

more sensible to pain than the lungs, the brain, or the stomach; but even the skin itself is more sensible in some parts than in others, which are apparently supplied with an equal number of nerves, and of nerves from the very same quarter. \* It is perhaps least sensible in the gums; a little more so on the hairy scalp of the head; much more so on the front of the body; and most of all so in the interior of the eyelids: while the bones, teeth, cartilages, cuticle, and cellular membrane, though largely supplied with nerves, have no sensation whatever in a healthy state.

As the degree of intelligence decreases, we have reason to believe that the intensity of touch or corporeal feeling decreases also, excepting in particular organs, in which the sense of touch is employed as a local power. And hence we may reasonably conjecture that in some of the lowest ranks of animals, the sensibility may not exceed, even in their most lively organs, the acuteness of the human cellular membrane, cuticle, or gums.

This, however, does not rest upon conjecture or even upon loose indefinite reasoning. We find in our own system that those parts which are most independent of all the other parts, and can reproduce themselves most readily, are possessed of the smallest portion of sensation; such are all the appendages of the true skin, the cuticle, horn, hair, beard, and nails: some of which are so totally independent of the rest, that they will not only continue to live, but even to grow, for a long time after the death of every other part of the body.

Now it is this very property by which every kind of animal below the rank of man is in a greater or less degree distinguished from man himself. All of them are compounded of organs which in a greater or less degree approach towards that independence of the general system which, in man, the insensible or less sensible parts alone possess; and hence all of them are capable of reproducing parts that have been destroyed by accident or disease, with vastly more facility and perfection than mankind can do.

I have once or twice had occasion to apply this remark to the lobster, which has a power not only of reproducing its claws spontaneously, when deprived of them by accident or disease, but of throwing them off spontaneously whenever laid hold of by them, in order to extricate itself from the imprisoning grasp. The tipula *pectiniformis*, or insect vulgarly called father-long-legs, and several of the spider-family, are possessed of a similar power, and exercise it in a similar manner. These limbs are renewed by the formative effect of the living principle in a short period of time: but it would be absurd to imagine that in thus voluntarily parting with them the animal puts himself to any very intolerable degree of pain; for in such case he would not exert himself to throw them off. The gad-fly, when it has once fastened on the hand, may be cut to pieces apparently without much disturbance of its gratification; and the polype appears to be in as perfect health and contentment when turned inside out as when in its natural state. This animal may be divided into halves, and each half by its own formative and instinctive effort will produce the half that is deficient, and in this manner an individual of the tribe may be multiplied into countless numbers.

In many animals of the three classes of amphibians, insects, and worms, the most dreadful wounds that can be inflicted, unless actually mortal, seem hardly to accelerate death; and hence we have a decisive proof that the pain endured by such animals must be very considerably and almost infinitely less than would be suffered by animals of a more perfect kind, and especially by man; since in these the pain itself, and the sympathetic fever which follows as its necessary result, would be sufficient to kill them independently of any other cause.

The life of man is in jeopardy upon the fracture or amputation of a limb; and even at times when his body has been spattered over with a charge of small shot, or only of gunpowder. But M. Ribaud, with a spirit of experimenting that I will not justify, has struck different beetles through with pins, and cut and lacerated others in the severest manner, all of which lived through their usual term of life as though no injury had been committed on

them. Vaillant, wishing to preserve a locust of the Cape of Good Hope, took out the intestines, and filled the abdomen with cotton, and then fixed it down by a pin through the chest; yet after five months the animal still moved its feet and antennas.

In the beginning of November, Redi opened the skull of a land-tortoise, and excavated it of the whole brain. He expressly tells us that the tortoise did not seem to suffer: it moved about as before, but groped for its path, for the eyes closed soon after losing the brain, and never opened again. A fleshy integument was produced, which covered the opening of the skull, but the instinctive power of the living principle was incompetent to renew the brain, and in the ensuing May, six months afterward, the animal died.\*

Spallanzani has incontestably proved that the snail has a power of reproducing a new head when decapitated: but it should be remarked that the brain of the snail does not exist in its head.

I will not pursue this argument any farther; it is in many respects painful and abhorrent; and consists of experiments in which I never have been, and trust I never shall be, a participant. But I avail myself of the facts themselves in order to establish an important conclusion in physiology, which I could not so well have established without them.

Let us turn to a more cheerful subject, and examine a few of those peculiarities in the external senses which characterize the different classes and orders of animals, so far as we are acquainted with such distinctions; and admire the wisdom which they display.

