LECTURES

ON

COMPARATIVE ANATOMY.

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TRANSLATED FROM THE FRENCH OF

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LECTURES

ON

COMPARATIVE ANATOMY.

LECTURE EIGHTH.

Of the Head, confidered as the principal Receptacle of the Organs of Senfe.

In treating of the organs of motion, we confidered the Head, as far as its figure, its motions, and the mufcles which act upon it, were concerned. Were we to ftop there, our knowledge of this portion of the body would be very imperfect. The hiftory of its bones forms the principal part of Comparative Ofteology, becaufe they are the moft variable and complicated of all the fkeleton; and a knowledge of them is befides of great importance, on account of the number of effential parts which they either fuftain or envelope. The brain—the principal nerves—the organs of feeing, hearing, fmelling, and tafting—thofe of maftication and deglution—and a part of thofe of refpiration, and voice, are either enclofed within the Head, attached to fome one of its bones, or pafs through its holes and canals. Having concluded our treatife on the Organs of Motion, it is proper that we fhould now defcribe the Head, which will complete our Syftem of Ofteology, and commence an account of the Organs of Senfe. We fhall thus fix with precifion the limits of each branch of our fubject.

ARTICLE I.

Of the Cranium—of its Form, and its Proportions with refpect to the Face.

THE Head allows of two principal divifions, 1ft. the cranium, which forms an offeous cafe to enclofe the brain; 2d. the face, which is made up of a collection of different bones, containing very complicated cavities, in which are lodged the organs of fight, fmell and tafte. The organs of hearing are fituated in the lateral parietes of the cranium.

The two organs which occupy the greateft portion of the face are thofe of fmell and tafte. In proportion as the organs of thefe two fenfes are developed, the magnitude of the face, and its proportion, with refpect to the cranium, is increafed. On the contrary, as the brain is enlarged,

ged, the cranium which contains it augments in capacity, and becomes more confiderable when compared with the face.

An extenfive cranium and a fmall face, therefore, indicate a large brain, with little developement of the organs of tafte and fmell; while a fmall cranium, and a large face, point out the oppofite proportions—a brain of a fmall volume, with very perfect organs of tafte and fmelling.

The nature of each animal depends in a great meafure on the relative energy of each of its functions, and it may be faid to be influenced and governed by thofe fenfations which are the moft powerful. We obferve daily illuftrations of this truth among ourfelves, though the differences which exift in that refpect, between one man and another, are much lefs than thofe which may be remarked between other animals. We fhall fee hereafter that the brain, the common centre of all the nerves, is alfo the point in which all perceptions terminate, and the inftrument by which the mind combines thofe perceptions, compares them, and makes deductions; in a word, reflects and thinks.

We fhall alfo find that animals participate more in this laft faculty, or at leaft appear to enjoy it more perfectly, in proportion as the mafs of the medullary fubftance, which forms their brain, furpaffes that which conftitutes the remainder of their nervous fyftem; that is to ſay, in proportion as the central organ of the ſenſes exceeds their external organs.

The relative proportion of the cranium and the face, which indicates immediately that of the brain, with reſpect to two of the principal external ſenſes, is likewiſe a mark of more or leſs perfection in the internal faculties. But another conſideration adds to its importance as an index of this kind, which is, that the two ſenſes we have mentioned are thoſe which act with the greateſt force on animals; thoſe which govern them moſt powerfully in conſequence of the energy which two of the ſtrongeſt deſires, hunger and love, communicate by the means of their perceptions. The actions to which theſe deſires determine animals, are thoſe into which they enter with the moſt blind fury, and the greateſt beſtiality, if we may be allowed to expreſs ourſelves thus, when man is not the ſubject of conſideration.

It is not aſtoniſhing, therefore, that the form of the Head, and the proportions of the two parts which compoſe it, are indications of the faculties of animals, of their inſtinct, of their docility, and, in a word, of all their ſenſitive being. This circumſtance renders the ſtudy of theſe proportions highly important to the Naturaliſt.

We ſhall ſoon find that man is the animal which has the largeſt cranium, and the ſmalleſt face; and that, according as this proportion is departed from in other animals, they become more ſtupid or more ferocious.

Among the different means that have been employed to exprefs conveniently the proportions of thefe parts, one of the moft fimple, but which is not always fufficient, is the *facial line* of Camper, and the angle which it forms with the bafe of the cranium. The facial line is fuppofed to pafs along the edge of the fuperior dentes incifores, and the moft prominent point of the forehead. The *bafilar line* of the cranium is that which bifects longitudinally a plane paffing through the external meatus auditorii, and the inferior edge of the anterior aperture of the noftrils. It is evident, that in proportion as the cranium is enlarged, the forehead muft project more forward, and the facial line form a larger angle with the bafilar. On the contrary, in proportion as the cranium diminifhes in fize, that line will incline farther back. We fhall fhew by a table, of the different fizes of the facial angle, that it is wider in man than in any other animal, and that it becomes always more acute in the mammalia, as they are removed from man, and in birds, reptiles and fifhes. The vulgar are even accuftomed to attribute ftupidity to animals which have very long fnouts, as cranes and woodcocks; but when fome circumftances tend to elevate the facial line, without augmenting the capacity of the cranium, as we find takes place in the elephant and the owl, in confequence of the extraordinary thicknefs of the diploë of the os frontis, we fancy we fee in animals of that defcription a peculiar air of intelligence, and are induced to afcribe to them qualities which they do not really poffefs. We know that the owl has been confidered as the emblem of wifdom, and that the elephant has in India a name which indicates that he poffeffes reafon.

The ancients appear to have been very fenfible of thefe relations. They not only perceived that an elevated facial line was the indication of a noble nature, and one of the characteriftics of beauty; but they even ftepped beyond nature, and made this line incline fomewhat more forward than it does in man, in figures to which they were defirous of giving a more than human air, as the ftatues of their gods, and thofe of their heroes, or men whom they wifhed fhould appear to partake of divinity. It feems they were defirous of placing man between beings of this fort, or a more perfect order, and brutes; and that they wifhed to indicate, by the oppofite inclination of the forehead, that their heroes were still more removed than common men from the forms or the nature of the inferior animals.

A. *In Man and other Mammiferous Animals.*

The facial angle being determined in the manner I have pointed out, which is that of Camper, we find that in European heads this angle is ufually

ufually 80°, in Mongols 75°, and in Negroes 70°, with the variations of fome degrees in refpect to age and individuals. For example, the face in children is fhort, becaufe their pofterior teeth are wanting. This makes their facial line more perpendicular, and is one of the caufes which renders their countenance always agreeable, and in confequence of which they become almoft always lefs beautiful as they increafe in age. The ancients, when they wifhed to imprefs an auguft character on their figures of men, have increafed the facial angle to 90°, and they have even extended it to 100° in their figures of gods. This finks the eyes more, and renders the branches of the lower jaw fhorter than in nature.

In the *ourang outang*, the facial angle is 65°. In the *fapajous*, and the *guenons*, it is about 60°. In the *magots*, and the *macaques*, about 45°. Laftly, in the *mandrils*, which are the moft mifchievous and ferocious of all the apes, it is only 30°. In the fpecies which have the ear much elevated, and the guttural cavity very deep, as the *Batavian pongo*, and the *alouatte*, the fmallnefs of this angle does not indicate a proportional elongation of the fnout. To demonftrate this accurately, the bafilar line of the cranium fhould be drawn parallel to the bafe of the noftrils.

Even with this regulation, however, the facial angle is not important, with refpect to the brain, except in the human fpecies, and among the Quadrumana, becaufe they have only very fmall frontal finufes, which do not elevate the facial line in a fenfible degree, and becaufe the nofe falls under that line.

But there are fome quadrupeds, as the Sarcophaga, the *hogs*, fome Ruminantia, and particularly the *elephant*, in which the frontal finufes fwell the cranium to fuch a degree, that they elevate the facial line much beyond what the proportion of the brain would require. In others, as the *morfe*, and the greater part of the Rodentia, the nofe occupies fo large a fpace that the cranium is inclined backward, and none of its parietes are entirely free anteriorly. In this conformation it is impoffible to tell what ought to be the direction of the facial line. Laftly, the Cetacea have the cranium elevated in the form of a pyramid, and fituated above a face which is very much prolonged, but flattened horizontally. The inclination of the facial line would be greater than it ought to be with refpect to the real capacity of their face.

The following, however, is a table of the extent of the facial angle, in a certain number of animals, formed by drawing a line parallel to the bafe of the noftrils, and another paffing along the anterior edge of the alveoli, and touching the convexity of the cranium, whether the point of contact be concealed by the face, or rife above it.

European Infant - - - -	90°.
European Adult - - - -	85°.

Aged

Aged European - - - -	75°.
Adult Negro - - - -	70°.
Young Ourang-outang - - -	67°.
Sapajou - - - - -	65°.
Talapoin Monkey - - -	57°.
Young Mandrill - - - -	42°.
Coati - - - - - -	28°.
Pole-cat - - - - -	31°.
Pug-dog - - - - -	35°.
Maſtiff-dog, the tangent taken at the external ſurface of the cranium	41°.
——— at the internal ſurface -	30°.
Hyæna, at the external ſurface -	40°.
——— at the internal - - -	25°.
Leopard, at the internal ſurface -	28°.

(A tangent cannot be drawn to the external ſurface, on account of the convexity of the noſe.)

Hare - - - - - -	30°.
Marmotte - - - - -	25°.
Porcupine - - - - -	23°.

The three laſt are meaſured by the internal ſurface of the cranium, becauſe a tangent cannot be brought to the external.

Pangolin - - - - -	39°.
Babirouſſa - - - - -	29°.
Ram - - - - - -	30°.
Horſe - - - - -	23°.
Dolphin - - - - -	25°.

We may, however, diſcover more important relations, in conſidering the cranium and the face,

face, under the vertical and longitudinal ſection of the Head. With reſpect to their relative proportions, the cranium, in this ſection, occupies an area ſometimes greater, ſometimes leſs, and ſometimes nearly equal to that of the face.

In the *European*, the area of the ſection of the cranium is almoſt four times greater than that of the face, the lower jaw not included.

In the *Negro*, the cranium remaining the ſame, the area of the ſection of the face is increaſed about one-fifth. In the *Calmuc*, it increaſes only one-tenth.

The proportion is leſs in the *ourang outang*. In the *ſapajous*, the area of the face is almoſt one-half of the cranium. It is nearly equal in the *mandrills*, and in moſt of the Carnivora, except in the varieties of ſhort-noſed dogs, as the *pug*, which have the face ſomewhat ſmaller in proportion to the cranium. The Rodentia, the Pachydermata, the Ruminantia, and the Solipeda, have all the area of the ſection of the face larger than that of the cranium. In the Rodentia, the *hare*, and the *marmotte*, have it one-third larger. It is more than double in the *porcupine*. It is nearly double in the Ruminantia; a little more than double in *hogs*, nearly triple in the *hippopotamus*, and almoſt quadruple in the *horſe*.

The *morſe* and the *elephant* have a large face, in conſequence of the height of the alveoli; but it cannot, in them, be conſidered as augmenting the extent of the organs of ſenſe.

The

The Cetacea have the cranium very globular, and the face very flat, in consequence of which the area of the latter is proportionally diminished; besides, the face is not occupied by the nose throughout its whole extent, and ought not to be considered here under this relation. The area of the face in the *dolphin* is perhaps about one-third larger than that of the cranium.

With respect to figure; were the curve of the human cranium continued inferiorly from the foramen magnum to the root of the nose, the section would form an oval which would be a little narrowed anteriorly, and of which the greatest axis would be nearly parallel to the floor of the nostrils, or at least inclined very little backward, and its proportion to the small axis would be as 5 : 4. But in the space I have pointed out, and which forms the limits of the cranium and the face, there is, instead of this curve, an irregular line forming a salient angle within the oval. The section of the face is a triangle, with its greatest side towards the cranium, and the smallest directed outward. The angle, which the latter forms with the third side, or the palate, is precisely the facial angle.

In *monkies*, the great axis is somewhat elongated with respect to the lesser; the line which separates the cranium and the face becomes more straight, and the anterior and inferior side of the triangle of the face is so much elongated, that the

the ſide which touches the cranium is the ſmalleſt of the three in the *macaques* and the *mandrills*. It is found the leaſt alſo in other quadrupeds. In the Sarcophaga and the Rodentia, the anterior part of the oval of the cranium is the narroweſt. In the Ruminantia, and the *horſe*, the poſterior is the moſt narrow. We perceive a ſtrong angle within the cavity of the cranium of thoſe that have an oſſeous ſeparation between the cerebrum and the cerebellum.

The great axis of the oval inclines forward in the Sarcophaga, with reſpect to the baſe of the noſtrils, but backward in all the herbivorous ſpecies. Its form and direction in the *morſe* are the ſame in the Sarcophaga.

The ſection of the cranium of the *dolphin* is almoſt triangular, the ſides are convex, and the angles rounded. One ſide is anterior; another, which is poſterior, is perforated by the foramen magnum. The third, which forms the baſe of the cranium, and which correſponds with the line that unites the cranium to the face, in other animals, is, however, ſituated completely behind the face, and is even parallel to the arch of the palate.

We may alſo examine the tranſverſe vertical ſection of the cranium, that is to ſay, a ſection made by a plane perpendicular to its great axis.

This forms in man a very conſiderable portion of a circle, wanting only a ſegment ſomewhat leſs than a third of the circumference towards the inferior

inferior part. The cranium of the *Negro* is flater on the fides than that of the *European*, becaufe his temporal foffæ are greater and deeper. This diminifhes his face upwards, but enlarges it inferiorly on account of the prominence of the cheeks.

In the Sarcophaga this fection produces a femi-ellipfis rounded towards the upper part, and having the bafe nearly equal to its height.

In the *hog*, it is an oval which is longeft vertically, and the fides of which are made irregular by large angles towards the pars petrofa directed interiorly.

In the *horfe*, the oval is more broad than high, and the inferior half has nearly the fame curvature as the fuperior.

Thefe remarks are the more interefting, as in all mammalia the brain is molded in the cavity of the cranium, which it fills exactly; fo that the defcription of the offeous part affords us a knowledge of at leaft the external form of that medullary mafs.

B. *In Birds.*

The longitudinal and vertical fection of the cranium in birds generally reprefents an oval, with its narroweft part anteriorly, the fide correfponding to the face lefs convex than that which is fuperior and pofterior, and the great axis directed upward and forward. The *owls* are

are the only birds in which this section is oval, and contracted nearly equally above and below, with the great axis almost vertical.

The face of birds being chiefly formed by their bill, their physiognomy depends upon the thickness and length of that part; but as the nose occupies a very small portion of it, and as the tongue is frequently so small as to take up very little room in the mouth, the proportion which the cranium bears to the face does not afford the same inductions in birds as in quadrupeds.

C. *In Reptiles and Fishes.*

As the brain of reptiles and fishes occupies only a small part of the cavity of their cranium, no important consequences can be deduced from its shape and size. In the *tortoise* this cavity is large, narrow from right to left, elevated anteriorly, and depressed posteriorly. Its lateral parietes are almost vertical, and its base is parallel to the palate. The external form of the head, and its apparent magnitude, are occasioned by the accessory bones, between which and the cranium there is a large space occupied by muscles and glands.

The small size of the cavity of the cranium, with respect to the external bulk of the head, is still more extraordinary in the *crocodile*. In an individual four metres long, that cavity will hardly

hardly admit the thumb, and the area of the ſection of the cranium is not one-twentieth part of that of the whole head. The figure of the ſection is oblong, rather larger anteriorly, and deſcending poſteriorly. There is a conſiderable depreſſion for the pituitary gland. Its breadth is equal to its height; and the lateral parts of the head, as in the tortoiſe, cover only the temporal foſſæ.

The cranium of *frogs* and *ſalamanders* is almoſt priſmatic.

That of fiſhes is generally very ſmall in proportion to the reſt of the head, but it varies greatly with reſpect to its form, and cannot be compared either with the brain or the ſurrounding parts. Its ſhape, however, approaches moſt frequently to an oval.

ARTICLE II.

Of the Bones which compoſe the Cranium.

A. *In Man.*

THE oſſeous caſe which forms the cranium, is divided into a certain number of bones, which are joined by immoveable articulations, called *ſutures*. Theſe diſappear more or leſs with age, becauſe the reciprocal indentations by which

 the

the edges of the contiguous bones are united, are ſooner or later oſſified together. As there exiſts, however, always ſome traces of the ſeparations of the bones, and as their ſituation or diſpoſition is varied in different animals, a knowledge of them becomes highly uſeful to the Anatomiſt, who wiſhes to diſcover the part and the kind of cranium to which fragments of foſſile heads ſhould be referred. We ſhall examine theſe ſutures, or lines of ſeparation between each of the bones of the cranium, in the different kinds of animals, beginning with Man.

The human cranium is compoſed of eight bones; they are all ſupported on one of their number, which is ſituated at the baſe of the cranium, to the arch of which it may be ſaid to ſerve as the key. It has been compared to the figure of a bat, and is called *os sphenoides*, or *os cuneiforme*, becauſe it anſwers the purpoſe of a wedge, with reſpect to the bones between which it is encloſed.

We ſhall here conſider its ſhape abſtractedly from its eminences and holes. It is bounded before by a curved line, the concavity of which is anterior, and which is continued obliquely on the bottom of each orbit of the eye, the external ſide and bottom of which are occupied by the ſphenoid bone. This line is called the *ſphenoidal ſuture*. At the temporal angle of the orbit, it is directed backward in the temporal foſſa, until it comes in contact with the os temporum. It ſeparates

ſeparates the ſphenoid from the frontal bone throughout almoſt its whole length; the two extremities of the os ſphenoides only touch the parietal bones. It is bounded on each ſide by another curved line, which makes an acute angle with the firſt, and which ſeparates the ſphenoid from the temporal bone; this is called the *ſpheno-temporal*, or *temporal ſuture*. The concavity of the bone is external; as it approaches the middle it deſcends and is carried backwards, ſo that the poſterior border of the bone is much leſs extenſive than the anterior; the poſterior border is divided into three lines, which are nearly ſtraight; a middle one, which is parallel to the middle of its anterior margin; and two lateral lines, directed obliquely backward, each uniting with the external margin of the ſame ſide by an acute angle. The middle part of the poſterior margin ſeparates the os ſphenoides from the os occipitis. This, which is called the *baſilar ſuture*, exiſts only in youth. The two bones are afterwards united, and form only one; its lateral parts ſeparate it from the pars petroſa of the os temporum. The longitudinal axis of the os ſphenoides is nearly one half the length of its poſterior margin, and ſomewhat more than a fourth of the anterior.

