evolution of the Brain, *Lancet*, January 15, 1910, p. 153.

The new breed of intelligent creatures rapidly spread from their South African home throughout the whole world, and exploited every mode of livelihood. The power of adaptation to the particular kind of life each group chose to pursue soon came to be expressed in a bewildering variety of specialisations in structure, some for living on the earth or burrowing in it, others for living in trees or even for flight; others, again, for an aquatic existence. Some mammals became fleet of foot, and developed limbs specially adapted to enhance their powers of rapid movement. They attained an early pre-eminence, and were able to grow to large dimensions in the slow-moving world at the dawn of the age of mammals. Others developed limbs specially adapted for swift attack and habits of stealth, successfully to prey upon their defenceless relatives.

Most of these groups attained the immediate success that often follows upon early specialisation; but they also paid the inevitable penalty. They became definitely committed to one particular kind of life; and in so doing they had sacrificed their primitive simplicity and plasticity of structure, and in great measure their adaptability to new conditions. The retention of primitive characters, which so many writers upon biological subjects, and especially upon anthropology, assume to be a sign of degradation, is not really an indication of lowliness. We should rather look upon high specialisation of limbs and the narrowing of the manner of living to one particular groove as confessions of weakness, the renunciation of the wider life for one that is sharply circumscribed.

The stock from which man eventually emerged played a very humble rôle for long ages after many other mammalian orders had waxed great and strong. But the race is not always to the swift, and the lowly group of mammals which took advantage of its insignificance to develop its powers evenly and very gradually, without sacrificing in narrow specialisation any of its possibilities of future achievement, eventually gave birth to the dominant and most intelligent of all living creatures.

The tree-shrews are small squirrel-like animals which feed on "insects and fruit, which they usually seek in trees, but also occasionally on the ground. When feeding they often sit on their haunches, holding the food, after the manner of squirrels, in their forepaws."[7] They are of "lively disposition and great agility."[8] These vivacious, large-brained little insectivores, linked by manifold bonds of relationship to some of the lowliest and most primitive mammals, present in the structure of their skull, teeth, and limbs undoubted evidence of a kinship, remote though none the less sure, with their compatriots the Malaysian lemurs; and it is singularly fortunate for us in this inquiry that side by side there should have been preserved from the remote Eocene times, and possibly earlier still, these insectivores, which had almost become primates, and a little primitive lemuroid, the spectral tarsier, which had only just assumed the characters of the primate stock, when nature fixed their types and preserved them throughout the ages, with relatively slight change, for us to study at the present day.

Thus we are able to investigate the influence of an arboreal mode of life in stimulating the progressive development of a primitive mammal, and to appreciate precisely what changes were necessary to convert the lively, agile Ptilocercus-like ancestor of the primates into a real primate.

In the forerunners of the mammalia the cerebral hemisphere was predominantly olfactory in function; and even when the true mammal emerged, and all the

[7] Flower and Lydekker, "Mammals, Living and Extinct," 1891 . 618
[8] W. K. Gregory, *op. cit.*, p. 269, and pp. 279, 280.

other senses received due representation in the neopallium, the animal's behaviour was still influenced to a much greater extent by smell impressions than by those of the other senses.

This was due not only to the fact that the sense of smell had already installed its instruments in, and taken firm possession of, the cerebral hemisphere long before the advent in this dominant part of the brain of any adequate representation of the other senses, but also, and chiefly, because to a small land-grubbing animal the guidance of smell impressions, whether in the search for food or as a means of recognition of friends or enemies, was much more serviceable than all the other senses. Thus the small creature's mental life was lived essentially in an atmosphere of odours, and every object in the outside world was judged primarily and predominantly by its smell; the senses of touch, vision, and hearing were merely auxiliary to the compelling influence of smell.

Once such a creature left the solid earth and took to an arboreal life all this was changed, for away from the ground the guidance of the olfactory sense lost much of its usefulness. Life amidst the branches of trees limits the usefulness of olfactory organs, but it is favourable to the high development of vision, touch, and hearing. Moreover, it demands an agility and quickness of movement that necessitates an efficient motor cortex to control and co-ordinate such actions as an arboreal mode of life demands (and secures, by the survival only of those so fitted), and also a well-developed muscular sensibility to enable such acts to be carried out with precision and quickness. In the struggle for existence, therefore, all arboreal mammals, such as the tree-shrews, suffer a marked diminution of their olfactory apparatus, and develop a considerable neopallium, in which relatively large areas are given up to visual, tactile, acoustic, kinæsthetic, and motor functions, as well as to the purpose of providing a mechanism for mutually blending in consciousness the effects of the impressions pouring in through the avenues of these senses.

