A

COMPARATIVE VIEW

OF THE

SENSORIAL AND NERVOUS SYSTEMS

IN

MAN AND ANIMALS.

Allow me, gentlemen, to congratulate you on the return of this anniversary. The assemblage of so great a number of medical practitioners from different parts of our commonwealth, and the attendance of such distinguished friends of the profession* show that the concerns of science and our duty to the community are not likely to be neglected. Your society was not instituted for private advantage, nor even as a mere litera-

* Appendix A.

ry institution. The principle it has adopted, is intended to operate in securing to the public a succession of well instructed physicians, and affording a distinct evidence of their qualifications. Such is the nature of medical practice, that the community must remain in ignorance of the merits of a physician, until he has exercised his art long enough to have been extensively mischievous, if not properly educated.

It must be highly satisfactory to you, Gentlemen, to observe, that since the formation of your society, the profession has assumed a new character in this part of the country. Empiricism is scarcely heard of in some districts; in all is rapidly diminishing; but its total disappearance is not to be expected. To frown on irregularities; to connect honourable and judicious physicians in a common bond; to make them known as such to each other and to the public is what your association has proposed to perform, and what it is successfully executing.

You have also the gratification of seeing these improvements extend their influence to other and distant places. The regulations of this corporation have served as the basis for medical institutions both near and remote; and a great national work is now auspiciously forming, whose foundations were laid by your Medical Society.

Since the last anniversary, a number of those who have been among the most active in con-

tributing to the improvement of the profession and the prosperity of this society, have been called to rest from their labours. The characters of such men should not be buried in the tomb which covers their mortal part; and as no place seems so proper, as the publications of the society, for preserving the names of its active and distinguished members, I propose to add to this discourse a brief memorial of the lives of our departed associates. (*See Appendix B.*)

The subject to which I invite the attention of the society, is a comparative view of the SENSORIAL and NERVOUS SYSTEMS in man and animals. By the Sensorial system, I mean the brain, and nerves of sense connected with it, or what are commonly called nerves of the external senses. This subject may perhaps be thought too extensive for an occasion like the present.—It would indeed be impracticable to give a minute account of these organs in the time allotted; but it will not be difficult to make a general comparison of their form and distribution in different classes of animals; and as these parts are among the most characteristic of the animal kingdom, and best fitted to distinguish it from the rest of the organized creation, such a sketch will not, I hope, be uninteresting, nor unproductive of results.

The subject is rendered inviting at the present time by the works of CUVIER, LAMARCK, GALL, LAWRENCE, PHILLIP, and others; and will call our attention to a branch of science which, notwithstanding the labours of many learned and industrious men, still presents a field ready to yield abundant fruits to the hand that shall cultivate it.

As our intention is to make a comparison between different *classes* of animals, it is necessary to determine what classification is to govern our inquiries; for you are aware that the arrangement of animals has varied with different states of knowledge and different opinions of naturalists.

LINNEUS arranged the animal kingdom in six classes, *Mammalia*, *Birds*, *Amphibia*, *Fishes*, *Insects*, and *Worms*. After his time, further observations induced the learned to divide his class of insects into *crustaceous animals* and *insects proper;* and also to divide the class of worms, into *molluscous animals*, *zoophytes*, and *worms*, commonly so called; thus making five of the two last classes of LINNEUS.

The distinguished naturalist LAMARCK,* has proposed to make three primary divisions of animals, on the ground of difference of the structure and functions of the sensorial and nervous systems. The first, he calls APATHIC ANIMALS, which do not feel, and do not move, but by ex-

**Histoire Naturelle des Animaux sans Vertèbres.* Tom. 1.

cited *irritability*. Of these, he makes four classes, 1. Infusoria; 2. Polypi; 3. Radiarii; 4. Worms, (*intestinal.*) Second division, SENSITIVE ANIMALS which feel, but obtain their sensations from *perceptions* only. These are 1. Insects; 2. Arachnides; 3. Crustacea; 4. Annelides, (*red-blooded worms*) 5. Cirrhipedes; 6. Mollusca. Third, INTELLIGENT ANIMALS, which feel, acquire, and preserve ideas, and are intelligent, in different degrees. These are, 1. Fishes; 2. Reptiles; 3. Birds; 4. Mammalia.

In the last systematic work of the celebrated CUVIER* a different arrangement is proposed. This author, who in the greatness of his acquisitions, and in the enlargement of his views of nature, is excelled by no one, is of opinion, that there are *four principal forms*, or four general plans, according to which all animals seem to have been modelled. In the first of these forms, which is that of man and the animals most like him, the brain and the principal trunk of the nervous system, are enclosed in a bony case, which consists of the cranium and vertebræ. At the sides of this bony column are fixed the ribs, and the bones of the limbs, which form the frame-work of the body. The muscles generally cover the bones they move, and the viscera are contained in the head and trunk. These he calls VERTEBRAL

**Règne animal, Tom* 1.

ANIMALS—*animalia vertebrata.*—In the second form, there is no skeleton. The muscles are attached to the skin, which forms a soft covering, contractile in different directions. In this, stony substances are deposited in many species, called cockles. The nervous system is contained with the viscera, in this general covering. These are called MOLLUSCOUS ANIMALS—*animalia mollusca.*—The third form is that observed in insects, worms, etc. They are peculiar for having a nervous system, consisting of a cord or cords running along the belly, swelled from space to space into knots or ganglia. Their trunk is divided by transverse folds into a certain number of rings, the coverings of which are sometimes hard, sometimes soft, and the muscles are attached to the internal part. The trunk sometimes has articulated limbs, fixed to its sides, but is often destitute of them. These are called ARTICULATED ANIMALS—*animalia articulata.* The fourth form comprehends the animals known under the name of zoophytes, and which may be called RADIATED ANIMALS—*animalia radiata.*—In the others, the organs of motion and the senses are placed symmetrically on each side of an axis. In these they are placed circularly in a radiated manner around a centre. Their organization is very simple, and in the last families there is nothing apparent but a homogeneous pulp, which is sensible and capable of motion.

Three of these divisions, the Vertebral, Molluscous, and Radiated, appear to be conformable to nature; but that of the Articulated is in some respects objectionable. The *annelides*, or red blooded worms, are placed with insects, from which they differ not only in form and in wanting articulated limbs, but also in their organization, as we shall hereafter see. We are unwilling, moreover, to bring together a second time the crustaceous animals and insects which had been separated after the time of LINNEUS. The difference in the habits of these animals is obvious, although there is a resemblance in form; but the strongest ground of distinction is in their internal structure; that of the former being more complicated than the latter.

The arrangement most convenient for our purpose, seems to be that of LINNEUS, improved by CUVIER and others. This has also the advantage of being more generally known, from having been adopted in many popular works.* According to this plan, animals are separated into two grand divisions, *Vertebral* and *Invertebral.* The vertebral animals are first, MAMMALIA; second, *Aves*, BIRDS; third, *Repentes*, REPTILES; fourth, *Pisces*, FISHES. These classes are generally known and distinguished from each other. The invertebral animals are first, MOLLUSCA, so called from the

* CUVIER *Anat. Comp.*—REES' and BREWSTER'S CYCLOPÆDIAS, etc.

soft consistence of their bodies; although they have frequently a shell, or a firm mantle. Second, CRUSTACEA, covered with a thin calcareous crust. Third, INSECTA. Fourth, VERMES. The red-blooded worms are the only invertebral animals with red blood. Their structure is more complicated than that of worms generated in animals, or *epizoary* worms. The latter are therefore not included in the class worms, but in that of zoophytes. Fifth, ZOOPHYTES, so called from forming an intermediary structure to animals and plants. They differ however essentially from the latter, and approach the former, in generally having the power of locomotion.

ANIMALS.	VERTEBRAL.	Double heart and warm blood.	Viviparous		MAMMALIA.	I.
			Oviparous		BIRDS.	II.
		Single heart and cold blood.	With lungs		REPTILES.	III.
			With gills		FISHES.	IV.
	INVERTEBRAL.	With vessels and nerves.	Simple vessels		MOLLUSCA.	V.
			Knotted vessels	With articulations	CRUSTACEA.	VI.
				No articulations	WORMS.	VII.
		Without vessels.	With articulations		INSECTS.	VIII.
			No articulations		ZOOPHYTES.	IX.

The vertebral animals possess an internal bony frame or skeleton, the most constant and essential part of which is the vertebral column, or spine, connecting the inferior with the superior parts of the body. They have been divided into *warm-blooded* and *cold-blooded*. The mammalia and birds are warm-blooded, for they each enjoy a peculiar temperature; while the reptiles and fishes have the temperature of the medium in which they live. This difference is connected with a peculiarity of organization; for the warm-blooded have a heart with two auricles and two ventricles, but the cold-blooded only a single ventricle, and usually but one auricle. The mammalia are distinguished from birds, in being viviparous, or bringing forth their young alive, while the latter are oviparous or produce theirs from an egg. Of the cold-blooded, one class respire by lungs, the reptiles, or amphibious animals; the other by a substitute for lungs, the *branchiæ*, or gills.

The five classes of invertebral animals have been subjected to similar distinctions, though not strongly and satisfactorily marked as in the first division. They are divided into the classes which have vessels, and those destitute of them. The first are the mollusca, crustacea, and worms; and the second, said to be without vessels, the insects and zoophytes. The mollusca are peculiar in having simple or strait vessels; the

crustacea, for their articulated limbs; and the worms, for wanting these articulations. The insects have articulated limbs, but are not known to have vessels for circulating the blood, except a single one, called dorsal. As, however, their organization is in other respects complicated, for they have various organs for digestion, a very distinct respiratory system, and an elegant muscular apparatus, it is not improbable that other circulatory vessels may hereafter be discovered. The zoophytes have neither vessels, articulated limbs, nor, so far as is known, a nervous system.

The first of the nine classes of animals, MAMMALIA, comprehends the varieties of man, and orders of quadrupeds. This arrangement, however offensive it may be to our pride, is required by a close resemblance in the anatomical structure of bones, muscles, and other parts; and by as remarkable differences in many particulars between this and the other classes. LINNEUS thought proper to place man in the same order even with monkies, lemurs and bats, on the ground of their possessing in common the front or incisor teeth, in which they differ from all other animals. This approximation is not justified by a comparison of the structure and habits of these quadrupeds. The bats are in many things different; the lemurs and monkies are peculiar for having an opposing pollex, or thumb, on the feet as well as the hands, whence they have

been called *quadrumanes*, or four handed; while man is truly *bi-manis*, or two-handed. These two genera differ from man in being endowed with a tail, and particular vertebræ to support this part; to which the human race have in reality no claims, notwithstanding some philosophers have attempted to establish such a pretension.—Neither these nor any other quadrupeds have such a structure of the pelvis and lower, or posterior limbs, as to admit of their walking steadily and constantly in an upright posture; so that man, although belonging to the same class as quadrupeds, may fairly be placed in a separate order.

As the monkey tribe approach nearest in structure to man, it is proper to begin our comparison of the sensorial system with these animals; and as the brain is the principal organ of this system, we shall compare this part first, and afterwards the nerves.

The human brain, you will recollect, is composed of a cerebrum and cerebellum, pons varolii and medulla oblongata. The surface of the cerebrum is divided by a deep fissure into its two hemispheres, and is indented by many furrows separating its convolutions. Between the hemispheres lies the corpus callosum. At the lower part or base, we observe the six lobes and various smaller protuberances. In its interior are seen the corpora striata, or central nuclei of the

cerebrum; behind these the optic thalami, tubercula quadrigemina and corpus pineale, or pineal gland. We notice also the three cavities of the ventricles, containing a number of minute parts; and lastly, a distinction of substance into exterior or cortical, and interior or medullary.—In the cerebellum we find, externally, two lobes, an appendix, and transverse eminences, analogous to the convolutions of the cerebrum: internally, a ventricle communicating with the ventricles of the cerebrum, and the distinction of cortical and medullary substance. In the medulla oblongata are seen the remarkable eminences, called anterior and posterior, corpora pyramidalia, and corpora olivaria.

The brain, in the most perfect *monkies*, has a form more circular than that of man, and also more flattened from above downwards. The middle lobes of the cerebrum are larger in proportion, while the whole bulk of the organ is considerably less. In other respects it has the closest resemblance to the human brain, for it possesses, without exception, all the parts belonging to the latter. Tyson, who has described the ourang outang, and is admitted as the first authority on this head, gives us the following statement. "The figure of the whole brain in our pigmy was globous; but by means of a greater jutting in, of the bones of the orbit of the eye, there was occasioned a deeper depression in the

anterior lobes of the brain in this place, than in a man. As to other circumstances here, I observed *all parts the same.*"* These are the only animals which resemble man in having the cerebrum prolonged into a posterior lobe; in having the tubercula quadrigemina bear the same relative proportions to each other and to the rest of the brain; in possessing the digital cavity of the lateral ventricles, and in having the olfactory nerves separated from the base of the brain. The organ is therefore alike in man and monkies, with the exception of some variation in form, and a difference in magnitude.

In the other orders of the class mammalia, the brain differs from the human in some important particulars. Its form is more flattened, and the convolutions on its surface less indented, except in the cetaceous or whale tribe, in which the cerebrum is both broad and elevated, and the convolutions deeply furrowed. The most remarkable variation in the mammalia consists in the deficiency of the posterior lobes of the cerebrum, and consequently of the posterior horns of the lateral ventricles. The base of the brain presents a tubercle under the anterior lobes, called by the ancients the mamillary caruncle, from which proceeds the olfactory nerve, containing a cavity or ventricle, connected with the

*.*Anatomy of a pigmy.* p. 56.

cavity of the lateral ventricle. This structure does not exist in the human brain. In other respects the organ resembles that of man, in the composition of its parts, varying in different orders of the mammalia in the form and magnitude of its eminences, and in the depth of the corresponding depressions. It is worthy of notice that the eminences called *nates*, or anterior tubercula quadrigemina* are uniformly small in carnivorous animals, compared with the posterior tubercles, or *testes;* while in the herbivorous the nates are large in proportion to the testes, and thus approach nearer to the human structure. It may be stated as a general fact, that the magnitude of the human brain, relatively to the rest of the body, exceeds that of other animals; though not without remarkable exceptions, to be noticed hereafter.