All the bones of the cranium are ſeparated by lines which proceed from different points of the os ſphenoides. The *frontal* or *coronal ſuture* extends from a point very near the lateral ſuperior

 angle

angle of this bone, to the correfponding point on the other fide, croffing the arch of the cranium almoft at the top. This future is the pofterior boundary of the bone which forms the forehead, and the fuperior arch of the orbits. The name given to this bone is the os frontis. In children it is divided by a longitudinal future, which fometimes remains even at a very advanced age. This feparation is marked in fome fkulls by a pretty confpicuous depreffion, and in others by a ridge more or lefs elevated. It is called the *medial* or *proper frontal* future. The os frontis is nearly of a femi-circular form. It is truncated inferiorly, and bends backward to form the arch of the orbits. Its vertical heighth is nearly two-thirds of its breadth.

At the external and fuperior angle of the fphenoid bone, another future commences, which is continued along the edge of the os temporum; the curve it forms is nearly circular. It is called the *fquamous future*, becaufe the edges of the bones which form it have the appearance of fcales; the fuperior and internal edge of the os temporum, covering the external and inferior edge of the os parietale. After defcribing about one-third of a circle, the edge of the temporal bone turns up, forms with the future an obtufe and inward angle and is directed pofteriorly until it reaches the os occipitis.

A line proceeds from each fide of the point where the bafilar joins the petro-fphenoidal future,

ture, and feparates the pars petrofa from the os occipitis; thefe two lines bend outward until they arrive oppofite the middle of each occipital condyle, where they are fuddenly carried backward, and re-afcend a little to finifh the outline of the temporal bone. All this pofterior part of the edge of the bone is called the *maftoid future.*

The thin, and almoft circular portions of the offa temporum, form a part of the lateral parietes of the cranium. The pofterior edge of the temporal bone is rounded as it advances to join the occipital. Its inferior edge produces that thick and hard prominence, called os petrofum, fituated between the bafilar procefs and the pofterior lateral edge of the os fphenoides, and thus forming a part of the bafe of the cranium. This pars petrofa is feparated from the reft of the bone in the human fœtus: it extends from the back part obliquely inward and forward.

The *lambdoidal* or *occipito-parietal* future, which concludes the figure of the os occipitis, begins at the middle of the maftoid future, and afcends fomewhat pofteriorly, fo as to form an angle with the correfponding future. It unites the occipital with the parietal bones, which complete the fuperior arch of the cranium. The portion of the occipital bone included between the foramen magnum and the os fphenoides, is called the *bafilar* or *cuneiform* procefs. It is almoft fquare in man, narrowed a little anteriorly, and very

 fhort.

ſhort. In youth it is ſeparated from the reſt of the bone by two ſutures which interſect the anterior portion of the condyles. The remainder of the bone, which forms what is properly called the occiput, is of an oval form, very concave internally, and pointed ſuperiorly. Its poſition is ſuch, that when the human body is erect, the cuneiform proceſs aſcends ſomewhat forward, and its other part is directed backward.

The oſſa parietalia are ſeparated from each other by a longitudin l line, called the *parietal* or *ſagittal* ſuture. The ſhape of theſe bones is quadrangular, the edge by which they touch each other is the longeſt. Their temporal margin is the ſhorteſt and the moſt concave. Their convexity is nearly uniform.

The os frontis has a vacant ſpace between the two orbits, which is occupied by the cribriform lamella of the os ethmoides. The form of this ſpace is that of a long ſquare. It is bounded poſteriorly by the os ſphenoides. The line of ſeparation is called the *ethmoidal* ſuture.

B. *In other Mammiferous Animals.*

The principal differences obſervable in the cranium of mammiferous animals, conſiſt in the number of the bones which conſtitute it ; in the connections of theſe bones; and, laſtly, in the particular form which each of them aſſumes. We ſhall proceed to conſider the craniums of the

the different families of mammalia under these three general points of view.

1. *Number of the Bones of the Cranium in Mammalia.*

All the Quadrumana have eight bones in the cranium, but the os sphenoides is frequently divided into two parts; one of which forms the orbitar wings, and the anterior clinoid processes; and the other the temporal wings, the posterior clinoid processes, and the basilar fossa. The two ossa parietalia unite together at a very early period in the Cheiroptera, so as to form only one bone; the same thing takes place in almost all the other Sarcophaga, which also generally have the os frontis divided into two parts by a medial suture. The cavity of the tympanum is separated from the rest of the temporal bone, by a suture, which seldom ossifies in the *cat*, *dog*, and *civet* genera.

This cavity is also separated in the Rodentia, and the os frontis remains divided into two parts. Their parietal bone is sometimes single, as in the *hares*, the *cavys*, the *porcupine*, the *marmotte*, the *rats*, and *squirrels*; and sometimes double, as in the *mice*, the *dormice*, and the *rabbit*.

The os frontis and the ossa parietalia of the *elephant* are, at a very early period, united by ossi-

 fication

fication with all the other bones of the cranium; ſo that the whole forms a brain-caſe, in which no traces of the ſutures appear.

In the *hog*, the *tapir*, and the *hippopotamus*, the two parietalia form only one piece. Their os frontis is double: the *rhinoceros* has the frontal and parietal bones double, but the ſeparation of the laſt ſoon oſſifies. The os ſphenoides of the animals of this and the two ſucceeding families, remains for a long time divided into two parts. The one forms the orbitar wing, or the little wings of Ingraſſias; the other produces the large wings, or temporal proceſſes, which are here much the ſmalleſt. This diſpoſition is exactly the oppoſite of that obſerved in man.

In the Ruminantia and Solipeda the os frontis remains for a conſiderable time divided by a medial ſuture. In theſe animals the place of the two parietalia is ſupplied by a ſingle piece which forms the top of the cranium. The cavity of the tympanum is always diſtinct.

The *ſeals* have two parietalia, and the os frontis divided into two parts; this alſo takes place in the *morſe*. The *lamantin* has only one parietal bone, and the cavity of the tympanum is ſeparated from the body of the temporal bone.

In the Cetacea the parietalia are very ſoon united with the occipital and temporal bones, in ſuch a manner that theſe five bones form only one. The bone of the ear is always ſeparate, and is connected with the cranium only by ſoft parts,

parts. The ſphenoides remains long diſtinct, and is even divided into ſeveral pieces.

2. *Connections of the Bones of the Cranium in Mammalia.*

Of all the Quadrumana, the *orang-outang* has the cranium moſt ſimilar to that of man in its form. It differs however in the connection of the bones. The temporal wing of the os ſphenoides is extremely narrow, and does not extend to the parietal bone. It touches the os frontis with its ſuperior extremity only, ſo that the temporal partly articulates with the frontal bone. The temporal ſuture is indented, and the edges of the bone are not ſquamous. In the *jocko*, this portion of the temporal wing neither touches the os frontis nor the oſſa parietalia; but the os temporum articulates immediately with the os malæ, by its ſquamous part.

In the *mandrils*, the *macaques*, the *magots*, and the *guenons*, the connection is the ſame as in the *orang-outang*.

In the *ſapajous*, the os frontis does not come in contact with the temporal wing of the ſphenoid bone, and the parietal articulates with the cheek-bone. In the *alouates* the connection is the ſame as in man.

The connections of the bones of the cranium with each other are the ſame in all the Sarcophaga as in man.

In all the Rodentia, the os ſphenoides only articulates with the os frontis, and oſſa temporum, without touching the oſſa parietalia. Its extent in the orbitar and temporal foſſa is very limited.

In the *armadillos*, the *pangolins*, and the *ſloths*, we diſcover the ſame connections as in the Rodentia; but in the *ant-eaters*, the oſſa parietalia are carried under the cranium, and unite in a very extenſive manner with the os ſphenoides, at the poſterior part of the temporal and orbitar foſſa.

In the *elephant*, the bones of the cranium are, at a very early period, united by oſſification, and form only one piece. The bone of the ear is always diſtinct and ſeparate from the os temporum.

In the *hog*, the *tapir*, the *rhinoceros*, and the *hippopotamus*, the os ſphenoides does not unite with the parietal bones, and its large wings occupy only a very ſmall ſpace in the orbitar and temporal foſſa. Only a ſmall part of the orbitar proceſſes appear externally, though they are extended much farther than the large wings. The bone of the ear, which is very diſtinct, is, however, oſſified at its baſe to the circumference of the meatus auditorius.

The os ſphenoides of the Ruminantia articulates, as in man, with all the other bones of the cranium, but its orbitar wing, which is very extenſive, is concealed in a great meaſure within the

the cerebral cavity, and covered by the orbitar lamella of the os frontis.

In the Cetacea in general, the futures which exift after an early age are all of the fquamous kind.

3. *Forms of the Bones of the Cranium in the Mammalia.*

The fhape of the os frontis is more irregular in the orang-outang than in man. The arch of the orbits is lefs depreffed. In the *fapajous*, the frontal bone has the form of a triangle, and terminates in a point towards the crown of the head. In the other *monkies*, this bone is nearly oval, and the orbitar arches almoft ftraight. Thefe arches form, in all monkies, as well as in man, the anterior margin of the os frontis, becaufe the root of the nofe is very narrow. In the *makis* it begins to affume a broad fhape, and the eyes become oblique. This gives a rhomboidal form to their os frontis.

The os frontis of the Sarcophaga, and in general of all the fucceeding mammalia down to the Cetacea, exhibits the irregular furface of a prifm or cylinder, in which three principal furfaces fhould be confidered; one fuperior, which is connected with the nofe anteriorly, and with the reft of the cranium pofteriorly; and two lateral, which defcend each into the orbitar and temporal foffa of the fame fide.

The

The form of the fuperior furface is principally determined by the pofition of the orbits. In *dogs*, *cats*, *bears*, *ternate-bats*, *weafels*, *oppoffums*, *&c.* thefe orbits correfpond with the anterior part of its lateral margins, and give to the whole bone a rhomboidal figure. In the Rodentia, the orbits form notches in the middle part of the lateral edges of the os frontis, and give to it a form more or lefs rectangular.

It is the fame in the *flying-lemur*.

The *hedge-hogs*, the *moles*, the *fhrews*, the *ant-eaters*, the *feals*, the *morfes*, and the *rhinocerofes* have no orbitar arches properly fo called. The frontal bone is fimply contracted, and becomes almoft cylindrical between the orbits. It is enlarged pofteriorly.

In the *hippopotamus*, the Ruminantia, and the Solipeda, the frontal bone is enlarged, and forms a vault over each orbit.

Laftly, in the Cetacea, the os frontis is narrow from the front backward. It refembles a fillet extended acrofs the cranium; but as, according to the laws which govern the ftructure of the head in mammiferous animals, this bone fhould form the upper part of the orbits; it defcends for that purpofe below the maxillary bones, fo that the order of the pofition of the bones in thefe animals is entirely reverfed to preferve that of their connections.

The offa parietalia of the *orang-outang*, differ only from thofe of man in having their temporal

temporal edges almoſt ſtraight; thoſe of the *monkies* are narrower, and their angles become more oblique in proportion as the cranium is flat. They return almoſt to a rectangular form in the Sarcophaga and the Edentata. We have already ſhown that they are united into a ſingle piece in a conſiderable number of the Rodentia. That piece is almoſt nearly ſquare; but it is ſometimes flat, ſometimes rounded, and ſometimes ſurmounted with a creſt.

The Ruminantia have alſo a parietal bone in a ſingle piece. In the *ſtags*, the greater part of the *antelopes*, the *ſheep*, and the *goats*, it is broad, and a narrow ſlip extends on each ſide of the temporal foſſa. It is ſituated before the occipital arch. In the *camel* it is narrow, and has a longitudinal creſt. In the *ox*, and in the *antilope-bubalis*, it is ſituated behind the occipital creſt, and reſembles a ribbon ſurrounding the poſterior part of the head tranſverſely.

In the Solipeda, the parietal bone, which is ſingle, is almoſt ſquare, and ſituated before the occipital creſt.

We have already explained the forms of the os occipitis in the firſt volume, when deſcribing the motions of the head on the ſpine.

We ſhall at preſent only notice the ſquamous part of the os temporum, reſerving our account of the pars petroſa until we treat of the ear. In the *orang-outang* and moſt *apes*, the ſquamous portion of the os temporum is of a trapezoid figure,

figure; the superior side is the longest, and its height varies according as the cranium is more or less elevated. It is shortest in the *sapajous*.

The squamous portion in the Sarcophaga is similar to that of the apes.

In the Rodentia it is very narrow posteriorly.

In the short-nosed Edentata, in the Ruminantia, and the Pachydermata, it is rounded a little.

It is necessary to remark, that the mastoid process forms a part of this bone only in *man* and *monkies*, and that in all the other mammalia it belongs to the os occipitis.

We shall describe the zygomatic process of the os temporum when we treat of the face, and particularly of mastication.

The os ethmoides shall be described when we treat of the sense of smelling.

The os sphenoides has been sufficiently explained, and we shall have no occasion to return to it. Its processes will be described in our account of the bones of the face.

C. *In Birds.*

The bones which compose the cranium of birds, are united at an early period, and the sutures cannot be perceived except in very young subjects.

These bones correspond in their number and position to those of the mammalia. There are two

two frontal bones which are prolonged anteriorly to form the roof of the orbits. When birds have a horn, or a creſt, it is alſo attached to the os frontis.

There are two ſmall oſſa parietalia behind the frontal bones.

The oſſa temporum occupy the ſides of the cranium and the auricular region.

The os ſphenoides cannot be diſtinguiſhed from the occipital bone, even in ſubjects that have the ſutures very conſpicuous.

It ſhould be further remarked, that this ſpheno-occipital bone unites with the oſſa temporum ſooner than the other bones unite with each other.

In new-hatched birds, however, we obſerve a ſuture which extends tranſverſely in a ſtraight line from the one ear to the other, and which ſeparates the ſphenoid from the occipital bone; the latter is then nearly of an annular form, and is ſubdivided into four portions; one ſuperior, two lateral, and one inferior, which is very ſmall.

The os ſphenoides forms the greater part of the baſe of the cranium. It is almoſt triangular, and has anteriorly a ſmall eminence, which articulates with the palatine arches, which we ſhall deſcribe when we treat of the face. It wants the pterygoid proceſſes, and does not come in contact with the poſterior aperture of the noſtrils.

The

The temporal bone has no zygomatic proceſs, but there is a ſmall apophyſis which contributes to the formation of the poſterior margin of the orbit.

The os frontis having covered a part of the cranium, is prolonged forward into a lamina more or leſs broad, which forms the ſuperior part of the orbits, and the lateral edges of which are uſually notched by theſe foſſæ. The two orbits are ſeparated from each other by only a vertical lamina, which alſo belongs to the os frontis, and which is attached to the plate that forms their roof.

The oſſeous eminences which we obſerve on the heads of the *caſſowary*, the *horn-bill*, the *pintado*, and ſome *curasows*, &c. are enlargements of this ſupra-orbitar portion. Their interior is filled with diploë of a very looſe texture.

D. *In reptiles.*

The bone of the baſe of the ſkull in the *crocodile* has the form of a very irregular truncated pyramid. The point of this pyramid is downward, and its baſe contains the cavity of the cranium. This pyramid has three ſurfaces, one poſterior, which forms the occiput, and two lateral. The occipital ſurface is almoſt triangular; one of its angles is inferior, the other two are ſuperior, and greatly prolonged backwards and to the ſide, in order to form the enormous articular proceſſes, which receive the lower jaw. Their poſition is almoſt horizontal. The foramen magnum is ſituated in the middle of this ſurface, and under it the ſingle condyle for articulating the head with the vertebral column.

Three ſutures depart from the foramen magnum, which divide the occiput into particular bones. The ſuperior part of the cranium is formed by a ſingle parietal bone. Anterior to it, there is an os frontis, alſo ſingle, which forms the roof of the orbits.

The oſſa temporum are ſituated on each ſide of the parietal bone, and are partly ſupported by that articular proceſs for the lower jaw already mentioned.

A ſmall arch on each ſide, different from the zygoma, leaves between it and the parietal bone a large round hole, which perforates the temporal foſſa. The arch is partly formed by a proceſs of the os temporum, and partly by a particular bone articulated to the junction of the parietal and frontal. This particular bone occupies the place of the poſt-orbitar proceſs of the os frontis in the mammalia; for it deſcends behind the orbit to join the cheek-bone, and with it finiſhes the frame of the orbit.

A cranium ſimilar to this of the *crocodile*, is found in the other *lizards*, notwithſtanding the great differences in the form, proportion, and the direction of the parts. In the *camelion*, therefore, the foramina by which the temporal

foſſæ

foffæ communicate with the cranium, are fo large, and the bony edges which form them fo thin, that the latter reprefent three flender branches rifing to fupport the kind of helmet which diftinguifhes this animal. The articular proceffes are not directed backward, but downward.

The laft peculiarity is alfo obferved in the other *lizards*, but they have not the crefts of the *camelion*, and the upper part of their cranium is broad like the *crocodiles*.

In *frogs* and *falamanders* the cranium is nearly of a cylindrical form, flat fuperiorly, and enlarged pofteriorly; the frontal bones have the fhape of an elongated rectangle, and occupy the interval of the orbits. The *Surinam toad* has the cranium much flatter than the other genera.

The eminences intended to affift in the articulation of the jaw are turned directly towards the fides.

The ftructure of the cranium of *tortoifes* bears more refemblance to that of crocodiles than of frogs. The frontal bones form only the roof of the orbits, and the cranium does not pafs between thefe cavities. They are very fhort, and the parietalia are three times longer. The latter are not confined to covering the cranium. They extend on each fide, and form an arch over the temporal foffa. In the *fea tortoifes* this arch is completed by two peculiar bones which extend from the os parietale to the zygoma, and the anterior of which bounds the orbit behind.

The

The articular proceffes are directed downward, as in the camelion. Above thefe and the meatus auditorius, we find confiderable maftoid proceffes which are pointed fuperiorly in *land tortoifes*, but are rounded and marked by a longitudinal furrow in the *fea tortoifes*.

Serpents have two frontal bones almoft fquare, and a fingle parietal bone. Their cranium advances forward between the orbits, as in frogs. The occipital bone has a procefs directed backward, and connected with a particular moveable bone, analogous to the fquare bones of birds, to which the lower jaw, and the arches which form the upper, are articulated.

E. *In Fifhes.*

The bones of the cranium of fifhes are foon offified together, and as the futures which unite them are fquamous, it is not eafy to difcover any traces of their feparation. The cranium of fifhes forms in general a very fmall portion of the head. Its figure varies confiderably; but as it is covered with fkin only, its forms appear externally; thefe have therefore been well defcribed by Naturalifts, and we have no occafion to give any account of them here.

Article III.

Of the Eminences and Depressions of the Internal Surface of the Cranium.