Thus a more equable balance of the representation of the senses is brought about in the large brain of the arboreal animal; and its mode of life encourages and makes indispensable the acquisition of agility. Moreover, these modifications do not interfere with the primitive characters of limb and body. These small arboreal creatures were thus free to develop their brains and maintain all the plasticity of a generalised structure, which eventually enabled them to go far in the process of adaptation to almost any circumstances that presented themselves.

Amongst the members of this group, as in all the other mammalian phyla, the potency of the forces of natural selection was immensely enhanced by the fact that the inquisitiveness of an animal which can learn by experience, *i.e.*, is endowed with intelligence, was leading these plastic insectivores into all kinds of situations which were favourable for the operation of selection. Various members of the group became specialised in different ways. Of such specialised strains the one of chief interest to us is that in which the sense of vision became especially sharpened.

The Origin of Primates.

Towards the close of the Cretaceous period some small arboreal shrew-like creature took another step in advance, which was fraught with the most far-reaching consequences; for it marked the birth of the primates and the definite branching off from the other mammals of the line of man's ancestry.

A noteworthy further reduction in the size of the olfactory parts of the brain, such as is seen in that of Tarsius,[9] quite emancipated the creature from the dominating influence of olfactory impressions, the sway of which was already shaken, but not quite overcome, when its tupaioid ancestor took to an arboreal life. This change was associated with an enormous development of the visual cortex in the neopallium, which not only increased in extent so as far to exceed that of Tupaia, but also became more highly specialised in structure. Thus, in the primitive primate, vision entirely usurped the controlling place once occupied by smell; but the significance of this change is not to be measured merely as the substitution of one sense for another. The visual area of cortex, unlike the olfactory, is part of the neopallium, and when its importance thus became enhanced the whole of the neopallium felt the influence of the changed conditions. The sense of touch also shared in the effects, for tactile impressions and the related kinæsthetic sensibility, the importance of which to an agile tree-living animal is obvious, assist vision in the conscious appreciation of the nature and the various properties of the things seen, and in learning to perform agile actions which are guided by vision.

An arboreal life also added to the importance of the sense of hearing; and the cortical representation of this sense exhibits a noteworthy increase in the primates, the significance of which it would be difficult to exaggerate in the later stages, when the simian are giving place to the distinctively human characteristics.

The high specialisation of the sense of sight awakened in the creature the curiosity to examine the objects around it with closer minuteness, and supplied guidance to the hands in executing more precise and more skilled movements than the tree-shrew attempts. Such habits not only tended to develop the motor cortex itself, trained the tactile and kinæsthetic senses, and linked up their cortical areas in bonds of more intimate associations with the visual cortex, but they stimulated the process of specialisation within or alongside the motor cortex of a mechanism for regulating the action of that cortex itself—an organ of attention which co-ordinated the activities of the whole neopallium so as the more efficiently to regulate the various centres controlling the muscles of the whole body. In this way not only is the guidance of all the senses secured, but the way is opened for all the muscles of the body to act harmoniously so as to permit the concentration of their action for the performance at one moment of some delicate and finely adjusted movement.

In some such way as this there was evolved from the motor area itself, in the form of an outgrowth placed at first immediately in front of it, a formation, which attains much larger dimensions and a more pronounced specialisation of structure in the primates than in any other order; it is the germ of that great prefrontal area of the human brain which is said to be "concerned with attention and the general orderly co-ordination of psychic processes,"[10] and as such is, in far greater measure than any other part of the brain, deserving of being regarded as the seat of the higher mental faculties and the crowning glory and distinction of the human fabric.

[By means of lantern slides representing Dr. Scharff's convincing elucidation of the modifications of the land connections during Tertiary times, a demonstration was given of the wanderings of the primates, which the facts of palæontology and comparative anatomy demand; the object being to direct attention to the fact

[9] "On the Morphology of the Brain in the Mammalia, with Special Reference to that of the Lemurs, Recent and Extinct," Trans. Linn. Soc. Lond., second series; *Zoology*, vol. viii., Part 1, February, 1903

[10] J. S. Bolton "The Functions of the Frontal Lobes," *Brain*, 1903.

that at each stage in the migrations of man's ancestors, menotyphlous, prosimian, platyrrhine, catarrhine and anthropoid, the unprogressive members remained somewhere in the neighbourhood of the home of their immediate ancestors, and that those which wandered into new surroundings had to struggle for their footing, and as the result of this striving attained a higher rank.