The distribution of the cerebral blood vessels in quadrupeds, in most respects like that in man, has one peculiarity finely illustrating the use of the tortuous course of the great arteries to the human head, and showing the providence of nature for inferior beings. Quadrupeds carry the head more nearly on a line horizontal to the heart than man, and of course the blood is not so much retarded in its passage to the brain by the influence of gravitation. Its impulse on the delicate vessels of this organ would often pro-

*More properly called bigemina.

duce apoplexy, especially when the head is inclined to the ground, were not the force of the blood diminished by a peculiar arrangement. The carotid arteries, as they go to the brain, are divided into a multitude of small and interrupted branches of a net-work form, hence called by GALEN "rete mirabile." These afterwards unite to form single vessels which are distributed, as in man. All quadrupeds do not possess this structure. In the horse the carotid arteries bend into deep cavities, communicating together by transverse branches; and thus the ordinary pressure on the brain is diminished, while it may be suddenly augmented when occasion requires: for, says the anatomist WILLIS, "the horse, being born for war and hazardous encounters, requires magnanimous and ferocious impulses; it was necessary therefore that the blood should, when occasion demanded, ascend to the brain in a more full and copious torrent." This structure however renders the horse more liable to apoplexy than other qudrupeds.

In the class of BIRDS, the brain varies greatly from that of the mammalia, although it possesses analogous parts. The hemispheres of the cerebrum are considerable, constituting a large portion of the mass of the organ, and in their centre we distinctly see the corpora striata. There are two optic thalami, comparatively much larger than in man and quadrupeds. Behind the cerebrum appears the cerebellum, and from its in-

ferior part extends the medulla oblongata. The hemispheres of the cerebrum contain two lateral ventricles with an intervening septum; under the thalami is a third ventricle, and a fourth in the cerebellum, all of which communicate together as in man. There is no corpus callosum nor corpora mamellaria, nor do we see the tubercula quadrigemina between the cerebrum and cerebellum; but there are four tubercles placed between the thalami and corpora striata. The anterior part of the cerebrum is prolonged into the olfactory nerve, thus forming in this part a third degree in the scale from man; for in the human head, the olfactory nerves are distinct from the brain: in quadrupeds the brain swells into an olfactory tubercle; and in birds the hemisphere is prolonged into the olfactory nerve. The optic tubercles or thalami in birds are remarkable for possessing ventricles as the olfactory nerves do in quadrupeds. These facts would lead us to expect what we find to be true, an extraordinary development of the organ of smell in quadrupeds, and of that of vision in birds.

In the third class, the REPTILES, or amphibious animals, the structure of the brain is varied in the four different orders of *Turtles*, *Frogs*, *Lizards* and *Serpents*. The following characters are common to the four orders. There is a cerebrum with proper hemispheres, but no convolutions; a cerebellum and a medulla oblongata;

but the pons varolii does not exist. The optic thalami are found, the corpora striata, the pineal and pituitary bodies, the four ventricles with their communicating passages.—The brain in the *turtle* is of an oblong form, the cerebrum is indented transversely, the cerebellum is readily distinguished from the cerebrum. The anterior part of the hemispheres of the cerebrum is prolonged into the olfactory nerves: below these lie the optic nerves proceeding from their thalami, and between the two are tubercles like those in birds. The dura mater has a firmness almost cartilaginous. In the interior of the organ are found the corpora striata and the ventricles.

The class of FISHES is divided into *osseous* and *cartilaginous*. Considerable difference of structure is seen in these two divisions, and even in the families which compose them.—The general characters are these: the brain is always contained in a cavity much larger than itself, and surrounded by a liquid of a peculiar nature. Different from the other classes of vertebral animals, it is composed of a collection of tubercles, no one of which is very conspicuously larger than the rest. The two hemispheres of the cerebrum are distinguishable; behind them a cerebellum of nearly equal size; before them the two olfactory tubercles almost as large as the hemispheres; and below, the tubercles, or thalami, with the optic nerves. Besides these, there is

an eminence behind the cerebellum; various tubercles at the base, giving origin to nerves; the pineal and pituitary bodies; the tubercula quadrigemina, and the four cavities of the ventricles. The interior of the hemispheres exhibits the corpora striata; but the interior of the cerebellum wants the arbor vitæ, as well in this as the preceding, or reptile class.

Having compared the great sensorial organ in man with that in the other classes of vertebral animals; it might be expected I should proceed next to an examination of the same part in the invertebral classes. But in these last, the brain differs greatly in its relative magnitude, and in the complexity of its organization, from that of the superior classes; for in most instances it appears more like the enlargement of a nerve than a distinct organ, and often it is very difficult to discriminate it from those swellings of nerves called ganglia, which form so conspicuous a part of the nervous system of invertebral animals. Any separate description of the brain would be impracticable; and it must therefore be described in connection with the nerves.—It will be proper now to take up the second part of the sensorial apparatus, THE NERVES OF SENSE, beginning with the superiour animals; and afterward to trace the nervous system down through the nine classes to the most simple structures of the animated creation.

The nerves in the human body are white cords issuing mostly from the brain and spinal marrow. At their origins they are soft; through their course they are rendered firm by a membranous coat called neurilema; their terminations are generally unknown. The membranous substance which envelopes them, penetrates and separates them into a great number of filaments, each containing a soft matter considered as medullary, and possessing the peculiar properties of the nerve. In their course through the body, the nervous cords are interrupted by *plexus* and *ganglia*. A plexus is a network formed by the union and separation of a number of nerves. A ganglion is a body composed apparently of a yellowish or grey coloured unctuous substance. Within this there are, according to many anatomists,* a multitude of small filaments, uniting and separating, in the manner of a plexus, covered by the unctuous matter. Ganglia are found in all animals which have nerves; and they are seen to increase in comparative magnitude as we descend to the lower classes. In worms and insects they are more conspicuous than the nerves connected with them, and their number is also greater relatively than in the superiour animals. Their use has been a subject of specula-

* Scarpa *de Nervorum Gangliis et Plexubus. In Annot. Anatom.*

tion among physiologists; some viewing their functions as analogous to that of the brain; others, as Gall and Spurzheim have hazarded the opinion that they are the matrix or source of nutrition for the nerves and that the brain itself is to be considered a ganglion.

The opinion that the ganglia serve to nourish the nerves is derived from the structure of the lower animals. Dr. Gall states that he has observed in them two kinds of nervous substance; a greyish gelatinous matter and the nervous filaments. The first almost wholly composes the polypi. In animals a grade higher, the viscera are provided with masses of this gelatinous substance, and the nervous filaments are seen to arise from it.*

If it is intended to say that the ganglia of invertebral animals are like those of man, the ex-

* Nous avons observé, dans les classes inférieures d'animaux, deux substances du système nerveux: la substance gélatineuse grisâtre et les filets nerveux. La première semble former la presque totalité des polypes et characteriser le commencement du règne animal, quoique l'existence des filets nerveux, n'ait pas encore pu être démontrée dans ces êtres. Dans un degré plus élevé, les entrailles sont pourvues d'amas particuliers de cette substance gélatineuse, et on voit distinctement des filets nerveux, y prendre naissance; ceux-ci se rendent dans leurs parties respectives et s'y épanouissent. Mais comme ces amas de substance gélatineuse forment des noeuds ou des renflemens avec les nerfs qui y naissent, on les appelle des ganglions. (*Anat. et Physiol. du Système nerveux.* *Tom.* 1. *p.* 44.)

actness of this opinion may be questioned. The ganglia of invertebral animals are not composed of an external unctuous substance; nor do they present an appearance of nervous filaments within. So far as I have observed, they are firmer externally, and are covered with a white coat or neurilema like the nerves. Within this is a soft medullary matter, homogeneous in appearance to the naked eye, mottled when examined by the microscope; but in no respect resembling the greyish or yellowish matter of human ganglia.—Nor is there within this matter any thing like the nervous filaments. The nerves connected with the ganglia in these animals disappear at the coat of the ganglia, and do not pass through these bodies.

Should it be said that the colour of the internal matter is not important, and that this is the substance which nourishes the nerves, all that can be answered is that it has every appearance belonging to nervous matter; and that if it nourishes the nerves, then the nervous matter nourishes nervous matter, or in other words, nervous matter nourishes itself.

Had it been asserted that the coats of the ganglia in invertebral animals form the medulla of the nerves, the apparent structure would have better supported such a position. But this, although it would have given a use for the ganglia, would not have made it more probable that the

medulla is formed by the coats of the ganglia than by the coats of the nerves.

The supposition that nervous matter is diffused throughout the bodies of the gelatinous zoophytes cannot be supported by observation, is contrary to analogy, and does not accord with the low state of the sensitive phenomena in these animals.*

The most probable conjecture as to the use of the ganglia seems to be that they are points of nervous communication, in some respects similar to the arterial communications, as they serve to diffuse more equally the nervous influence, or to lymphatic glands which collect parts and change their mode of distribution.

The terminations of nerves are not well known, except in the instances of the optic and auditory, and perhaps the olfactory nerve. These end in a pulpy expansion; whence analogically we conclude that the other nerves terminate in a soft substance, and that this is very extensively diffused, since there is scarcely any fibre of a living body which does not afford proof of the existence of nerves. Mr. John Hunter thought the nervous influence to be uniformly spread through every texture: and Sir Everard Home has supported this opinion by experiments and observa-

* An account of Mr. Home's observations is contained in the appendix.

tions tending to show that the nerves contain a mucous matter, serving as a medium to carry their influence from one part to another.*

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* The distinguished anatomist, Mr. Charles Bell, has published a paper in the Philosophical Transactions for 1821, part second, giving some account of the structure and functions of nerves, leading to a new arrangement of the system.

This author supports the opinion, that where various nerves from different sources go to one part, they perform different functions. The tongue, the larynx, and many other parts are supplied in this manner.

He divides the nerves of all animals into two kinds, one simple and regular, the other complex and irregular. The first contains all the spinal nerves, the suboccipital and trigeminus; all these are highly sensible. The second contains the respiratory nerves: which are 1. the par vagum; 2. facial, or respiratory nerve of the face; 3. spinal accessory, 4. phrenic or internal respiratory; 5. external respiratory, sent from the nerves of the neck to the thorax. These nerves are not very sensible.

The nerves of the face belong partly to one, partly to the other of these divisions; and of course have different degrees of sensibility and different functions. The branches of the trigeminus belong to the tongue, the salivary glands, the parts about the mouth, etc. and are highly sensible.—The seventh pair, facial, or, as Mr. Bell calls it, respiratory nerve of the face, differs in structure and function from the trigeminus. Its texture resembles that of the par vagum, being more dense than that of the other nerves. When this nerve was divided in experiments on animals, little pain was expressed, the muscles dilating the nose in inspiration were paralyzed and some of the face.—When the suborbitar branch of the trigeminus was divided, great pain was given and the upper lip paralyzed.

On a rapid glance of the nervous system in the various classes of animals from the highest to the lowest, we are struck with the fact that this part of the animal economy presents a greater

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As the trunk of the elephant is concerned in two functions, that of touch and respiration, it was examined with a view to ascertain whether it was supplied by different nerves, and it appeared that it possessed two large nerves from different origins.

The lungs and the muscles surrounding them are not the only parts necessary to respiration. Various other organs, some of them remote, concur in this function : all of them are supplied by nerves whose actions harmonize with each other and differ from those of other nerves. Further observations will separate the respiratory nerves in the body from other nerves, in the same manner as has been done in regard to the face ; and this will prepare for a new arrangement of the nervous system.

In the lower animals the respiratory nerves do not exist ; and therefore the symmetrical nerves are seen by themselves : the nervesof the back, for example, correspond with the spinal nerves and the trigeminus.

The observations I have made in surgical operations agree with those of Mr. Bell and his co-adjutor Mr. Shaw, and I think it a duty to record them. In four or five cases in which I removed the principal lobe of the parotid gland, the facial nerve, or many of its branches have been divided, and the muscles of the face on that side paralyzed. In the last and most formidable of these, the tumour involved the external carotid artery, which I divided and tied ; the nerves were of course extensively cut, the muscles of the face were paralyz-

uniformity in appearance and texture, in different animals than any other structure.

The particular distribution of the nerves, in the four classes of vertebral animals, is remarkably uniform, considering the difference in the external figure of these animals; but in the invertebrals is subject to great variations.

In vertebral animals, two great divisions are made of the nerves, first, those which issue from the brain, the nerves of sense, and second, those from the spinal marrow.

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ed; and when, after her recovery, the patient smiled, the muscles on the opposite side alone contracted; so that after the lady had discovered this peculiarity, I could never extort a smile till the paralysis began to diminish. It is also proper to remark, that in this case the patient was, soon after the operation, seized with a sense of constriction about the throat and larynx, that constantly threatened suffocation and alarmed me greatly for her life. This I attributed at the time to the division of branches of the par vagum; but as the symptom disappeared about the third or fourth day; it seems more likely to have been caused by a sympathy between the facial and laryngeal nerves. In this case as well as some others, I was surprised at the want of acute pain in the part of the operation when the nerves were divided: especially when I compared it with that of the operation for dividing the suborbitar nerve. In the latter, the pain has always appeared to be excruciating; in one instance a patient cried "you are knocking all my teeth out." After the division of the suborbitar, the face has not been paralyzed; but the upper lip has lost its sensibility on the same side.