A. *In Man.*

The ſuperior part of the cranium is almoſt quite ſmooth internally; it is only ſlightly marked by the veſſels of the dura mater, and the circumvolutions of the brain. The moſt remarkable of the impreſſions thus produced, is that which extends along the whole of the middle of this vault, and which correſponds to the longitudinal ſinus. The baſe or floor of the cranium, however, is more unequal, and we obſerve in it ſome very conſpicuous cavities and eminences. It may be divided into three regions or large foſſæ.

The *poſterior foſſa* is named *cerebellous*, becauſe it is chiefly occupied by the cerebellum. It is the deepeſt of the three, and has alſo been called the *inferior occipital* foſſa. Its loweſt part is perforated by the foramen magnum of the os occipitis. A ſlight excavation aſcends obliquely forward from this foramen, and terminates anteriorly by an elevated ridge, having on each ſide a ſmall hook, denominated *poſterior clinoid proceſs*. This ridge forms the anterior boundary of the foſſa. It is an apophyſis of the os ſphenoides;

noides; but the broad canal ſituated behind it is chiefly formed by the cuneiform proceſs of the occipital bone, and is called the *baſilar foſſa*.

Another projecting ridge extends from each ſide of the clinoid proceſs, and is directed obliquely backward. This ridge belongs to the petrous portion of the temporal bone, and completes the anterior limits of the large cerebellous foſſa. This foſſa is incloſed poſteriorly by an elevated line proceeding like the branches of a croſs from the tuberoſity in the middle of the os occipitis. Another elevated line, which proceeds likewiſe from this tuberoſity, deſcends to the edge of the foramen magnum, and divides the cerebellous foſſa into two parts, throughout the whole of its length. In this foſſa there alſo appear ſome impreſſions of veſſels, of which we ſhall ſpeak hereafter.

The level of the *anterior foſſa* is more elevated than that of the other two. It is ſituated above the orbits and the noſe. It is united anteriorly, without any conſpicuous ſeparation, to the ſuperior vault of the cranium. Poſteriorly it is ſeparated from the middle foſſæ by a ſharp ridge, which is concave on the back part, and formed by the orbitar wing of the os ſphenoides. Theſe two ridges extend towards the middle line, and backward. They are terminated nearly oppoſite to the poſterior clinoid proceſſes, but ſomewhat more outward, each by a hook called *anterior clinoid proceſs*; the interval between theſe two hooks conſiſts of another ridge, but leſs ſharp, which completes the boundary of this foſſa poſteriorly. The middle of the foſſa is more depreſſed; it is formed by the cribriform lamella of the os ethmoides, which bears on its middle a ſharp edged ridge in the form of a ploughſhare, called the *criſta galli*, or *ethmoidal creſt*. Its lateral parts are convex and ſcabrous.

The *middle foſſæ* of the cranium occupy the ſpace between the anterior and poſterior; their limits have therefore been already deſcribed. Their level is intermediate between that of the other two. As the anterior and poſterior foſſæ are more extenſive towards the middle than at their ſides, they approach each other at that part. The interval, which ſeparates them, and which is ſituated between the four clinoid proceſſes, is more elevated than the middle foſſæ, and is denominated *ſella turcica*, or *ſella ſphenoidalis*.

B. *In other Mammiferous Animals.*

The three large foſſæ of the cranium exiſt in the inferior mammalia; but they are leſs deep, and the eminences which ſeparate them are effaced in proportion as the animal is removed from man. Even in the *jocko*, we begin to obſerve, that the cerebellous foſſa is nearly on a level with the middle foſſa; that the ſella turcica is leſs marked, and that the ridge of the ſmall

wings

wings is lefs eminent. The cribriform lamella of the os ethmoides is more depreffed, and has no creft.

The *mandrils*, the *magots*, and different fpecies of *guenons*, differ from the jocko, only in having their pofterior foffa narrower, and not fo deep; while their os petrofum extends directly backward, and the occipital furface of their cranium is more elevated. The frontal foffa has two lateral convexities, which are more globular, particularly in the *guenons*.

In the *fapajous*, the orbitar wings of the os fphenoides have no ridge. Inftead of the anterior foffa, there is only a convexity: the intermediate foffæ are as deep as the pofterior. The fella turcica is nearly on a level with them, and the cribriform lamella is fituated in a narrow depreffion.

In the *alouates*, the pofterior and the intermediate foffæ, and the fella turcica, form only one plane, from which the two offa petrofa, and the four clinoid proceffes, arife. Inftead of the anterior foffa, there is an oblique furface, the middle of which is depreffed, and leads to a very fmall cribriform lamella.

The fame level exifts in the different parts of the bafe of the cranium in all the Sarcophaga, in which the anterior foffa is feldom diftinguifhed from the intermediate foffæ, but forms merely a fhort and broad canal, terminated anteriorly by a very large cribriform lamella. It muft be obferved,

 however,

however, that, in the *bear*, the middle foſſæ are ſeparated from the anterior foſſa by a ridge attached to the ſide of the cranium, and belonging partly to the os frontis, and partly to the os parietale. In the *ſeal*, on the contrary, there is no anterior foſſa, properly ſo called, as the front of the cranium riſes perpendicularly like a wall, and has the cribriform lamella in its ſuperior part. The ſuperior foſſa is more conſpicuous in the *morſe*. With reſpect to all theſe animals, it will be eaſily conceived, that, in proportion as the cerebellous foſſa is flattened, and the foramen magnum is directed backward and upward, the baſilar foſſa muſt be elongated. At the ſame time the poſterior boundary of the cerebellous foſſa will aſcend, and terminate by forming a girdle, dividing the cranium vertically, and ſituated before the cerebellum. In the greater part of the Sarcophaga, the cerebellous foſſa is formed by a broad and thin projecting lamina, which continues over the oſſa petroſa, and ſeems to form a particular cavity for the cerebellum. The Sarcophaga have no ſella turcica, properly ſo called, and their clinoid proceſſes are very ſmall.

The baſe of the cranium is very level in the Rodentia. There is no diſtinction between the anterior and the middle foſſæ. The ridge of the pars petroſa is obtuſe. Only a few ſpecies, as the *hares* and the *agoutis*, have the clinoid proceſſes. The place which correſponds with the ſituation of the ſella turcica is even depreſſed in the *cavy*.

There is alſo very little difference as to level in the foſſæ of the cranium of the Edentata. Their cribriform lamella is ſituated in a depreſſion diſtinguiſhed by a vertical ridge. The limit between the middle and poſterior foſſæ is not very apparent in the *ſloths*, the *armadillos*, and the *ant-eaters*; but in the *pangolin* it is a large vertical ſeptum, perforated by an oval hole in the middle.

The three foſſæ are very diſtinct in the *elephant*. The middle is the moſt depreſſed; they are ſeparated by blunt elevations: the cribriform lamella occupies almoſt the whole of the bottom of the anterior foſſa, becauſe the noſe of this animal is ſituated under the cranium, as in Man, and not before it, as in the Sarcophaga, the Rodentia, &c. The ſella turcica is not very much elevated. The clinoid proceſſes are ſhort, particularly the poſterior.

The anterior and the middle foſſæ are not diſtinguiſhed from each other in the *rhinoceros*. The poſterior foſſa is deeper than the others, and is ſeparated from the middle foſſæ by an acute elevated ridge, which is ſituated before them, but is not attached to the pars petroſa. The part which correſponds to the ſella turcica is conſiderably more depreſſed than the middle foſſa, inſtead of being elevated, as in man. The part anſwering to the poſterior clinoid proceſſes is not

 attached,

attached, as in other animals, to the base of the cranium, but extends like a bridge from the one middle fossa to the other; while the sella turcica, which, as we have observed, is lower than these fossæ, communicates under this bridge with the cuneiform process of the os occipitis.

The three fossæ, and the sella turcica, are on the same level in the *hippopotamus*, and cannot be distinguished from each other, except by a projecting lamina, which corresponds to the posterior clinoid processes. The ossa petrosa, the figure of which is very irregular, project into the cranium, but they form no regular partitions. It is the same with respect to the *tapir*; but, in the *hog*, the posterior fossa is lower than the others, and is distinguished from them, as in the *rhinoceros*, by an elevation situated before the ossa petrosa. The posterior clinoid processes are attached to the bottom of the cranium; the anterior processes do not exist, and the part which corresponds to the sella turcica is depressed and very broad. The anterior fossa is distinguished from the middle, merely by a little more elevation, and a slight convexity. All these Pachydermata have the cribriform lamella of the os ethmoides very broad, much depressed, and divided into two parts by a very thick crest.

In the Ruminantia the middle fossæ are scarcely perceptible from the anterior. The sella turcica

cica is very broad, and confiderably lower than the middle foffæ, between which it is fituated. It continues on the fame level with the pofterior foffæ, without any diftinctive mark, except a fmall lamella, which correfponds to the pofterior clinoid proceffes. The fella turcica of *ftags* and *camels* is lefs depreffed than that of the other genera. The cribriform lamellæ of the os ethmoides are broad, but they are more depreffed, and feparated by a broader creft in the *camel* than in the other genera. In the *chevrotins*, the anterior foffa is proportionally fomewhat more elevated than the middle foffæ.

In the Solipeda the fella turcica is lefs depreffed than in the greater part of the Ruminantia. On each os petrofum there is an elevated ridge, which extends to the fuperior vault of the cranium, as in the Sarcophaga.

In the Cetacea the cerebellous foffa is diftinguifhed from the middle foffæ by a lateral partition, but the whole bafe of the cranium is nearly level, and there is neither ethmoidal foffa, nor cribriform lamella. The middle foffæ are much feparated from each other, and a little more elevated than the cerebellous. There are no clinoid proceffes; the line of divifion between the middle and pofterior foffæ is not formed by the os petrofum; that ridge is fituated before it.

C. In

C. *In Birds.*

The cranium of birds is divided into two principal foſſæ, one of which is ſituated above and ſomewhat before the other. The firſt contains the cerebrum, properly ſo called, and conſequently correſponds to the anterior and part of the middle foſſæ of the human ſkull. The ſecond contains the thalami nervorum opticorum, the cerebellum and the medulla oblongata, and correſponds to a part of the middle foſſæ and the cerebellous foſſa of man. The line which ſeparates theſe two foſſæ is ſharp and horizontal on the ſides, but, poſteriorly, it aſcends and forms an arch above the cerebellum. The ſuperior foſſa is ſeparated into two parts, by a ſlight convex eminence, produced by the roof of the orbit; but the inferior foſſa preſents ſeveral remarkable cavities.

In the firſt place, there is, on each ſide, under the ridge which ſeparates it from the firſt foſſa, a round cavity which contains the correſponding thalamus. Between theſe two optic cavities there is another which correſponds to the ſella turcica, and in which we obſerve a particular excavation for the pituitary gland. Theſe three little foſſæ form together a kind of arch, the convexity of which is directed forward. In the concavity of this arch, and before the foramen

men magnum, there is a fourth foſſa, which corresponds to the baſilar foſſa in man, and, like it, ſupports the medulla oblongata.

The inferior foſſa of the cranium of birds, being conſiderably narrower than the ſuperior, the body of its lateral parietes is occupied by the cavities of the internal ear.

The differences which exiſt in birds, with reſpect to the internal foſſæ of their cranium, are very inconſiderable, and conſiſt merely in a greater or leſs degree of depth. In general, we obſerve, that their inequality is leſs in the ſwimming and wading birds; and that, on the contrary, the parrot kind, and birds of prey, have theſe inequalities largeſt.

D. *In Reptiles.*

The general form of the cavity of the cranium of reptiles is oblong, and almoſt of an equal breadth, being merely a little contracted between the ears. The *tortoiſe* has a kind of ſella turcica, the four clinoid proceſſes of which are directed forward. The ſphenoidal foſſa is ſomewhat depreſſed in the *ſerpents*, but it has no clinoid proceſſes. It is a ſemi-lunar depreſſion, the plane of which is ſituated obliquely from before backward.

The baſilar foſſa is lower than the other foſſæ in the *crocodile*, and in ſome *tortoiſes*.

E. *In Fishes.*

We have alſo very little to ſtate with reſpect to the inſide of the cranium of fiſhes. As the cavity of their cranium is not completely filled by the brain, its form does not correſpond with the eminences of that viſcus, and the different depreſſions we obſerve within the cranium are not ſeparated by ſharp ridges. The baſe is almoſt always plain, with the exception of a depreſſion found in ſome ſpecies, and which correſponds by the place it occupies to the baſilar foſſa, but which is deſtined to contain the whole of the brain.

The cranium of oſſeous fiſhes is enlarged between the ears inſtead of being contracted, becauſe theſe organs are contained in the ſame cavity as the brain. The contrary diſpoſition prevails in the Chondropterygii.

Article IV.

Of the Foramina of the Baſe of the Cranium.

A. *In Man.*

The baſe of the cranium is perforated by a great number of holes, which afford paſſages for

nerves

nerves and veſſels. Some communicate with the face, others open into the parts ſituated poſteriorly. The moſt conſiderable of the latter is the *foramen magnum occipitale*, through which the medulla oblongata, and the veſſels that accompany it, paſs. It is ſituated at the bottom of the cerebellous foſſa, immediately below and behind the baſilar foſſa. Its ſhape is oval, its greateſt diameter is between the fore and back part. Under the anterior of each of its lateral edges, we find one of the prominences by which the head is articulated with the vertebral column, and which are called the *occipital condyles*. The body of each of theſe condyles is perforated by a ſmall canal, which is directed from within outward, and a little forward and upward, and through which the nerves of the ninth pair are tranſmitted. This is the *anterior condyloid* foramen, which affords a paſſage to the nervus hypogloſus major. A little more outward and backward, we obſerve another ſmall hole, which is ſometimes wanting; it is directed backward and downward, and ſerves for the paſſage of a ſmall vein. This is called the *poſterior condyloid* foramen.

A little farther forward and outward, there is a large hole formed by the poſterior edge of the os petroſum and the os occipitis. It is called the *foramen lacerum poſterius*. It is ſituated exactly below an impreſſion formed behind the os petroſum by the great lateral ſinus. A groove, made by the inferior petrous ſinus, alſo joins

this

this hole, and it is indeed by it that all the blood of the brain defcends into the jugular vein. This hole, at the fame time, affords a paffage for the *par vagum*, the *gloffo-pharyngæus*, and the *nervus acceffórius* of the eighth pair. The part which tranfmits the gloffo-pharyngæus is frequently feparated by a fmall offeous lamina.

At the pofterior furface of the os petrofum, a little above the foramen lacerum, we find a conical depreffion directed outward. It penetrates into the interior of the os petrofum, where it terminates in two holes, the inferior of which tranfmits the auditory nerve into the labyrinth of the ear. The other is the orifice of a canal which contains the facial nerve in its paffage through the os petrofum, and which is terminated between the maftoid and ftyloid proceffes by a fmall hole called *foramen ftylo-maftoideum*. The depreffion we have defcribed is denominated *meatus auditorius internus*.

The cerebellous foffa alfo exhibits on each fide fmall holes for the paffage of the blood-veffels. One is fituated in its temporal part behind the maftoid procefs; its courfe is very oblique. It correfponds internally with the cavity of the lateral finus.

Another called *aquæductus* Cotunnii, is fituated towards the creft of the os petrofum, above and without the meatus auditorius internus. It admits fome fmall branches of veins.

In

In the middle foſſæ, we remark the following holes:

The *foramen lacerum anterius*, ſituated between the point of the os petroſum and the poſterior angle of the ſella turcica. Its edges are formed by the temporal, the ſphenoid, and the occipital bones. It is cloſed in the freſh ſtate by a cartilaginous ſubſtance. There is another hole at its external ſide, through which the carotid artery enters the cranium, and which is only the opening of a twiſted canal, the orifice of which is in the inferior ſurface of the os petroſum, immediately before the foramen lacerum poſterius. This is called the *canalis carotideus*. It tranſmits, beſides the artery, the great ſympathetic nerve.

In the inferior ſurface of the os petroſum, and before the orifice of the carotid canal, we obſerve the opening of another canal, which communicates with the cavity of the tympanum, and which forms a part of the *Euſtachian* tube, or *guttural conduit* of the ear.

In the ſphenoid bone, a little before the os petroſum, and without the anterior foramen, there is a large hole, called *foramen ovale*, and which is really of an oval ſhape. It gives paſſage to the third branch of the fifth pair of nerves, called *maxillaris inferior*.

A little behind, and without the foramen ovale, there is another hole called *foramen ſpinale*, through which an artery paſſes.

Internally,

Internally, with refpect to the foramen ovale, and very near the pofterior angle of the fella turcica, there is another fmall hole which tranfmits a vein.

Still more forward, but not quite fo near the fella, we find the *foramen rotundum*, which is directed forward, and tranfmits the fecond branch of the fifth pair of nerves, called *maxillaris fuperior*; it is fmaller than the oval foramen.

Under the fharp ridge which feparates the anterior foffa from the middle foffæ, there is a long flit which proceeds from the anterior angle of the fella turcica, and extends obliquely outward and forward. It communicates with the bottom of the orbit, and tranfmits to it the firft branch of the fifth pair of nerves, or *ophthalmicus* of *Willis*, and the whole of the *third*, *fourth*, and *fixth* pairs of nerves of the brain, as well as the *internal orbitar artery*: this is called the *fuperior orbitar fiffure*, or *fpheno-orbitar fiffure*.

The *optic foramina* open into the cranium a little above the anterior edge of the fella turcica, and on the infide of the anterior clinoid proceffes they are directed obliquely outward into the orbit, to which they convey the *optic nerve* and the *central artery* of the retina.

The numerous holes of the cribriform lamella, of which there are about 40, occupy the bottom of the anterior foffa, and afford a paffage for the *olfactory nerves* to the nofe.

Before the crifta galli, and at its union with the

the os frontis, we obſerve a ſmall hole which tranſmits a vein to the noſe. It is called *foramen cæcum*, or *foramen fronto-ethmoidale*.

B. *In other Mammiferous Animals, and in Birds.*

In examining ſucceſſively the variations which exiſt in the mammalia and birds, with reſpect to the principal foramina of the cranium; we ſhall begin with thoſe ſituated anteriorly, and ſhall omit the foramen magnum, which we have already deſcribed in the 3d Lecture, when we treated of the articulation of the head; and the foramina of the cribriform lamella, which will be noticed under the article Smelling.

1. *Optic Foramina.*

a. Thoſe foramina are not ſo far ſeparate in *monkies*, as in man.

In the Sarcophaga, theſe holes and their intervals are ſometimes covered by an oſſeous lamella, directed from before, backward like a roof.

In ſome of the Rodentia, as the *agouti*, they are ſeparated by only a thin vertical lamina, which is altogether wanting in the *hare*. They are however very much ſeparated in the greater number of the genera.