Other slides were shown to demonstrate the fact that in this series of primates there was a steady development of the brain—expansion and differentiation of the visual, tactile and auditory centres, and development of the meeting territory between them; a marked growth and specialisation of the motor centres, and the power of skilled movements, especially of the hands and fingers; and a regular expansion of the prefrontal area—along the lines marked out once for all when the first primate was formed from some menotyphlous progenitor.]

Thus the outstanding feature in the gradual evolution of the primate brain is a steady growth and differentiation of precisely those cortical areas which took on an enhanced importance in the earliest primates.

So far in this address I have been delving into the extremely remote, rather than the nearer, ancestry of man, because I believe the germs of his intellectual preeminence were sown at the very dawn of the Tertiary period, when the first anaptomorphid began to rely upon vision rather than smell as its guiding sense. In all the succeeding ages since that remote time the fuller cultivation of the means of profiting by experience, which the tarsioid had adopted, led to the steady upward progression of the primates. From time to time many individuals, finding themselves amidst surroundings which were thoroughly congenial and called for no effort, lagged behind; and in Tarsius and the lemurs, the New World monkeys, the Old World monkeys, and the anthropoids, not to mention the extinct forms, we find preserved a series of these laggards which have turned aside from the highway which led to man's estate.

The primates at first were a small and humble folk, who led a quite unobtrusive and safe life in the branches of trees, taking small part in the fierce competition for size and supremacy that was being waged upon the earth beneath them by their carnivorous, ungulate, and other brethren. But all the time they were cultivating that equable development of all their senses and limbs, and that special development of the more intellectually useful faculties of the mind which, in the long run, were to make them the progenitors of the dominant mammal—the mammal which was to obtain the supremacy over all others, while still retaining much of the primitive structure of limb that his competitors had sacrificed. It is important, then, to keep in mind that the retention of primitive characters is often to be looked upon as a token that their possessor has not been compelled to turn aside from the straight path and adopt protective specialisations, but has been able to preserve some of his primitiveness and the plasticity associated with it, precisely because he has not succumbed or fallen away in the struggle for supremacy. It is the wider triumph of the individual who specialises late, after benefiting by the many-sided experience of early life, over him who in youth becomes tied to one narrow calling.

In many respects man retains more of the primitive characteristics, for example, in his hands, than his nearest simian relatives; and in the supreme race of mankind many traits, such as abundance of hair, persist to suggest pithecoid affinities, which have been lost by the more specialised negro and other races. Those anthropologists who use the retention of primitive features in the Nordic European as an argument to exalt the negro to equality with him are neglecting the clear teaching of comparative anatomy, that the persistence of primitive traits is often a sign of strength rather than of weakness. This factor runs through the history of the whole animal kingdom.[11] Man is the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialisation either of structure or mode of life, which would be fatal to its plasticity and power of further development.

Having now examined the nature of the factors that have made a primate from an insectivore and have transformed a tarsioid prosimian into an ape, let us turn next to consider how man himself was fashioned.

The Origin of Man.

It is the last stage in the evolution of man that has always excited chief interest and has been the subject of much speculation, as the addresses of my predecessors in this presidency bear ample witness.

These discussions usually resolve themselves into the consideration of such questions as whether it was the growth of the brain, the acquisition of the power of speech, or the assumption of the erect attitude that came first and made the ape into a human being. The case for the erect attitude was ably put before the Association in the address delivered to this section by Dr. Munro in 1893. He argued that the liberation of the hands and the cultivation of their skill lay at the root of man's mental supremacy.

If the erect attitude is to explain all, why did not the gibbon become a man in Miocene times? The whole of my argument has aimed at demonstrating that the steady growth and specialisation of the brain has been the fundamental factor in leading man's ancestors step by step right upward from the lowly insectivore status, nay, further, through every earlier phase in the evolution of mammals—for man's brain represents the consummation of precisely those factors which throughout the vertebrata have brought their possessors to the crest of the wave of progress. But such advances as the assumption of the erect attitude are brought about simply because the brain has made skilled movements of the hands possible and of definite use in the struggle for existence: yet once such a stage has been attained the very act of liberating the hands for the performance of more delicate movements opens the way for a further advance in brain development to make the most of the more favourable conditions and the greater potentialities of the hands.