In man, twelve pairs of nerves proceed from the brain, and the same number is found in the various orders of quadrupeds. They are also distributed nearly in the same manner, a large part to the organs of the external senses. In some animals of the class mammalia, the cetaceous or whale tribe, there is a remarkable exception to this arrangement, as will be noticed.—When speaking of the nerves belonging to the organs of the external senses, I shall ask leave to introduce some facts of comparative anatomy, relating to the organs themselves.

The first pair of nerves of the head or olfactory, in quadrupeds, arising from the lower and fore part of the cerebrum, is short, very thick, and contains a ventricle, which communicates with the cavities of the lateral ventricles of the cerebrum. In man and the monkies there is not any such ventricle in the olfactory nerve; nor of course in these is the organ of smell so largely developed as in quadrupeds. But in the latter, the face is prolonged anteriorly and has at the termination of the upper jaw two bones, not found in man, called inter-maxillary; whence it is that a more ample space exists for the organ of smell, as well as for that of taste. On this fact is grounded the remark of Cuvier, that instead of taking as the indication of intellectual superiority, the projection of the forehead and the facial angle, which are liable to inaccura-

cy from the thickness of the frontal bone, we might substitute the surface of the nasal and oral cavities, seen in a vertical section of the head; for as the superficies of these two organs increases in proportion to the superficies of a section of the cranium, so do the organs of taste and smell predominate over the organ of intellect: and in this respect there is a pretty regular gradation from man to the inferiour vertebral animals. There is a remarkable exception as to the olfactory nerve in one order of mammalia, the cetacea, or whale tribe. They are entirely destitute of this nerve and of the olfactory organ. A peculiarity more worthy of notice, because the other inhabitants of the waters, of the class fishes, possess the olfactory nerve and the organ of smell.

The second pair of the head, or optic nerves, exist in all the vertebral, as well as most of the invertebral classes, and are usually among the most conspicuous nerves in the body. They originate in man from the tubercles called *nates* and after passing some distance unite together, then separate and go to the globe of the eye, penetrate the sclerotic and choroid coats and expand on the inside of the latter, thus forming a third or interior coat of the eye, the retina. This nervous coat is composed of a most delicate membrane, covered internally by a pulp, the true nervous matter. The pulp, examined by the microscope, according to Sir E. Home, appears to

be composed of bundles of fibres, radiated from the optic nerve, and these consist of globules connected into fibres by a gelatinous substance, soluble in water, transparent during life, becoming opaque after death. The discovery of this transparent jelly is thought by Sir E. Home, to be very important, since, according to him, it will enable us to form some idea of the action of nerves.*

The retina, the expansion of the optic nerve presents very similar appearances in the four classes of vertebral animals. The other coats and humours of the organ of vision are also generally alike; but there are some peculiarities worthy of being noticed. The form of the pupil varies in different orders. In the graminivorous, or ruminating, it is horizontally oblong, for the purpose of enabling the animal more readily to discover its food on the surface of the earth; while in the carnivorous it is vertical, and thus keeps sight of an object, during the vertical changes of position that occur, when these animals leap on their prey. In some of the ruminating, there is a muscle, not found in man, called suspensorius or retractor, extending from the back part of the orbit to the globe of the eye. By its contraction the globe is drawn into the socket; an action, we may suppose, destined by

* See Appendix.

nature to prevent injury to the organ, when exposed during a rapid course through forests.

The optic nerve and organ in the second class present some interesting peculiarities. Birds are mostly feeble animals, liable to become the prey of others, yet possessed of peculiar means of security, by flight. In order to enable them to employ these means usefully, a keen and extensive sense of vision is required. Their optic nerves are large and connected with thalami or tubercles, which have ventricular cavities. The eye is so prominent on the side of the head, as to discern objects before and behind, as well as those in a lateral situation; and might therefore be exposed to injury, were it not protected by a range of lamina, or scales, encircling it at the circumference of the socket. The cornea is firm, very large, and receives additional protection from the *membrana nictitans*, a third eyelid placed at the inner angle of the eye, and capable of being expanded over the cornea by means of two muscles, extended from the back part of the sclerotica and by their action drawing the membrane toward the outer angle. The membrana nictitans is a fold of the conjunctiva, it is thin and therefore does not wholly intercept the passage of light. In water-fowl it is drawn over the eye, when the head is plunged into the water to seize their food; and it enables those which soar high in the air to support without inconvenience the full blaze of

the sun. The coats and humours are, as already mentioned, similar to those of the mammalia; but there is an additional membrane at the back part of the cavity of the eye, which perforates the retina and extends forward, almost to the crystalline,in some species. This,from its purse-like shape, is called *marsupium.* It is covered with a black pigment like the choroid membrane, and has therefore been thought to have, for its use, the absorption of superfluous rays of light, to which these animals are peculiarly exposed. The aqueous humour in birds occupies an ample space, but the crystalline is of small size. To these facts we shall have occasion to refer hereafter.

In the fourth class, the fishes, the optic nerves have a peculiarity of course, which throws light on an obscure point of human physiology. In man and other mammalia, these nerves, after coming from the brain, approach each other and form a union into a common mass. It has always been a question, whether they cross each other, or whether they are perfectly united in this mass : a question which anatomical researches have not satisfactorily answered. In fishes, the optic nerves, after issuing from their thalami, lie one over the other, for some distance, without any union, though they are loosely connected by transparent cellular membrane; and at length that of the left side goes to the right eye, that that of the right side to the left eye. Here is a

distinct and remarkable instance of a nerve from the left side of the brain, going to an organ on the right side of the head. Although we do not know the reason for this arrangement, it must, I think, be admitted that the more extraordinary it is, the more likely is it to be connected with some important law of vision, and the stronger ground have we for believing that the same structure exists in man.

The globe of the fishes' eye is covered externally by a thick and strong membrana conjunctiva, serving as a substitute for eyelids, and protecting it from the water. The membranes, choroides, and retina, consist of more than one layer, and thus seem to differ from the eye of the mammalia; but the observations of some anatomists give us sufficient assurance that the retina has two layers, a membranous and nervous; and there is reason to believe that the choroides has the same number. There is in some fishes a marsupium, of smaller size than that of birds. The iris is externally covered by a silvery coat, while its inner surface is endued with a black pigment, to absorb the rays that might penetrate it. In the humours of the eye, nothing remarkable appears in the vitreous; the aqueous and crystalline exhibit peculiarities, well fitted to excite admiration.

The aqueous humour is ample in BIRDS, as before stated, and acts an important part in the vision of these animals; for as they reside in air

and sometimes soar to its thin upper regions, they are of course situated in a medium, rarer than the fluid, composing the aqueous humour. Now we know that light, in passing from one medium to another, suffers a refraction proportioned to the difference of their density; but the water of the aqueous humour is denser than air, and, being of great extent in birds, must cause a considerable refraction in a direction fitted to bring the rays to a focus; and, what is worthy of particular admiration, the more elevated the animal's flight, and consequently the more remote the objects of vision, in so much more is the refraction augmented by the increased rarity of the air, and consequent increase of difference in the media, through which light passes to the eye. The *crystalline lens* is small in birds, and contributes but moderately to the approximation of the rays of light; because the refractive power of the aqueous humour diminishes the importance of the crystalline.

Fishes, on the other hand, live in a fluid equally dense with the aqueous humour, which can, of course, have no power of refracting the light. Nor could the density of this humour be increased without depriving the iris of a bed proper for its movements; it is therefore no larger than is necessary to admit the iris to float freely in the operations required for increasing and diminishing the aperture of the pupil. The crys-

talline lens is destined to perform the refraction of light. It is large, possesses the greatest degree of convexity, and has, of course, a high refracting power. This power is increased by the internal structure of the lens; for while, like the human, it is soft and gelatinous externally, its nucleus is very hard, so as to yield with difficulty to the knife. The difference of density, between its exterior and interior, the difference between the whole lens and the water, together with the convexity of the lens, give it probably the highest refracting power which a single body can possess, and thus the animal has an adequate degree of vision, notwithstanding the density of the medium in which it exists.— By recent experiments and observations of Dr. Brewster, it appears that the difference of density, between the nucleus and exterior, serves another purpose in the vision of the inhabitants of the deep.* This philosopher noticed that the polarization of light is remedied, or in other words that light is depolarized by substances of unequal density, as hardened jelly or glass cooled in such a way as to possess unequal densities in different layers; whence he was led to conclude that the crystalline of fishes possessed the same power; and on examination his suspicion was found to be confirmed. The depolarizing pow-

* *Philosophical Transactions.*

er, we may suppose, has under these circumstances the effect of bringing the light more truly to the eye, and presenting objects in their proper place.

The comparative view we have taken of the structure of the nerve and organ of vision in man, birds, and fishes, must, I think, inspire us with high notions of the wisdom of the creative power. Such views may serve also to teach us a modest estimation of our own abilities; for while we are surrounded by phenomena, whose ultimate objects are wrapt in impenetrable obscurity, nature sometimes lifts the veil, which conceals her designs, and indulges us with a full view of their utility and beauty. Whenever, therefore, the mystery of final causes eludes our research, we ought not fall into a despairing skepticism; we should be contented with what is unfolded to our view, and believe that what is unintelligible is not less wisely and wonderfully formed.

The other nerves of the head are much the same in number and arrangement in the four classes of vertebral animals; varying so far as the difference in the form of the head requires. The fifth pair possess a greater number of branches in birds and fishes; while the eleventh pair, or sublingual appear to be wanting in fishes, the deficiency being supplied probably by the additional branches of the fifth, since in the

mammalia we know that these nerves both send branches to the tongue.

The spinal division of nerves contains, in the human subject, about thirty pairs. Issuing from each side of the spinal medulla, between the bones of the spine, they correspond in number with these bones, not only in man, but in the four classes of vertebral animals. Quadrupeds, having the same number of vertebræ of the neck as man, possess the same number of cervical nerves, seven, except a single species, which has two additional bones and nerves. The dorsal vertebræ and nerves are generally more numerous. The neck in birds is long; their cervical vertebræ and nerves, of course, are numerous, amounting in some genera to twenty; their bodies being short, the dorsal nerves are always fewer than in the mammalia. Some of the reptiles, as the serpent order, present a vast number of vertebræ and corresponding nerves. An analogy in distribution is striking in all the classes; even in fishes, where there are no limbs, we yet perceive a nervous network supplying the place of the brachial plexus, whence nerves are sent to the pectoral fins; and as the abdominal fins are the parts analogous to the inferior extremities of man and posterior extremities of other vertebral animals, they have nerves sent to them in a similar way from the spinal mar-

row, though more in number in some fishes, than in the other classes of animals.

A proper *phrenic* nerve has not been discovered in birds, reptiles, or fishes. The *great sympathetic*, with its ganglia, is seen in all the mammalia, birds, and reptiles; but in fishes it is a very small nerve without ganglia. Perhaps the size of the spinal marrow, the number and magnitude of the nerves which proceed from it, their proximity and connexions with each other supply the place of the great sympathetic.

INVERTEBRAL ANIMALS.

The invertebral animals are so called from being destitute of vertebræ, and of course of an internal skeleton. As in this they differ greatly from the vertebral animals, so in other particulars are they widely dissimilar. In the form of the vertebral animals the same type is distinguishable in all the classes; but in the invertebrals there is no resemblance to the superiour animals in external appearance, nor do the different classes resemble each other, nor even do the different orders of the same class. The variety in structure is equally great. Instead of an internal apparatus of bones, they have an external coat of various firmness; in some of stony hardness, as in the oyster, and other shell

fish; in some it is a crust as in the lobster, and most insects; in some it it is a strong yet soft substance, as in the cuttle fish; while in others this covering is thin and membranous, as in worms and many polypi. Their internal organization also differs from that of the vertebral animals.—The organs of the circulation are generally very simple and few in number. In the polypi, there are neither arteries nor veins; but merely vessels which absorb nutritious matter from the stomach and convey it to every part. In insects there appears to be a single vessel, called either a heart, or an artery. In worms, there are arteries and veins, to the number of three or four.*

The respiration of these animals is never performed by lungs, unless we should consider to be such certain vesicles existing in the arachnides or spiders, and in the red-blooded worms. The mollusca and crustacea breathe by *branchiæ*, or gills, like fishes; insects, by *tracheæ* and *stigmates*, that is, air tubes and air holes; worms and polypi by orifices or pores of the skin.

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* In crustacea and many mollusca we find one or more hearts; the sepia has three, one middle and two lateral. Each heart has a ventricle, one and sometimes more than one auricle, and corresponding arteries and veins.

The nervous system also differs greatly from that of the vertebral animals. As there is no spine, there is, of course, no proper spinal marrow. The brain is wanting in almost all the classes, and instead of it, there is a nervous mass, surrounding the esophagus, thence denominated the *collar*, from which *nerves are sent* in various directions. In four of the five classes, the principal nerve from this *collar* is the most conspicuous nerve in the body; and is very uniform, in having a number of ganglia placed along it, at nearly equal distances. The fifth class, or zoophytes are apparently destitute of nerves.

The invertebral animals compose by far the greater part of the animated creation: and from their number as well as from the varieties of their form and the obscurity of their structure are objects of great interest to the naturalist. They have been divided into five classes, MOLLUSCA, CRUSTACEA, INSECTA, VERMES, ZOOPHYTA.

The MOLLUSCA are placed first among the invertebral animals, because their structure is the most complicated. The name is taken from the soft consistence of their bodies; yet we must admit it to be an unfortunate term as applied to this class. No one would expect to find that animals covered with strong shells, as all the testaceous animals, were to be found in a division denominated from their softness. Their bodies are in fact soft,

though the part which covers them is hard; but the term applies with more exactness to a different class, the zoophytes. A more important objection may be made to the arrangement, than to the name. This class comprehends not only animals with soft and with hard coverings; but also such as are different in structure and habits. The cephalopode mollusca have a complicated organization; while that of the testacea is comparatively simple. In the genus sepia, belonging to the former, we find a distinct and extensive nervous system, various organs of sense, hearts with arteries and veins, many articulated limbs, and a power of free loco-motion. In the testacea, the nervous system is obscure, there are no distinct organs of sense, the heart and vessels are small, there are no limbs, and in general almost no power of loco-motion.

