Such are the more salient points of Dr. Calori's paper, a translation of which I have thought it better to lay before the reader. There remains no longer any necessity to discuss the question whether this amphibia is a larval form; but still there is much to be done in reference to its organs of respiration in its early life. From finding the lungs in the young axolotl in a complete state of acatylectesis, while the tissue is beautifully developed in those of adult form, I am led to believe that branchial respiration is that of young life, while the older animal becomes as equally dependent for respiration on its lungs.

IX.—On the Zoological Relations of Man with the Lower Animals. By Professor Huxley, F. R. S.

As the biological sciences have grown in breadth and in depth, and as successive generations of naturalists have succeeded in penetrating further and further into the arcana of nature, the questions—In what relation does the thinker and investigator stand to the objects of his inquiries? What is the tie which connects man with other animated and sentient beings?—have more and more forcibly pressed for a reply.

Nor have responses been wanting; but, unfortunately, they have been diametrically opposed to one another. Theologians and moralists, historians and poets, impressed by a sense of the infinite responsibilities of mankind, awed by a just prevision of the great destinies in store for the only earthly being of practically unlimited powers, or touched by the tragic dignity of the ever-recurring struggle of human will with circumstance, have always tended to conceive of their kind as something apart, separated by a great and impassable barrier, from the rest of the natural world.

On the other hand, the students of physical science, discovering as complete a system of law and order in the microcosm as in the macrocosm, incessantly lighting upon new analogies and new identities between life as manifested by man, and life in other shapes,—have no less steadily gravitated towards the opposite opinion, and, as knowledge has advanced, have more and more distinctly admitted the closeness of the bond which unites man with his humbler fellows.

A controversy has raged between these opposed schools, and, as usual, passion and prejudice have conferred upon the battle far more importance than, as it seems to me, can rationally attach to its issue. For whether, as some think, man is, by his origin, distinct from all other living beings, or whether, on the other hand, as others suppose, he is the result of the modification of some other mammal, his duties and his aspirations must, I apprehend, remain the same. The proof of his claim to independent parentage will not change the brutishness of man's lower nature; nor, except to those valet souls who cannot see greatness in their fellow because his father was a cobbler, will the demonstration of a pithecoid pedigree one whit diminish man's divine

right of kingship over nature; nor lower the great and princely dignity of perfect manhood, which is an order of nobility, not inherited, but to be won by each of us, so far as he consciously seeks good and avoids evil, and puts the faculties with which he is endowed to their fittest use.

Important or unimportant in its final results as it may be, however, there can be no doubt that the controversy as to the real position of man still exists; and I have therefore thought that it would be useful to contribute my mite towards the enrichment of the armoury upon which both sides must, in the long run, be dependent for their weapons, by endeavouring to arrange and put in order the facts of the case, so far as they consist of the only matters of which the anatomist and physiologist can take cognizance—I mean facts of discernible structure and of demonstrable function. If any one assert that there are other orders of facts which enter into this question, but which are distinguished by being neither demonstrable nor discernible, all that can be replied is, that science is incompetent either to affirm or deny his proposition, confined, as she is, to the humble, if safe, region of observation and of logic.

No one denies, I believe, that there are multitudes of analogies and affinities of structure and function connecting man with other living beings. Man takes his origin in an ovum similar in form, in size, and in structure to that whence the dog or the rabbit arise. The physical process which determines the development of the embryo within that ovum; the successive stages of that development; the mode in which the human fœtus is nourished within the maternal organism; the process of birth; the means provided by nature for the due supply of nutriment after birth: are essentially alike in all three cases. Compare the bony frame-work, the muscles, the great vessels, the viscera, of man, the dog, and the rabbit, and the demonstration of a pervading unity of plan in all three is one of the triumphs of modern science.

The most certain propositions entertained by the human physiologist, those upon which the scientific practice of the healing art depends, are largely, or wholly, based on the results of experiments on animals. The poison which hurts them does not leave us unscathed; and we share with them two of the most terrible diseases with which mortal beings are afflicted, glanders and hydrophobia. Nor can any impartial judge doubt that the roots, as it were, of those great faculties which confer on man his immeasurable superiority above all other animate things, are traceable far down into the animal world. The dog, the cat, and the parrot return love for our love, and hatred for our hatred. They are capable of shame and of sorrow; and though they may have no logic nor conscious ratiocination, no one who has watched their ways can doubt that they possess that power of rational cerebration which evolves reasonable acts from the premises furnished by the senses—a process, be it observed, which takes fully as large a share as conscious reason in human activity. There is a unity in psychical as in physical plan among animated beings; and the sense of this unity has been expressed in such

strong terms by Professor Owen, that his words may form a fitting climax to these introductory sentences.

"Not being able to appreciate or conceive of the distinction between the psychical phenomena of a chimpanzee and of a Boschisman, or of an Aztec, with arrested brain-growth, as being of a nature so essential as to preclude a comparison between them, or as being other than a difference of degree, I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty."*

That there are a great number of points of similarity between ourselves and the lower animals, then, appears to be clearly admitted on all hands. It is, further, universally allowed that the Vertebrata resemble man more nearly than do any invertebrates; that among vertebrates the Mammalia, and of these the Quadrumana, approach him most closely. Lastly, I am aware of no dissentient voice to the proposition, that in the whole, the genera *Troglodytes*, *Pithecus*, and *Hylobates*, make the closest approximation to the human structure.

The approximation is admitted unanimously; but unanimity ceases the moment one asks what is the value of that approximation, if expressed in the terms by which the relations of the lower animals one to another are signified. Linnæus was content to rank man and the apes in the same order, Primates, ranging in terms of zoological equality, the genera, *Homo*, *Sima*, *Lemur*, and *Vespertilio*. Among more modern zoologists of eminence, Schreber, Goldfuss, Gray, and Blyth, have followed Linnæus, in being unable to see the necessity of distinguishing man ordinally from the apes.

Blumenbach, and after him, Cuvier, conceived that the possession of two hands, instead of four, taken together with other distinctive characters of man, was a sufficient ground for the distinction of the human family as a distinct order—*Bi-mana*.