It is a fact beyond dispute that the divergent specialisation of the human limbs, one pair for progression, and the other for prehension and the more delicately adjusted skilled action, has played a large part in preparing the way for the emergence of the distinctively human characteristics; but it would be a fatal mistake unduly to magnify the influence of these developments. The most primitive living primate, the spectral tarsier, frequently assumes the erect attitude, and uses its hands for prehension rather than progression in many of its acts, and many other lemurs, such as the Indrisinæ of Madagascar, can and do walk erect.

In the remote Oligocene, a catarrhine ape, nearly akin to the ancestors of the Indian sacred monkey, Semnopithecus, became definitely specialised in structure in adaptation for the assumption of the erect attitude; and this type of early anthropoid has persisted with relatively slight modifications in the gibbon of the present day. But if the earliest gibbons were already able to walk upright, how is it, one might ask, that they did not begin to use their hands, thus freed from the work of progression on the earth, for skilled work, and at once before men? The

11 "The Brain in the Edentata," Trans. Linn. Soc., 1899.

obvious reason is that the brain had not yet attained a sufficiently high stage of development to provide a sufficient amount of useful skilled work, apart from the tree-climbing, for these competent hands to do.

The ape is tied down absolutely to his experience, and has only a very limited ability to anticipate the results even of relatively simple actions, because so large a proportion of his neopallium is under the dominating influence of the senses.

Without a fuller appreciation of the consequences of its actions than the gibbon is capable of, the animal is not competent to make the fullest use of the skill it undoubtedly possesses. What is implied in acquiring this fuller appreciation of the meaning of events taking place around the animal? The state of consciousness awakened by a simple sensory stimulation is not merely an appreciation of the physical properties of the object that supplies the stimulus: the object simply serves to bring to consciousness the results of experience of similar or contrasted stimulations in the past, as well as the feelings aroused by or associated with them, and the acts such feelings excited. This mental enrichment of a mere sensation so that it acquires a very precise and complex meaning is possible only because the individual has this extensive experience to fall back upon; and the faculty of acquiring such experience implies the possession of large neopallial areas for recording, so to speak, these sensation-factors and the feelings associated with them. The "meaning" which each creature can attach to a sensory impression presumably depends, not on its experience only, but more especially upon the neopallial provision in its brain for recording the fruits of such experience.

Judged by this standard, the human brain bears ample witness, in the expansion of the great temporo-parietal area, which so obviously has been evolved from the regions into which visual, auditory, and tactile impulses are poured, to the perfection of the physical counterpart of the enrichment of mental structure, which is the fundamental characteristic of the human mind.

The second factor that came into operation in the evolution of the human brain is merely the culmination of a process which has been steadily advancing throughout the primates: I refer to the high state of perfection of the cortical regulation of skilled movements, many of which are acquired by each individual in response to a compelling instinct that forces every normal human being to work out his own salvation by perpetually striving to acquire such manual dexterity.

This brings us to the consideration of the nature of the factors that have led to the wide differentiation of man from the gorilla. Why is it that these two primates, structurally so similar and derived simultaneously from common parents, should have become separated by such an enormous chasm, so far as their mental abilities are concerned?

There can be no doubt that this process of differentiation is of the same nature as those which led one branch of the Eocene tarsioids to become monkeys while the other remained prosimiæ; advanced one group of primitive monkeys to the catarrhine status, while the rest remained platyrrhine: and converted one division of the Old World apes into anthropoids, while the others retained their old status. Put into this form as an obvious truism, the conclusion is suggested that the changes which have taken place in the brain to convert an ape into man are of the same nature as, and may be looked upon merely as a continuation of, those processes of evolution which we have been examining in the lowlier members of the primate series. It was not the adoption of the erect attitude or the invention of articulate language that made man from an ape, but the gradual perfecting of the brain and the slow upbuilding of the mental structure, of which erectness of carriage and speech are some of the incidental manifestations.