These facts have led M. Cuvier to divide his molluscous animals into six classes, thus separating from each other, in some instances, animals much alike in structure. M. Lamarck, while he makes objections to the arrangement of Cuvier has also divided the mollusca into a number of classes, in a different manner from the latter, and placed them in his primary division of *sensitive animals.* If to these opposing facts and opinions we add that the researches of M. Savigny have lately shown that a number of the minute animals, considered as zoophytes, have a complicated

structure and are really mollusca; moreover that it is probable many of this class will hereafter be found to have a similar structure, it must appear that the arrangement of this part of the animal kingdom is yet unsettled, and liable to many changes, on further discoveries.

For our present purpose, it will be sufficient to give an idea of the nervous structure of the two orders called cephalopoda and acephala. The *cephalopoda* have heads, with many legs placed around. The acephala are without heads.

The most remarkable of the cephalopoda are the sepiæ, the species of which called sepia officinalis, or cuttle fish, is pretty generally known. They vary in size from a few inches to a considerable magnitude.* They have a cartilaginous head, surrounded by eight legs; and some of them have two tentacula, or feelers, longer than the legs; two large eyes, ears, a central and two lateral hearts with blood vessels, a complicated digestive and generative apparatus; and they are invested by a firm cloak or mantle, which contains a bone.

The nervous system of the sepia approaches to that of some vertebral animals on one side and to that of the crustacea on the other: the resemblance to the latter is stronger than to the same system in other animals of the same class, that is, to the acephalous mollusca.

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*The accounts of enormous sepia are not credited by M. Cuvier; nor are they supported by satisfactory testimony.

The brain is situated in a cartilaginous ring, a part only of which it occupies. From its sides issue two nerves to form the *collar*, around the esophagus. The optic nerves proceed from the brain to the eye, and there form a ganglion, nearly equal in size to the brain, sending out innumerable filaments to the coats of the organ of vision. The collar is a flat nervous mass, furnishing the legs of the animal with nerves, one to each; besides which there are many ganglia and nerves supplying other parts of the body. The most distinct and beautiful of these are placed on the inner surface of the mantle about the middle of the back; they are two in number, one on each side. A long nerve from the collar gives origin to them, and on every part they radiate small nerves which give them a resemblance to the sub-maxillary ganglion in the human head. The organ of vision is very complicated and beautiful; that of hearing is of simple structure; the tentacula possess the sense of touch; and as the animal has a mouth and tongue it probably enjoys the sense of taste.

In the acephalous mollusca a very different nervous apparatus exists. The brain, if it can be so called, is placed on the esophagus under a sort of cap or hood, formed by the soft mantle which lines the shells. Connected with it is a very considerable nerve running within the mantle almost round the shell; from this, nervous filaments are

sent to the liver, heart, especially to the branchiæ and to the fringe about the mouth. There are also ganglia connected by nerves with the principal nerve, one is situated near the brain, another on the muscle which closes the shells.*

The CRUSTACEA have received their name from the crust or hard coat which invests them. By LINNEUS they were placed in the class of insects. CUVIER admitted them formerly to rank apart from insects; but since his new arrangement, the crustaceous animals, though made a distinct class, are placed in the same division with insects, under the head of ANIMALIA ARTICULATA. Such an authority as M. CUVIER is hardly to be questioned on any point of natural history or comparative anatomy; yet it must be admitted that the propriety of this approximation is at least doubtful. The crustacea are generally of great size compared to insects; a character not indeed important by itself, but which, taken in connexion with other distinctions, is not to be passed over in forming arrangements agreeable to the order of nature. Their habits are different; the insect tribes mostly living on the earth and in the air; crustaceous animals mostly in the waters, approaching in their habits to fishes. The organization of the crustacea is more complicated than that of insects. The former breathe by branchiæ or gills, the latter by air vessels.—

* See plate II. Ostrea edulis, the oyster.

The crustacea have a heart, arteries, and veins; insects only a single vessel. The principal common characters are articulated limbs and a knotted nervous system, that is, a principal nerve with ganglia placed at small intervals.

The nervous system in the different orders of CRUSTACEA is formed on much the same general plan; as from its distinctness it is readily examined, is well fitted to give a notion of the arrangement of the nervous system in other invertebral animals, and of the difference between this and the same system in the vertebral animals, I shall describe it more minutely. For greater exactness we shall take one species as the subject of our description. The *cancer gammarus*,* common lobster, has a small head placed at the root of the antennæ, or feelers; its situation is readily discovered by the eyes, on its fore part. Behind the eyes lies the brain, small, yet very distinct, and divided into two lobes. From the anterior part of the lobes, the optic nerves proceed to the eye. This organ is of an oblong form, rounded anteriorly, where it appears of a dark colour. The cornea is hard and fixed in a sclerotica connected with a membrane, the softness of which allows the organ to be drawn inward. The optic nerves, having entered the shell of the eye, form an enlargement whence

* (See plate I.)

proceed filaments to the choroid coat. The latter is of a purple colour, thick and soft; it is penetrated by filaments of nerves going to terminate on the inner face of the cornea.

The brain also sends anterior nerves to each of the four antennæ, the organs of touch. From its posterior part proceed the two nerves that surround the esophagus and constitute the collar. The organ of hearing receives its nerves from the collar; it is placed on the root of the great antennæ, and externally presents a membrane of a circular form, about a line in diameter, inserted in the shell; within this membrane there is a small bone, behind which we observe the expansion of a soft greenish substance, displaying a beautiful arborescent distribution of the nerves from the collar.

The most conspicuous part of the nervous system of this animal consists of two nervous cords, with many ganglia, extending through its whole length. These two cords arise from the posterior part of the collar, and passing along the stomach, form a ganglion, which sends nerves to the jaws: the two nerves, still running on in contact, form successively five ganglia, corresponding with the pairs of claws, and each claw receives a nerve, that penetrates to its extremity. After this, the two nerves unite and form six ganglia successively, extending along the tail and furnishing nerves, as they proceed, to

different parts, the last being distributed to the fins or swimming organs.

The CRUSTACEA therefore possess a brain, nervous collar, an oblong nerve, separable into two nerves, with ganglia, other nerves arising from the former, and three distinct organs of sense, that of vision, of hearing, and of touch.

INSECTS, the third class of invertebral animals, although various in form and size, present a great degree of uniformity in their organization. They differ from crustaceous animals in their organs of respiration. Instead of branchiæ, they breathe by tracheæ, two oblong tubes on each side the body, communicating with the external air by orifices, denominated stigmates. To this structure there is an exception in a part of the arachnides or spiders, which have vesicles, or bags, supposed to perform the office of respiration.—This fact, together with the want of antennæ, has led some naturalists to put them in a different class from insects. The *pulmonary arachnides* are also said to differ from insects in their organs of circulation; insects, possessing only a single dorsal vessel, serving for heart and arteries, while these arachnides have an oblong vessel considered as a heart, connected with lateral vessels which receive blood from it.

The nervous system of INSECTS preserves the same general characters in the variously formed animals belonging to their class. There is a

brain supplying nerves to the organs of sense, a nervous collar encircling the œsophagus, whence proceed the two longitudinal nerves with ganglia, from which the nerves of the limbs are sent out. To this general arrangement there are some exceptions. Insects with bodies of a rounded form have their nerves distributed in a radiated manner, and the same may be said of crustaceous animals; while those with oblong bodies exhibit the appearances just described.—We shall select a single species in order to give some notion of the common distribution of nerves, in this class.

The centipede, scolopendra morsitans, is convenient for our purpose on account of its size and the distinctness of its nervous system.* The brain in this insect is comparatively of large size and of a rounded form. It sends two nerves forward to the antennæ, two others, the optic, to the organs of vision. Posteriorly issue two nerves which separate, surround the œsophagus, afterward re-unite, and form a ganglion on the first ring;† from this issues a nerve, which divides; then another union is formed and another ganglion on the next ring, and so of the rest.—

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* Plate 4.

† The rings are circular crusts, corresponding in number with the pairs of legs.

From each ganglion, three pairs of nerves proceed; one pass forward, the second laterally, the third backward, and from them the neighbouring muscles, viscera, and limbs are supplied. The nerves of the larva in the winged insects are larger than those of the perfect insect. This fact appears less extraordinary, when we consider that in the young subject of the mammalia and other vertebral animals, the nerves are larger in proportion, than at a subsequent period when the body has reached its full growth.

The external senses are not wanting in insects. The organs of vision are usually large, often numerous, and are divided into two kinds, simple and compound. The compound eyes are so called from their surface being divided into a vast number of facettes like cut glass, which in some species have been computed to be 25,000, and to each of these goes a filament of the optic nerve. In various instances, the simple and compound eyes are found to exist together in the same insect. The sense of touch resides in the antennæ, which are, for this function, supplied with large nerves. The proboscis, or rather the tongue contained in it, is the seat of taste, when it exists; and when wanting, its place is probably supplied by some of the complicated parts which compose or surround the mouth.— No organ of hearing has been discovered; we are led to believe that there is a sense of smel-

ling, by the fact that they are able to find their food in situations, where it could be discovered by no other sense we are acquainted with.

The fourth class of invertebral animals, worms, VERMES, in the arrangement of LINNEUS comprised the three classes, mollusca, zoophyta, and vermes. CUVIER and LAMARCK have agreed in abandoning this as a class, placing one portion of it in a separate class under the name of *annelides*, referring the other, *epizoaria* to the zoophytes, or animalia radiata. The annelides have a more complicated structure than the epizoaria, are therefore very properly separated from the others, and are the animals we shall describe under the head of VERMES; for the epizoaria, the intestinal or parasitic worms, so called from growing in other animals, do not exhibit the same organization; their structure is extremely simple, and brings them properly among the zoophytes.

The annelides have received their name from the numerous rings composing their bodies.— They are very remarkable for being the only invertebral animals with red blood; and therefore form an exception, the only one, to the law formerly alluded to, which assigns white blood to the vast number of animated beings comprised in the invertebral division. This peculiarity might be explained in regard to some of them, which feed on the blood of red-blooded

animals, as some of the leeches; but such an explanation will by no means apply generally; since the greatest part of this class live on animals and vegetables affording fluids of a different colour from red blood, as the earth worm and most of the sea worms.

Separated from the epizoary worms, the annelides form a very small class. Their general organization is more complicated than that of insects, since most of them breathe by branchiæ, and possess a double system of sanguiferous vessels, performing the functions of arteries and veins. Their digestive apparatus is complicated and extensive; being composed of a mouth, œsophagus, one, and sometimes many stomachs, an intestine, and an orifice for excretion.

For a specimen of the nervous structure in the class of red-blooded worms, we shall take an animal generally known, the leech, hirudo medicinalis.* Its nervous system is principally composed of a nervous cord knotted, with ganglia, extending the whole length of the body, *contained in and covered by the abdominal blood vessel.* The latter fact led M. Cuvier, I suppose, to say that the coat of this nerve is black, for the red coat of the blood vessel, which invests it, assumes a blackish appearance on immersion in alcohol: but the coat of the nerve, so far as I have noticed, has

* Plate 3.

the same white appearance as that of other nerves. The long nervous cord has twenty-two or twenty-three ganglia. The first, placed in the head, is small, and sends forward two nerves to the disk: it also sends two nerves backward, which separate, surround the esophagus, thus form the collar, and afterwards reunite in the largest ganglion of all. From this are sent out many nerves, lying near each other, and forming a nervous mass like a plexus near the esophagus and minute nerves are also sent to the mouth: out of the plexus proceed nerves along the animal, supplying various parts, particularly the cutis, cuticle and muscular expansion under the cutis, which performs the animal's movements. The principal or knotted nerve, passing a little distance from the second or large ganglion, forms a third, afterwards a fourth, and so to the number of twenty-two, when it terminates at the posterior extremity of the body. Each of these ganglia sends two pairs of nerves, to be distributed to the stomachs and other parts in their vicinity. The only distinct organs of the external senses are those of vision. There are five pairs of eyes, placed on the sides of the head, the two anterior being the largest. The sense of touch probably resides in the anterior pointed extremity; and although there is no apparent organ of smell, we cannot doubt the existence of the sense, on considering the sensibility, displayed by the

animal, to odorate substances. There is no reason to believe it has a distinct sense of hearing, although it may be sensible, through the medium of the skin, to those impulses of the air, which produce sound.

Zoophytes, the last class of invertebral animals, received their name from a supposed union of the animal and vegetable natures. In form, some of them have a great resemblance to vegetables: but in other respects they are different; and especially are they to be distinguished from the vegetable world by the possession of a power of acting or contracting and generally a power of moving from place to place. By Lamarck they have been denominated *apathic animals*, from being destitute of sensibility: for their motions do not, in his view, appear to be the result of the application of external stimuli, but rather to be instinctive. Cuvier has given to them the name *animalia radiata*, because in most of them the parts are placed in a radiated form, around a common centre.