Professor Owen goes a step further, and raises *Homo* into a subclass, "*Archencephala*," because "his psychological powers, in association with his extraordinarily developed brain, entitle the group which he represents to equivalent rank with the other primary divisions of the class *Mammalia*, founded on cerebral characters."†

M. Terres‡ vindicates the dignity of man still more strongly, by demanding for the human family the rank of a kingdom equal to the Ani-

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* Prof. Owen on the Characters, &c., of the Class Mammalia, "Journal of the Proceedings of the Linnæan Society of London," vol. ii., No. 5, 1857, p. 20, note. It is to be regretted that this note is omitted in the "Essay on the Classification of the Mammalia," which is otherwise nearly a reprint of this paper. I cannot go so far, however, as to say, with Prof. Owen, that the determination of the difference between *Homo* and *Pithecus* is the 'anatomist's difficulty.'

† Professor Owen on the Characters, &c., of the Class Mammalia, l. c., p. 33.

‡ L'homme ne forme ni une espèce ni une genre comparable aux Primates. L'homme à lui seul constitue un regne à part—le Regne humain."—Resumé des Leçons sur l'Embryologie Anthropologique, Comptes Rendus, 1851.

malia or Plantæ; while, finally, a countryman of our own arrogates to his fellows so high a place in the aristocracy of nature as to deny that mankind can be thought of zoologically at all.

From the conception of man as a genus of *Primates* to the refusal to conceive of him as a subject of zoological investigation, is a wide range of opinion—so wide, indeed, as to include all possible views; for in the present state of science, no one is likely to propound the idea that man is only a species of some genus of ape. Ingenious and learned men have held all the doctrines which have been mentioned; great men have held some of them; and, therefore, it is more than probable that the question at issue, if we put the problem in this way, is in reality more one of opinion as to the right method of classification and the value of the groups which receive certain names, than one of fact. But, after all, it is the latter question which really interests science; and, therefore, it seems to me, that some service may be done by setting about the inquiry in a different way—by endeavouring, in fact, to answer the question—What is the value of the differences observed between man and the lower animals, as compared with the differences between the lower animals themselves? Are the differences between man and the apes, for example, as great as those between the ape and the fish? or are they rather comparable to those between the ape and the bird; or, to take a less range, to those between the ape and the Marsupial; or, to occupy a lower stand still, to those presented by the ape, and, say, the Pachyderm: or, after all, are the differences no greater than those which obtain between different genera of the Quadrumana?

These are questions which can plainly enough be settled independently of all theoretical views. Differences of structure can be weighed by the mind, as definitely as differences of gravity by the balance; nor can any dialectic skill refine them away. It will save trouble, if the attempt be made to answer the last question first—Are the structural differences between man and the Quadrumana no greater than those between the extreme genera of the Quadrumana? If, as I shall endeavour to show, this question can be demonstrably answered in the affirmative;—if it can be proved beyond doubt, that whether we consider the skeleton, the muscles, the brain, or the other viscera, man is far less distant from *Troglodytes* or *Pithecus*, than these apes are from the Lemur, and still more from the *Galeopithecus* or the *Cheiromys*, the other queries will need no separate solution. I have hardly any new facts to bring forward, nor any need to advance such. Thanks to the researches of Duvernoy, Tiedemann, Isidore St. Hilaire, Schrœder van der Kolk, Vrolik, Gratiolet, Professor Owen, and others, all the elements of the problem have long since been determined. It is only necessary to range the admitted facts side by side, in order to show that there is no escape from the conclusion.

And, first, with respect to the differential characters presented by the brains of the chimpanzee and orang from that of man on the one hand, and those of the lowest quadrumana on the other. I begin with this question, because it was my misfortune, at the last meeting of the British

Association, to find myself compelled to give a diametrical contradiction to certain assertions respecting the differences which obtain between the brains of the higher apes and of man, which fell from Professor Owen; and in the interest of science, it is well that the real or apparent opposition of competent inquirers, as to matters of fact, should be put an end to as soon as possible, by the refutation of one or the other. Happily, it is unnecessary that I should trust to my memory of what took place on the occasion to which I refer; for the assertions alluded to were already familiar to me, inasmuch as their substance occurs in two of Professor Owen's latest works—the paper "On the Characters, Principles of Division, and Primary Groups of the Class Mammalia," read before the Linnæan Society on February 17th, and April 21st, 1857; and the essay "On the Classification of the Mammalia," delivered as a lecture before the University of Cambridge.

I quote from the former essay, as that intended for an audience of experts, and hence, in all probability, to be regarded as more strictly scientific:—

"In man, the brain presents an ascensive step in development, higher and more strongly marked than that by which the preceding sub-class was distinguished from the one below it. Not only do the cerebral hemispheres (figs. 5 & 6 A) overlap the olfactory lobes and cerebellum, but they extend in advance of the one, and further back than the other (fig. 6, C). Their posterior development is so marked, that anatomists have assigned to that part the character of a third lobe; *it is peculiar to the genus Homo, and equally peculiar is the posterior horn of the lateral ventricle, and the 'hippocampus minor,' which characterise the hind lobe of each hemisphere.* Peculiar mental powers are associated with this highest form of brain, and their consequences wonderfully illustrate the value of the cerebral character; according to my estimate of which I am led to regard the genus *Homo* as not merely a representative of a distinct order, but of a distinct sub-class of the Mammalia,* for which I propose the name of '*Archencephala*' (fig. 6)."

It might be a grave question whether, granting the existence of the differences assumed to distinguish the human brain, they would justify the establishment of a sub-class for the genus *Homo;* but that difficulty is not worth discussing, inasmuch as I shall endeavour to demonstrate, in the course of the following pages, the accuracy of the three counter statements which I made to the audience assembled in Section D, viz.:—

1. That the third lobe is neither peculiar to, nor characteristic of man, seeing that it exists in all the higher Quadrumana.

2. That the posterior cornu of the lateral ventricle is neither peculiar to, nor characteristic of man, inasmuch as it also exists in the higher Quadrumana.

3. That the *Hippocampus minor* is neither peculiar to, nor characteristic of man, as it is found in certain of the higher Quadrumana.

I support the first two propositions by the evidence of every original observer who has written upon the subject, including Professor Owen

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* Here occurs the note which I have already quoted at p. 69. The italics in the above extract are my own.

himself, and by my own personal observations. The third rests upon the evidence of Messrs. Schrœder van der Kolk and Vrolik, and of an eminent countryman of our own, Dr. Allen Thomson, to whom I am indebted for unpublished observations made with express reference to these very points.