The only sense which seems common to animals, and which pervades almost the whole surface of their bodies, is that of general touch or feeling; whence M. Cuvier supposes that the material of touch is the sensorial power in its simplest and uncompounded state; and that the other senses are only modifications of this material, though peculiarly elaborated by peculiar organs, which are also capable of receiving more delicate impressions. † Touch, however, has its peculiar local organ, as well as the other senses, for particular purposes, and purposes in which unusual delicacy and precision are required; in man this peculiar power of touch is well known to be seated in the nervous papillæ of the tongue, lips, and extremities of the fingers. Its situation in other animals I shall advert to presently.

The differences in the external senses of the different orders and kinds of animals, consists in their number and degree of energy.

All the classes of vertebral animals possess the same number of senses as man. Sight is wanted in zoophytes, in various kinds of moluscous and articulated worms, and in the larvae of several species of insects. Hearing does not exist, or at least has not been traced to exist, in many moluscous worms, and several insects in a perfect state. Taste and smell, like the general and simple sense of touch, seem seldom to be wanting in any animal.

The local sense of touch, however, or that which is of a more elaborate character, and capable of being exercised in a higher degree, appears to be confined to the three classes of mammals, birds, and insects: and even in the last two it is by no means common to all of them, and less so among insects than among birds.

In apes and macaques, constituting the quadrumana of Blumenbach, it resides partly in the tongue, and tips of the fingers, as in man, but equally, and in some species even in a superior degree, in their toes. In the racoon (*ursus lotor*) it exists chiefly in the under surface of the front toes. In the horse and cattle orders, it is supposed by most naturalists to exist conjointly in the tongue and snout, and in the pig and mole to be confined to the snout alone; this, however, is uncertain; as it is also, though there seems to be more reason for such a belief, that in the elephant it is seated in the proboscis. Some physiologists have supposed the bristly hairs of the tiger, lion, and cat, to be an organ of the same kind; but there seems little ground for such an opinion. In the opossum (and especially the Cayenne opossum) it exists

\* Dalzell's Introd. to his Transl. of Spallanzani, p. xlv.

† Anatom. Comparat. i. 25.

very visibly in the tail; and M. Cuvier suspects that it has a similar existence in all the prehensile-tailed mammals.

Blumenbach supposes the same sense to have a place in the same organ in the platypus, or ornithorhynchus, as he calls it, that most extraordinary duck-billed quadruped which has lately been discovered in Australia, and, by its intermixture of organs, confounds the different classes of animals, and sets all natural arrangement at defiance.

The local organ of touch or feeling in ducks and geese, and some other genera of birds, appears to be situated in the integument which covers the extremity of the mandibles, and especially the upper mandible, with which apparatus they are well known to feel for their food in the midst of mud in which they can neither see nor perhaps smell it.

We do not know that amphibials, fishes, or worms possess any thing like a local sense of touch: it has been suspected in some of these, and especially in the arms of the cuttle-fish, and in the tentacles of worms that possess this organ; but at present it is suspicion, and nothing more.

In the insect tribes, we have much reason for believing such a sense to reside in the antennas, or in the tentacles; whence the former of these are denominated by the German naturalists *fühlhorner* or feeling-horns. This belief has not been fully established, but it is highly plausible, from the general possession of the one or the other of these organs by the insect tribes, the general purpose to which they apply them, and the necessity which there seems for some such organ from the crustaceous or horny texture of their external coat.

The senses of TASTE and SMELL in animals bear a very near affinity to the local sense of touch; and it is difficult to determine whether the upper mandible of the duck-tribe, with which they distinguish food in the mud, may not be an organ of taste or smell as well as of touch; and there are some naturalists that in like manner regard the cirrous filaments or antennules attached to the mouths of insects as organs of taste and touch equally. Taste in the more perfect animals resides jointly in the papillæ of the tongue and the palate; but I have already had occasion to observe that it may exist, and in full perfection, in the palate alone, since it has been found so in persons who have completely lost the tongue from external force or disease.

In animals that possess the organ of nostrils this is always the seat of smell; and in many quadrupeds, most birds, and perhaps most fishes, it is a sense far more acute than in man, and that which is chiefly confided in. For the most part it resides in the nerves distributed over a mucous membrane that lines the interior of the bones of the nostrils, and which is called the Schneiderian membrane, in honour of M. Schneider, a celebrated anatomist, who first accurately described it. Generally speaking, it will be found that the acuteness of smell bears a proportion in all animals to the extent of surface which this membrane displays; and hence, in the dog and cattle tribes, as well as in several others, it possesses a variety of folds or convolutions, and in birds is continued to the utmost points of the nostrils, which in different kinds open in very different parts of the mandible.