In the *four-toed ant-eater* the optic foramina are very large, and united at their origin ſo as to form a ſmall foſſa on the orbitar portion of the os ſphenoides. In the *armadillo*, and more particularly in the *pangolin*, they are very ſmall. They exhibit no peculiarity in the *ſloth*.

The optic holes of the *elephant* ariſe from a common canal formed upon the body of the os ſphenoides, at the origin of which we obſerve a hole which penetrates that bone. The direction of theſe holes is oblique; they form a very obtuſe angle anteriorly.

They are diſtinct in the *rhinoceros*, and extend almoſt directly forward, and form a canal in the body of the bone, of nearly one decimetre in length.

In the *hippopotamus* theſe holes are very much removed from one another, and they are more oval than round.

Their direction and their reſpective diſtance vary in the Ruminantia. In the *chevrotin*, there is only a ſingle optical hole divided by the vomer.

b. The optic foramina of birds, are ſituated before the ſmall foſſa which is placed between their two optic foſſæ. They are ſeparated only by the ſame vertical lamina which divides their orbits.

The part of this lamina which correſponds to them being ſometimes notched, as in the *cock*, &c. they there appear to form only one hole, when viewed on the inſide of the cranium.

2. *Spheno-*

2. *Spheno-orbitar Fiſſure.*

a. The ſpheno-orbitar fiſſure of *monkies* is very ſhort, and is even reduced to a ſimple oval foramen, except in the *orang outang*, in which it reſembles that of man.

In the Sarcophaga it is always oval, and has the form of a canal.

In the Rodentia there is only one hole internally, which ſupplies the place of both the ſpheno-orbitar fiſſure, and the foramen rotundum.

In the *two-toed ant-eater* the ſpheno-orbitar fiſſure, which is very diſtinct from the optic hole in the inſide of the cranium, is confounded with that hole in the orbitar and temporal foſſa. It is rounded, and before it penetrates the cranium, is indicated by a long furrow or canal in its baſe: the ſame ſtructure prevails in the other *ant-eaters* and *armadillos*, as well as in the *ſloths*; except that in the latter, the fiſſure, inſtead of being rounded within the cranium, has there a triangular form.

In the cranium of the *elephant* this fiſſure is a large hole rounded internally; it proceeds directly downward into the tempero-orbitar foſſa, but before it, we obſerve another hole which is directed horizontally into the body of the bone. Theſe two holes, as well as that of the optic nerve, are covered on the outſide by an oſſeous lamina, which extends from the ſuperior orbitar angle to the moſt poſterior part of the os maxillare ſuperius; ſo that we obſerve no hole in the orbit, but merely this large oſſeous margin.

In the *rhinoceros* the ſpheno-orbitar fiſſure takes the place of the foramen rotundum; it forms a round canal, the internal opening of which is ſituated in the ſphenoidal foſſa, which is very deep. Its external opening is covered by an oſſeous ridge at the bottom of the temporal foſſa.

In the *hippopotamus* this fiſſure is a ſimple round hole, of a large diameter.

In the Ruminantia it is alſo a hole, rounded inferiorly, but truncated and angular ſuperiorly.

In the Solipeda it is interſected throughout its whole length, by an elevated oſſeous line, which divides it into two diſtinct holes.

b. There is no ſpheno-orbitar fiſſure in birds, but its place is ſupplied by four diſtinct holes; one is ſituated above the optic hole, for the nerve of the fourth pair; two behind, very near each other, for that of the third pair; and the ophthalmic branch, of the fifth pair. Laſtly, one under the baſe of the cranium anteriorly, which correſponds on the inſide to the baſilar foſſa, and which ſerves for a paſſage to the nerve of the ſixth pair.

3. *Foramen Rotundum.*

a. The foramen rotundum of the *monkey* is marked,

marked, for a confiderable length, before it leaves the cranium, by a furrow on the internal furface of the os fphenoides, near the fella turcica.

In the Sarcophaga it is rather oval than round, and very large.

In the Rodentia it is frequently confounded with the fpheno-orbitar fiffure, as in the *porcupine*, the *cavy*, and the *marmot*.

In the Edentata the round hole is always diftinct, and forms a canal of different lengths, according to the genus, within the bone.

In the *elephant* the round foramen is confounded with the fpheno-orbitar fiffure. The fame difpofition prevails in the *rhinoceros* and the *hippopotamus*; in the Ruminantia and the Solipeda.

b. There is only one hole in birds which occupies the place of the round and oval foramina of man; it exifts in the line which feparates the optic from the bafilar foffa.

4. *Foramen Ovale.*

In *monkies* this hole does not perforate the os fphenoides only, but is included between that bone and the os petrofum.

In the Sarcophaga it exifts entirely in the os fphenoides. In feveral genera, as *bears*, *cats*, and the *civet*, the external edge of this hole is protected by an offeous lamina, which extends along it to the fpheno-orbitar fiffure.

In the *feal*, the *bear*, the *badger*, and the *rouffet*, this hole is wanting, or rather it unites with the foramen rotundum.

Amongft the Rodentia, the *marmot*, the *agouti*, and the *fquirrel*, have a diftinct oval foramen; but in the *cavy*, and the *porcupine*, it is confounded with the anterior foramen lacerum.

In the *ten-banded armadillo*, and the *four-toed ant-eater*, the oval hole does not exift, or is confounded either with the foramina lacera, which are united, or with the foramen rotundum, which is very large, and of an oblong form.

The foramen ovale is very diftinct in the *floth*.

In the *elephant*, it is confounded with the anterior foramen lacerum, which is very large. It is the fame with refpect to the *hippopotamus*.

In the Ruminantia, animals which have no anterior foramen lacerum, the ovale foramen is very large.

It does not exift in the Solipeda.

5. *Foramen Lacerum Anterius.*

a. This hole is wanting in *monkies*, and the Sarcophaga. In feveral of the Rodentia, as the *cavy*, the *porcupine*, and the *marmot*, it is very large: we obferve it alfo in the *agouti* and the *hare*, but it is not found in the *fquirrel*.

In the *pangolin* and the *floths*, this hole is very fmall.

ſmall. It is confounded with the poſterior foramen lacerum in the *armadillo*.

It is very large, in proportion to the others, in the *elephant*, and very diſtinct from the carotid canal.

In the *hippopotamus* it is confounded with the poſterior foramen lacerum.

It does not exiſt in the Ruminantia.

In the Solipeda it is confounded with the poſterior foramen.

b. Birds have no anterior foramen lacerum.

6. *Canalis Carotideus.*

This canal is ſimilar in *monkies*, and in *man*; but it is much ſhorter, and leſs tortuous, in the Sarcophaga.

It does not exiſt in the Rodentia, and the artery paſſes immediately through the anterior foramen lacerum.

In the *elephant*, it perforates the body of the os petroſum, and terminates at the internal extremity of its anterior angle.

In the *hippopotamus* it is confounded with the foramina lacera.

The ſame thing takes place in birds.

7. *Foramen Lacerum Poſterius.*

a. This foramen exhibits no peculiarity either in *monkies* or the Sarcophaga. It is ſmall in

 moſt

moſt of the Rodentia; it forms a very round hole in the *pangolin*, and the *ſloth*; but the anterior condyloid foramen is very remarkable in theſe animals, as it is exceedingly large, and ſituated before the condyle.

In the *elephant*, the poſterior foramen lacerum is oval, and very great. This animal has no anterior condyloid foramen.

In the *rhinoceros*, the anterior and poſterior foramina lacera are confounded in one large fiſſure, which ſurrounds the os petroſum. The anterior condyloid hole is very diſtinct, and very large: there are even ſometimes two foramina on the ſame ſide, which unite and form one.

With reſpect to the Ruminantia, the poſterior foramen lacerum, in the *ſtag*, is a very narrow fiſſure poſteriorly, and round anteriorly; in the *camel* it is contracted before, and circular poſteriorly.

b. This foramen, in birds, is a ſmall round hole, ſituated under and within the external aperture of the ear.

8. *Meatus Auditorius Internus.*

a In the *monkies* above, and without the meatus auditorius internus, there is another larger depreſſion, which receives a projection of the cerebellum; the bottom of this depreſſion is not perforated. It is wanting in the *orang-outang* and *jocko*.

This

This depreſſion is even deeper in the Sarcophaga than in *monkies*.

The meatus auditorius internus of the *elephant*, is covered by a large oſſeous ridge of the os petroſum, at the point of which it is ſituated.

In the *rhinoceros*, it is ſmall, oval, and ſituated in the middle of the petroſe bone. Its greateſt diameter extends from before backward.

In the *hippopotamus*, the meatus is ſituated in the middle of the os petroſum. Its diameter is very large, and its edges form a kind of oſſeous canopy.

It preſents no remarkable peculiarity in the Ruminantia. It is ſituated in the centre of the os petroſum. Its place is the ſame in the Solipeda.

b. The meatus auditorius internus of birds, is in general pretty conſiderable.

C. *In Reptiles and Fiſhes.*

The interior part of the cranium is frequently not cloſed by oſſification in reptiles and fiſhes, and the olfactory nerves paſs through a large vacant ſpace, which is not ſub-divided into particular holes. This at leaſt is the caſe with the *camelion*, the *iguana*, *tortoiſes*, the *pike*, the *anarchichas*, &c. In others, the olfactory hole is contracted, but is ſtill ſimple, as in the *crocodile*.

It

It is double in *frogs* and *ſalamanders.* The *rays* and the *ſharks* have alſo two holes, which are conſiderably removed from each other.

The optic holes are likewiſe ſometimes united into one, as in the *crocodile* : thoſe of the *tortoiſe* are much removed from each other, and are diſtinguiſhed from the great hole in the front of the cranium, by only a ſmall boney partition. The ſtructure of the cranium in the *pike* is ſimilar. In the *frogs,* the *rays,* the *anarrhichas,* and it ſhould ſeem, in the greater number of fiſhes, the optic holes are at a great diſtance from each other, and perforate the ſides of the cranium. Theſe animals have no ſpheno-orbitar fiſſure, and the ſmall nerves tranſmitted to the eyes, paſs each through a particular foramen.

There is, in general, only one hole on each ſide for the three branches of the fifth pair of nerves, which, therefore, ſupplies the place of the foramen rotundum, foramen ovale, and in part of the ſpheno-orbitar fiſſure. This hole, however, is divided into three in the *carp.*

The meatus auditorius internus exiſts only in the Reptiles, and the Chondropterygii order of fiſhes. The other fiſhes, having the cavity of the ear united with that of the cranium, want this hole.

Fiſhes have a large foramen for the eight pair of nerves, which is very conſiderable ; and a ſmall hole beſide the foramen magnum, for the ninth

ninth pair. It muſt be remarked, that the veins do not paſs through this hole, as in the Mammalia and birds.

ARTICLE V.

Of the Bones which compoſe the Face.

A. *In Man.*

WE have already obſerved, that the face is that portion of the head which is ſituated under the anterior part of the cranium: its form is chiefly determined by the bones of the upper jaw, or *oſſa maxillaria ſuperiora*; we ſhall commence our deſcription with them.

When the maxillary bones are united, the common baſe repreſents a parabola; it is arched inferiorly, to form the palate, and its circumference contains the alveoli of the teeth. A ſuture, which extends from its anterior part backward, divides it into two ſemi-parabolæ. The body of the bones has the ſame curvature, as it ariſes from this baſe; but it ſoon enlarges towards the ſides, and becomes flattened anteriorly. Its ſuperior part, a proportion of which ſerves for the lower ſurface of the orbit, is plain, almoſt triangular, and inclined forward and outward. The internal edges of the ſuperior ſurfaces

faces of thefe two bones, do not come in contact like thofe of their bafe: on the contrary, they are very much removed from each other by the nafal foffa, which penetrates the face horizontally from before, backward, between the two offa maxillaria, and to which the arch of the palate ferves as a bafe. The external angle of the fuperior furface of each jaw-bone is inclined ftill more outward than the other parts; this gives to the lateral enlargement of thefe bones a fharp figure: to this external prominence, which is called the malar procefs, is articulated the cheek bone (*os malæ*, or *os jugale*), one of the bones by which the face is joined to the cranium.

From the internal and anterior angle of this orbitar furface of the os maxillare, as well as from the anterior edge of the body of the bone, there arifes another apophyfis, called the afcending or nafal procefs, which forms the internal margin of the orbit, and articulates with a correfponding procefs of the os frontis. Between the nafal proceffes of the two offa maxillaria, we find the two bones of the nofe (*offa quadrata*, or *offa nafi*), which form a kind of roof above the entrance of the nafal foffæ: this is one of the points by which the face is attached to the cranium.

The *os ethmoides* is fituated between the orbitar proceffes of the maxillary bones. We have already obferved, in treating of the cranium, that

that the cribriform lamella of this bone fills up the vacant ſpace of the os frontis, between the two arches of the orbits: there deſcends from each ſide of the cribriform lamella, a thin plain lamina, which joins the internal edge of the ſuperior ſurface of the maxillary bone, and thus forms the internal parietes of the orbit. This lamina was formerly called *os planum*: between it and the naſal proceſs of the os maxillare, there remains a ſmall ſpace, which is occupied by a thin bone, called *os unguis*, or *lacrymale*.

From what has been obſerved, reſpecting the os ethmoides, it will appear, that it may be ſaid to form the ceiling of the naſal foſſa; this ceiling is very irregular; we ſhall deſcribe its different laminæ and ſinuſes when we come to the article Smelling: at preſent we ſhall juſt mention, that there is a vertical lamina extended longitudinally over its middle part, and which, being continued with the *vomer*, by means of a cartilage, divides the cavity of the nares into two portions nearly equal.

This cavity of the nares is extended poſteriorly beyond the oſſa maxillaria; its poſterior limits are partly formed by the os ſphenoides, and partly by the *oſſa palati*.

The os ſphenoides contributes to terminate the cavity of the nares poſteriorly, by the means of two proceſſes, which deſcend almoſt vertically from each ſide of its body, between the foramen rotundum, and foramen ovale; theſe

are

are called the *pterygoid*, or wing-like proceffes; they are divided pofteriorly by a foffa, into two lamina, called the internal and external wings, into which fome mufcles are inferted.

Between the anterior edge of this procefs, and the pofterior edge of the os maxillare fuperius of the fame fide, we find the *os palati*, which is a fmall bone, compofed of two laminæ, or principal parts; one is inferior and horizontal, and is continued with the arch of the palate, of which it forms the pofterior border; the other afcends againft the internal parietes of the nafal foffa, paffes over the os maxillare, and is articulated with the fphenoidal and ethmoidal bones in the bottom of the orbit.

We have thus traced the middle junction of the face with the cranium, by the os frontis, os ethmoides, and os fphenoides. It remains for us to fhew how its lateral connection takes place, for which it is only neceffary to defcribe the os malæ.

This bone, as we have already obferved, is attached to the malar procefs of the os maxillare; its external furface exhibits four edges: 1. That by which it joins the before mentioned procefs, and which forms an oblique future in the front of the face, under the eye: 2. That by which it affifts, with the os frontis, and os maxillare, in completing the anterior frame of the orbit; it is joined in this part to the os frontis, by an afcending procefs, which correfponds to the

the external orbitar procefs of that bone: behind this procefs there is a lamina, which extends a little inward and backward. It unites with the orbitar procefs of the os fphenoides, and in concert with it completes the external parietes of the orbit: Laftly, The other two edges of the malar bone are feparated by a procefs called the *zygomatic*, which is connected with one produced from the os temporum, and with it forms a figure like the handle of a veffel, on each fide of the head, which is named *zygoma*, or the *zygomatic* or *jugal arch*.

The *zygomatic* procefs of the os temporum arifes a little above and before the meatus auditorius externus, by a double elevated ridge, and forms nearly two thirds of the jugal arch; under its bafe is fituated the glenoid cavity, which ferves for the articulation of the lower jaw. We fhall fhortly notice this laft part, to complete our account of the bones which compofe the face; it will, however, be defcribed more in detail when we treat of Mastication.

The curvature of the *maxilla inferior* is nearly the fame as that of the alveolar edge of the offa maxillaria fuperiora. In white men its furface is continued with that of the upper jaw, but in negroes thefe two furfaces form anteriorly an angle of 70°: its lateral parts are more prolonged pofteriorly, and rife towards the zygomatic arch. This afcending branch is nearly fquare; its fuperior edge is deeply notched; the

 condyle,

condyle, which ferves for its articulation, is fituated at the pofterior angle. The anterior angle, which is called the coronoid procefs, is flat and pointed ; it affords an attachment to the mufcles, which affift in maftication.

B. *In other Mammiferous Animals.*

The fhape and fize of the face depend chiefly on the form and extent of the bones of the upper and lower jaw.

Quadrupeds have two bones in the jaws, in addition to thofe of man : they are called *offa inter-maxillaria, offa inciforia,* or *offa labialia,* and are fituated at the extremity of the mouth, between the offa maxillaria: they contain the dentes incifores. This difference, however, between quadrupeds and man, is not in reality of very great importance ; for the future which feparates thefe bones from the maxillary, exifts alfo in the human fœtus, and is obliterated at a very early period, in fome quadrupeds. The fkeleton of the *jocko* of the mufeum, though young, exhibits no trace of this future, but it is very diftinct in that of the *orang-outang.*

The face of *monkies,* in other refpects, does not differ from that of man, as to the manner in which it joins the cranium, nor as to the bones of which it is compofed. The principal difference as to form, is produced by the great elongation

elongation of their offa palati, and offa maxillaria, in proportion to their height; and by the anterior part of thofe bones being inclined more or lefs forward, inftead of being almoft vertical, as in man.

This prolongation of the face varies confiderably in the different fpecies: it may be determined by the angle, which its anterior plane forms with its bafe, or the palate: this angle is more acute in proportion as the face is elongated.

Thefe animals have frequently only one nafal bone, which is very narrow. The *fapajous*, however, have always two: the interval between the orbits is more contracted than in man, and pofteriorly it is reduced to a fimple partition. It is thus in the *guenons*, and in the *fapajous*. But the *orangs*, the *magots*, and the *alouates*, have this interval fufficiently broad to allow the nafal foffæ to afcend into it.

The face of the Sarcophaga is diftinguifhed from that of the Quadrumana; 1ft, In having the afcending proceffes of the offa maxillaria much broader, which removes the orbits towards the fides; 2dly, Becaufe the orbitar furface does not form the inferior, but the anterior parietes of the orbit; 3dly, Becaufe the os malæ neither articulates with the os frontis nor os fphenoides, and only contributes to form the zygomatic arch, and the inferior edge of the orbit; 4thly, Becaufe the orbit is not inclofed either pofteriorly or inferiorly, and communicates freely with the temporal foffa; 5thly, Becaufe the offa palati are much elongated, and form a confiderable portion of the internal parietes of the orbit, to which the os ethmoides contributes nothing.