1. *The third lobe or posterior lobe of the cerebrum.*—Many anatomists divide the cerebral hemispheres of man into only two lobes, the anterior and the posterior, separated from one another by the fissure of Sylvius; but it is more usual to speak of three lobes,* an anterior, a middle, and a posterior, the latter, or 'third lobe,' being the posterior, inasmuch as it consists of the hinder part of that, which those who divide the cerebral hemispheres into two lobes, call 'posterior.' It is in this sense that Cuvier, Meckel, and Tiedemann use the term third, or posterior lobe. It is generally admitted that no very strict line of demarcation is traceable between the middle and posterior lobes; anatomists being content to accept Cuvier's curt definition:—

"La partie du cerveau située au-dessus du cervelet est ce qu'on nomme le lobe postérieur du cerveau."†

So far as I am aware, the terms "third" or "posterior lobe," have never been applied in any other senses than those which I have indicated. Under these circumstances, it is utterly incomprehensible to me how any one competently informed, either with respect to the literature or to the facts of the case, can assert that the hind lobe "is peculiar to the genus *Homo*;" for not only will the inspection of any ape's brain convince one of the contrary, but the facts were originally ascertained and published by a most competent authority, and have never been doubted for nearly forty years.

Tiedemann's "Icones Cerebrorum Simiarum," published in 1821, in fact, ought to be familiar to every student of mammalian anatomy. On turning to his first Plate, one finds the first figure to be a representation of the brain of "*Simia nemestrina*." The explanation of the figures says: "*a*,

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* It is not a very easy matter to determine with whom these divisions originated. Vesalius (Humani Corporis Fabrica, libri septem, MDCXLII.) speaks neither of lobes nor of special 'prominentiæ' in the cerebral hemispheres, though he describes them very accurately, explaining particularly that the under surface of these hemispheres is adapted to the 'tubera' of the cranial bones.

"Varolius (Anatomiæ sive de Resolutione Corporis Humani, libri iii., MDXCI. p. 131) says, in his letter to Hieronymus Mercurialis: 'De nervis opticis multisque aliis præter communem opinionem in humano capito observatis;'

"Sunt autem tres cerebri prominentiæ: anterior, media, et posterior . . . . . postrema cerebri prominentia replet cavitatem productam á superiori parte occipitii à posteriori ossis sincipitis et ossis petrosi.'

This looks like the origin of the division into three lobes, while Willis seems to have originated the division into two.

"Porro in homine cui cerebrum præ ceteris animalibus capax et amplum est, utrumque hæmisphærium rursus in duos lobos nempe anteriorem et posteriorem subdividitur: inter quos arteriæ carotidis ramus, utrinque instar rivi limitanei productus eos veluti in binas provincias distinguit"—Willis, Cerebri Anatome, 1664.

† Leçons d'Anatomie Comparée, 2de ed., tome iii., p. 44.

lobus anterior paullulum acuminatus; *b*, lobus medius; *c*, lobus posterior, "*cerebellum obtegens.*" Fig. 2, represents the brain of "*Simia rhesus*;" and the explanation of the figures says: "*a*, lobus anterior; *b*, lobus medius; *c*, lobus posterior." Fig. 3, a figure of the brain of *Simia sabœa*, and fig. 4, of "*Simia capucina*," have the same lettering, and the letters have the same signification.

And, to permit of no mistake, Tiedemann, at page 48 of the same work, tells us expressly:—

"Cerebrum simiarum quoad magnitudinem et divisionem in lobos ad humanum proxime accedit: dividitur enim per fissuram mediam longitudinalem in duo æqualia hemisphœria *quorum utrumque rursus in tres lobos partitur. Lobi posteriores uti in homine faciem superiorem cerebelli obtegunt.* In cæteris a nobis dissectis quodrupedibus encephali hemisphæria sunt magis plana et brevia. Lobi posteriores quamvis breviores quam in Simiis tantommodo in Phoca occurrunt, in reliquis Feris in Leone, Fele, Nasua, Lotore, *et ipso Lemure* ac Bradypode cerebellum fere nudum vel ab hemisphæriis haud obtectum conspicitur."

In 1825, Tiedemann, describing the brain of the orang (Hirn des Orangs mit dem des Menschen verglichen), particularly states that each hemisphere is, as in man, divided into three lobes—an anterior, a middle, and a posterior; and that the ovate cerebral hemispheres cover the cerebellum almost entirely, though they do not, as in man, project beyond its posterior margin.

In the third volume of the second edition of the "Leçons," Cuvier expressly affirms, in speaking of the apes:—

"Their hemispheres are also prolonged backwards, as in man, to form the posterior lobes, which repose on the cerebellum.

"The cerebellum is almost wholly covered by the hemispheres in the seal and otter.

"In the dolphin, a large proportion of the cerebellum is covered."—pp. 84–86.

And, in the "Regne Animal," he gives as part of the definition of the order Quadrumana: "Le cerveau a trois lobes de chaque côté, dont le postérieur recouvre le cervelet."

In his elaborate essay "On the brain of the negro, compared with that of the European and the orang outang," published in the Philosopical Transactions for 1836, Tiedemanns's zeal for the cause of the oppressed black has occasionally led him into something very like special pleading; and yet he does not dream of hinting the absence of the posterior, or third lobe, present in the negro's brain, from that of the orang. His summary, at p. 518, runs thus:—

"The brain of the monkey and the orang outang differs, as follows, from the human brain:—

"1. The brain is absolutely and relatively smaller and lighter, shorter, narrower, and lower than the human brain.

"2. The brain is smaller, in comparison to the size of the nerves, than in man.

"3. The hemispheres of the brain are, relatively to the spinal marrow, medulla oblongata, the cerebellum, corpora quadrigemina, the thalami optici, and corpora striata, smaller than in man.

"4. The gyri and sulci of the brain are not so numerous as in man."

I do not think that any valid objections can be raised as to the accuracy of the statements already cited; but in case such should be brought forward, I will now produce one authority which I am sure Professor Owen will regard as irrefragable. This is the third volume of the Catalogue of the Hunterian Collection, where, at p. 34, I find the following passages:—

"1338. The brain of a baboon (*Papio mormon*, Cuv.) The cerebral hemispheres are of greater proportionate size than in any of the preceding specimens, and they are developed so far backwards as to cover the cerebellum. The posterior lobes exhibit anfractuosities characteristic of the brain in the higher simiæ, as the baboons and orangs.