The frontal sinuses, which are lined with this delicate membrane, are larger in the elephant than in any other quadruped, and in this animal the sense is also continued through the flexible organ of its proboscis. In the pig the smelling organ is likewise very extensive; and in most of the mammals possessing proper horns it ascends as high as the processes of the frontal bone from which the horns issue.

It is not known that the cetaceous tribes possess any organ of smell; their blowing holes are generally regarded as such; but the point has been by no means fully established. We are in the same uncertainty with respect to amphibials and worms; the sense is suspected to exist in all the former, and in several of the latter, especially in the cuttle-fish, but no distinct organ has hitherto been traced out satisfactorily.

In fishes there is no doubt; the olfactory nerves are very obviously distributed on an olfactory membrane, and in several instances the snouts are

double, and, consequently, the nostrils quadruple, a pair for each snout. This powerful inlet of pleasure to fishes often proves fatal to them from its very perfection; for several kinds are so strongly allured by the odour of majorum, asafoetida, and other aromas, that by smearing the hand over with these substances, and immersing it in the water, they will often flock towards the fingers, and in their intoxication of delight may easily be laid hold of. And hence the angler frequently overspreads his baits with the same substances, and thus arms himself with a double decoy.

There can be no doubt of the existence of the same sense in insects; for they possess a very obvious power of distinguishing the odorous properties of bodies, even at a considerable distance beyond the range of their vision; but the organ in which this sense resides has not been satisfactorily pointed out: Reimar supposes it to exist in their stigmata, and Knoch in their anterior pair of feelers.

The general organ of HEARING is the ear, but not always so; for in most of those who hear by the Eustachian tube only, it is the mouth, and in the whale tribes the nostrils or blow-hole. It is so, however, in all the more perfect animals, which usually for this purpose possess two distinct entrances into the organ; a larger and external, surrounded by a lobe; and a smaller and internal, opening into the mouth. It is this last which is denominated the Eustachian tube. The shape of the lobe is seldom found even in mammals similar to that in man, excepting among the monkey and the porcupine tribes. In many kinds there is neither external lobe nor external passage. Thus, in the frog, and most amphibious animals, the only entrance is the internal, or that from the mouth; and in the cetaceous tribes the only effective entrance is probably of the same kind; for, though these may be said to possess an external aperture, it is almost imperceptibly minute. It is a curious fact, that, among the serpents, the blind-worm or common harmless snake is the only species that appears to possess an aperture of either sort; the rest have a rudiment of the organ within, but we are not acquainted with its being pervious to sound.

Fishes are well known to possess a hearing organ, and the skate and shark have the rudiment of an external ear; but, like other fishes, they seem chiefly to receive sound by the internal tubule alone.

That insects in general hear is unquestionable, but it is highly questionable by what organ they obtain the sense of hearing. The antennas, and perhaps merely because we do not know their exact use, have been supposed by many naturalists to furnish the means; it appears fatal, however, to this opinion to observe, that spiders hear, though they have no true antennas, and that other insects which possess them naturally seem to hear as correctly after they are cut off.

The sense of vision exhibits perhaps more variety in the different classes of animals than any of the external senses. In man, and the greater number of quadrupeds, it is guarded by an upper and lower eyelid; both of which in man, but neither of which in most quadrupeds, are terminated by the additional defence and ornament of cilia or eyelashes. In the elephant, opossum, seal, cat-kind, and various other mammals, all birds, and all fishes, we find a third eyelid, or nictitating membrane, as it is usually called, arising from the internal angle of the eye, and capable of covering the pupil with a thin transparent veil, either wholly or in part, and hence of defending the eyes from danger in their search after food. In the dog this membrane is narrow; in oxen and horses it will extend over half the eyeball; in birds it will easily cover the whole; and it is by means of this veil, according to Cuvier, that the eagle is capable of looking directly against the noonday sun. In fishes it is almost always upon the stretch, as in their uncertain element they are exposed to more dangers than any other animal. Serpents have neither this nor any other eyelid; nor any kind of external defence whatever but the common integument of the skin.

The largest eyes in proportion to the size of the animal belong to the bird tribes, and nearly the smallest to the whale; the smallest altogether to

the shrew and mole; in the latter of which the eye is not larger than a pin's head.

The iris, with but few exceptions, partakes of the colour of the hair, and is hence perpetually varying in different species of the same genus. The pupil exhibits a very considerable, though not an equal, variety in its shape. In man it is circular; in the lion, tiger, and indeed all the cat-kind, it is oblong; transverse in the horse and in ruminating animals; and heart-shaped in the dolphin.