The fnout alfo differs with refpect to the degree of its elongation; the anterior opening of the nofe is truncated more or lefs obliquely at the extremity.

The os lachrymale advances a little upon the cheek in fome fpecies, as the *flying lemur*.

The feparation of the orbits is ftill larger in the Rodentia than in the Sarcophaga; their inter-maxillary bones, which are immenfe, in confequence of the magnitude of their incifive teeth, throw the offa maxillaria very far back: the latter form a great part of the internal parietes of the orbit, in which the palate bones occupy only a fmall fpace. The anterior parietes are formed by a procefs of the os maxillare, which affifts in compofing the zygomatic arch, fo that the cheek-bone is fufpended in the middle of that arch between the maxillary and temporal proceffes; it neither joins the os frontis nor the os fphenoides. The elongation of the bones of the nofe is fuch, that the aperture is always fituated at the extremity of the fnout.

The face of the *elephant* has the greateft refemblance to that of the Rodentia; the magnitude of the inter-maxillary bones, the pofition

of

of the offa maxillaria, and offa malarum, and the connections of the latter are fimilar. The height of the alveoli of the tufks elevates, however, the fituation of the nofe, and fhortens its bones. This circumftance completely changes the phyfiognomy of the head.

The face of the *floths* is very fhort fuperiorly, in proportion to the cranium: the offa maxillaria extend to the internal furface of the orbits: the os malæ is attached to the os maxillare only; it does not join the zygomatic procefs of the os temporum, and there is a vacant interval between thefe two bones: the offa malarum have a long defcending procefs. Though thefe animals want the incifive teeth, they have two very fmall offa inter-maxillaria, which form the inferior margin of the aperture of the noftrils.

In the long-nofed Edentata the face has a conical form; the maxillary bones do not extend to the orbit; the os lachrymale, being very large, feparates them from it; and the os palati, which is very long, forms alone the lower part of the internal parietes of that foffa. The pterygoid proceffes are fupplied by two laminæ, which are continued with the offa palati, and which, joining each other inferiorly, prolong the canal of the nares to the foramen magnum. The zygomatic arch is not entirely offified in the *ant-eaters* and *pangolins*, but it is completed in the *oryćteropus*, or *cape ant-eater*, and in the *armadillos*. The fituation of the os malæ of these animals is almost the same as in the Rodentia.

The form and disposition of the bones of the face in *hogs*, are nearly the same as in the Sarcophaga, except that the ossa lachrymalia advance farther upon the cheek. In the *tapir*, the os maxillare is directed backward under the orbit, to which it furnishes a kind of horizontal floor. The bones of the nose do not form an arch, which, with the ossa maxillaria, would inclose the nasal cavity, but only furnish to it a kind of projecting roof, which supports the superior part of the proboscis.

The os maxillare of the *rhinoceros* passes under the orbit, as in the tapir; the ossa nasi do not form a continued canal with the maxillary bones, but a kind of suspended arch, which is very thick, and which supports the horn: when there are two horns, the posterior one is supported by the os frontis. The inter-maxillary bone is very small.

The disposition of the ossa nasi is the same in the *hippopotamus* as in the hog; the inter-maxillary bones are very large; the jaw-bones do not form the lower part of the orbits; their anterior portion, which contains the tusks, is directed considerably outward. This circumstance produces that great breadth of the muzzle observed in the hippopotamus. The os malæ has a post-orbitar process, which nearly joins that of the os frontis; but it does not unite to the

os-

os ſphenoides, and the orbit is not ſeparated from the temporal foſſa poſteriorly, though its frame is almoſt complete.

The *daman* (*hyrax*), which ſhould be claſſed with the Pachydermata, and not with the Rodentia, to which order it has hitherto been referred, reſembles the hog in the diſpoſition of the bones of the face: it is only proportionally ſhorter, and the maxillary bone paſſes under the orbit, ſo as to form its inferior parietes, as in the tapir.

The face of the Ruminantia has much reſemblance to that of the hog; the inter-maxillary bones are prolonged farther forward, and are not furniſhed with teeth, except in the camel; the oſſa maxillaria form a ſmall part of the floor of the orbit. The os lachrymale is extended conſiderably forward on the cheek, where it is perforated in different ways, and moſt remarkably in the *deer*. The poſt-orbitar proceſs of the os malæ unites by a future to a like proceſs of the os frontis, and thus completes the frame of the orbit; but as it does not touch the os ſphenoides, there remains a large communication poſteriorly, between the orbit and the temporal foſſa.

The face of the Solipeda differs little from that of the Ruminantia, except that it is not joined to the os frontis by an aſcending proceſs of the os malæ; on the contrary, a proceſs deſcends from the os frontis, and joins the body of the os malæ, behind the orbit.

The orbits are always widely ſeparate from each other in the Ruminantia and Solipeda.

The magnitude of the alveoli of the dentes canini greatly enlarge the os maxillare of the *morſe*, and give a ſwollen appearance to the anterior part of the muzzle, but the connection of the bones is nearly the ſame as in the Sarcophaga.

In the *lamantin*, the oſſa maxillaria are not much elevated; they form a baſe to the orbit, and afterwards extend to a conſiderable diſtance behind it. That foſſa being much advanced, a proceſs of the os frontis, which is extended forward and outward, forms the roof of the orbit, and contributes to incloſe the anterior aperture of the naſal foſſa, which is very large, and has its plane directed upward. The inter-maxillary bones are very extenſive, although the inciſive teeth are wanting.

In the Cetacea, the maxillary and inter-maxillary bones are prolonged into a kind of flattened beak, which they divide into four parallel bands, the oſſa inter-maxillaria forming the two middle, and the maxillaria the two external bands. The latter only contain the teeth in thoſe genera which are furniſhed with them. The naſal foſſa is perforated vertically in the anterior part of the cranium; the inter-maxillary bones aſcend to it, and incloſe it anteriorly and on the ſides. The oſſa maxillaria alſo aſcend ſo as to cover all the part of the os frontis, which

which forms the arch of the orbit, but they do not enter into that cavity. The oſſa naſi are two ſmall tubercles implanted in the os frontis above the aperture of the nares. The os malæ has a ſtyloid form, and is ſuſpended by cartilages below the orbit. The frame of this foſſa is completed poſteriorly by a proceſs of the os frontis, which deſcends to join the zygomatic proceſs of the os temporum, but the orbitar and temporal foſſæ communicate with each other below that proceſs.

C. *In Birds.*

We have already ſhewn that the os frontis of birds is prolonged above the orbits in a plate more or leſs thick, more or leſs narrow, and more or leſs notched, under which is ſituated vertically the ſeptum, which ſeparates theſe two foſſæ, and which adheres by its ſuperior edge to the os frontis, and by its poſterior to the os ſphenoides. The inferior and anterior edges of this ſeptum are free from adheſion, but they articulate with the bone of the bill, as we ſhall hereafter explain.

The os lachrymale, or os unguis, is articulated to the external and anterior angle of the os frontis. It has two principal proceſſes: one extends from above downward, and forms the anterior margin of the orbit; the other is directed from before backward, and forms the superciliary ridge. The laft procefs is moft remarkable in the diurnal birds of prey, in which it is prolonged by an epiphyfis, in the form of a plate, and produces a confiderable projection above the eye.

In the *oftrich* there is a feries of fmall bones, which continues this arch to the fuperior edge of the orbit, leaving a vacancy between it and the os frontis. This procefs is very fhort, or is even altogether wanting in the *owls*, the *parrots*, the grallæ, and the web-footed birds.

The defcending procefs of the os lachrymale is moft confiderable in the *parrots*; it extends backward to form the inferior margin of the orbit, which is complete in this genus only.

Next to the *parrots* the *ducks* have this procefs the longeft, and the frame of their orbit is almoft complete.

The remainder of the face of birds is formed by the bone of the upper mandible, which, in them, reprefents the offa maxillaria, inter-maxillaria, nafi and palati of the mammalia; we even fometimes obferve futures correfponding to thofe which feparate thefe bones in mammiferous animals.

The form of the bone of the mandible is commonly that of the bill itfelf, to which it ferves as the mould or nucleus. It reprefents more or lefs accurately the half of a cone or pyramid; the convex furface of which is outward

ward and upward, and the plain or concave ſurface of which ſupplies the place of the palate. We ſhall not here deſcribe the forms and curvatures of different bills. That is one of the objects of natural hiſtory; and beſides we ſhall have occaſion to return to it when we treat of maſtication.

The baſe of the convex ſurface of the mandibula is united to the anterior extremity of the os frontis, ſometimes by a moveable articulation; and ſometimes their parts are ſoldered together, but always in ſuch a manner as may admit ſome degree of motion, as the oſſeous lamina at this place is more or leſs elaſtic.

The baſe of the palatine ſurface of the bill is divided into four branches, which extend backward as they diverge, and which are ſometimes articulated, and ſometimes intimately united with the bone of the mandible. The two external branches correſpond to the zygomatic arches; they are generally thin, and articulate poſteriorly to a ſmall bone peculiar to birds, called *os quadratum*, which moves upon the temporal bone before the ear. The two intermediate arches correſpond to the pterygoid proceſſes of mammiferous animals. They are almoſt parallel, are ſituated under the ſeptum of the orbits, and are not above half the length of the zygomatic arches; but there is a ſmall ſlender bone at their poſterior extremity, which alſo joins with the os quadratum. We ſhall deſcribe in detail all theſe parts, and the variations they

undergo,

undergo, when we come to the article of Maſtication, as it is on them the mobility of the ſuperior mandible of birds depends. The inferior mandible is articulated to the os quadratum.

D. *In Reptiles.*

In the *crocodile* the face reſembles one half of a cone irregularly flattened on its convex ſurface. It is chiefly formed by two oſſa maxillaria, and two oſſa naſi, which are ſituated almoſt parallel to each other, and two oſſa inter-maxillaria, which form the end of the muzzle, and ſurround the aperture of the noſe like a ring.

The bones analogous to the lachrymalia are four in number, two on each ſide. The os malæ, which is very large, after forming the inferior, and affording a ſmall proceſs to the poſterior edge of the orbit, extends directly backward to join the great maſtoid protuberance: thus the temporal foſſa has no communication outwardly, except by a hole which is ſmaller than the orbit, and the greater part of which is covered by theſe bones, as by an arch.

The naſal foſſæ are continued in a long and narrow tube under the foramen magnum. They perforate the oſſa palati, and a particular bone which is analogous to the pterygoid proceſſes of the os ſphenoides. This bone is ſituated almoſt preciſely under the cranium, and is enlarged on each

each ſide until it forms a kind of ſquare and almoſt horizontal wing. An oſſeous branch unites it laterally to the os maxillare and os malæ, in ſuch a manner that a large hole is left on each ſide of the arch of the palate.

In the *camelion* the face is concave ſuperiorly, and bordered by a ſerrated ridge throughout the whole of its circumference. We obſerve two holes which communicate with the orbits, and two other oval foramina, which correſpond to the inciſive holes in the palatine ſurface. The bones which compoſe the face are nearly the ſame as thoſe of the crocodile. The other lizards exhibit ſtill leſs difference.

The *frog* and the *ſalamander* have the naſal and inter-maxillary bones very ſhort, and broader than long, which renders their face round anteriorly. The os maxillare is very narrow, and is ſcarcely contracted in forming the zygomatic arch. The orbits are large, but have no inferior ſurface, and therefore communicate with the palatine foſſa. The oſſa palati form the anterior edge of the orbitar foſſa inferiorly. They reſemble portions of a circle. They are furniſhed with pointed teeth on their circumference. The canal of the nares is very ſhort in the *ſalamander*. There is only a ſimple hole in the *frog*.

The face of the *Surinam toad* is very flat, but the bones are the ſame as in the frog. The orbitar

bitar foſſæ are oval, and no aperture ſimilar to the canal of the nares can be diſtinguiſhed.

The face of *ſerpents* is rounded nearly in the ſame manner as that of the lizards. Between the os frontis and os parietale, there is a particular bone which terminates the frame of the orbit poſteriorly. Theſe animals have no os malæ. We can, however, eaſily diſtinguiſh two oſſa naſi, two oſſa maxillaria ſuperiora, two oſſa inter-maxillaria, and ſome bones analogous to the palatine arches of birds, which are furniſhed with teeth, and which are articulated to the bone which ſupplies the place of the os quadratum, with reſpect to the lower jaw. Two particular bones unites theſe arches to the maxillaria ſuperiora.

In thoſe that have teeth or poiſonous hooks, as the *viper*, the *rattleſnake*, &c. there are beſides two ſmall peculiar bones, articulated and moveable, which ſupport thoſe teeth. They are ſituated upon the inter-maxillary bones and the anterior extremity of the oſſeous branch which joins the ſuperior maxillary bone to the arch of the palate.

The face of the *tortoiſe* is circular before, and rounded on every ſide. It is compoſed of nearly the ſame bones as that of the crocodile. The inter-maxillary bones are, at a very early period, conſolidated with thoſe of the upper jaw. The bones analogous to the os malæ are three in number;

number; one articulates with the os temporum and with the two others; it is ſituated poſteriorly, and forms the zygomatic arch. The other two portions are received on its anterior extremity; one extends upwards, and unites with the orbitar angle of the os frontis; the other is directed downward, and articulates with the poſterior and external proceſs of the os maxillare ſuperius.

The oſſa palati are broad, and form the poſterior arch of the naſal foſſæ.

The bones of the face of tortoiſes commonly cover each other at their edges, which are refined into thin laminæ. It is therefore very difficult to diſtinguiſh the ſutures.

In the *ſea tortoiſes* the temporal foſſæ, which are very deep, are covered by an oſſeous lamina, which forms a very ſolid arch above them.

E. *In Fiſhes.*

Fiſhes, like birds, have commonly a ſeptum or vertical lamina between the orbits, which proceeds from the baſe of the cranium. This lamina is very remarkable in the *anarrhichas*, which has it entirely oſſeous. In the greater number of other fiſhes it is membraneous, and ſupported inferiorly by an oſſeous canaliculated ſtalk, which is directed towards the end of the mouth, where it is enlarged, and to which it is oſſified. This bone

bone reſembles the vomer. It is greatly elongated in the *whiting*, the *turbot*, &c.

The oſſa palati, which are ſmall, receive the anterior extremity of the vomer. They are furniſhed with teeth in a great number of fiſhes. The form and diſpoſition of theſe teeth vary conſiderably, as will appear when we treat of Maſtication.

Two bones, and even ſometimes four, proceed from the anterior and ſuperior parts of the cranium to the anterior extremity of the vomer. They repreſent the oſſa naſi. They cover the olfactory nerves; a ſmall interval is left between them in the *ſilurus galeatus*.

As in birds, there is on each ſide of the cranium a large moveable bone, to which the lower jaw and the arches of the palate are attached, but in fiſhes it alſo ſupports the operculum of the branchiæ. It is not ſquare as in birds; it is elongated, flattened, and bent lengthways, ſo as to preſent its concave edge anteriorly, and its convex edge poſteriorly towards the branchiæ. This bone is exceeding large in the *pleuronectes*. It has ſome acceſſary laminæ in the *perch*, the *pike*, and a number of other fiſhes.

The arches of the palate appear to form part of the oſſa maxillaria ſuperiora. They are articulated to the bones which ſupport the lower jaw; they are frequently flattened, and project from the lateral parts of the mouth, as in the

dory,

dory, the *whiting*, the *herring*, &c.: they are cylindrical towards the middle, flat pofteriorly, furnifhed with teeth in the front, and fituated in the centre of the mouth, in the *fea-wolf*, or *anarrhichas*.

The zygomatic arches are fituated obliquely; they defcend from before backward, between the extremity of the fnout, behind the inter-maxillary bones, and the middle or pofterior portion of the lower jaw; their pofterior extremity frequently does not extend to the bone analogous to the os quadratum of birds: when this is the cafe, it remains free in the flefh, as in the *herring*, the *pike*, the *perch*, the *fea-dragon*, and fome *pleuronectes*, as the *plaice* and the *fole*. Thefe zygomatic arches never extend to the teeth.

Two bones, commonly furnifhed with teeth, are fituated before the anterior extremities of the arches; they may be regarded as inter-maxillary bones; they form the anterior part of the fnout; they are very large and folid in the *anarrhichas*; narrow, and much elongated pofteriorly, in the *whiting*, the *perch*, and the *fea-dragon*; fhort, triangular, and flat in the *pike*, and the *chætodons*; that on the fide, which does not contain the eyes, is confiderably more developed in the *pleuronectes*.

Befides the anterior and pofterior orbitar proceffes which form the anterior part of the cranium, there is a bone, or rather a feries of fmall bones, ſituated under the orbit, which completes the frame of that cavity; theſe bones appear analogous to the os lachrymale: they are wanting in the falſe orbit which we obſerve on one ſide of the head of the *pleuronectes*.

The face of the Chondropterygii, though ſimilar in its compoſition to that of other fiſhes, differs from them with reſpect to its connection, as it is articulated with the cranium only, by the means of the bone analogous to the os quadratum of birds.

Article VI.

Of the Foſſæ of the Face.

A. *In Man.*

A front view of the face exhibits three principal foſſæ; the noſe and the two orbits.

The anterior aperture of the noſe is oval, and notched in the middle by a ſmall ſpine; it is bounded by four bones, the two ſuperior maxillary, and the two naſal. The interior of this foſſa will be deſcribed more in detail when we come to the article Smelling.

The orbits are two foſſæ, the margin of which is irregularly rounded, and almoſt rhomboidal; they are contracted into the form of a funnel; the

the edges of their aperture are nearly in the ſame plane. Three bones contribute to the formation of theſe edges, the os frontis, the os maxillare, and the os malæ. Seven bones form their parietes, viz. the frontal, ethmoid, lachrymal, palatine, maxillary, malar, and ſphenoid: their internal, external, and inferior parietes are almoſt plain; the ſuperior is concave, the internal or naſal parietes of the two orbits are parallel to each other; the internal ſide forms, with the external, an angle of about 45°; and the axes of the two orbits form an angle of ſimilar magnitude.

On viewing the face laterally, there appears a large depreſſion, ſituated behind the orbit. It is called the temporal foſſa; a conſiderable portion of it is impreſſed on the cranium. The zygomatic arch extends like a bridge over this foſſa, which becomes deeper as it deſcends before—it is moſt hollowed at the poſterior ſurface of the ſuperior maxillary bone, and the adjacent portion of the os ſphenoides. The part which is oppoſite to the zygoma is called the zygomatic foſſa; ſome muſcles are lodged in it. When the face is viewed inferiorly, this foſſa is alſo ſeen.