"1338A. The brain of a chimpanzee (*Simia troglodytes*, Linn.) This brain, in the relative proportions of the different parts, and the disposition of the convolutions, especially those of the posterior lobes, approaches nearest to the human brain. It differs chiefly in the flatness of the hemispheres, in the comparative shortness of the posterior, and the narrowness of the anterior lobes."

In the year 1842, Dr. Macartney read a paper "On the Minute Structure of the Brain of the Chimpanzee, and of the Human Idiot, compared with the perfect Brain of Man," before the Royal Irish Academy; and the essay, accompanied by two plates, is published in the 19th volume of the Transactions of that Academy. At p. 323, Dr. Macartney says—"The proportions of the cerebellum to the cerebrum were exactly as in man." "The parts in the lateral ventricles corresponded very nearly with the same in man." The figure of the upper surface of a plaster cast of the brain of this Chimpanzee, in Plate I., distinctly exhibits the posterior cerebral lobes projecting beyond the cerebellum.

The "Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche overseesche Bezittingen," pp. 39–44, contains a valuable memoir,* by Dr. Sandifort, on the anatomy of the orang, in which, at p. 30, I find the following distinct statement:—

"The base of the brain is divided into three lobes (lobi), of which the most anterior is short; the middle one descends remarkably below the foremost and hindmost; while the hindermost not only covers the cerebellum, but extends still further backwards than it. In vertical sections of the skulls of full-grown specimens, the bony frame-work showed that such is always the case, so the cerebral lobes appear to extend more backward over the cerebellum as age advances. In the brain investigated by Tiedemann, which belonged to a young orang, the cerebral lobes covered the cerebellum, but did not extend further back than it."

Vrolik, in the valuable article, "Quadrumana," contributed by him to "Todd's Cyclopædia" (1847), expressly affirms (p. 207), that, in the orang, the cerebral hemispheres "are protracted behind the cerebellum." And M. Isidore Geoffroy S. Hilaire ("Seconde Mémoire sur les Singes Americanes," Archives du Musèum, 1844) draws particular attention to the fact, that in the Saimiri, *Chrysothrix* (*Saimiris*, I. G. St. H.) *ustus*, a platyrhine monkey, and therefore far more distant from man than the

* "Ontleedkundige Veschouwing van een Volwassen Orang-oetan (*Simia satyrus*, Linn.), van het Mannelijk Geslacht."

tailless catarrhine apes of the old world, the cerebral hemispheres project far back beyond the cerebellum, though the latter is very well developed —in fact, as the cerebral hemispheres project nearly a centimetre behind the cerebellum, while the whole brain is only $5\frac{1}{2}$ centimetres long, the backward projection of the third lobe is, in this monkey, relatively greater than in man.

The "Transactions of the Royal Netherlands Institute at Amsterdam for 1849" contain one of the most valuable memoirs on the cerebral organization of the higher apes that has yet been written, entitled, "An Anatomical Investigation of the Brain of the Chimpanzee," by Schroeder van der Kolk and Vrolik. In their two plates they represent the brains of a chimpanzee, an orang, and a new-born child, and, in all, the letter *c* is applied to the same part—the posterior or third lobe, which they term "achterhoofds-kwab," "occipital lobe," in the explanation of the plates, or frequently in the text, "achter-kwab," "posterior lobe"; nor among the heads of their careful enumeration of the differences between the brain of man and the higher apes does any one of the three differential characters whose existence I have denied find a place.

Finally, in the preface to the most elaborate special memoir that has yet appeared upon the conformation of the brain in the higher Mammalia—the "Memoire sur les plis Cérébraux de l'Homme et des Primatés," by M. P. Gratiolet,—I find the following passage (p. 2):—

"The convoluted brain of man and the smooth brain of the marmoset resemble one another in the fourfold character of a rudimentary olfactory lobe, *a posterior lobe, which completely covers the cerebellum*, a well-marked fissure of Sylvius, and lastly, *a posterior cornu to the lateral ventricle*. These characters are met with in combination only in man and in the apes."

M. Gratiolet's beautiful original figures of the brain of the chimpanzee (Pl. vi), and of the orang (Pl. vii), show quite clearly that the hinder margin of the cerebral lobes in these animals, when the brain is in its natural condition, overlaps the hinder margin of the cerebellum.

Many months ago, having learned that my friend Dr. Allen Thomson had at one time occupied himself with the dissection of the brain of the chimpanzee, I applied to him for information, and he has very kindly allowed me to print the following extracts from his letters. Of the first brain he examined—that of a young female chimpanzee, seven or eight months old,—this eminently careful anatomist and physiologist says (under date of May 24, 1860):—

"There is, very clearly, a posterior lobe, separated from the middle one by as deep a groove between the convolutions on the inner side of the hemispheres, as in man, and equally well marked off on the other side. I should be inclined to say, that the posterior lobe is little inferior to that of man, excepting, perhaps, in vertical depth. The cerebral hemispheres completely covered the cerebellum, as seen from above. I took pains to observe this while the brain was still within the cranium, looking down upon it at right angles to the longtitudinal axis of the cranial cavity, and I found the posterior extremity of the cerebral hemispheres projected a little beyond the vertical line, passing the back of the cerebellum."

Thus, every original authority testifies that the presence of a third lobe in the cerebral hemisphere is not "peculiar to the genus Homo," but that the same structure is discoverable in all the true Simiæ among the Quadrumana, and is even observable in some lower Mammalia; and any one who chooses to take the trouble to dissect a monkey's brain, or even to examine a vertically bisected skull of any of the true Simiæ, may convince himself, on the still better authority of nature, not only that the third lobe exists, but that it extends to the posterior edge of, if not behind the cerebellum.

2. *The posterior cornu.*—In the "Icones," already referred to, Tiedemann not only described but figured the posterior cornu of the lateral ventricle in the *Simiæ* (Tab. 2°, Fig. 3ª), as "*e.* scrobiculus parvus loco cornu posterioris;" and when giving an account of the brain of the seal (Tab. 3ª), he says: "*e.* cornu descendens s. medium. Præterea cornu posterioris vestigium occurrit."