The ability to perform skilled movements is conducive to a marked enrichment of the mind's structure and the high development of the neopallium, which is the material expression of that enrichment. There are several reasons why this should be so The mere process of learning to execute any act of skill necessarily involves the cultivation, not only of the muscles which produce the movement, and the cortical area which excites the actions of these muscles, but in even greater measure the sensory mechanisms in the neopallium which are receiving impressions from the skin, the muscles, and the eyes, to control the movements at the moment, and incidentally are educating these cortical areas, stimulating their growth, and enriching the mental structure with new elements of experience. Out of the experience gained in constantly performing acts of skill, the knowledge of cause and effect is eventually acquired. Thus the high specialisation of the motor area, which made complicated actions possible, and the great expansion of the temporo-parietal area, which enabled the ape-man to realise the "meaning" of events occurring around it, reacted one upon the other, so that the creature came to understand that a particular act would entail certain consequences. In other words, it gradually acquired the faculty of shaping its conduct in anticipation of results.

Long ages ago, possibly in the Miocene, the ancestors common to man, the gorilla, and the chimpanzee became separated into groups, and the different conditions to which they became exposed after they parted company were in the main responsible for the contrasts in their fate. In one group the distinctively primate process of growth and specialisation of the brain, which had been going on in their ancestors for many thousands, even millions, of years, reached a stage when the more venturesome members of the group, stimulated perhaps by some local failure of the customary food, or maybe led forth by a curiosity bred of their growing realisation of the possibilities of the unknown world beyond the trees which hitherto had been their home, were impelled to issue forth from their forests, and seek new sources of food and new surroundings on hill and plain, wherever they could obtain the sustenance they needed. The other group, perhaps because they happened to be more favourably situated or attuned to their surroundings, living in a land of plenty which encouraged indolence in habit and stagnation of effort and growth, were free from this glorious unrest, and remained apes, continuing to lead very much the same kind of life (as gorillas and chimpanzees) as their ancestors had been living since the Miocene or even earlier times. That both of these unenterprising relatives of man happen to live in the forests of tropical Africa has always seemed to me to be a strong argument in favour of Darwin's view that Africa was the original home of the first creatures definitely committed to the human career; for while man was evolved amidst the strife with adverse conditions, the ancestors of the gorilla and chimpanzee gave up the struggle for mental supremacy simply because they were satisfied with their circumstances; and it is more likely than not that they did not change their habitat.

The erect attitude, infinitely more ancient than man himself, is not the real cause of man's emergence from the simian stage; but it is one of the factors

made use of by the expanding brain as a prop still further to extend its growing dominion, and by fixing and establishing in a more decided way this erectness it liberated the hand to become the chief instrument of man's further progress.

In learning to execute movements of a degree of delicacy and precision to which no ape could ever attain, and the primitive ape-man could only attempt once his arm was completely emancipated from the necessity of being an instrument of progression, that cortical area which seemed to serve for the phenomena of attention became enhanced in importance. Hence the prefrontal region, where the activities of the cortex as a whole are, as it were, focussed and regulated, began to grow until eventually it became the most distinctive characteristic of the human brain, gradually filling out the front of the cranium and producing the distinctively human forehead. In the diminutive prefrontal area of Pithecanthropus,[12] and to a less marked degree, Neanderthal man,[13] we see illustrations of lower human types, bearing the impress of their lowly state in receding foreheads and great brow ridges. However large the brain may be in *Homo primigenius*, his small prefrontal region, if we accept Boule and Anthony's statements, is sufficient evidence of his lowly state of intelligence and reason for his failure in the competition with the rest of mankind.

The growth in intelligence and in the powers of discrimination no doubt led to a definite cultivation of the æsthetic sense, which, operating through sexual selection, brought about a gradual refinement of the features, added grace to the general build of the body, and demolished the greater part of its hairy covering. It also led to an intensification of the sexual distinctions, especially by developing in the female localised deposits of fatty tissue, not found in the apes which produced profound alterations in the general form of the body.

Right-handedness.

To one who considers what precisely it means to fix the attention and attempt the performance of some delicately adjusted and precise action it must be evident that one hand only can be usefully employed in executing the consciously skilled part in any given movement. The other hand, like the rest of the muscles of the whole body, can be only auxiliary to it, assisting, under the influence of attention, either passively or actively, in steadying the body or helping the dominant hand. Moreover, it is clear that if one hand is constantly employed for doing the more skilled work, it will learn to perform it more precisely and more successfully than either would if both were trained, in spite of what ambidextral enthusiasts may say. Hence it happened that when nature was fashioning man the forces of natural selection made one hand more apt to perform skilled movements than the other. Why precisely it was the right hand that was chosen in the majority of mankind we do not know, though scores of anatomists and others are ready with explanations. But probably some slight mechanical advantage in the circumstances of the limb, or perhaps even some factor affecting the motor area of the left side of the brain that controls its movements, may have inclined the balance in favour of the right arm; and the forces of heredity have continued to perpetuate a tendency long ago imprinted in man's structure when first he became human.