In this laſt view of the face, we alſo perceive the palatine foſſa, or arch of the palate, encircled on the front, and on the ſides, by the teeth:—the poſterior extremity of the naſal foſſæ, and at their ſide the *pterygoid foſſæ*, ſituated between the two proceſſes of that name, which belong to the os ſphenoides.—Laſtly, all the ſpace included between the foramen magnum, and the poſterior margin of the palate, which is called the *guttural foſſa.*

B. *In other Animals.*

We ſhall proceed to conſider each foſſa of the face ſeparately, in all the claſſes of animals.

1. *Naſal Foſſæ.*

a. The anterior aperture of the naſal foſſa in the *jocko,* is, as in man, broadeſt inferiorly.

In the *orang-outang,* the *ſapajous,* the *alouates,* and ſome *guenons,* it is oval, and is broadeſt in its middle part. In other guenons, as the *Chineſe monkey,* &c. in the *Barbary ape,* and the *mandrils,* it is broadeſt towards the upper part. In all theſe animals this aperture is flattened down upon the face, and ſurrounded by four bones only, viz. the oſſa naſi, and the oſſa inter-maxillaria.

In the Sarcophaga, this aperture approaches nearer to the end of the ſnout; its form is nearly round, but broadeſt towards the upper part; it is inclined more backward in the *ſeal,* than in the other genera.

In the Rodentia, it cuts the end of the muz-

zle

zle vertically; its form is that of a heart, with the broadeſt ſide uppermoſt.

This form is nearly ſimilar in the Edentata. In the *ſloths*, however, the aperture of the noſtrils is ſurrounded by ſix bones, viz. the inter-maxillary, maxillary, and the naſal. In the *ant-eaters*, this foſſa is extended towards the foramen magnum.

The naſal foſſæ of the *elephant* open at nearly an equal diſtance between the ſummit of the head, and the edge of the alveoli; their breadth conſiderably exceeds their height, and their form reſembles that of two ovals joined together.

In the Pachydermata the oſſa naſi of the *hog* form a pointed projection over the aperture of the naſal foſſæ. Between their point, and the correſponding part of the oſſa inter-maxillaria, there are two ſmall peculiar bones, which ſerve to ſtrengthen the ſnout, called *the bones of the ſnout*. In the *rhinoceros*, and particularly in the *tapir*, the aperture of the nares is conſiderably longer; the oſſa naſi advance upon it beyond its anterior extremity in the rhinoceros, but only one third of its length in the tapir: in both it is ſurrounded by ſix bones. In the *hippopotamus* the aperture of the noſe is very broad, and ſituated vertically at the end of the muzzle.

In the Ruminantia this aperture is very large, and inclined backward. The oſſa naſi form only a ſhort ſerrated projection in the *ox*, the *deer*, the *camel*, and the *muſk*. The projection is

 pointed

pointed in the *antelopes*, the *ſheep*, and the *goats*.

In the *morſe* this projection is long and pointed.

The *morſe* has a ſmall round aperture in the middle of the end of his thick ſnout; the *dugon* and the *lamantin* have a large oval aperture directed upward; their oſſa naſi are very ſmall.

In the Cetacea the aperture of the nares is directed upward, or even backward; it is more broad than long, and ſurrounded by ſix bones; the oſſa naſi are ſmall tubercles.

b. The naſal foſſæ of birds do not form a canal paſſing from before backward, but merely a cavity which occupies the thickeſt part of the baſe of the bill, and which opens upward by two nares, and downward by a fiſſure, leaving between them the two palatine arches: it is not ſeparated from the orbit poſteriorly by an oſſeous lamina, but by a membrane.

The external aperture of the nares is formed in the baſe of the convex ſurface of the bill. Its figure and magnitude, which vary conſiderably, ſhall be deſcribed when we treat of the Organ of Smell.

c. The naſal foſſa of *tortoiſes* forms a large ſpace occupying the thick part of the noſe before the eyes; it is very ſhort from before backward; it opens outwardly by a large hole almoſt ſquare, the plane of which is a little inclined, and poſteriorly by two round holes, which correſpond nearly to the middle of the palate; its anterior aperture is ſurrounded by ſix bones.

In the *crocodile* the naſal foſſa is a long narrow canal, which extends from the end of the ſnout to below the occiput; its anterior aperture is directed upward; it is ſurrounded by the two oſſa inter-maxillaria only.

The nares in other *lizards* open nearly in the ſame manner as thoſe in birds, that is to ſay, outwardly upon the noſe, and inwardly on the middle of the palate. In *frogs* they are ſtill ſhorter.

d. The naſal foſſæ of *rays* and *ſharks*, are ſimple cavities formed in the bone, and do not communicate with the mouth; it is the ſame in ſeveral oſſeous fiſhes, ſuch as the *gurnards*; but in moſt of the other fiſhes theſe foſſæ are in part oſſeous, and completed by membranes.

2. *Orbitar Foſſæ.*

a. All the *monkey* tribe have their orbits directed forward, as in man, and the angle formed by their axes is even ſmaller than in the human cranium. The form of theſe cavities, and the bones which ſurround them, exhibit no difference, but the ſhape of their margins vary. In the *jocko* they are ſimilar to thoſe in man. The *orang-outang* and the *ſapajous* have them of an oval form, always higher than broad. In the *guenons*, the ſuperior arch is leſs curvated than the reſt of the margin, which produces a conſpicuous angle on the ſide of the noſe; the breadth of their foſſæ exceeds their heighth: this difference is ſtill greater in the Barbary ape.

The angle formed by the axes of the orbits, enlarges in the other animals, as we have already remarked. The margins of the orbitar foſſæ are nearly round in the Sarcophaga, the Rodentia, the Edentata, and the Pachydermata; but poſteriorly there is always an arch which is not incloſed by the bones; there is alſo no partition between the orbit and the temporal foſſa. In treating of the face, we have already pointed out the differences which prevail in the number and kind of the bones that contribute to form this foſſa.

The Ruminantia and the Solipeda have a round orbit, the margin of which is complete, but it is not ſeparated from the temporal foſſa.

The roof of the orbit of the Cetacea is ſemicircular; their two axes are in the ſame right line: they have no inferior parietes.

b. The orbitar foſſæ of birds are ſimilar to the impreſſions which might be produced by two fingers pinching the cranium in a ſoft ſtate; they have no oſſeous parietes inferiorly: the lamina which ſeparates the orbits is only partially oſſified, and the portion which continues membranous is even very large in ſome birds; but there is nothing uniform in this reſpect.

c. The orbitar foſſæ of reptiles are never ſeparated

parated from the temporal foſſæ, except by an oſſeous branch, which even is not complete in the *lizards* and the *tortoiſes*, and which does not exiſt at all in *frogs*, *ſalamanders*, and *ſerpents*.

The plane of the edges of the orbit is lateral in *tortoiſes*, *ſerpents*, and the *camelion*: it is directed more or leſs upward in the *crocodiles*, *ſalamanders*, and *frogs*.

It varies from a circular to a triangular form.

The inferior parietes is never complete; it is ſometimes entirely wanting; at other times it is perforated by a large hole. The ſame obſervation applies to the ſeptum between the orbits.

d. The orbitar foſſa of fiſhes varies conſiderably with reſpect to its ſhape, its direction, and the compoſition of the bones that form its edges. It is lateral in the greater number, but is directed upward in ſome, as in the *ſtar-gazer*, and ſeveral others. The *pleuronectes* have only one perfect orbitar foſſa. We can, with difficulty, diſcover the ſecond in their ſkeleton; becauſe it is placed on the ſame ſide with the other, and is exceedingly ſmall and deformed.

The inferior margin of the orbitar foſſa is formed, in ſome fiſhes, by a continued piece analogous to the os malæ; and in the others, by a ſeries of ſmall bones, ſuſpended by ligaments articulated to each other. There are frequently five of theſe bones.

There is never any oſſeous ſeparation between the orbits and the temporal and palatine foſſæ.

3. *Temporal Foſſæ.*

a. The extent of the temporal foſſa depends on the magnitude of the ſpace depreſſed on the ſide of the cranium, and of the external convexity of the zygomatic arch; this foſſa is entirely occupied by the temporal muſcle which raiſes the lower jaw. It appears, however, more proper to refer our account of this foſſa to the article on Maſtication.

To the ſame article we ſhall alſo refer the conſideration of the palatine pterygoid, and guttural foſſæ.

ARTICLE VII.

Of the Holes of the Face.

A. *In Man.*

THE orbitar foſſa communicates with the interior of the cranium, by the *optic foramen,* and by the *ſpheno-orbitar fiſſure,* of which we have already treated; it communicates with the deep portion of the temporal foſſa, by the *ſpheno-maxillary* fiſſure, extending between the orbitar proceſs of the os ſphenoides, and the orbit ſurface

ſurface of the os maxillare, which are not united. Part of the fifth pair of nerves paſſes through this fiſſure, as it proceeds from the orbit into the temporal foſſa. The communication of the orbitar with the naſal foſſa takes place, firſt, by one or two ſmall holes, ſituated ſometimes in the os frontis, and ſometimes in the ſuture, by which it joins the os planum; theſe are called the anterior *internal orbitar foramina*; they afford a paſſage to the naſal nerve, which proceeds from the ophthalmic branch of the fifth pair. Secondly, it communicates with the noſe by the *lachrymal canal*, which paſſes along the inner margin of this foſſa, and is ſituated partly in the aſcending proceſs of the os maxillare, and partly in the os lachrymale; it deſcends almoſt vertically into the noſe.

The ſpheno-maxillary fiſſure is prolonged a little as it deſcends into the temporal foſſæ. In its deepeſt part is found the *ſpheno-palatine* hole, which is formed by a groove in that part of the palate bone which joins with the body of the os ſphenoides; it extends partly into the noſe, and aſſiſts in forming the orifice of a ſmall conduit, which deſcends between the os palati and the pterygoid proceſs; and which opens towards the poſterior angle of the arch of the palate, by a hole called *foramen guſtatorium*, or *poſterior guſtatory hole*; it affords a paſſage to a ſmall ramification of the fifth pair of nerves, in its courſe towards the ſuperior maxillary branch.

There

There is alſo in the middle ſuture of the arch of the palate, and immediately behind the dentes inciſores, a ſingle hole, called *foramen inciſorium.* Some branches of the ſuperior maxillary nerve paſs through this hole.

Laſtly, we obſerve in the front of the face, and under the orbit, another hole, called the *ſub-orbitar* foramen. It ſerves as the outlet of a ſmall canal, which paſſes under the floor of the orbit, and gives exit to the laſt branches of the ſuperior maxillary nerve. We alſo remark a much ſmaller hole above the orbit, which is ſometimes merely a notch; it is called the *ſuperciliary foramen,* and tranſmits the frontal branch of the ophthalmic nerve.

B. *In other Animals.*

We ſhall conſider the principal holes of the face as they appear in the different claſſes of animals.

The lachrymal canal we ſhall omit till we have occaſion to treat of the Eye.

1. *Spheno-maxillary Fiſſure.*

The ſpheno-maxillary fiſſure of the *monkey* kind is much ſhorter than that of man; it is reduced to a ſimple hole in ſome *ſapajous.* It is entirely cloſed in the *alouate*; it is partly ſupplied

plied by a hole in the cranium, ſituated behind the orbit, at the deepeſt part of the zygomatic foſſa, and probably alſo by a pretty large round hole ſituated in the os malæ.

The animals that have no partition between the orbit and the temporal foſſa, have alſo no ſpheno-temporal fiſſure; the latter, therefore, does not exiſt in any of the mammalia, except the Quadrumana, nor in any of the other claſſes.

2. *Internal Orbitar Foramina.*

The anterior and poſterior internal orbitar foramina, are very ſmall in the *monkies*; the latter is even often wanting; when it exiſts, it paſſes through the os frontis.

In the Sarcophaga, the anterior foramen is very large, and ſituated at the inferior part of the orbit in the os maxillare: the poſterior foramen terminates in the cranium by an aperture, ſituated behind and above the cribriform lamella.

In the Rodentia, the anterior foramen reſembles that of the Sarcophaga; the poſterior is ſmaller, and ſituated entirely behind the cribriform lamella.

In the Edentata, the anterior internal orbitar foramen is ſituated altogether in the lower part of the orbit, and perforates the os palati: the poſterior foramen, on the contrary, is ſituated above,

above, and ſomewhat before the orbit, in the body of the os frontis.

In the *elephant* the two internal orbitar foramina are formed in the os frontis; the anterior ſomewhat before the orbitar-fiſſure, and the poſterior under the oſſeous ridge which covers that fiſſure; the aperture of the latter, in the cranium, is ſituated behind, and a little above the cribriform lamella.

It is nearly the ſame with reſpect to the other Pachydermata.

In the Ruminantia and Solipeda, the anterior internal orbitar hole is very large, and perforated below and before the orbit, between the os palati and the os ſphenoides: the poſterior is alſo conſiderable; it is directed towards the ſide, and behind the cribriform lamella.

It is very difficult to trace theſe holes in the Cetacea, becauſe they are covered with oſſeous laminæ, and are very ſmall.

The internal orbitar foramina do not exiſt in the other claſſes of animals.

3. *Foramen Inciſorium.*

a. In all the mammalia, the foramen inciſorium belongs to the inter-maxillary bones; it is ſmall and ſingle in the *jocko* and the *orang outang*; but it is ſomewhat enlarged in the other monkies, and in the Sarcophaga it is double.

In the Rodentia the *hares* have it very large, even

even exceeding the folid part of the palate; it is fmaller in the other genera; it occupies nearly the middle fpace between the incifor and the malar teeth.

The Edentata, which have very fmall intermaxillary bones, have alfo the foramen inciforium fmall, and fituated near the end of the muzzle.

It is fingle and elongated in the *tapir* and the *rhinoceros*. In the *elephant* its place is fupplied by a long narrow canal.

In the Ruminantia it is exceedingly large; it is oval, double, and fituated quite at the end of the fnout.

It is nearly fimilar, but lefs in *horfes* and *hogs*. In the horfe there is a fingle round hole, fituated before the two incifive holes.

It is almoft obliterated in the *morfe*; fmall, and much removed from the edge of the alveoli in the *dugon*; fingle, oval, large, and fituated clofe at the end of the fnout in the *lamantin*.

The Cetacea have no foramen inciforium.

b. In fome birds, as the *heron*, the *flamingo*, the *eagle*, &c. the incifive foramina are fmall and numerous; there is only one of a middle fize, and fituated towards the bafe of the bill, in the *duck*, the *curaffow*, the *cormorant*, the *fpoon-bill*, &c. The *caffowary* has a fmall foramen fituated towards the point of the bill. The *owls* and the *cocks* have it pretty large. It is of a very great fize in the *oftrich*.

c. The

c. The foramen inciforium of the *crocodile* is confiderable; as is likewife that of the *frog* and the *falamander*. The *tortoife* has two very fmall foramina. We have not been able to difcover them in the other *lizards*.

d. There can be no foramen inciforium in fifhes, as no part of their face can, with propriety, be called the nafal cavity.

4. *Sub-orbitar Foramen.*

The fub-orbitar foramen is fingle only in the *jocko*. There are two fmall foramina in the *orang-outang*, and the *fapajous*; three in the greater number of *guenons* and *magots*; four or five in the *macaques* and *mandrils*; the *lemurs* have but one.

There is alfo only one in the Sarcophaga; it is pretty large, and fhould rather be named the *ante* or *præ-orbitar* foramen: it is fituated farther forward in *dogs* than in the other genera.

In the Rodentia it is fimple, and exceedingly large. In the *cavys*, the *agoutis*, the *porcupines*, the *rats*, and particularly in the *jerboas*, it almoft equals the orbit in fize. It is formed in the malar procefs of the maxillary bone.

In the other genera of Rodentia, as the *hares*, *beavers*, *fquirrels*, and *marmots*, it is fmall, and fituated upon, or even before the firft dentes molares.

It is fimple and fmall in the *floths*, but in the long-

long-nofed Edentata, it forms a canal in the bafe of the malar procefs of the os maxillare.

In the *elephant* it is of a confiderable fize, and opens on the lower part of the malar procefs.

In the other Pachydermata, it is nearly the fame as in the *dog*.

It is the fame in the Ruminantia and Solipeda.

The *feals*, the *morfe*, and the *lamantins*, have it fituated in the bafe of the malar procefs.

There are three or four of thefe foramina in the Cetacea, fituated in a longitudinal line; one of them is even perforated in the inter-maxillary bone; thofe that are fuperior have a retrograde direction. The pofition of the os maxillare in thefe animals places the foramina above the orbit, inftead of below it.

There are no fub-orbitar foramina in birds, or in the other claffes, as the mammalia alone have lips.

5. *Spheno-palatine Canal.*

The fpheno-palatine canal of *apes* does not differ from that of man.

But in all animals, in which the temporal foffa is not feparated from the orbitar, we eafily diftinguifh a fuperior aperture fituated in the lower and fore part of the temporal foffa. It receives two canals, one of which extends to the

the nofe, and the other to the palate; the latter is fometimes very fhort, and has often two or three openings into the palate. It is almoft horizontal in the Cetacea.

There is none in birds. We find it, however, in reptiles; not indeed in the form of a canal, but as a fimple hole in the palatine bone.

LECTURE

LECTURE NINTH.

OF THE BRAIN OF ANIMALS WITH VERTEBRÆ.

Article I.

Of the Organization of the Nervous Syſtem in General.

The nerves, with the central maſs from which they all ariſe, that is to ſay the ſpinal marrow and brain, form the common organ of ſenſation and volition.

The ſenſations we experience from the action of external bodies on our own, are more perfect in proportion as the nerves terminating at the part which receives the impreſſion, ariſe more immediately from the medulla ſpinalis, and through it from the brain.

If theſe nerves, however, are tied or cut, all the parts of the body to which they are diſtributed become inſenſible, whatever be the diſtance from the brain at which the ſection or ligature is made.

In the ſame manner, if we tie or divide the ſpinal marrow itſelf in the neck, the whole body becomes paralytic and infenfible, though the vifcera may for a time continue their motions, becaufe they receive a great part of their nerves immediately from the brain. Finally, a general compreffion of the brain inftantly deftroys every kind of fenfation.

Thefe obfervations have produced the opinion that there exifts a *fenforium commune*, or centre of fenfation, to which the impreffions of all the nerves are tranfmitted; and this common organ is fuppofed to be the brain.

There are, however, feveral animals in which this union of the branches of the nerves, with their common trunk, is not neceffary to fenfation. We may, for example, completely remove the brain of a tortoife or a frog, and thefe animals will ftill feem to fhew by their motions that they poffefs fenfation and volition.