Tiedemann's statements are confirmed by every authoritative writer since his time. According to Cuvier* (Leçons, T. iii., p. 103), "the anterior or lateral ventricles possess a digital cavity [posterior cornu] only in man and the apes. This part exists in no other mammifer. Its presence depends on that of the posterior lobes. In the seals and dolphins alone, in which the posterior part of the hemisphere is considerable, the lateral ventricle, at the point where it descends into the temporal tuberosity, bends a little backwards, thus exhibiting a sort of vestige of the digital cavity of the human brain."

Vrolik (Art. Quadrumana, Todd's Cyclopædia), though he carefully enumerates the differences observable between the brains of the Quadrumana and that of man, does not think of asserting the absence of the posterior cornu. And lastly, Schrœder van der Kolk and Vrolik (op. cit., p. 271), though they particularly note that "the lateral ventricle is distinguished from that of man by the very defective proportions of the posterior cornu, wherein only a stripe is visible as an indication of the hippocampus minor;" yet the figure 4 in their second Plate shows that this posterior cornu is a perfectly distinct and unmistakeable structure, quite as large as it often is in man. It is the more remarkable that Professor Owen should have overlooked the explicit statement and figure of these authors, as it is quite obvious, on comparison of the figures, that his wood-cut of the brain of a Chimpanzee (l. c., p. 19), is a reduced copy of the second figure of Messrs. Schrœder van der Kolk and Vrolik's first Plate.

As M. Gratiolet (l. c., p. 18), however, is careful to remark, "unfortunately the brain which they have taken as a model was greatly altered (profondément affraissé), whence the general form of the brain is given in these plates in a manner which is altogether incorrect." Indeed, it is perfectly obvious, from a comparison of a section of the skull of the Chimpanzee with these figures, that such is the case; and it is greatly to

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* Leuret, Longet, and Stannius, agree with or, perhaps, only repeat Cuvier.

be regretted that so inadequate a figure should have been taken as a typical representation of the Chimpanzee's brain.

3. *The Hippocampus minor.*—But even supposing that the posterior cornu of the lateral ventricle and its appendage, the hippocampus minor, were absent in the apes, and "peculiar to the genus Homo," what classificatory value would the distinction possess? This, of course, depends upon the constancy of the supposed distinctive character; but it so happens that, as every anatomist knows, the posterior cornu and the hippocampus minor, are precisely those structures which are most variable in the human brain. This is by no means a novel discovery. The work of the brothers Wenzel* has now been published nearly half a century, and it contains (pp. 144–146) the following account of the special researches of these observers on the posterior cornu and the hippocampus, which they call simply "Tuber":—

"*Tuber in cornu posteriore ventriculorum lateralium*:—Non semper plerumque tamen adest, et quidem utroque in latere sive in utroque cornu. Inter quinquaginta et unum, eo specialiter fine a nobis examinata cerebra diversæ omnino ætatis atque utriusque sexus, tria tantum reperiebamus in quibus tuber illud in utroque latere et duo in quibus uno in latere desiderabatur. Quam constans autem, in universum tuberis istius præsentia, tam varians est magnitudo illius, non in diversis tantum subjectis, sed etiam in uno eodemque absque omni prorsus et ætatis et sexus discrimine. Quandoque admodum longum, interdum latum nonnunquam valde angustum est. Magnitudo illius in universum spectata, sequitur magnitudinem posterioris cornu ventriculorum lateralium: hæc quam maxime diversa est, quin et in uno eodemque cerebro et utroque latere. Quandoque enim cornu istud fere usque ad posteriorem cerebri marginem pertingit, sæpe terminus prope initium est, sæpe contingit ut in minore cornu magis, in majore minus sit tuber, id quoque eodem nonnunquam in cerebro evidentissime animadvertitur. Rarius in hoc tubere est quod sicut hippocampus ad finem suum crenas sive sulcos habeat quod superficies ejus duo in tubera superius atque inferius, divisa sit; plerumque autem in medio latissimum est et crassissimum, in terminis angustius: sed et hoc quoque varium est.

"Situs illius atque interior structura semper sunt eadem. Semper juxta interius latus cornu videtur, ideoque superficiei cerebri prope adjacet, idque cum interiore ejusdem structura cohæret, quae, ut sectio in transversum ducta clare demonstrat, eadem omnino est ac in gyris cerebri. Constat videlicet ex interiore in laterales ventriculos continuato, sive prolongato pariete cujus gyri in superficie cerebri siti, qui inflectitur, ac deinde interiori de parte exteriorem versus ad superficiem cerebri rediens in alium gyrum transit. Paries ist intra cornu medullosa, quœ cornu ipsum vestit, lamina obducitur; paries ipse autem ex cinerea, in ambitu cerebri sita, ubique conspicua substantia constat, quæ hoc loco neque latior est, neque alium colorem exhibet ac in quovis alio cerebri gyro.

"Inter utrumque tuberis parietem spatium invenitur, quod vasculosa cerebri æque explet ac sulcum inter duos alios gyras in superficie cerebri sitas.

"Si in superficie cerebri eo, qui eminentiæ isti opponitur loco membrana cerebri media et interior detrahitur, tuber illud evanescit, ut quamprimum cerebri superficies extenditur, in planum mutatur.

"Discrimen ergo, hoc tuber inter et processum cerebri lateralem in eo consistit, quod illud verum absolutum, gyris in exteriore cerebri superficie sitis omino simile, quoad interiorem vero structuram plane æquale, in interiore cerebro sive in aliqua ventriculorum ejusdam parte existens gyrus sit; quod e contrario hippocampus, si cum gyris in superficie cerebri existentibus comparatur, tantummodo gyri alicujus pars, non autem absolutus atque integer gyrus sit, cujus initium in interiore cerebro, aut in aliqua ventriculorum parte existit."

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* Jos. et Car. Wenzel, "De penitiori structura Cerebri Hominis et Brutorum. Tubingæ, MDCCCXII.

The brothers Wenzel figure in their excellent plates the various conditions of the posterior cornu and hippocampus minor to which they refer; and it is remarkable that the brain which they have selected as exemplifying the absence of the hippocampus minor on both sides, Tab. v., Fig. 1, is said to be "ex triginta annorum æthiope," while the most remarkably developed hippocampus, Tab. vii., Fig. 3, is "ex septem annorum puero."