This class is composed of animals, the greater part extremely minute, yet inconceivably numerous, and by their aggregation sometimes producing masses of vast extent. In order to give some idea of these singular beings, we must say a few words of each of their different orders. The *infusory* animals, seen in vinegar and in stagnant water, are the most minute of the animated king-

dom; for many of them are only to be discovered by the microscope. Their structure has the greatest simplicity, so far as we can ascertain it; no other part being distinguishable than a sac, various in form, with one opening for the reception and rejection of alimentary substances. They have neither vessels, nerves, nor internal organs. On examination by the microscope, they present a great diversity of curious forms, as those of globes, suns, comets, in truth almost every imaginable shape. Next to the infusory stand the *polypi*, animals larger and better known. They constitute the most considerable part of the zoophyte class and contain a great number of genera and species. The polypi are gelatinous animals with an oblong body. They have a mouth, surrounded by tentacula or other projections placed in a circular form; this orifice leads to a cavity occupying the interiour of the animal and possessing no outlet but the mouth. As they have no vessels for circulating fluids, they are nourished immediately by absorption from the interiour of their sac or stomach; while their respiration is probably performed by the external surface of the body. The best known of these animals is the hydra of fresh water streams, seen attached to the under surface of the leaves of aquatic plants. It has a green colour and a form difficult to describe. Fixed by one extremity to a leaf or stalk, it extends the other; by the tenta-

cula seizes insects and other substances approaching it, swallows them, digests whatever is adapted for its nourishment, and rejects the rest. The rays of the sun are agreeable to this animal and appear to influence its motions, and favour its increase. The mode of production is by the growth of an eminence from the body, which attains the form of the parent; in some separates, and in others lives in common with it, the different animals communicating together and receiving each a share of nourishment from what is taken by the others. The *vaginated polypi* are analogous to the hydra in their form, soft consistence, and the simplicity of their organization. They grow together in great numbers communicating by a common base. Although their organization is simple they have the power of covering themselves with a hard substance formed by exudation or exhalation from their surface. The nature of the substance varies according to the genus which produces it. and the corals, madrepores, sponges, gorgonias or sea fans, all are the productions of little polypi, springing from each other and afterwards forming these solid investments. In this way are formed the bodies of calcareous substance which pave the bottom of the ocean; and if, says the great naturalist Lamarck, "they do not generate or produce the greatest part of the calcareous matter which exists, they are at least its principal collectors and deposit it in immense masses. In the

hot climates, especially, they influence the changes of coasts by increasing the inequalities of the bottom, and thus unceasingly modifying the surface of the globe. Sometimes they block up the entrance of harbours by erecting reefs and dikes impassable to vessels; and sometimes they raise islands in the midst of the vast plains of the ocean, which they continually increase in circumference and height."*

The third order of ZOOPHYTES is the RADIARII. Some of these are commonly known as the echinus, sea-urchin or sea egg; asterias, the star fish; and few can have failed to notice the medusæ, large gelatinous masses so numerous in our harbours and often seen dissolving on the shores under the influence of the sun. In the radiarii, the internal and external parts are arranged in a radiated manner. The stomach is somewhat more complicated than in the polypi, having on its sides many bodies of a vascular form, to each of which naturalists have given the name of coecum. Organs of respiration also are found in the *radiarii*. These are pores or tubes sucking water into aquiferous *tracheæ*, which act on the air and decompose its oxygenous portion. Other genera have reservoirs for containing air.*

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* LAMARCK, *Système des animaux sans vertèbres.*

The fourth order of zoophytes is the *epizoaria*, or worms inhabiting and subsisting on animal bodies, as parasites. A small part of this order is independent of other animals. The structure of the epizoaria differs greatly from the red-blooded worms; for they have neither head, nor eyes, nor vascular, nor generative system. The intestinal worms have two orifices connected with the digestive canal; but in others, for example the hydatid, as in the simplest zoophytes, we find only one orifice serving the purpose of both.

None of the zoophytes exhibit a distinct nervous system. In some *radiarii* and *epizoaria* there are indeed parts bearing a resemblance to nerves; as for example in the asterias, a circle of soft white substance surrounds the esophagus; from this issue ten filaments, two for each of the branches which form the body of the star; the two filaments belonging to each branch, having reached the base of the bony articulated stalk, which serves as its principal support, reunite by a short cord passing directly from one to the other; they continue along the stalk to the extremity of the branch, constantly diminishing in size. At the place where they unite, a fasciculus of filaments is sent out which is distributed to the stomach, situated between the five branches. Such is the description of Cuvier;*

* *Anatom. compar. Tom. 2. p.* 360.

but he considers it necessary to perform galvanic experiments on these animals, before it can be determined whether the parts described are really nerves ; especially as their appearance is rather tendinous than nervous. Not having examined any species of these animals which have appearances of a nervous system, I can say nothing on this point, from personal observation.

Thus have we attempted to give some idea of the sensorial and nervous apparatus in the different classes of animals. A comparison of this kind gives rise to many interesting reflections. Among the most obvious is the great similarity in the appearance of the nerves in all these animals, otherwise so differently constituted; for the muscular, vascular and other textures are constantly varying, while the nerves always present themselves in the form of strait, white cords. This observation cannot be applied to the brain however, since its form, size, and consistence present great varieties.

As the functions of this system in man are involved in obscurity, it is natural to inquire whether comparative anatomy, which has shed so much light on other parts of physiology, assists in solving any of the problems relating to this part of the animal economy.

The brain is thought to be the seat of the intellectual functions: the common centre of the

impressions transmitted by the nerves; some physiologists have believed it to be the source of the muscular power which it supplies through the nerves; and by some it is considered as not only the seat but the producing cause of the immaterial soul, which is supposed to be nothing more than the result of its collective operations.

The nerves are considered as the recipients of external impressions: those dispersed over the body receive the common sensations, and those belonging to the organs of the external senses receive the impressions of these senses, all of which they transmit to the sensorium commune, the brain. The nerves are believed by some to transmit to the muscles the influence which causes their contractions; this they either bring from the brain or generate themselves.

This is not the place to enter into a discussion of these subjects; all we have here to consider is, whether a comparative view of the sensorial and nervous systems in animals tends to strengthen or weaken any of these opinions.

In the first place, we are allowed, I think, to infer that the brain and nerves are not essentially connected in function; or, at least, that this is true in regard to the function of the nerves.—There appears to be no relative proportion in the magnitude of these organs in different animals. In man and most of the mammalia the bulk of the brain is considerable, compared to

that of the nerves; while in reptiles and fishes the *nerves* may compare in size with those of the superiour classes, but the brain is very small. The same is true even in different orders of mammalia; in the horse, for example, the brain is small, the nerves of great size.—Another fact bearing on this point is, that in the invertebral animals there is no proper brain: at least the organ we call by this name in the acephalous mollusca, crustacea, worms, and insects differs greatly from the brain of the vertebral animals, and is in truth little different from the ganglia. Yet in these animals the nerves are very distinct and even, in many large, in proportion to the other organs. Analogical reasoning is useful where we cannot resort to facts; but we would not have it applied too confidently, nor even without recollecting that the degree of belief due to it is lower than that belonging to fact.

In the second place, we may conclude that the brain is not the source of the muscular power. This conclusion is founded on a consideration of the disproportion in the size of this organ to the muscular strength of various animals. In the horse, the brain, as just stated, is small, the muscular vigour great; in the great sea shark, *squalus maximus*, the brain, compared with the body, is near the smallest among the vertebral animals; while the strength of the animal is so great that one of them has been known to drag a

vessel of seventy tons, under full sail, against the wind.

Third. It seems probable that the muscular power does not take its source from the nerves. The facts in support of this opinion are few in number, and the principal one is the non-existence of nerves in some animals capable of moving. In the gelatinous polypi and some other zoophytes no nerves have been discovered, and we are, from their texture, led to believe it impossible they should have any such nerves as other animals; yet they move, some of them with considerable rapidity.

Fourth. Many of the facts noticed tend to prove that the nerves receive the impressions of objects made on the external senses, and that by them these impressions are transmitted to the brain It is not intended here to involve the hypothesis, that perception in the brain is caused by any kind of movement in the matter of the nerve; all that we wish to say is, that when the nerve expanded in an organ is affected by objects to which the organ is susceptible; it is in consequence of this affection that the brain perceives, and that, without the continuity of nerve, the brain cannot perceive. This has been thought to be satisfactorily proved by the suspension of perception, consequent on the division of a nerve; but those who maintain the opposite doctrine, consider the division of a nerve so far to impair

its perfection, as to render the experiment uncertain. If we look to comparative anatomy to determine these questions, we find that whenever an organ of sense is more than commonly developed, the nerve belonging to it, is sn the same degree developed in the organ. Further, that the size of the nerve before reaching the organ is always proportioned to the development of the nerve and organ; and that whenever a sense is wanting, the nerve usually going to the organ of that sense is also wanting. In birds, the sense of sight being acute, the optic nerve is largely developed in the organ, the size of the nerve before reaching it is considerable, and there is a ventricle connected with the nerve. We have before noticed the same fact in regard to the olfactory in some quadrupeds. Why should the optic nerve be of large size between the brain and the eye, except to transmit to the brain, the impressions received in the eye? In the whale, the organ of smell is wanting, the nerve, sent to it in other mammalia, is also wanting. In some birds, the organ of touch is placed at the extremity of the bill, and there is a correspondent arrangement of elegant nerves of the fifth pair. The same is true of certain quadrupeds, as the elephant, which has the sense of touch at the extremity of the trunk; and the ornythoryncus paradoxus, the duck billed animal of New Holland. In this singular creature most

of the qualities of a quadruped are united with some of those of a bird; and particularly it has a bill like a duck covered with a sensible membrane, which enables it to discover its food in the mud, where it could not employ the sense of sight; and the distribution of nerves accords with the peculiar situation of this sense.

The manner in which the nerves act in transmitting impressions to the brain, or causing perceptions in this organ is no more explained by comparative anatomy than by the numerous experiments and theories on nervous action.—Nor have we much reason to expect we shall ever be well acquainted with the functions of this part of the animal fabrick; though Sir Everard Home seems to think his late discovery of the mucous matter, connecting the globules of nerves, will throw light on its mode of operation.

Fifth. The brain is the common centre for receiving the impressions of the senses transmitted by the nerves, and is therefore rightly called *sensorium commune;* and where there is not a proper brain, the ganglion, which supplies its place, performs the same office.—In all animals with organs of external sense, the nerves belonging to these organs go from them to the brain. This is true not only in the more perfect animals, it is so in the mollusca, crustacea, insects, and annelides : with the inconsiderable exception that in some instances the nerves of an organ of

sense are connected with the brain, or substituted ganglion, through the medium of the collar, instead of being immediately so with the brain.

Sixth. This comparative view of the sensorial system does not seem to support the opinion, that the difference in the intellectual faculties of man and animals is to be explained by a difference in organization alone.

This question involves considerations so important, that it appears proper to give it more attention than the others, especially as some ingenious physiologists have advanced this doctrine, and supported it by comparative anatomy. It is incumbent on us to inquire how far this science affords grounds for such opinions.

That there is a vast superiority in the intellectual powers of man over those of brutes, is a position sufficiently established by the opinion of the world, or in other words, by common sense. This opinion is also admitted to be just by a part of the most intelligent of those who support the doctrine, that these powers are altogether dependent on organization.

*"Mankind in general," says the ingenious Mr. Lawrence, "the unlearned and the scientific do not commit the gross mistake of confounding

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*Lectures on Physology, Zoology, etc. pp. 124, 126.

together men and animals; this distinction, at least so clear to common observation and unprejudiced common sense, is preserved in their short division of the animal kingdom into man and brutes."

"I do not hesitate to assert that the notion of specific identity between the African and ourang outang is as false philosophically, as the moral and political consequences, to which it would lead, are shocking and detestable."

"The peculiar characteristics of man appear to me so very strong, that I not only deem him a distinct species, but also put him in a separate order by himself. His physical and *moral* attributes place him at a much greater distance from all other orders of mammalia than these are from each other respectively."

Mr. White, the author alluded to in the above quotation, is one of the very few writers, who maintain the opinion, that there is a regular gradation in intellectual as well as physical qualities from man down to the lowest animal.* "The inferences, he tells us, to be drawn from the above facts and observations are these: That there is a general gradation from man through the animal race; from animals to vegetables and through the whole vegetable system. By gradation, I mean the various degrees in the powers,

* White *on the gradation of man.*

faculties, and organization." (p. 39.) "It can scarcely be denied that 'man differs more from man, than man from beast'—whether it proceeds from a difference in the quantity of brain or from any other source, there seems a difference in the original capacity of the different tribes of mankind." (p. 65.)

As a reason why animals of the monkey kind, the nearest allied to man, are destitute of speech, he quotes the discovery of Camper, that there is a bag lying in the neck which communicates with the larynx, and prevents, from a physical cause, as he appears to think, their attaining this privilege of the human race.*

Can such opinions as these quoted from Mr. White be seriously advanced, and do they demand a serious refutation? Is there an approximation in the mental powers of the highest order of brutes to the lowest races of man? Have we ever seen apes or other brutes approach men in the general course of their intellectual operations? An idiot man may be more stupid than a brute, and a madman more mischievous: but can we find instances of a number of brutes imitating men, even in the most degraded state, in the general tendency of their actions? Beavers build their cottages, parrots talk, monkeys perform

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* P. 29.

the gestures of man: but do any of them carry on trains of reasoning, make inductions, store up the results of their reasonings, and communicate them to each other? If there is not a radical difference in the brute intellect, why do they not transmit their intellectual improvements to their posterity, and gradually elevate their race in the scale of beings? But while man has been increasing the stock of his knowledge from the time of our first father to the present day, brutes have remained precisely in the same condition, and with the same state of intellect, as when they originally came from the hand of the great Creator.

I suppose it is unnecessary to urge this point further, and that all who are not under the influence of a particular theory will agree, that there is an essential difference of mental faculties between men and brutes.

If then such a difference really exists; in order to make it appear probable by comparative anatomy, that the intellectual powers depend merely on organization, it must be shown that there is a correspondent difference in the organ which is the instrument of these powers.

On the other side, *the demonstration that there is no such difference, will deprive this doctrine of the argument drawn from comparative structure.*

It may be objected, that this course does not advance us in our knowledge of mind, nor its connexions with matter: to which I agree entirely.

The subject is beyond our powers, and the best we can do, is to avoid falling into errour, in the midst of the profound obscurity, which always has and probably always will darken this subject to human eyes.