The fact that a certain proportion of mankind is left-handed, and that such a tendency is transmitted to some only of the descendants of a left-handed person, might perhaps suggest that one half of mankind was originally left-handed and the other right-handed, and that the former condition was recessive in the Mendelian sense, or that some infinitesimal advantage may have accrued to the right-handed part of the original community, which in time of stress spared them in preference to left-handed individuals; but the whole problem of why right-handedness should be much more common than left-handedness is still quite obscure. The superiority of one hand is as old as mankind, and is one of the factors incidental to the evolution of man.

It is easily comprehensible why one hand should become more expert than the other, as I have attempted to show; and the fact remains that it is the right hand, controlled by the left cerebral hemisphere, which is specially favoured in this respect. This heightened educability of the (left) motor centre (for the right hand) has an important influence upon the adjoining areas of the left motor cortex. When the ape-man attained a sufficient degree of intelligence to wish to communicate with his fellows other than by mere instinctive emotional cries and grimaces, such as all social groups of animals employ, the more cunning right hand would naturally play an important part in such gestures and signs; and, although the muscles of both sides of the face would be called into action in such movements of the features as were intended to convey information to another (and not merely to express the personal feelings of the individual), such bilateral movements would certainly be controlled by the left side of the brain, because it was already more highly educated.

The Origin of Speech.

[This argument was elaborated to explain the origin of speech. The increasing ability to perform actions demanding skill and delicacy received a great impetus when the hands were liberated for the exclusive cultivation of such skill: this perfection of cerebral control over muscular actions made it possible for the ape-man to learn to imitate the sounds around him, for the act of learning is a training not only of the motor centres and the muscles concerned, but also of the attention, and the benefits that accrued from educating the hands added to the power of controlling other muscles, such as those concerned with articulate speech.

The usefulness of such power of imitating sounds could be fully realised in primitive man, not only because he had developed the parts of the brain which made the acquisition of such skill possible, but also because he had acquired, in virtue of the development of other cortical areas, the ability to realise the significance and learn the meaning of the sounds heard.]

I do not propose to discuss the tremendous impetus that the invention of speech must have given to human progress and intellectual development, in enabling the knowledge acquired by each individual to become the property of the community and be handed on to future generations, as well as by supplying in words the very symbols and the indispensable elements of the higher mental processes.

We are apt to forget the immensity of the heritage that has come down to us from former generations of man, until we begin dimly to realise that for the vast majority of mankind almost the sum-total of their mental activities consists of imitation or acquiring and using the common stock of beliefs. For this accumulation of knowledge and its transmission to our generation we are almost wholly indebted to the use of speech. In our forgetfulness of these facts

[12] Eug. Dubois, "Remarks upon the Brain-cast of Pithecanthropus," Proc. Fourth Internat. Cong. Zool., August, 1898, published Camb., 1899, p. 81.

[13] Boule and Anthony, "L'encephale de l'homme fossile de la Chapelle-aux-Saints," *L'Anthropologie* tome xxii., No. 2, 1911, p. 50.

we marvel at the apparent dulness of early man in being content to use the most roughly chipped flints for many thousands of years before he learned to polish them, and eventually to employ materials better suited for the manufacture of implements and weapons. But when we consider how slowly and laboriously primitive man acquired new ideas, and how such ideas—even those which seem childishly simple and obvious to us—were treasured as priceless possessions and handed on from tribe to tribe, it becomes increasingly difficult to believe in the possibility of the independent evolution of similar customs and inventions of any degree of complexity.

The hypothesis of the "fundamental similarity of the working of the human mind" is no more potent to explain the identity of customs in widely different parts of the world, the distribution of megalithic monuments, or the first appearance of metals in America, than it is to destroy our belief that one man, and one only, originally conceived the idea of the mechanical use to which steam could be applied, or that the electric battery was not independently evolved in each of the countries where it is now in use.