The work whence these extracts are taken is contained in the libraries both of the College of Surgeons and of the Royal Society; but, even if it were inaccessible, a well-known and more modern writer fully bears out the doctrine it contains. I refer to Longet,* who states that, in the human brain, "the posterior cornu is found of very different lengths and breadths. I have found brains in which it extended up to within a few millimetres of the surface of the posterior lobe, and others in which it ended at more than three centimetres therefrom."

The same excellent authority, in describing the posterior cornu of the lateral ventricle, says:—

"Its inner and lower wall is raised by a convolution which forms a more or less distinct, and at times, double projection into the cavity itself. This projection (Hippocampus minor, eminentia unciformis, calliculus, unguis, calcar avis) was well described by Morand, and after him was called the 'Spur of Morand'—'Ergot de Morand.'

"The Hippocampus minor exhibits differences in its form and circumference, as Greding has stated; usually it is bent on itself, arched forwards and outwards, sometimes narrow and long, sometimes broader. Very frequently it is smooth, at other times it exhibits many fissures and small enlargements, especially posteriorly; or it may be divided by a longitudinal cleft into two halves, the upper of which is almost always larger than the lower. Its dimensions are by no means directly proportional to the development of the posterior lobe. In the same subject it may be very distinct upon the one side, and yet be hardly perceptible upon the other. For the rest I can certify that, in spite of Meckel's† assertion to the contrary, it is not always present. My own observations agree with those of Wenzel, who, among fifty-one subjects that he examined with express reference to this point, found three in which the hippocampus was absent upon both sides, and two in which every trace of it was absent upon one side only."

To allow a structural character totally absent in six per cent. of the members of any group to stand as part of the definition of that group, *considered as a sub-class*, would be a very hazardous proceeding. But, is it true that the hippocampus minor is altogether absent in the highest apes? I suspect that Tiedemann is responsible for the not unfrequently admitted doctrine that it is; for, in the "Icones" he writes:—

"Pedes hippocampi minores vel ungues, vel calcaria avis, quæ a posteriore corporis callosi margine tanquam processus duo medullares proficiscuntur, inque fundo cornu posterioris plicas graciles et retroflexas formant, in cerebro simiarum desunt; nec in cerebro aliorum a me examinatorum mammalium occurrunt. *Homini ergo proprii sunt.*"

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* German edition, by Hein, under the title, Anatomie und Physiologie des Nervensystems des Menschen und der Wirbelthiere, 1847, Bd. i., p. 463.

† Dr. Hein here adds: "What Meckel says is that he himself never failed to find the hippocampus minor, but that he by no means wishes to throw doubts on Wenzel's statements;" and on reference to Meckel's work, I find this to be quite correct.

However, the citation from the Memoir of Schroeder van der Kolk and Vrolik, given above, proves that in their opinion a rudimentary hippocampus minor does exist in the Chimpanzee, and Dr. Allen Thomson adds his valuable testimony in a still more decided manner to the same effect. In the letter which I have already quoted, he says:—

"I found an eminence in the floor of the posterior cornu and towards its inner side, which I regarded as the hippocampus minor, and I found it produced exactly in the same manner as in man, by the bulging into the ventricles of a portion of the brain, by a very deep groove between the convolutions."

In another letter (the 11th of November, 1860), replying to further troublesome inquiries of mine, Dr. Thomson writes:—

"I thought it best for my own satisfaction and yours, to open the lateral ventricle from above, in a second brain which I possess. This brain, which was extracted from a young animal in Africa, was placed in rum there, and it was both much discoloured and not so well preserved as I could have wished. The appearances are, however, sufficiently distinct to enable me to confirm entirely what I think I stated to you before, viz.: 1. The prolongation of the cavity of the posterior cornu, to a considerable distance beyond the plane of the posterior edge of the corpus callosum (which, I presume, may be taken as the best measure of the position of the parts); and, 2. The existence on the inner side, and partly in the floor of that posterior cornu, of an eminence corresponding in all respects with the hippocampus minor. . . . . Just as I was setting about the examination of this point, I found an opportunity, in my dissecting-room, of looking at a fresh human brain, and I thought it might be more satisfactory to examine the two brains together. It so turned out, that the brain I cut in upon presented an example (not uncommon) of great deficiency in the extent of the posterior cornu. I think it is worth sending you a sketch of it, for it is really scarcely more developed than that of the chimpanzee in this respect."

Having now, as I trust, redeemed my pledge to prove that neither the third lobe of the cerebrum, nor the posterior cornu of the lateral ventricle, nor the hippocampus minor, are structures distinctive of and "peculiar to the genus *Homo*," I may leave it to the reader to decide the fate of the "sub-class *Archencephala*," founded upon the supposed existence of these three distinctive characters.

And here I might fairly leave the question; but, essential as I have felt it to be to my personal and scientific character to prove that my public assertions are entirely borne out by facts, I am far from desiring to deal with this important matter in a merely controversial spirit. Therefore, although the differences hitherto referred to are certainly non-existent, I proceed to inquire whether there are any other marked and constant characters by which the human may be distinguished from the Simian brain.

Without doubt such characters are to be found; and in all probability, as in the case of any other two distinct genera, the more carefully and minutely our inquiries are carried out, the greater will be the number of these differentiæ. So far as my knowledge goes, the most prominent and important are the following:—

1. In the anthropoid apes the brain is smaller, as compared with the nerves which proceed from it, than in man.

2. In the anthropoid apes the cerebrum is smaller, relatively to the cerebellum, than in man.

3. In the anthropoid apes the sulci and gyri are generally less complex, and those of the two cerebral hemispheres are more symmetrical, than in man.

4. The hemispheres are more rounded and deeper in man than in the anthropoid apes, and the proportions of the lobes to one another are different. Furthermore, certain minor gyri and fissures, present in the one, are absent or rudimentary in the other.