The question now to be considered is, *Whether there be an essential difference in the brain of man from that of all brutes?* In a former part of this discourse, it has been stated that the human brain generally exceeds that of brutes in magnitude. A superiority in this point cannot however account for the difference in intellect, unless it be very remarkable and *wholly without exception;* and whether this be true will be considered hereafter. This fact alone, as we have admitted it, is not therefore sufficient to settle the question.

Physiologists, always anxious to discover in the brain a material cause for the superiority of man, have long sought for some point of excellence, peculiar to the human brain. They have not agreed what this is, or ought to be. Some have placed it in the magnitude of the organ; others in the magnitude of a single part, as the cerebrum or the cerebellum, or the medulla oblongata; and others seem disposed to make it consist in a general superiority in size, and structure. There is a discordance of opinions on this subject, which of itself leads to a suspicion that in no one important particular does the human brain, uniformly and without exception, differ from that of brutes.

The opinion which places the peculiarity of the human brain in the collective excellence of all its parts appears the most plausible; yet when we come to compare the organ with that of the nearest mammalia, this will not, I believe, be thought adequate to explain the difference of intellectual phenomena.

The monkeys, it is well known, approach nearest in structure to man. Those I have been able to examine, have been of the smaller species; but dissections of the ourang outang and others are found in the works of various anatomists, and on examination it will be seen that they bear a close resemblance to man in the structure of the brain.

In these animals are found the four principal parts of the organ, the cerebrum, cerebellum, pons varolii, and medulla oblongata; they have also the cerebral hemispheres, lobes and convolutions; the corpus callosum; the lateral, third, and fourth ventricles, and the minute parts within these cavities; the corpora mamellaria, olivaria, and pyramidalia; the pineal and pituitary bodies; the decussation of the pyramidalia. In short, they have all the remarkable eminences and depressions, belonging to the human brain. The principal differences observable are in the depth and number of its convolutions; and in its flatness, as stated in the description of the brain of the ourang outang.

These variations in the form and extent of parts which exist in both animals, are not such as would, I think, be called essential; and might be considered as less important than the absence of any one peculiar eminence.—It may be said that it is in the power of the Creator to make the smallest part of the brain the exclusive seat of the mind. This will be questioned by no one; but such a supposition would be hostile to the doctrine, that the perfection of the brain consists in the perfection of all its parts.

Let us next consider the brain in other animals of the class mammalia. All these differ from man and simiæ in wanting the posterior part of the cerebrum; that is, the posterior lobes of the organ, and consequently the posterior cavities, or horns of the lateral ventricles. Here indeed we find a striking variation of structure; and this, if it had existed in all animals but man, would undoubtedly have been fixed on as the material cause of the disparity of intellect; unfortunately for the material hypothesis, it is observed in quadrupeds and not in the apes, for the latter resemble man in this point of his organization.*

* We shall see in the history of the ourang outang, says Buffon, that if attention were paid to his form only, we might equally regard this animal as the first of monkeys or the last of men, because *with the exception of the soul*, he wants nothing that we have, and because he differs less from man as to body

If, again, it could be shown, on the one side, that the faculties of simiæ are nearly on a level with those of men; and on the other that the faculties of the rest of the brute creation are greatly inferiour to those of simiæ, then indeed, the want of the posterior lobe in quadrupeds would be a fact highly favourable to the material hypothesis, since its absence might be said to explain the inferiority of the latter, and its presence the equality of the former.

This inferiority of quadrupeds does not appear to exist. The elephant, many dogs, and some other animals, are nearly on a level with monkeys, in signs of intelligence, and the capacity of imitating human actions; and among birds we find one faculty at least, more perfect than in the quadrumanes, or quadrupeds, I refer to that of speech.

This general comparison does not on the whole present a decisive superiority in the parts composing the human brain, taken collectively.

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than he differs from other animals, to which the name of monkey has been given.

The soul, thought, speech, do not then depend on the form or organization of the body. Nothing better proves that it is a peculiar gift, bestowed on man alone, than that the ourang outang, which neither speaks nor thinks, has nevertheless the body, the limbs, the senses, the brain, and the tongue entirely like men; and that he knows how to imitate all his motions, and actions, and yet does not perform any human act.

(1. Buffon. *Histoire Naturelle. Nomenclature des Singes.*)

We must now proceed to examine in succession the particular points, in which the human brain has been supposed to excel that of all brutes.

The magnitude of the organ would naturally attract attention first, as the quality, most likely to form the grounds of a superiority in function. The consideration of this point of comparison is not free from difficulties; since a mere excess in bulk, would obviously afford no satisfactory conclusion, when it is observed that animals of small size are as intelligent as the larger; that the monkey with a small brain is not inferiour in sense to the ox with one of greater size;* nor man inferiour to the elephant which has the organ more voluminous than any other animal. It is not then by the positive magnitude of the part, that the question is to be settled; but by the size of the brain, compared with some other part. If we consider it in relation to the rest of the body, it will appear that the human brain is larger in proportion than in *most* other instances; but if there should be found a single exception it will be fatal to the doctrine that this relative magnitude is the cause of the superiority in mind.

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* Some of the monkeys have a brain weighing 4 or 5 ounces; that of Tyson, which is to be considered among the largest, weighed above 11 ounces. An ox of 1500 pounds weight, had, according to Haller, a brain of two pounds. (*Elementa Physiologiæ. Lib.* 10. *Sect. de Cerebro.*)

Cuvier has given a table of the relative weights of the brain in man and other vertebral animals. In examining this it is proper to notice that in the *same species*, the relation will vary with the accidental size of the body; as in a lean man the proportion of the brain would be greater than in one charged with a quantity of fat; hence it is that physiologists have found a variation in man, from one twenty-third part to one thirty-sixth, if we take the table of Cuvier as a fair representation of the opinion of naturalists. This distinguished author has in regard to the human brain, introduced the facts contained in Haller. The Prince of physiology states that he found the proportion, as 1 to 22 in a boy six years old, at which age, it is well known, this proportion is much more in favour of the brain than in an adult; and the other proportions mentioned by him are $\frac{1}{23}$, $\frac{1}{33}$, $\frac{1}{30}$,* all of which are precisely the numbers, set down by Cuvier. We are therefore authorized to consider $\frac{1}{30}$ as the average proportion of the brain to the body in an adult.

Man	1:30
MONKEYS.	
†Gibbon	1:48
Saïmiri	1:22
Saï	1:25

* *Elem. Phys. Lib.* 10. *Sect.* 1. § 5.

† *Anat. Comp. Art.* 5. p. 149.

Ouïstiti 1:28
Coaita 1:41
Young Malbrook . . . 1:24
Callitriche 1:41
Mone 1:44
Mongabey 1:48

QUADRUPEDS.

Mole 1:36
Dogs, different species 1:47
. . . . . 1:50
. . . . . 1:57
. . . . . 1:154
. . . . . 1:161
. . . . . 1:305
Cat 1:82
. . . . . 1:156
Beaver 1:290
Rat 1:76
Mouse 1:43
Field mouse 1:31
Elephant 1:500
Sheep 1:351
. . . . . 1:192
Ox 1:860
Horse 1:400

CETACEOUS ANIMALS.

Dolphin 1:25
. . . . . 1:36
. . . . . 1:66
. . . . . 1:102

Porpoise	1:903
BIRDS.	
Eagle	1:260
Goose	1:360
Cock	1:25
Sparrow	1:25
Canary birds	1:14
REPTILES.	
Land Turtle	1:2240
Frog	1:170
FISHES.	
Shark	1:2496
Carp	1:560

This table shows that five species of monkeys; the dolphin; and three kinds of birds, the canary bird, sparrow, and cock, exceed man in the proportion of the brain to the body; and that various other animals are nearly on a level with him. Of course it establishes the position, that we are not justified in attributing his intellectual superiority to an excess in the *bulk* of the cerebral organ.

Haller has indeed said that the human brain is the largest among animals. "*Maximum inter animalia homini cerebrum esse." "Quadrupedum nullum hominem superat, pleraque infra eum sunt." But in this passage he merely intends to state the general fact, as immediately

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* *Elem. Phys. loco citato.*

before he has given the above proportions of the sparrow, the canary bird, and those of a finch he was dissecting when he wrote: he also informs us that the pigmy of Tyson had a brain "certainly not less than the human;" and that the elephant's, though small in proportion to his body, weighs from 7 to 10 pounds, while the weight of the human brain, in a man of 140 pounds, is fixed at 4 pounds.

The facts already exposed would perhaps be sufficient to satisfy us that the desired peculiarity in the human brain is not to be discovered. Other comparisons have however been presented as the grounds on which an hypothesis might be erected; and as it may be believed we are ready to take for granted what ought to be proved, let us proceed to examine such as are most worthy of consideration.

The beautiful organization of the cerebellum, and the care with which nature has guarded it, more than the cerebrum, led former anatomists to the opinion of its being a more vital part than any other; and might have given it the preeminence over the cerebrum, as the seat of intellect; but that it is found to exist in almost all vertebral animals, even of the lowest orders, and that in a number of them, it has a ratio to the cerebrum greater than in man, as appears by the following table of Cuvier.*

* *Lib. cit. p.* 153.

In man, the cerebellum is to the cerebrum

as		1 : 9*
Saïmiri	monkeys,	1 : 14
Saï	monkeys,	1 : 6
Magot	monkeys,	1 : 7
Baboon	monkeys,	1 : 7
Dog		1 : 8
Cat		1 : 6
Mole		1 : 4½
Beaver		1 : 3
Rat		1 : 3¼
Mouse		1 : 2
Hare		1 : 6
Boar		1 : 7
Ox		1 : 9
Sheep		1 : 5
Horse,		1 : 7

In the mouse it appears that the cerebellum is half the size of the cerebrum ; and in most of these animals, the proportion of the cerebellum to the cerebrum is greater than in man.

As therefore this ratio could not afford a result favourable to the human brain; the position has been inverted, and the *cerebrum* considered as the part conspicuously larger in man.

The last table will show that the ratio of the cerebrum to the cerebellum, is more favourable than the other ; yet not so much, as to give it an

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* According to Wenzel, 7½, *De Pen struct. Cer.*

exclusive superiority. In one species of monkey, saïmiri, it is greater than in man; and in a number of instances the ratio is the same and nearly the same, for example, in the ox it is the same; in the cat, various monkeys, and in the horse, it is nearly the same. Moreover, it appears by the observations of the Wenzels, that the cerebrum bears a greater proportion to the cerebellum in a fœtus of five months, than in an adult; and that the ratio lessens from that period to the end of the third year, after which it remains about the same during life.

The distinguished Professor Soemmerring has taken a view of the subject, which he considers more favourable to the human brain than any other.* In order to give importance to it, he first supposes that different parts of the organ are devoted to the intellectual functions, and to those of the external senses. Most of the nerves of the head are connected with the medulla oblongata, where of course he places the organ of the external senses. The rest of the brain is the organ of reflexion.—Some objections may be made to this hypothesis, besides the preliminary one that there is nothing distinct in its favour. "The olfactory nerves take their origin, not in the medulla, but in the cerebrum, not-

* Cuvier, *Anat. Comp.* Art. 5, p. 153.

withstanding all the efforts of GALL and others, to trace them further. The motores communes cannot be followed into the medulla oblongata; and as to the optic, pathetic, auditory, trifacial, facial, and motores externi, it is not satisfactorily determined that they are to be considered nerves of the medulla, rather than of the cerebrum and cerebellum. Comparative anatomy affords indeed facts strongly in favour of the opinion that they proceed from the medulla, at least some of the last named; but these are cases susceptible of demonstration, and nothing short of a visible connexion with the medulla in man will determine, to the satisfaction of physiologists, that they originate from this part.

These are some of the objections to SOEMMERRING's opinion, that the medulla oblongata gives origin to the nerves of the senses and is to be considered as the organ of these senses. We now proceed to the comparison of facts.

The proportion of the brain to the medulla oblongata is estimated, says CUVIER, by the measure of their diameters, and gives the following results.*

The breadth of the medulla oblongata behind the pons varolii, to that of the cerebrum is

In man . . . . . 1 : 7

*Anat. comp. p. 153.

In the monkey, bonet chinois,	1 : 4
Short tailed macaw . . .	1 : 5
Dog	6 : 11
or	3 : 8
Cat	8 : 22
Rabbit	3 : 8
Hog	5 : 7
Ram	5 : 7
Stag	2 : 5
Cow	5 : 13
Calf	2 : 5
Horse	8 : 21
Dolphin	1 : 13

Some of the monkeys approach near to man in the ratio here proposed; and an insuperable objection to itexists in the dolphin; this animal having the proportion of the medulla to the cerebrum nearly double that in the human brain, and of course, on the hypothesis, an organ of reflexion twice the size of that in man.

The human brain has been said to exceed all others in the proportion of the medullary or interior to the cortical or exterior substance. How this is determined I know not: but it would require something more than the common section of the organ to establish this assertion, especially if we consider the errours likely to arise from the irregular distribution of the cortical matter. It is a common opinion that the cortical substance in the cerebellum is much greater in quantity than the

medullary. *Bichat has shown that this opinion is founded on a fallacious appearance, produced by the mode in which the section is made, and that the layer of cortical substance is less than in the cerebrum. Why may not the same illusion have existed in regard to the cerebrum; when sections have been made in various animals? If we admit however that the medullary matter is most abundant in the human brain, it must also be admitted that the disproportion is small; and that therefore it is not sufficient to account for the difference of phenomena. Further it is to be considered, that that this is merely opposing one hypothesis to another, since the cortical part has been formerly thought the more essential texture. Anatomists seem to have satisfied themselves, that the cortical is the most vascular portion, and have therefore been led to attribute to it the function of secretion, while that of conducting the secreted fluid has been given to the medullary; opinions founded on a supposed analogy to secreting organs like the kidneys. The texture which forms a fluid may be considered more essential than that which conveys it, therefore, the cortical is more essential to the function of the brain, than the medullary; and we might expect to find it predominant in the

*Bichat, *Anat. descript. Tom.* 3. p. 105.

human brain, contrary to the opinion abovementioned. I do not wish to attribute any importance to this analogy. The brain has no other resemblance to the glands than that alluded to; and in some respects differs greatly; especially it differs in wanting a visible excretory tube and a visible secreted fluid.—It is not to be doubted that the cortical and medullary substance are equally necessary to the operations of the brain, that they are of course worthy of the same rank, and that they bear a due proportion to each other in different animals; whether this proportion varies and how it varies does not appear to be well settled.