In these discursive remarks I have attempted to deal with old problems in the light of newly acquired evidence; to emphasise the undoubted fact that the evolution of the primates and the emergence of the distinctively human type of intelligence are to be explained primarily by a steady growth and specialisation of certain parts of the brain; that such a development could have occurred only in the mammalia, because they are the only plastic class of animals with a true organ of intelligence; that an arboreal mode of life started man's ancestors on the way to pre-eminence, for it gave them the agility, and the specialisation of the higher parts of the brain incidental to such a life gave them the seeing eye, and in course of time also the understanding ear; and that all the rest followed in the train of this high development of vision working on a brain which controlled ever-increasingly agile limbs.

If, in pursuing these objects, I may have seemed to wander far from the beaten paths of anthropology, as it is usually understood in this section, and perhaps encroached upon the domains of the Zoological Section, my aim has been to demonstrate that the solution of these problems of human origins, which have frequently engaged the attention of the Anthropological Section, is not to be sought merely in comparisons of man and the anthropoid apes. Man has emerged not by the sudden intrusion of some new element into the ape's physical structure or the fabric of his mind, but by the culmination of those processes which have been operating in the same way in a long line of ancestors ever since the beginning of the Tertiary period.

If I have made this general conception clear to you, however clumsily I have marshalled the evidence and with whatever crudities of psychological statement it may be marred, I shall feel that this address has served some useful purpose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG the honorary degrees to be conferred by the University of Leeds on October 3, in connection with the visit of the Iron and Steel Institute, are:—LL.D. on the president of the institute, Mr. Arthur Cooper, and degrees of D.Sc. on Sir Robert Hadfield, past-president, Mr. J. E. Stead, and M. Adolph Greiner, vice-presidents, and the president of the Society of German Ironmasters.

AMONG the public lectures to be delivered in connection with the opening of the new session at University College, London, we notice the following:—*Faculty of Arts.*—October 3, amulets, Prof. Flinders Petrie; October 4, the philosophy of Shadworth Hodgson, Prof. G. Dawes Hicks; October 5, general phonetics, D. Jones; October 9, introduction to comparative psychology, Carveth Read. *Faculty of Science.*—October 4, Joseph Dalton Hooker, Prof. F. W. Oliver. *Faculty of Engineering.*—October 9, the sources of energy available to man, Prof. J. A. Fleming.

IN connection with the Faculty of Engineering of the East London College, one of the constituent colleges of the University of London, a special course of lectures on the management of public electric supply undertakings has been arranged. The lectures will be given by Mr. A. Hugh Seabrook, and will commence on Monday evening, October 14. It is hoped by this means to arouse the interest of electrical engineers and others in the practical working of modern electrical undertakings. The principal of the college will be pleased to provide particulars of the fees for these lectures, and also of other special courses in connection with the engineering faculty of the college.

IT is unusual to find astronomy and meteorology among the subjects of courses of lectures arranged by a local education committee. We are glad to see that the Manchester Education Committee is an exception to the rule, and that such lectures are being given at the Municipal School of Technology. Mr. W. C. Jenkins is delivering a course of twenty-six lectures on descriptive astronomy in the Godlee Observatory, of which he is curator, dealing with the descriptive and popular aspect of astronomy; a course of twelve lectures on elementary meteorology, supplementary to those on descriptive astronomy, demonstrations to be given at the Meteorological Station, established in the garden adjacent to the Municipal Secondary School; and a course of twenty-six lectures on astronomical observations and the use of the Nautical Almanack for students familiar with the elements of astronomy.

THE Newcastle Section, the Society of Chemical Industry, and the Armstrong College are this winter arranging courses of evening lectures on special chapters in applied chemistry, which, it is anticipated, will prove specially interesting to those chemists and engineers already engaged in the industries. To inaugurate the scheme a special fund is being raised, which has already received liberal support from the principal manufacturers in the district. Two courses of five lectures each have been arranged for this winter, for which the committee has secured the services of well-known specialists. The first course is one on coal-gas manufacture and the carbonisation of coal, by Dr. Harold G. Colman, of London, and the second on metallography, by Dr. Desch, of Glasgow University. The first course will commence on October 16, and continue at fortnightly intervals; the second course is to commence on January 28, 1913.

THE East Ham Technical College begins its seventh session this month. Being situated in a district largely devoted to chemical industries, it endeavours to provide instruction suitable to the locality. The chemical department, which has been reconstructed during the vacation, comprises two lecture rooms, an inorganic laboratory, with bench accommodation for sixty-four students, an organic laboratory of similar dimensions, specially arranged for technological work, two smaller organic laboratories, and a research laboratory. A metallurgical subdepartment has been recently