The evidence of the first of these differences has, I believe, been universally admitted since the time of Sœmmering. The second and fourth clearly result from the observations of Schroeder van der Kolk and Vrolik, and those of Gratiolet (Mem. sur les plis cerebraux des Primatès, 1854), as will appear from the following extracts. The first citation is taken from the work of the first-named authors, which seems to be so little known in this country, that I make no apology for length of the extract:—

"According to very precise investigations which the first named of us has carried out with reference to this point, the difference between the brains of the higher apes and that of man is to be sought, not only in the smaller size of the hemispheres, but also in a totally different relation of the lobes. Relatively, the under surface of the first lobe of the cerebrum, in the chimpanzee, is much larger than in man; while, on the other hand, the distance from the most anterior point of the middle lobe to the hindermost point of the posterior lobe is much smaller. In our chimpanzee the distance from the root of the olfactory nerve to the anterior margin of the brain is about 44 millimetres, from the point of the middle lobe to the extreme end of the posterior lobe, 69 mm. In the adult man, according to measurements which the first of us has instituted, and which wholly agree with those of the ninth plate of Foville, the first named measurement is 57 mm., the second, 145 mm. In the brain of a new-born child, examined by us, the first dimension amounted to 33 mm., the second to 70 mm. The length of the base of the anterior lobe was thus to the distance from the point of the middle lobe to the end of the posterior lobe, in the chimpanzee, as 1 : 1·52; in the adult man as 1 : 2·54; in the child, as 1 : 2. Hence it appears that the relative proportions of the lobes of the child's brain hold just the mean between the chimpanzee and the adult man; and that in the course of the growth of the child to manhood, the posterior and middle lobes increase more in length than the base of the anterior lobe. In the orang, the same proportion obtains as in the new-born child, or 1 : 2, a result which is certainly remarkable, and proves that, in this respect, the brain of the orang stands higher than that of the chimpanzee. The second point to which we would direct attention is, that in comparing the brain of man with that of animals, and especially in determining in what manner the cerebellum becomes covered, we too exclusively attend to the posterior elongation of the cerebral hemispheres, while the varying size of the cerebellum itself ought to be taken into account. On comparing the perpendicular section of the brain of the new-born child (pl. ii., fig. 3.) with fig. 1, the brain of the three-year-old chimpanzee, and with fig. 2, that of the orang of a like age, it is at once apparent that the cerebellum of the orang, and especially of the chimpanzee, is much larger than that of the child; so that, supposing one could place the cerebellum of the chimpanzee behind the medulla oblongata of the child, it would be even less covered.

In fact, the distance from the anterior edge of the most anterior part of the cerebellum, close to the corpora quadrigemina, to its posterior margin, measures, in the chimpanzee, 38 mm.; in the orang, 35 mm.; in the child, 22 mm. If we compare the measurements with the whole distance from the anterior to the posterior lobe of the cerebrum, we obtain, according to measurements taken by the first named of us,—

Chimpanzee, ...	38 : 101 mm.	= 1 : 2·66.
Orang, ...	35 : 96	= 1 : 2·74.
Human child, ...	22 : 96	= 1 : 4.36.
Adult man, ...	50 : 157	= 1 : 3·1.

Hence, it is clear 1°, that the cerebellum in the Chimpanzee and in the Orang are proportionally larger than in man; 2°, that the Orang in this respect approaches man more closely than does the Chimpanzee."—"Anatomical Investigation," &c., l. c. pp. 265–7.

The authors go on to remark that the same large proportion of the cerebellum to the cerebrum is characteristic of the lower Mammalia, as Soemmering had already observed, and that, consequently, the uncoveredness of the cerebellum arises as much from the disproportionately large size of the latter, as from the defect of the posterior lobe of the cerebrum. They further show that the human cerebellum is proportionally still smaller in a six-months' fœtus (1 : 4·7); and that, while in the adult the cerebellum has more than double the size it had in the new-born child (50 : 22), the cerebrum of the adult is only $1\frac{1}{2}$ times as large in the adult as in the new-born child (157 : 96). At the same time the cerebellum attains its full size by the end of the third year—a fact which indicates very interestingly the relations of the cerebellum with the locomotive power.

M. Gratiolet commences his description of the cerebral convolutions of man thus:—

"The form of the human brain is well known. Its singular height, the width of the frontal lobe, whose anterior extremity, instead of narrowing to an acute point, is terminated by a surface whose extent corresponds to that of the frontal bone; the large angle which the two orbital fossæ form, the depression of the fissure of Sylvius, the richness and complications of the secondary convolutions, at once distinguish this brain from that of all the Primates. But these differences, great and characteristic as they may be, yet consist with the existence of such analogies between the brain of man and that of apes, that the same general description serves both equally well. There are the same principal divisions, the same lobes, the same convolutions; all the parts are not the same, but they are homologous."—L. c., pp. 57, 58.

M. Gratiolet then goes on to point out what the differences of these homologous parts are; but I cannot give them in detail here, without entering upon a full explanation of his terminology, which would occupy too much space.

There is no lack, then, of real differences enough between the brain of man and those of the highest Quadrumana, though they are not those which have been asserted to exist. The question, what is the value of these differences? could only be satisfactorily answered, if the extent of variation exhibited by the brain among the different races of mankind had been carefully determined. We are greatly in want of knowledge on this important subject; but what little is known tends distinctly to the conviction, that no very great value can be set upon these distinctions, inasmuch as the differences between the brains of the highest races and those of the lowest, though less in degree, are of the same order as those which separate the human from the simian brain. I am

well aware that it is the fashion to say that the brains of all races of mankind are alike; but in this, as in other cases, fashion is not quite at one with fact.

Soemmering and Tiedemann are directly at variance with respect to the relative proportions of the size of the nerves to the brain in the higher and in the lower races of mankind; and, as respects the relative proportions of the cerebrum and cerebellum, the ratios deducible from Tiedemann's measurements give so small a difference, that though it is rather in favour of the existence of a larger proportional size of the cerebellum in the lower races, I do not think it can be depended upon.

But, with regard to the third especially Simian cerebral character mentioned above, Tiedemann's observations (though, as the negro's advocate, he endeavours to explain them away) are definite, and to the point:—

"The only similarity between the brain of the negro and that of the orang outang is, that the gyri and sulci on both hemispheres are more symmetrical than in the brain of the European. It remains, however, to be proved whether this symmetry is to be found in all negro brains, which I very much doubt."—L. c., p. 519.