There are alfo infects and worms, which, when cut into two or feveral pieces, form immediately two or feveral individuals, having each a fyftem of fenfation and volition. It is only in the animals which are the moft perfect, and which approach neareft to man, that the connection of the different parts of the nervous fyftem, and particularly the prefence of its central parts, is abfolutely neceffary to the exiftence of its functions.

The neceffity of this connection increafes in proportion to the magnitude of the common trunk, compared with its ramifications. The more

more equally the medullary maſs is diſtributed, the leſs eſſential is the exiſtence of central parts: animals which have this ſenſitive ſubſtance diffuſed over the whole body, as is the caſe in *polyps*, may be divided and ſubdivided to any degree of minuteneſs, yet each fragment will be endowed with a particular *ſelf-exiſtence*, and become a ſeparate and perfect individual of its kind.

From theſe obſervations, it may be conjectured, that the parts of the nervous ſyſtem are homogeneous, and ſuſceptible of a certain number of ſimilar functions, in the ſame manner as the fragments broken from a large magnet, become each a ſmaller magnet, having its poles and motion; and that in the higher orders of animals the connexion of parts is rendered neceſſary only by acceſſory circumſtances, and the complication of the functions they have to perform, which is alſo the reaſon that each part anſwers a particular uſe.

With reſpect to the laſt fact, it indeed appears that the appropriation of certain nerves to the acquirement of determined ſenſations, and of others to the performance of particular functions, is the effect of the nature of the external organs, in which the former terminate; and the number of blood veſſels which the latter receive at their diviſions and unions: in a word, it is rather to be aſcribed to any acceſſory

 circum-

circumſtance, than to the peculiar nature of the nerves themſelves.

We ſhall render the truth of this obſervation more apparent, by proceeding to conſider the general *diſtribution* of the nervous ſyſtem, and the nature of its ſubſtance.

With reſpect to the *diſtribution*, we find that, in all animals which have diſtinct nerves, theſe nerves ariſe from one common maſs, which moſt frequently is of a cord-like figure, and called the *ſpinal marrow*; the anterior extremity of this medullary rope is always more or leſs enlarged, and exhibits ſeveral tubercles or eminences, which, in animals that have vertebræ, are ſituated in the head, and have obtained the common name of *brain*.

There are animals, as ſome Moluſca, in which we diſcover only a ſimple medullary maſs without any cord-like prolongation.

The nerves ariſe by pairs from the common trunk, or from the maſs which ſupplies its place, and ramify like the branches of a tree as they proceed to the parts they are deſtined to animate.

Some of theſe nerves have a ſimple origin; but the greater part ariſe or proceed from the trunk in ſeveral filaments, which afterwards unite and form one common faſciculus.

The principal branches of the nerves do not always continue to ſubdivide: on the contrary, it it frequently happens that ſeveral branches, whether belonging to the ſame or different nerves, unite and ſeparate again in various manners to form plexus, from which new trunks of nerves ariſe.

Neither do the ramifications always diminiſh in thickneſs, in proportion as they divide. We very often meet with a branch which is thicker than that from which it proceeds.

It is even obvious, that the nerves muſt increaſe in magnitude as they advance towards the extremities; for the ſkin, which is ſenſible in every part, and which conſequently is every where furniſhed with nerves, has ſeveral hundred times more ſuperficial extent than all the roots of the nerves taken together.

Communications are eſtabliſhed between a great number of very different nerves, by cords which extend from the one to the other: where theſe communications take place, there is almoſt always an enlargement or ſmall maſs of medullary matter, which ſeems to be only a very compact plexus, and which is called a *ganglion*.

Filaments, proceeding from ſeveral nerves, very often unite into one ganglion, from which other filaments ariſe, and are tranſmitted to different parts.

Sometimes alſo a ſingle nerve ſwells into a ganglion, and is afterwards contracted.

From this ſummary deſcription, it appears

 that

that the comparifon of the nervous fyftem to the trunk of a tree and its branches is not perfectly accurate; it fhould rather be confidered as a kind of complicated net-work, in which the greater part of the threads communicate with each other, and in which there appear, at different places, maffes or enlargements, more or lefs confpicuous, which may be confidered as centers of communication.

The middle part of this net-work always preferves the greateft fize, the moft immediate connexion, and the moft powerful influence with refpect to all the other parts.

But the degrees of this influence vary as much as thofe of its proportional magnitude.

In the animals of the higher claffes, the fize of the medulla fpinalis vaftly exceeds that of the nerves which proceed from it, and the brain alfo greatly furpaffes in fize the fpinal marrow.

Thefe two circumftances are more remarkable in man than in any other animal. His brain is the largeft of all, in proportion to the reft of the nervous fyftem. In the other warm-blooded animals, the volume of the brain diminifhes in proportion as the fpinal marrow becomes larger. In the molufca there is only a brain, from which the nerves proceed like radii, and form fcattered ganglia almoft as large as the brain itfelf. In infects, the brain is not larger than each of the numerous ganglia of the fpinal marrow, and the nerves arife from both in the fame manner: thus,

thus, in proportion as we defcend in the fcale of animals, we find the medullary fubftance lefs concentred in a particular region of the fyftem, and more equally diftributed to all the parts.

The *texture* of the nervous fyftem may be confidered in the brain, in the medulla oblongata, in the medulla fpinalis, in the nerves, and in the ganglia.

The brain of animals that have red blood and vertebræ, confifts of a mafs varying in folidity and firmnefs, eafily divided or compreffed, and flightly vifcous. We obferve in it two principal fubftances, the *cortical* and the *medullary*; and two others lefs extenfive, which are called the *foft* and the *black* fubftances. The brain of cold-blooded animals is fofter than that of the warm-blooded. Some fifhes have the brain almoft fluid.

The *cortical* fubftance is reddifh, and femi-tranfparent; it appears homogeneous to the eye. Injections, however, penetrate its fubftance to a certain extent, and fhew that it is chiefly compofed of blood-veffels. Its pofition, with refpect to the medullary fubftance, varies in the different parts of the brain; but in the circumference of the hemifpheres, and of the cerebellum, it is external. Hence it has received its name. The limits of thefe two fubftances are very diftinct. They do not change by degrees into each other. The cortical fubftance poffeffes no fenfibility. Its quantity, with refpect to the reft of the brain, decreafes in the cold-blooded animals. It is proportionally greater in man than in other animals.

The *medullary* ſubſtance is white, opaque, and firmer than the cortical. It appears to the eye compoſed of very fine fibres, the directions of which are various. Few veſſels are obſerved in it, and injections do not pervade its intimate ſtructure. This ſubſtance forms the greater part of the interior of the brain; and the medulla oblongata, and medulla ſpinalis, are its prolongations. Their texture is altogether ſimilar to that of the medullary part of the brain. We obſerve in them the ſame fibrous appearance, mixed internally with a ſmall quantity of cineritious ſubſtance.

The *ſoft* ſubſtance is greyiſh, ſemi-tranſparent, and almoſt fluid. In ſome parts it covers the ſurface of the brain. The *black*, or *blackiſh* ſubſtance, colours the medullary part of the brain in two places.

The medullary and cortical ſubſtances of white-blooded animals preſent no difference as to colour, and it is even with ſome difficulty that we diſcover any in their conſiſtence. The Cruſtacea and the inſects only have a kind of ſpinal marrow. It is compoſed of a double medullary cord, united at different ſpaces by ganglia. Perhaps it ſhould rather be regarded as a kind of great ſympathetic nerve.

The texture of the nerves ought to be conſidered in their courſe, at their cerebral extremity

mity or origin, and at their termination in the different parts of the body.

The nerves are not merely enveloped by membranes, which appear to be continuations of thofe that furround the brain. The membrane to which fome modern anatomifts have given the name of *neurilema, (nerve-tunic)*, penetrates alfo into the interior, and forms fepta, which divide the medullary filaments from each other. The medullary fubftance may be diffolved by alcaline lixivia, and there will remain only the tubes formed by the neurilema. The latter may alfo be diffolved by acids; we then obferve that the medullary filaments, which ftill remain, anaftomofe together in various ways. The nerves receive a confiderable quantity of blood, which is tranfmitted to their fubftance by the veffels of the neurilema, in the fame manner as the blood is conveyed to the brain by the veffels of the pia mater.

The term *origin of the nerves* is applied to that part of them which is neareft the brain or medulla fpinalis, before it has entered the fheath furnifhed by the dura mater.

Some nerves appear to derive the medullary fibres, of which they are compofed, from the furface of certain parts of the brain. Such in particular are the olfactory and optic nerves in all red-blooded animals, and the auditory nerve in mammalia and birds. Others feem to come from the internal fubftance of the brain, into which

which their roots may be traced like thofe of a tree into the earth. This is moft remarkable in the third pair of nerves in the mammalia; but the greater part of the nerves arife by filaments, which are connected to the medulla oblongata, or medulla fpinalis, and which unite to form nervous trunks. This, at leaft, is the difpofition which prevails in all animals that have red blood, with refpect to the nerves that fucceed the auditory, that is to fay, reckoning from the par vagum.

It is probable that all the nerves penetrate more deeply into the fubftance of the brain and medulla than it is poffible for us to trace them. It is even fuppofed that they crofs each other, fo that thofe which proceed to the left fide of the body arife in the right fide of the brain; and that thofe tranfmitted to the right of the body come from the left of the brain. It is certain that wounds received on one fide of the brain have frequeently produced a paralyfis on the oppofite fide of the body. We can alfo clearly perceive the decuffation of the optic nerves of fifhes, and we conclude that the fame thing takes place in other animals, as one of the nerves frequently diminifhes in fize above and below the place where they are confounded in croffing.

The fibres that compofe the medulla fpinalis feem alfo to crofs each other in the groove by which it is divided.

In animals that have white blood, the nerves proceed from the brain or the other ganglia; but they never arife immediately from the fpinal marrow. Their fibres, however, cannot be diftinguifhed either in thefe ganglia or the tubercles.

The *termination of the nerves* is different, according to the parts to which they are tranfmitted. Thofe which are diftributed internally, are accompanied by the neurilema to their moft imperceptible extremities. The optic nerve is terminated by a nervous expanfion which fpreads over the interior of the eye. The acouftic terminates by filaments which fwim in a gelatinous fluid. The nerves that belong to the organ of tafte are dilated in the nervous papillæ of the tongue; thofe of feeling terminate in the papillæ of the fkin, &c.

The ganglia of red-blooded animals do not appear to differ from *nervous plexus*, except that the filaments which compofe them are more compact, and more intimately united. Even the fimple ganglia, that is to fay, thofe that are formed by a fingle nerve, are refolved, by maceration, into feveral filaments, which anaftomofe together.

It is the fame with refpect to the Molufca; but in the Cruftacea, the Infects, and the Worms, the ganglia are merely homogeneous enlargements of the medullary cord to which they belong.

From what has been faid, it is obvious, that

we

we have but a very limited knowledge of the real texture of this medullary fubftance which forms the effential part of the nervous fyftem. Is it merely an accumulation of excretory veffels? Is it a kind of gland or parenchyma? Or is it fimply a homogeneous mafs? Each of thefe opinions has its partizans and its adverfaries.

The chemical nature of this medullary fubftance is alfo imperfectly known to us. It is certain, however, that it differs effentially from all other animal matter. It is foluble in cauftic alkali, and partly in oil: it is not fat: and yields no oil by expreffion. It dilutes, but does not diffolve in water; alcohol extracts from it, when warm, a fubftance, which in cooling precipitates into needles or fmall laminæ. This matter may be compreffed or extended between the fingers. It foftens a little at the heat of boiling water, becomes black at a greater heat, and burns without fufing, emitting the fame odour, and leaving the fame carbon as other animal fubftances. The medullary part of the nerves prefents the fame chemical refults as the medullary part of the brain.

Article II.

Of the Nervous Syſtem conſidered in Action.

The nervous ſyſtem is ſuſceptible of two kinds of action; one which is confined to our ſenſitive faculty; and another which affects our vital and vegetative functions only. Voluntary motions and ſenſations belong to the firſt of theſe actions; the influence of the nerves on digeſtion, circulation, and ſecretion, to the ſecond. The ſympathies and phyſical changes which are the conſequence of certain ideas, or of certain paſſions, ſeem to participate in the effect of both.

Senſations may be divided into *external*, *internal*, and *ſpontaneous*. The firſt are produced by the impreſſions of external bodies on our ſenſes. The ſecond by changes which take place in the ſtate of the internal parts of the body, to which the nerves are diſtributed. The third reſemble both the former as to effect; but they are cauſed by a change in the nerves, or in the brain itſelf, without any external excitement. The ſenſations we experience in dreams are ſimilar to thoſe produced in us by external bodies: they originate, however, from motions produced in the brain by internal cauſes, and may be excited or allayed by certain medicines.

Men

Men who have loſt their eyes frequently dream that they ſee; thoſe who have had their limbs amputated, imagine ſometimes, even when awake, that they experience pains in the abſent members.

Theſe kind of ſenſations tend to throw a light on the nature of others. They confirm what ſections and ligatures of nerves had already ſhewn; that ſenſation does not reſide in the external organs, but merely in the centre of the nervous ſyſtem, and that the external organs ſerve only to receive the action of external bodies, and to convey it to the nerves, by which it is propagated to a greater diſtance.

They alſo farther demonſtrate, that this propagation is not produced by any matter or concuſſion, which external bodies could alone communicate, but by a change in the ſtate of the nervous ſubſtance, which may ariſe from internal cauſes.

This change may alſo be produced by external cauſes altogether different from thoſe which uſually occaſion it. A blow on the eye; the contact of two different metals, one piece being placed under the upper lip, and another under the tongue, make us perceive a flaſh in the ſame manner as if light had really ſtruck the eye: this can only take place in conſequence of a change in the optic nerve ſimilar to that which light itſelf produces.

Other phænomena afford ſome farther notions

tions refpecting the nature of this change. It feems, for example, that the fenfitive faculty is confumed or exhaufted, not only in a body fatigued by too lively or too long continued fenfations, but alfo in each particular organ. Feeble fenfations are fcarcely perceptible when they fucceed thofe that are much ftronger; a fenfation becomes weaker by duration, though the external bodies which caufe it remain the fame: for example, if at twilight we look ftedfaftly towards a point of the fky, in which fome obfcure body appears upon the azure ground, and afterwards turn the eye to another part of the fky, we fhall ftill continue to fee the figure of the obfcure body; but that figure will then appear more luminous than the reft of the fky. The caufe of this is, that the part of the retina, on which the fhade fell, receives a ftronger impreffion from the light than the part of the fame membrane which was expofed to its rays before, while the former part experienced a kind of repofe. For the contrary reafon, after the eye has been fixed on a very luminous body, it fees for a time an obfcure fpot of the fame fhape as that body.

The other fenfes afford fimilar examples, but they are not fo evident; becaufe in this we have the advantage of comparing two parts of the fame organ, which have been both acted upon, and one of which has experienced the action for a longer time than the other.

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This experiment ſhews that the nerves are not merely paſſive agents with reſpect to our ſenſations; and that they are not ſimply the conductors of a matter furniſhed by external bodies, nor even the reſervoirs of a matter in which theſe bodies may excite vibrations, but that the ſubſtance which produces ſenſation is liable to be conſumed, or to loſe its activity, by exertion.

There are phænomena which ſhew that the general ſuſceptibility of the nerves, for receiving ſenſations, may vary in conſequence of cauſes external to the nerves themſelves, and which can only operate by altering their ſubſtance. Certain medicines weaken or revive that ſuſceptibility—inflammation frequently encreaſes it to an exceſſive degree. Does this take place in conſequence of an increaſed ſecretion of the nervous matter? the moſt remarkable change that occurs in the ſuſceptibility of nerves, is ſleep. It is not unnatural to ſuppoſe that this change may be occaſioned by the temporary loſs of the ſubſtance which is eſſentially ſenſitive. But how does it happen that ſleep depends, in a certain degree, on the will? Why do we awake ſuddenly, or from cauſes which do not appear calculated to reſtore that ſubſtance? Why does cold produce ſleep? From theſe obſervations may it not rather be ſuppoſed that this ſtate is the effect of a change in the chemical nature of the nervous ſubſtance?

But whether the ſubſtance contained in the nerves

nerves is exhaufted by fenfations; or whether it merely undergoes an alteration in its chemical compofition, and becomes, as it were, naturalized, it muft remain in the nerve throughout the whole of its courfe, and leave it only at one of its extremities. It does not, however, refemble the blood in the veffels, either as to the manner in which it is retained, or in which it moves in the nerve. There is no evidence of the nerves being tubular. No phænomenon indicates that any matter efcapes from them when they are divided. Befides, what veffels could have parietes fufficiently compact to retain fo fubtile a fluid as that of the nerves muft be. It is far more probable that it is retained in the nerves, in the fame manner as the electric matter is in electric bodies, by communication and infulation; and that the nervous fyftem is its only conductor, while all the other parts of the animal body are, with refpect to it, cohibent fubftances.

In whatever manner the received action is tranfmitted, it is neceffary, at leaft in all the higher orders of animals, that it fhould be propagated to the brain. But what part of the brain is particularly deftined to receive its impreffion? Confiderable portions of that vifcus have been loft by wounds, without producing any diminution in the fenfitive faculty. When wounds have penetrated farther, they have caufed pains and convulfions which have too much

 altered

altered the refult of the experiment. Thefe means, therefore, are not capable of refolving the queftion. It has been endeavoured to form fome conjectures founded on the ftructure of the parts. It has been generally imagined that the common fenforium muft be found in fome central part, with which all the nerves might be fuppofed to communicate: fome have chofen for this part the pineal gland, others the corpus callofum; but the latter exifts only in the mammalia and the pineal gland, only in red-blooded animals; the latter even is not very apparent in all fifhes. The cerebellum is the only part of the brain which conftantly exifts in all animals that have a vifible nervous fyftem; and on this account it might have fome claim to the poffeffion of this common fenforium: but it has been fuggefted by M. Sœmmering, that a folid part is not fufficiently moveable, nor alterable, with fufficient promptitude, to admit the impreffions of the nerves with that rapidity which really takes place. Having befides obferved, that all the nerves appear to arife mediately, or immediately, from the parietes of the ventricles, and that thefe ventricles always contain a certain quantity of water; he has fuppofed that it is precifely this fluid which anfwers all the conditions of the problem, and that it ought to be regarded as the common centre of fenfation.

To trace the nervo s motion to its centre, and

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to eſtabliſh, with certainty, what we have hitherto advanced only as conjectures, more or leſs probable, is a taſk which the anatomiſt has yet to perform.

How does it happen that an idea or image, of which we are conſcious, is formed within us, at the moment this change takes place in the nervous ſyſtem? How are thoſe ideas accumulated in our memory? By what means is our imagination able to re-produce them, and our judgment to combine them, draw concluſions, and form abſtractions from them? Theſe, and other effects of habit and attention, the metaphyſician may eſtabliſh hiſtorically, but the phyſiologiſt cannot explain.