In man, and the monkey tribes, the eyes are placed directly under the forehead; in other mammals, birds, and reptiles, more or less laterally; in some fishes, as the genus *pleuronectes*, including the turbot and flounder tribes, both eyes are placed on the same side of the head; in the snail they are situated on its horns, if the black points on the extremities of the horns of this worm be real eyes, of which, however, there is some doubt; in spiders the eyes are distributed over different parts of the body, and in different arrangements, usually eight in number, and never less than six. The eyes of the *sepia* have lately been detected by M. Cuvier: their construction is very beautiful, and nearly as complicated as that of vertebrated animals.\* Polypes and several other zoophytes appear sensible of the presence of light, and yet have no eyes; as the nostrils are not in every animal necessary to the sense of smell, the tongue to that of taste, or the ears to that of sound. A distinct organ is not always requisite for a distinct sense. In man himself we have already seen this in regard to the sense of touch, which exists both locally and generally: the distinct organ of touch is the tips of the tongue and of the fingers, but the feeling is also diffused, though in a subordinate and less precise degree, over every part of the body. It is possible, therefore, in animals that appear endowed with particular senses, without particular organs for their residence, that these senses are diffused, like that of touch, over the surface generally; though there can be no doubt that, for want of such appropriate organs, they must be less acute and precise than in animals that possess them.†

But who of us can say what is possible? who of us can say what has actually been done? After all the assiduity with which this attractive science has been studied, from the time of Aristotle to that of Lucretius, or of Pliny, and from these periods to the present day,—after all the wonderful and important discoveries which have been developed in it, natural history is even yet but little more than in its infancy, and zoonomy is scarcely entitled to the name of a science in any sense. New varieties and species, and even kinds of beings, are still arising to our view among animals, among vegetables, among minerals:—new structures are detecting in those already known, and new laws in the application of their respective powers.

But the globe has been upturned from its foundation; and with the wreck of a great part of its substance has intermingled the wreck of a great part of its inhabitants. It is a most extraordinary fact, that of the five or six distinct layers or strata of which the solid crust of the earth is found to consist, so far as it has ever been dug into, the lowermost, or granitic, as we observed on a former occasion,‡ contains not a particle of animal or vegetable materials of any kind; the second, or transition formation, as Werner has denominated it, is filled, indeed, with fossil relics of animals, but of animals not one of which is to be traced in a living state in the present day; and it is not till we ascend to the third, or floetz stratification, that we meet with a single organic remain of known animal structures.

M. Cuvier has been engaged for the last fifteen years in forming a classification, and establishing a museum of non-descript animal fossils, for the purpose of deciding, as far as may be, the general nature and proportion of those tribes that are now lost to the world: and in the department of quadrupeds alone, his collection of unknown species amounted in the year 1810 to not less than seventy-eight, some of which he has been obliged to arrange

\* Le Règne Animale distribué d'après son Organization, 4 tomes, 8vo. Paris, 1817.

† Study of Med. vol. iv. p. 14, 2d edit. 1825.

‡ Series i. Lecture vi. p. 69

under new genera, as we shall have occasion to notice still farther in a subsequent study. In the new and untried soil of America, the bones of unknown kinds and species lie buried in profusion; and my late friend Professor Barton, of Philadelphia, one of our first transatlantic physiologists, informed me by letter a short time before his death, that they are perpetually turning up skeletons of this description, whose living representatives are nowhere to be met with.

In few words, every region has been enriched with wonders of animal life that have long been extinct for ever. Where is now that enormous mammoth, whose bulk outrivalled the elephant's? \* where that gigantic tapir, of a structure nearly as mountainous,\* whose huge skeleton has been found in a fossil state in France and Germany; while its only living type, a pigmy of what has departed, exists in the wilds of America? where is now the breathing form of the fossil sloth of America, the *magaloninx* of Cuvier, whose size meted that of the ox? \* where the mighty monitor,\* outstripping the lengthened bulk of the crocodile? itself, too, a lord of the ocean, and yet, whose only relics have been traced in the quarries of Maestricht; to which, as to another leviathan, we may well apply the forcible description of the Book of Job, "at whose appearing the mighty were afraid, and who made the deep to boil as a caldron: who esteemed iron as straw, and brass as rotten wood; who had not his like upon the earth, and was a king amid the children of pride."†

Over this recondite and bewildering subject skeptics have laughed and critics have puzzled themselves; it is natural history alone that can find us a clew to the labyrinth, that enables us to repose faith in the records of antiquity, and that establishes the important position, that the extravagance of a description is no argument against the truth of a description, and that it is somewhat too much to deny that a thing has existed formerly, for the mere reason that it does not exist now.

\* See Series ii. Lecture ii.

† Job, xli. 25. 27. 31. 33, 34.