Sir Everard Home,* in his paper on the structure of the brain, very distinctly supports the opinion of the essential importance of the cortical substance on account of its vascularity; and seems disposed to rank it higher than any other part, except the pons varolii, the part connecting the cerebrum, cerebellum, and medulla oblongata. He is also induced by certain observations, to consider it as the seat of memory.

This learned physiologist is not the only one who has been disposed to assign definite parts of the brain as the seats of particular faculties.

Glaser placed the memory and will in the cerebellum; Willis, the imagination in the corpus

*See Appendix.

callosum; perception has been fixed in the corpora striata; reflexion and common sense in the medulla oblongata; instinct in the anterior tubercula quadrigemina; the passions in the pons varolii; judgment in the pituitary gland; GALL and SPURZHEIM have marked out portions of the brain as special organs of the powers, propensities, and passions; DESCARTES fixed on the pineal body, as the seat of the soul; and SOEMMERRING considers the ventricles as uniting the qualifications necessary for the residence of the spiritual principle.

Although many of these opinions are founded on analogies, none are capable of a distinct and satisfactory support from comparative anatomy, I believe, and to some it is decidedly hostile. The pineal body, for example, exists not in man alone, but in all quadrupeds and in birds; in the former it bears as a large a proportion to the rest of the brain as in man; of consequence is not likely to be the seat of the superiour intellectual principle.

The authors of the craniological or physiognomical system seemed disposed to refer frequently to comparative anatomy for the support of their doctrines; but so far as I have observed, there do not appear to be very good grounds for such a reference. If any animal be remarkable for a propensity, and exhibit a peculiarity in the form of the cranium, they connect these two facts together, and consider the peculiar part of the

cranium or of the corresponding brain to be the seat of the propensity; and this they think certain when such facts concur in regard to more than one kind of animals; and they believe that these facts tend to confirm the connexion between similar appearances and propensities in the human species.

One or two examples will be sufficient to show how far they are justified in their appeal to the anatomy of animals. The organ of *combativeness*, or courage is said to reside in the space between and behind the ears; that is, in the part which corresponds to the posterior inferiour angle of the parietal bone, behind the mastoid process: and "courageous animals have the head between and behind the ears large."* Some of them, in truth, have the head large, but not the brain. The cavity of the cranium in the *lion* and in *large dogs* is oblong in a direction from before backward; the skull is narrow at this part and the appearance spoken of does not exist in the bones. In the skulls of two lions in my possession, and various large dogs, the cranium is more narrow at this part than in the skulls of *various monkeys*, and is not materially broader than in the sheep. In birds, the cranium of an owl is broader than that of the eagle.—The great apparent breadth, in this part of the head of the lion, is produced by the enormous thickness of the temporal muscles:

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* *Physiognomical System*, p. 302.

and when they are stripped off, the skull is seen to be actually narrow.

The *organ of amativeness*, which Dr. Gall formerly called organ of physical sensibility, is placed in the cerebellum, its region externally, corresponding with the lowest posterior part of the os occipitis. An examination of this region in animals, remarkable for the propensity, does not exhibit a considerable development of the part. In the monkeys generally, it is much less developed than in man; and in the baboon, the most extraordinary of all animals for the propensity,* it is in no way remarkable. Further, a comparison of the proportionate bulk of the cerebellum is still more unfavourable to this opinion; although Dr. Spurzheim seems to consider this as one of his strongest positions; for the cerebella, he says, are always proportioned to the propensity; they are larger in men and males, than in women and females; and, on the whole, he concludes, "that this organ and its special faculty are fairly established."† If the table of the cerebellum, before given, be noticed, it will appear that the proportion of the cerebellum is, in many animals, greater than in the monkeys, and that precisely the same proportion exists in the baboon and in the horse: animals differing widely in the degree of this propensity.

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* V. Buffon. *Hist. Nat. des singes.*

† *Phys. System.* p. 284.

On comparing the skulls of various birds, I have not been able to verify, in a distinct manner, the supposed situation of the *organ of tune ;* and the remarks relating to some other parts of the structure of the brain, and to its organs, in animals, have not appeared to be stated in such a form as to render it possible to determine their exactness.

Since it is generally admitted, that there is a vast disparity in the intellectual powers of man and brutes; and since it has been shown, that in physical organization, there is not a uniform and essential difference, or at least none proportionate to the difference of the phenomena; it will be allowed, I suppose, that the anatomy of animals cannot fairly be brought to support the doctrine that our intellectual faculties are altogether dependent on the organization of the brain. Yet I am aware it may be said there is a species of facts, presented in our daily intercourse with men, sufficient alone to invalidate any inferences drawn from brutes. Although our topic does not necessarily demand a refutation of such objections, it might appear an admission of their validity to pass them over in silence, and therefore I shall hazard some remarks on this subject.

Every one has noticed the various shapes of the head in different individuals. Differences are also seen to exist between the various races of men, and are supposed to be accompanied by corresponding differences of mind.

In order to examine this opinion in its application to different races of men, it is proper to notice the principal varieties, which distinguish the members of the human family. Blumenback, the celebrated anatomist and physiologist, in his treatise, "De generis humani varietate nativa," has admitted five races or varieties of men.

First, the Caucasian,* so called, because the finest specimens of it are found in the vicinity of Mount Caucasus. This comprehends the Georgians, Circassians, Turks, Jews, Arabians, Moors, Greeks, and the European nations generally.—In this variety, the forehead is elevated, and laterally enlarged; the face small in proportion to the cranium, and the nose prominent. The skin is of a white colour.

Second, the Mongol, contains most of the Asiatics; the Calmucs, the Chinese, Japanese, Hindoos, Laplanders and other inhabitants of the hyperborean regions. The forehead is more depressed than in the former; the cheek bones are prominent and project laterally, nose broad,

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* Plate 5.

and the whole head of a square form. The complexion of an olive colour.

Third, the African or Ethiopian variety, is composed of the inhabitants of that quarter of the globe, with some exceptions. The skull is compressed laterally at the fore part; the forehead consequently is narrow; it is also low and slanting. The face is long, the upper jaw prominent, the lower retreating. Skin black.

Fourth, American Indian,* contains the greater part of the inhabitants of our continent. In this race, the prominent features are high cheek bones, with the zygomatic arches laterally extended, forehead projecting in a ridge above the orbits, and flattened the rest of its extent; opening of the nostrils large, upper jaw prominent, but flattened before, orbits wide and quadrangular, vertex elevated. Skin red or copper coloured.

Fifth, Malay or Island race,† inhabit the innumerable isles in the Pacific, Southern, and Asiatic oceans. The face is long, from the extent of the upper and lower jaws; the upper is projecting, though not so much as in the African; orbits near together; forehead retreating. Colour of the skin tawny, but varying.

The characters indicated above are to be

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* Plate 6 and 7. † Plate 8.

considered as taken from strongly marked specimens; but if we compare a considerable number of individuals in either variety, it will be found that the distinguishing marks are not so striking, that the peculiar features run into each other, and that in a great number of instances, it is impossible to discriminate between the varieties.

The characters of the Asiatic of the Caucasian race pass into the Persian; the latter, of Mongol origin, into the Tartar and Chinese; these are connected with the Malay of the neighbouring islands; while the Mongol of the north of Asia run into the American variety.—The Abyssinians connect together the African and Caucasian; a portion of the Malays, as the natives of New Holland approach the African; while the inhabitants of Otaheite, Nooahevah,* and

* Nooahevah is one of a group of islands, near the Marquesas, called Washington islands. "The men of this island are remarkably handsome, of large stature, and well proportioned; they possess every variety of countenance and feature, and a great difference is observable in the colour of the skin, which, for the most part, is that of a copper colour; but some are as fair as the generality of working people, much exposed to the sun of a warm climate."—"The young girls were handsome and well formed, their skins were remarkably soft and smooth, and their complexions no darker than many brunettes in America, celebrated for beauty."—(*Capt.* PORTER'S *Journal of a cruise to the Pacific in* 1812, *etc.*—*p.* 14. *v.* 2.)

other islands, come nearer to the Caucasian.—A part of the natives of North America, varying from the common characters of their race, more resemble the Caucasian than the Mongol. Instances of such resemblance are seen among those called in the United States southern Indians, inhabiting south of the Ohio, on the eastern bank of the Mississippi; and south of the Missouri on the western.* From all these facts, it is obvious that no distinct boundary lines can be drawn between the different varieties of the

* Among the band of Osages, who visited Boston a number of years since, some of the individuals were remarkably well formed. Sketches of the heads of two of them were taken. One, a young man, six feet, six inches, in height, and well proportioned, had a light colored skin, aquiline nose, and a mild, intelligent countenance. In the other the face had an expression of acuteness and habitual reflection; the nose was aquiline, thin, and pointed; chin projecting. Neither of them could be distinguished from fine European heads, but by the colour of the skin, and the habiliments. A late traveller in their country, informs us "that the complexion of the Quapaws, like that of the Choctaws and Creeks, is dark, (as if tanned?) and destitute of any thing like the cupreous tinge. The symmetry of their features, mostly aquiline, often amounts to beauty, but they are not to be compared, in this respect, to the Osages, at least, those of them who now remain." Charlevoix says, "the Arkansas are reckoned to be the tallest and best shaped of all the savages of this continent, and they are called by way of distinction, *the fine men*."—Nuttall's *travels into the Arkansa Territory, in* 1819, *p.* 83.

species, since they are on each side passing by imperceptible grades into each other.

All the variations in the form and colour of man are to be ascribed to the gradual operation of moral and physical causes, acting for a great length of time. These causes are, difference of climate, food, habits, and the propensity, modified by these causes, which all animals have to vary the form, size, colour, and disposition of their offspring. The opinion that they are to be explained by supposing half a dozen different origins, is scarcely maintained by any one; and affords no better solution of the cause of all the varieties, than the belief that all have sprung from one common stock.

The various modes of education, and other peculiarities in the condition of the different races render it difficult to judge how far their intellectual powers are modified by the differences in the shape of the cranium.

The Mongolian race is perhaps as susceptible of improvement as the Caucasian. The Chinese, Japanese, and other nations are acquainted with many arts not known in Europe: and it seems fair to believe that if their prejudices were brokken down by intercourse with foreign nations, and their minds enlarged by the introduction of Christianity, they might rival the Europeans in literary and scientific acquirements.

The North American Indians are at last beginning to submit to the discipline of civilized life. The slowness with which they have done this, might be supposed to arise from incapacity of attaining the sciences of Europe: but this would be a mistake. The difficulty in civilizing these inhabitants of the forest has been dependent on the injudicious and inadequate efforts made to reclaim them. Habits of living are so early formed that a boy educated to the age of ten years in the European manner, would not by any subsequent treatment make a figure as an Indian warrior: and the young Indian, allowed to pass the ten first years with his nation, is a savage and will continue so the rest of his life. It is vain to put him in a school or college subsequently to that period; he will, after a short residence almost certainly make his escape to his native forests and his favourite rivers.* There is but

* At an early period of the existence of Harvard University our pious ancestors placed there a number of young Indians. These, after a short term of study, uniformly disappeared, and I believe the name of *Caleb Chees-chaumuck* stands on the college catalogue, a solitary instance of a native regularly graduated. It is well known however, that among our aboriginals, converted to Christianity, there were a number who served as devout and useful assistants in the instruction of their countrymen. A recent example of the difficulty of reducing the young savage to the habits of civilized life is well known in this vicinity. The government of the United States, after the late Indian war placed the son of the prophet

one way in which we can expect these nations to become broken to the habits of civilization. They must be taken from the cradle and placed in schools, before they have acquired the habits and inclinations of a wandering life: and the rest of their education must be conducted like that of a European or an inhabitant of the United States. This system is now happily reduced to practice by the missionaries among the Chickasaws, Choctaws, Creeks, Cherokees, and Arkansas; and among the Hindoos of India, the Negroes of Africa and the Malays in many of the South sea islands. If any persons are disposed lightly to estimate or to deride the missionary labours, they must do so from a very partial view of the great plan of operations now executing in every part of the globe, and slowly, though surely producing the greatest changes, especially among the Indians of this country. Those who are blind to the importance of diffusing the Christian religion among our aborigines, will be ready, I presume, to admit the necessity of making efforts to rescue this interesting people from the misery and destruction, of which, we and our fathers have been the cause. The administration of this country is, fortunate-

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Tecumseh at the West Point establishment of cadets. The young man conformed at first with apparent ease to the strict discipline of the institution; but on their visit to this place in 1821, he availed himself of an opportunity to quit them and has not I believe since rejoined the corps.

ly, favourable to the proper system, and if supported by the opinion of the enlightened part of the community will, through the missionaries, as well as by their own influence certainly effect a great change in the condition of the Indians. Instead of insults and encroachments on the one part, drunkenness and murders on the other, we may hope soon to see them composed into regular societies, governed by appropriate laws, and, adding a moral force to their physical strength, they may become incorporated with and form a valuable accession to our country. Already the arts are beginning to flourish among them. The Cherokees have adopted a written constitution: they have a number of large and well regulated schools; and the Choctaws have, of themselves, set aside a considerable sum, from the annuity granted them by the government of this country, in order to establish and support their schools. Many of these people have undertaken the more necessary trades: manufactures are beginning to appear among them, and their country is interspersed with a multitude of small, yet well cultivated farms.*

* The secretary at war in his report states, That there are now in the Indian territories, supported by the government of the United States, eleven principal schools and three subordinate ones, and that three are in a state of preparation: that the number of scholars at the last return amounted to five hundred and eight.