One would like to know the ground of Professor Tiedemann's doubts, because the only other observation he details, bearing on this subject, leads him to precisely the same conclusion. Thus, at p. 316 of the same memoir, I find the express statement:—"This [symmetry] is particularly visible in the brain of the Bosjes woman." Indeed, the fact must at once strike every one conversant with the ordinary appearance of a European brain, who glances at Pl. xxxiv. of Tiedemann's Memoir, in which a view of the Bosjesman brain referred to is given.

Fortunately, M. Gratiolet has also particularly described and carefully figured this brain (which is that of the "Hottentot Venus;" who died in Paris, and had the honour of being anatomized by Cuvier), and his remarks upon the subject are exceedingly important and instructive:—

"This woman, be it premised, was no idiot. Nevertheless, it may be observed, that the convolutions of her brain are relatively very little complicated. But what strikes one, at once, is the simplicity, the regular arrangement of the two convolutions which compose the superior stage of the frontal lobe. These folds, if those of the two hemispheres be compared, present, as we have already pointed out, an almost perfect symmetry, such as is never exhibited by normal brains of the Caucasian race. . . . . This regularity—this symmetry, involuntarily recall the regularity and symmetry of the cerebral convolutions in the lower species of animals. There is, in this respect, between the brain of a white man and that of this Bosjesman woman a difference such that it cannot be mistaken; and if it be constant, as there is every reason to suppose it is, it constitutes one of the most interesting facts which have yet been noted."—L. c., p. 65.

"The antero-superior curve is less convex than in the white man: lastly, the orbital fossæ are more concave; and there may be observed at the level of the anterior extremity of the temporo-sphenoidal lobe, a very marked constriction, which results from a very remarkable predominance of the supraciliary lobe. This disposition appears to result from the less development of the superior divisions. The brains of fœtuses belonging to the white race present it at the maximum, when the operculum of the fissure of Sylvius does not yet cover the central lobe; it is still quite apparent at birth; but it be-

comes slowly effaced with age, and in the adult it has completely disappeared. The brain of the Hottentot Venus is, then, in all respects, inferior to that of white men arrived at the normal term of their development. It can be compared only with the brain of a white who is idiotic from an arrest of cerebral development."—p. 66.

Finally, with respect to the fourth difference, Tiedemann observes (p. 515) of the negro's brain:—

"The anterior part of the hemispheres is something narrower than is usually the case in Europeans. This is particularly remarkable in the brain of the Bosjes woman."

Thus, the cerebral hemispheres of the Bosjesman (and to a certain extent of the negro), so far as the evidence before us goes, are different from those of the white man; and the circumstances in which they differ—viz., the more pointed shape of the cerebral hemispheres, the greater symmetry of their convolutions, and the different development of certain of these convolutions,—are all of the same nature as most of those which distinguish the ape's brain from that of man. In other words, if we place A, the European brain, B, the Bosjesman brain, and C, the orang brain, in a series, the differences between A and B, so far as they have been ascertained, are of the same nature as the chief of those between B and C.

The brains of the lowest races of mankind have been hardly at all examined; and it would be a matter of great interest to ascertain whether, in these races, there is any trace of the external perpendicular fissure, any diminution of the lobule of the marginal convolution, and any increase of the proportional size of the nerves to the cerebral mass. Medical men living at the Cape of Good Hope, in Australia, and within reach of the Hill-men of India, will, it is to be hoped, some day solve these problems for the zoologist.

Let it be admitted, however, that the brain of man is absolutely distinguished from that of the highest known apes—

1st. By its large size, as compared with the cerebral nerves;

2nd. By the existence of the lobule of the marginal convolution;*

3rd. By the absence of the external perpendicular fissure—

And then let us turn to the other side of the argument, and weigh these differences against those which separate the brains of *Pithecus* or *Troglodytes* from those of the lowest Quadrumana.

The brain of *Lemur mongos* is well figured, and constantly referred to by Tiedemann in the "Icones" so often referred to. The few gyri; the shortness of the cerebral hemispheres, in the region of the third lobe, which leave fully half the cerebellum uncovered; the large size of the vermis superior; the prominence of its flocculus; the great size of the olfactory nerves, which rather deserve the name of olfactory lobes; the singleness of the corpora candicantia; the comparatively small and flat pons varolii; the presence of corpora trapezoidea; and, in

* The second and third differences are mentioned by Gratiolet, to whose Memoir I must refer for a statement of their nature.

the internal structure of the brain, the large size of the optic thalami in relation to the corpora striata, and the total absence of a posterior cornu to the lateral ventricle*—are all characters which are perfectly obvious, and which separate the brain of the *Lemur* as completely from that of *Pithecus* or *Troglodytes*, as from that of man.

The description of the brain of *Stenops tardigradus*, by Vrolik, tells the same story even more strikingly; and the brains of *Perodicticus* and other Prosimiæ, exhibited in the Hunterian Museum, fully bear out the conclusion, that the vast differences noted obtain throughout the Prosimian division of the Quadrumana.

M. Gratiolet, in fact, has been so struck by the immense discrepancy between the Simiæ and Prosimiæ in cerebral structure, that he proposes to consider the latter as forming a part of the order Insectivora. In this view he is at variance with all the other zoologists; but, in order to meet all possible objections, I will, for the moment, suppose that he is right, and that the order Quadrumana should be restricted to the Simiæ. Even on this supposition, the force of my argument remains unchanged; for the brains of the lower true apes and monkeys differ far more widely from the brain of the orang than the brain of the orang differs from that of man. Not only do they differ from the orang (and to a greater degree) in most of those respects in which the orang differs from man, but they present the absolute distinction, that while the orang, like man, has two corpora candicantia, the lower apes, like the other Mammalia, have only one.

In respect of their cerebral characters, therefore, I hold it to be demonstrable that the Quadrumana differ less from man than they do from one another; and that, hence, the separation of *Homo* and *Pithecus* in distinct sub-classes, while *Pithecus* and *Cynocephalus* are retained in one order, is utterly inconsistent with the principle of any classification of the Mammalia by cerebral characters.

On a future occasion I propose to take up the question, whether, on other grounds, there is any reason for departing from the Linnean view, that man is to be regarded as a genus of the same order as that which contains the Quadrumana.

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* "Cornu posterius in Simiis et Phocis brevissimum et vix conspicuum est: in cæteris mammalibus plane desideratur."—Icones, p. 54.