The facts hitherto reported as to the capacity of the Indians for improvement are favourable :

It may be affirmed, he says, that all the tribes within our settlements and near our borders are even solicitous for the education of their children —The reports of the teachers are almost uniformly favourable as to the capacity and docility of their youths. Their progress appears to be quite equal to that of white children of the same age; and they appear to be equally susceptible of acquiring habits of industry. At some of the establishments, a considerable portion of the supplies are raised by the labour of the scholars and teachers.

The Cherokee nation, which has made the greatest progress in education, has also made the greatest progress in government. Their zeal for improvement is further evinced by the liberal provision they have made for a school fund, for which the last treaty with them stipulates, and the fact that there are now established in the nation six schools, two of which are on the Lancasterian system, containing in the aggregate two hundred and fifty scholars. (*Report to Congress on Indian civilization, February* 8, 1822. *By Secretary* CALHOUN.)

The Creeks are not willing to admit the establishment of schools by the whites through jealousy of them; but they are not backward in introducing improvements of their own.— "The more reflecting part of the Creeks," says an English missionary, "think much, but say little of the change which is taking place in their condition. They see plainly, that with respect to their future destiny, it is a question of civilization or extinction; and a question, the decision of which cannot be long postponed. They are therefore becoming very solicitous for the establishment of schools, and the introduction of the various arts from which the whites derive their superiority. In some of these, they have already made considerable progress; and the nation at this time exhibits the spectacle of society in several of its early stages. The hun-

but the experiment will not have been fairly tried, until they have received the education of whites, have come forward to perform professional and political duties, and have themselves had an opportunity of answering the question, whether nature has made them inferiour to the Caucasian race.

The Africans in their native land are generally subjected to political institutions, domestic habits and the action of a climate, calculated to reduce them low in the scale of men. In the very few native Africans seen in this part of the United States, the countenance is often contracted, the body ill-formed, and the mental faculties of a low order. In the second generation, their appearance alters for the better, the features expand, and assume a milder character; the body becomes more upright. In one of the New-England states, where slavery was retained, in a mitigated form, longer than in the rest, it has been distinctly noticed, that the children of Afri-

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ter, who still spends much of his time in his favourite pursuit, is the possessor of perhaps several hundred head of cattle, and if the warrior do not literally turn his tomahawk and scalping knife into pruning-hooks, he is satisfied to regard them as mere ornaments of dress, until war and ambition shall again call him into the field; and is ambitious to obtain distinction in agricultural pursuits. I saw several neat and flourishing little farms, as I passed through the nation."—(*London Missionary Register, for November*, 1821.)

cans, born in this country, and brought up with those of the whites, as occasionally happened in large country estates, were as intelligent, as gay, as ready to imbibe the rudiments of learning as the whites; and if their education had kept pace with that of the latter, they might generally have continued on the same level through life. An experiment in regard to this people is now making in St. Domingo on a large scale. At present, it promises a successful result; as the policy adopted since the establishment of the Haytian republic appears to be unexceptionable, and stands on as respectable a footing as that of the nations of Europe. If they can maintain their independence long enough for one generation to rise under the new order of affairs, the reputation and the future fate of the African race will be settled in the opinion of the civilized world.*

Some nations have the practice of altering the shape of the head by artificial means. Very remarkable changes from this cause are occasionally seen. Yet it does not appear that the

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* L'inegalité d'esprit qu'on remarque entre les hommes dépend donc et du gouvernement sous lequel ils vivent et du siècle, plus ou moins heureux où ils nâissent, et de l'éducation meilleure ou moins bonne qu'ils reçoivent, et du désir plus ou moins vif qu'ils ont de se distinguer et enfin des idées plus ou moins grands ou fécondes, dont ils font l'objet de leurs méditations.—*Helvetius. De l'Esprit. Tom.* 1. *p.* 618.

mental powers undergo a correspondent alteration. The Caribs of the West Indies were scarcely less peculiar for their gigantic stature and great strength, than for the extraordinary depression of the forehead: and it is no where I believe stated that they were inferiour in mental ability to other Indians; but as they were more powerful, we have reason to suppose they were more intelligent. Charlevoix long since described the custom of the North American Indians of compressing the head and giving it a rounded or flattened form, according to the fashionable idea of beauty, in different nations. But we have more direct knowledge on this subject from authorities of the present day and our own experience. Captains Lewis and Clark, who were sent by the government of the United States to explore the Missouri and the Columbia rivers, lived a considerable time among the nations remarkable for this practice, and have given us a very satisfactory account of their character and habits. All the Indians situated between the Rocky Mountains and the Pacific Ocean, with the exception of the Snake nation, are accustomed to flatten their foreheads by compression made at an early period of life.* This fashion begins to show itself

* See Lewis and Clark's description. The machines used for producing the compression have been obtained from

on the westesn side of the mountains, becomes more predominant as we approach the sea-coast, and probably extends northward along the coast to a high latitude. The degree of distortion varies. In the two skulls we have represented, one, plate sixth, has only a slight circular depression, extending over the crown of the head, behind the coronal suture and corresponding with this in its direction. The other, taken from the same place, on the banks of the Columbia, is greatly distorted.* From its large dimensions, it seems to have belonged to a man of ample frame: and as our navigators say that the chiefs are always the most remarkable for the degree of this deformity, we may consider it probable that this was the skull of a person of high standing in his nation.—These people, denominated *flat heads*, are described by Lewis and Clark, as "inquisitive and loquacious, with understandings by no means deficient in acuteness, and with very retentive memories."†—"Every thing they see excites their attention and inquiries; but having been accustomed to the whites, nothing appeared to give them more astonishment than the air gun. To all our in-

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the north-west coast, by colonel Perkins of this place, and are in the hands of Dr. Channing.

* See description accompanying the plate.

† Lewis and Clark's Expedition. Vol. 2. p. 136.

quiries they answered with great intelligence, and the conversation rarely slackened, since there is a constant discussion of the events and trade and politics in the little but active circle of the Killamucks, Clatsops, Cathlamahs, Wahkiacums, and Chinnooks."* They are singular among savages for their kind treatment of old people and of their women. The latter are more on a level with the men, are allowed to give their opinions freely, and even sometimes assume an air of authority. These people are acute and dexterous in their bargains, equalling in finesse the most experienced European traders: they are perfectly acquainted with the use of fire arms, yet are friendly, peaceable, and, although in the habits of intercourse with the whites for the last thirty years, have never adopted the use of ardent spirits.—Most of the Indian nations, visited by these travellers, were either mischievous and dangerous, or weak and fearful; the flat heads of the Columbia met them with boldness and associated with them freely. One of the natives of this coast I have often seen, and shall ask leave to give some account of him. This young man was well known

* Mr. Keith, the gentleman who procured the two skulls engraved, lives in the settlement at the mouth of the Columbia, and in his letter on the subject, among other things he informs us, that the change in the form of the head, "appears no wise to affect their intellectual or corporeal faculties."

to a great number of persons in Boston by the remarkable appearance of his head. His forehead was flat; at the posterior part of the crown, the cranium rose to an extraordinary height in the form of a sugar loaf; the elevation appeared so considerable to those who knew him that I should not venture to state its estimated measurement. This boy, when ten years old, was brought from the Port Bucarely, in one of the Queen Charlotte islands, by a gentleman of this place,* who purchased him for a trifle to prevent his being put to death as a prisoner, taken in war with a neighbouring nation. He lived here many years as a servant; was found to be in no respect wanting in understanding; his apprehension was quick, and his capacity for retaining what he learnt, quite equal to that of other boys of his age, To use the words of a gentleman of the family in which he lived, "he was remarkably intelligent and sagacious, but inclined to mischief." He was not easy to control, was therefore taken a voyage, at the age of eighteen; and having an opportunity, he quitted the ship at some of the West India islands, and has not since been heard of.—The existence of a single case like this, shows what great alterations of form the brain may undergo without any change in the amount of intellectual facul-

* E. Dorr, Esq.

ties, and without any obvious defect or diminution of any one mental quality.

The peculiarities of the female mind in every nation on the globe are not accompanied with a visible difference in cerebral organization. The most acute anatomists have sought in vain for characteristic distinctions in the brain of females; but neither in its general form, its size, or the proportion of its parts have any such distinctions been ascertained to exist. The face in this sex is smaller, the thickness of bone usually less than in males, so that although the head is not so large, the brain is of equal size and weight.*

Common observation shows that the degree of intellect is not proportioned in different individuals to the size of the head; since we often see stupid people with large heads and sensible men with the head small. Opportunities have been afforded me of examining the brain in a considable number of persons of high standing, in our country and such as were remarkable for talents; in some instances it has appeared that a large brain had been connected with superiour mental

* Quemodmodum verum caput virile in universum majus est femineo, ita et cerebrum virile in universum majus, et ideo etiam ponderosius *videtur* femineo. Verum tamen, quod cavum capitis, cerebrum continens ratione faciei habita, in femina majus est quam in viro hoc discrimen solvitur. (Soemmerring *De Corp. hum. Fabr.* Tom. 4, p. 39.) Also, Gordon's *Anat.* p. 169.)

powers, in about as great number, the reverse: and one individual, most distinguished for the variety and extent of native talent had an uncommonly small brain.*

If we were willing to admit that the form or size of the head in different individuals, races, and sexes has a direct and important influence on the mental qualities, it would not necessarily follow that the difference in the form of the head and brain in brutes, afforded an adequate explanation of the inferiority of their intellect. The difference in the faculties of human individuals or nations is in degree only; that between man and brutes is immeasurable: in all the varieties of men we find the same number of faculties and propensities, but in brutes many of those belonging to mankind are wholly deficient.

The only remaining point of comparison between the brain of man and animals is their chemical composition. Some persons might possibly believe that although there be no difference of form or bulk sufficient to explain the disparity of function, yet there may be a difference in the chemical constituents worthy of consideration. According to a late analysis of Vauquelin, the most remarkable parts of the human brain

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* Aristotle gives a decided preference to a *small* head, διὰ γὰρ τοῦτο καὶ μικροκεφάλους, καὶ αὐλῶν οἱ τοιοῦτοι μᾶλλον τῶν μεγαλωκεφάλων φρονιμώτεροι. *Aristot. Problem. Sect.* 30

are composed of a reddish and whitish fatty matter; albumen; osmazome; phosphorus; acids; salts, and sulphur, in the following proportions:

1. White fatty matter . . .	4 : 53
2. Reddish fatty matter . .	0 : 70
3. Albumen	7
4. Osmazome	1 : 12
5. Phosphorus	1 : 50
6. Acids, salts, and sulphur .	5 : 15
7. Water	80 : 00
	100 : 00

"The cerebellum of man and the brain of herbaceous animals being examined in the same manner, and with the same precautions gave similar results."* The experiments of other chemists have, so far as I am informed, presented the same phenomena, with re-agents, in the cerebrum of brutes as in that of man; and we have reason to believe that their similarity in this respect is greater than in any other of the particulars we have formerly spoken of.†

No one will suspect me of intending to say that the condition of the brain has not an influence on the mental powers.—The mind, it has been said, employs the brain, as the material instrument of

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*Vauquelin, *Annales de Chimie.* V. 80. p. 37.

†V. Klaproth, *Dict. de Chimie. Trad. Franc. Art. Cerveau.*

its operations, and these may of course be more or less perfect according to the perfection of the instrument: but in what this material perfection consists, or to what extent it may influence the intellectual faculties, we are wholly unable to say. Our powers fail in the attempt to estimate the connexion between the visible matter and the invisible mind; there is nothing like nor analogous to it in the world which surrounds us; no wonder is it then that all metaphysicians and physiologists from the time of PLATO and ARISTOTLE have not thrown a ray of light on this part of our economy, and that it remains veiled in the same impenetrable and mysterious obscurity from their day to the present.

GENTLEMEN,—The views we have taken, of various points of comparative structure, must, I think, satisfy you that there is not such a peculiarity in the great sensorial organ in man, as to elevate him as much in physical as in moral superiority. Man, gifted with the use of language, improvable by education, transmitting improvements to his posterity, and elevating his thoughts to an invisible world—while he is allied to animals in his material organization, is connected by mind with the spiritual.

We must then, my friends and fellow-labourers, throw aside the discouraging and degrading notion

that we form a part of the same chain which connects different classes of the brute creation—a thought that binds us to the earth and weighs down our most animating hopes. In vain would a sense of moral duty or the consciousness of utility be resorted to, as the support of the physician, through disgust, overwhelming fatigue, and the menace of disease and death; he must look higher than the material or the moral world for his reward; and he who cannot confidently turn *thither* his expectations, though he may be esteemed skilful, popular, and fortunate, must still experience the depression of heart, arising from the sentiment that the rewards of his fellow men bear no proportion to his efforts and his responsibility.

Having concluded this imperfect view of the sensorial apparatus, and adverted to the physiological inductions most obviously arising from it, we take leave of the subject with a reflection likely to present itself to every mind. Looking back through the long range of beings, whose structure we have, in part, delineated; when we consider the wonderful adaptation of their structure to the habits, the wants, the abodes of each animal; when we notice the gradual change of organization from the higher to the lower beings, the regular diminution and disappearance

of parts; when we observe that in creatures, whose general appearance, and structure, and habits, are widely dissimilar, traces of the same organs, fitted for the same functions, are constantly re-appearing:—the most insensible must recognise the work of ONE HAND, the blindest must see the traces of a single omnipotent, omniscient power, ever varying the features of his works, yet always stamping them with the impression of a common, almighty origin.