Phyſiology, however, ſhews us that there is a certain order of corporeal motions which correſpond exactly to thoſe ſenſations and combinations of ideas: ſtudy, too long continued, produces a ſenſation of fatigue in the brain. Certain ſtates of diſeaſe change the natural order of ideas; ſuppreſs, or conſtantly preſent them of a certain kind; perplex and diſorder the imagination: age renders our ideas leſs vigorous; wine and opium produces conſiderable changes in them. Other aliments, or other medicines, produce leſs important alterations; but each operates according to its ſpecies, and according to the diſpoſition of the ſubject. Beſides, the imagination and the will produce phyſical effects on the body, which ſeem to be a repercuſſion of

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the influence which the phyſical changes of the body has on them.

Theſe effects of the will and the imagination conſtitute two other claſſes of animal actions, originating in the nervous ſyſtem. That which includes voluntary motion was conſidered, in the firſt volume of this work, in treating of the muſcular fibre: it was there ſhewn that the nerves are the organs by which the will excites the contraction of muſcles, and that it is probable this contraction takes place in conſequence of a chemical change which the nerve produces in the fibre. But is the matter that cauſes this change the ſame as that which excites ſenſation, and is it tranſmitted by the ſame portion of nerve? How does it happen that, in certain diſeaſes, we preſerve the free uſe of our members, while they are totally deprived of ſenſibility? Is this the conſequence of an alteration which affects only the external organ of feeling, and not the nerve? In the night-mare, why is our ſtrong deſire to eſcape from the imaginary objects that oppreſs us ineffectual, and why is the will incapable of producing the ſmalleſt motion in the body? When a nerve, which has been divided, is afterwards united, why is motion only re-eſtabliſhed, and not ſenſation?

Some have ſuppoſed that the envelopes of the nerves form the conductor of their moving power, and their medullary part that of their ſenſibility. To the reaſons which they have advanced

vanced in ſupport of this opinion, we may add, that the envelopes communicate with the ventricles by the plexus choroides, which are continuations of the pia-mater. It muſt be confeſsed, however, that this idea can as yet be regarded only as an hypotheſis.

There are effects which belong to the imagination, as voluntary motion belongs to the will; they are confined almoſt entirely to a ſudden augmentation of certain ſecretions, or the accumulation of blood in certain parts. Before we attempt to explain theſe effects, it is neceſſary to enquire how far the nervous ſyſtem participates in the purely vegetative functions of our body.

The part it performs in that reſpect is very decided. We know that the influence of the nerves on the vital organs, and of the latter on the nerves, is reciprocal. Grief, or an exceſſive application of the mind, alters digeſtion, and diminiſhes the ſecretion of the gaſtric and ſeminal fluids. On the other hand, an over-loaded ſtomach blunts ſenſibility, and induces ſleep. If this kind of exceſs be too frequently repeated, ſtupor ſeizes the mental faculties. Too great a waſte of the ſpermatic fluid deſtroys memory, extinguiſhes imagination, and produces extreme irritability and fearfulneſs. Remedies, calculated to reſtore the powers of the mind, give alſo new energy and vigour to the vital organs. The diſeaſes which moſt enfeeble the powers of

 perception

perception and underſtanding, alſo reduce the body to an inert ſtate, which is ſpeedily followed by diſſolution. Mental excitation is uſually accompanied by heat, irritation, and an increaſed energy in all the vital motions.

Upon an attentive examination of this ſubject, it will appear that the part the nerves perform, in all theſe functions, may be reduced to their influence on the irritability of the arteries: by preſerving this irritability the nerves promote circulation to the extremities of the veſſels, and keep up all the ſecretions. When the excitement of the nerves heightens the irritability, the ſecretions are augmented.

All the phyſical changes that take place in the body, in conſequence of the images that occupy the mind, belong to the ſame claſs of action. In general the mind poſſeſſes no influence over the organs of circulation, and the will cannot ſtop their motion: but when lively images heighten the excitement of the whole, or a part of the nervous ſyſtem, the mental influence extends to thoſe muſcular fibres which produce circulation: thus the hope of a much deſired event cauſes the heart to palpitate. Voluptuous ideas make the blood flow into the cells of the corpora cavernoſa of the penis, and produce erection; anger or ſhame impells it to the ſkin of the face, whence it is driven back again by the re-action of the veſſels: this is the reaſon why theſe paſſions produce alternate bluſhing blufhing and palenefs. Sudden terror inftantly augments the fecretion of the fluids of the inteftines, and caufes a diarrhœa. The fight of a good meal occafions a great fecretion of faliva in a hungry man; even mentioning victuals is fufficient, according to the common phrafe, to *make his mouth water;* in the fame manner fpeaking of difgufting fubftances, ferves to ficken the ftomach of men of delicate feelings. Exceffive forrow or joy increafes the fecretion of the tears fo confiderably, that they cannot flow through the lachrymal points, but fall upon the cheek.

In other cafes the action of the imagination does not extend beyond the nervous fyftem; it is confined to the production of fenfations in certain parts of the body, independently of any external impreffion. Fear and uncertain hope always excite a fingular fenfation in the præcordial region. This fenfation, which doubtlefs takes place in the nervous plexus of that region, is ufually the precurfor of that alvine excretion which is excited by the nerves proceeding from thefe plexus; in the fame manner as, by a contrary movement, the accumulation of blood in the corpora cavernofa of the penis precedes that vivid fenfation which has reached its height at the moment of the expulfion of the femen. Efforts made to recollect certain painful feelings which we have experienced, fometimes bring back thofe fenfations themfelves.

The fufceptibility of the nervous fyftem to be thus governed by the imagination, may be more varied than the capacity it poffeffes for receiving external impreffions. The age, fex, and health of the individual; the manner in which a perfon has been educated, either with refpect to his body or moral principles; the empire which reafon holds over his imagination, and the temporary ftate of his mind, all produce in this refpect aftonifhing differences; which may be compared to thofe that difeafe, fleep, medicines, &c. may occafion in the fufceptibility of the nerves for external impreffions.

There appear befides, in the nervous fyftem, certain phænomena which depend on the union of different nerves, whether that communication be produced by cords paffing from one to the other, or through the medium of the brain. Thefe phænomena are called *fympathies*: they confift of involuntary motions, or rather of fenfations, experienced in places different from thofe that are affected. Thefe fenfations do not feem to depend upon the influence of the will, or the imagination, and frequently exift while we are ignorant of the place really affected, or the motion that has occurred.

The fneezing which fucceeds to irritations of the noftrils, affords an example of the fympathy produced by the union of nerves: the nerves of the noftrils, which come from the ophthalmic branch of the fifth pair, are connect-ed ed by the ſympatheticus major, with the nerves of the diaphragm, and by this means the excitement is communicated. The ſneezing which takes place upon looking at a bright light, is to be aſcribed to the union of the ciliary nerves with the fifth pair: the irritation is communicated to the noſe, and thence to the diaphragm.

Another example of the ſame kind conſiſts in the great changes which the eyes preſent in different internal diſeaſes of the body. Theſe changes, ſo important to the phyſician, are almoſt all produced by the union of the ſympatheticus major with the fifth pair, and by that pair with the ciliary nerves.

Sympathetic actions occur ſtill more frequently, when different parts of the body receive branches of the ſame nerve, which may communicate irritation.

Thus tears are excited by a ſtrong ſmell. This is occaſioned by the ophthalmic nerve ſending at the ſame time branches to the noſtrils and the lachrymal gland.

The vomiting produced by puſhing a finger into the throat, is owing to the diſtribution of the eight pair of nerves, which go both to the pharynx and the ſtomach.

This eight pair, or nervus vagus, and the great intercoſtal or triſplanchnicus, are the nerves which produce the greateſt number of this kind of phænomena, becauſe they are diſtributed

buted to a great number of parts, and form unions with a great many other nerves; they have therefore been named *ſympatheticus major*, and *ſympatheticus medius*.

To conclude this brief account of the action of the nervous ſyſtem, we ſhould alſo notice the influence which the nervous ſyſtem of two different individuals may exerciſe upon each other. The abuſe which has been made of this influence by impoſtors, and the exaggeration with which it has been deſcribed, have brought the ſubject into ſuch contempt, that philoſophers can ſcarcely think themſelves permitted to mention it.

It muſt be confeſſed, that it is extremely difficult, in the experiments which have this action for their object, to diſtinguiſh the effect of the imagination of the perſon ſubjected to the experiment, from the phyſical effect produced by the operation; and the problem is frequently very complicated. The effects, however, obtained on perſons who were inſenſible before the proceſs commenced, thoſe that appear in others after the operation itſelf has rendered them inſenſible, and thoſe exhibited by different animals, place it beyond all doubt, that the proximity of two animated bodies, in certain ſituations, and with certain motions, produces a real effect, independent of any participation of the imagination of one of them. It alſo appears ſufficiently evident, that theſe effects

fects take place in confequence of a certain communication being eftablifhed between their nervous fyftems.

Finally, it were to be wifhed that we were able to compare the action of the nervous fyftem, in the different orders of animals, in the fame manner as we fhall compare its ftructure and diftribution : but this examination prefents infurmountable difficulties ; becaufe we have no means of difcovering the manner in which animals are affected, except by very equivocal marks.

In all animals that have nerves, voluntary motions, and direct fenfations, take place by the fame means as in man. The differences in their motions depend partly on the intrinfic mobility of their fibres, and partly on the difpofition of their mufcles, and the parts to which they are attached. Thefe differences have been explained in the firft part of this work.

The differences in their fenfations depend on the number of their fenfes, and the perfection of the organs belonging to each fenfe. The animals that approach neareft to man have their fenfes equal in number to his. In certain fpecies fome of thefe fenfes are even more perfect in the ftructure of their organs, and fufceptible of more lively and delicate impreffions than ours : on the contrary, in proportion as animals are removed from us, the number of their fenfes and the perfection of certain organs are diminifhed ;

niſhed; but perhaps ſome animals at the ſame time poſſeſs ſenſes of which we can form no idea. We ſhall particularly conſider theſe ſubjects in this ſecond part of our work.

We know not whether there are differences in the intrinſic ſenſibility of the nervous ſyſtem of different animals; that is to ſay, whether an equal impreſſion, applied to an organ equally perfect, would affect every animal with the ſame force. This it is evident we ſhall never be able to learn.

The animals next in order to man have, like him, ſpontaneous ſenſations. Images are excited in them at times when they receive no immediate impreſſion from external objects. Dogs and parrots dream; but we are not certain whether the very inferior ſpecies of animals experience ſimilar ſenſations.

The paſſions produce effects in animals which reſemble thoſe they produce in us. Love is manifeſted in the ſame manner in all claſſes: terror occaſions a diſcharge of excrements in quadrupeds and birds: fear makes them tremble, and even renders inſects immoveable; but the other animals afford fewer examples of theſe kind of phænomena than man, becauſe they are not maſters of their imagination, cannot direct it towards certain objects and create for themſelves factitious paſſions. We are even ignorant whether their imaginations can, like ours, be wrought up to ſuch a pitch as to make them experience

experience emotions of anger, defire, or fear from fimple ideas or fimple recollections; and whether the real prefence of the objects which caufe thefe paffions, is not always neceffary to excite them in the inferior animals: we know, however, that thofe which approach neareft to us, the mammalia and the birds, have their forrows. The affliction they feel on the abfence or lofs of a companion, friend or benefactor, is manifefted by evident figns, in the fame manner as they teftify their attachment without any temporary inducement.

The fame animals exhibit frequent proofs of a very perfect memory; fome even appear to poffefs a certain degree of judgment.

But does any thing fimilar exift in the inferior claffes, and particularly in the loweft? of this we fhall probably remain always ignorant.

With fo much refemblance in the ftructure of the nervous fyftem, in its mode of action, and in the number and ftructure of the principal external organs, why is there fo vaft a difference, as to the total refult, between man and the moft perfect animal?

Is this owing to a more accurate proportion in the relative perfection of the external organs, fo that one does not too much furpafs another? or has the internal organs, in which are performed all the intermediate operations between the fenfation received and the movement executed, that is to fay, the organ of perception, memory

memory and judgment, greater differences than we have yet obferved? or finally, is the fubftance by which thefe proceffes are effected of a different nature? Thefe, however, are not anatomical queftions.

The fympathies or effects refulting from the connections of nerves with each other, and the influence of the nerves on the vegetable or vegetative functions, are fubject to the fame laws in man and the other animals.

Article III.

General Comparifon of the different Nervous Syftems.

On comparing together all the nervous fyftems, we find only one common part, which is a fingle tubercle, fituated at the anterior extremity of the fyftem, and always producing two lateral and tranfverfe fafciculi or crura, which unite it to the reft of the fyftem.

This part appears always to correfpond to that named *cerebellum* in man. The cerebellum of animals that have red blood and vertebræ, is always preceded by feveral pairs of tubercles, forming ufually a larger mafs than the cerebellum itfelf, and united to the reft of the fyftem by by two longitudinal fafciculi or crura, which are interwoven in croffing with thofe of the cerebellum. This union takes place in fuch a manner that both are confounded in the common mafs which forms the root of the medulla oblongata, and medulla fpinalis, and leave no fpace between them. Thefe tubercles make what we call the cerebrum. They prefent confiderable differences in the various claffes of animals, which we fhall explain in fubfequent articles.

In the white-blooded animals, or thofe that have no vertebræ, there are alfo tubercles fituated before the part correfponding to the cerebellum; but thefe tubercles are a great deal fmaller, much removed from each other, and connected with the cerebellum only by feparate nervous filaments. The crura of the cerebellum leave a large interval between them, which receives the œfophagus as in a collar.

The long production of the brain, called the medulla oblongata, and medulla fpinalis, in vertebral animals, is fituated on the back, above the inteftinal canal, and is inclofed in the canal of the vertebræ. The two fafciculi which form it are intimately united, and no trace of their feparation remains, except a longitudinal furrow before and behind. But in the animals that have no vertebræ, when this production exifts, it is formed below the œfophagus by the union of the two crura of the cerebellum. Thefe two

fafcifasciculi commonly remain distinct throughout the greater part of their length, and are only united at different spaces by knots from which the nerves proceed. This production, however, frequently does not exist. In some animals with white blood, which have no elongation of the medullary substance, as in the Molusca, the nervous trunks, which are derived from the crura of the cerebellum, enlarge and form ganglia, or two or three nerves unite with each other to produce a common ganglion; and in general it is only from their ganglia that the nerves, which are distributed throughout the body, take their origin.

In those white-blooded animals that have a knotted and double medullary production, that is to say, the insects, the crustacea, and certain worms, the nerves all arise from the knots or ganglia of the medulla, or from some of the anterior ganglia of the cerebellum.

In the red-blooded animals the nerves of the spine arise from the medulla spinalis in two bundles of medullary filaments, which unite after the posterior bundle has formed a ganglion. They afterwards separate into two trunks, the anterior of which communicates with the great sympathetic nerve by one or two filaments, and a ganglion is always formed at the place where they unite.

The nerves of the brain do not arise precisely in the same manner, the different tubercles

7 which

which form it, however, ſeem to ſerve as ganglia. This at leaſt is evident in the corpora ſtriata, with reſpect to the olfactory nerves; and in the thalami nervorum opticorum, with reſpect to the optic nerves. The nerve of the fifth pair has a particular tubercle, which is very conſpicuous in fiſhes. The corpora olivaria may be conſidered as the ganglia of the eighth pair. There are no tubercles apparently belonging to the third and fourth, though the *teſtes* may perhaps be aſſigned to the latter.

The ſympatheticus major, which is conſtantly found in all red-blooded animals, exiſts in none of thoſe with white blood; unleſs we ſhould regard, as that nerve, the two nervous cords which unite all the ganglia, and which we have called medulla ſpinalis in the cruſtacea, inſects, and worms.

Were this opinion adopted, a medulla ſpinalis would no longer be attributed to theſe animals, and the abſence of that production would then be the common character of all the white-blooded claſſes.

Article IV.

Defcription of the Human Brain.

A. *The Brain of Man viewed on its fuperior Surface.*

When we remove the upper part of the cranium and the dura-mater, there appears an oval fubftance, the length of which is to its breadth nearly as 4 : 3. This oval contracts a little anteriorly. Its convexity is pretty uniform, and nearly half as high as broad.

A deep fiffure, which receives the falx, divides this oval longitudinally into two nearly equal parts, called hemifpheres.

In this view we do not fee the cerebellum, becaufe that part is entirely covered by the brain.

The furrows of this furface are very numerous and deep. The depth of fome is equal to 0.021 metre. They convolute in various directions. The parts of thefe intervals, which are vifible externally, are about 0.01 metre broad, more or lefs; thefe convolutions have the appearance of a number of fmall inteftines.

Reckoning thofe which touch the fiffure that divides the two hemifpheres, we find eighteen or twenty. Reckoning tranfverfely, we find ten or or twelve: but these numbers depend upon that part in which they are counted.

The surface by which each hemisphere is opposed to the other is plane; we find furrows in it as well as in the convex surface. Its height is 0.04. The falx, which is not so high, does not separate these surfaces entirely; and the hemispheres unite below the falx by vessels and cellular substance.

On separating the hemispheres, we observe, at the bottom of the fissure, which divides them, a kind of bridge of medullary substance, which extends from the one to the other, and disappears under them. It does not cover the whole length of the fissure, but leaves anteriorly a space equal to one-third of its length; and posteriorly another space which is double the former: the bridge then is only half the length of the hemispheres. We observe that it folds under itself at both extremities.

B. *The Brain of Man viewed laterally.*

In this view the superior margin of the brain presents a curved line, which resembles one half of an ellipsis; but its inferior margin is very irregular. It first exhibits a concave line, which extends downward from the posterior extremity to the middle of the total length, which is also the lowest point. The cerebellum, which is entirely covered by the cerebrum, is ſituated under this concave line.

The area of the cerebellum, viewed thus in profile, is ſcarcely equal to one-eighth of that of the cerebrum; the part of the brain ſituated above the cerebellum, is called the poſterior lobe of the cerebrum; the part projecting downward, which is terminated by the before-mentioned concave line, is called the middle lobe; this line bends forward, and after being continued in a convex form, terminates in a deep ſulcus, which is directed backward on the lateral ſurface of the brain, and completes the diviſion of the middle lobe from the anterior. The anterior lobe, ſituated before the ſulcus, occupies nearly one-fourth of the whole length of the cerebrum; but inferiorly, and towards the middle line, it is prolonged backward to the internal ſide of the middle lobe, at the depreſſion which contains the pituitary gland.

The furrows on this lateral ſurface of the brain are as numerous, and as irregular, as thoſe on its ſuperior part.

C. *The Brain of Man viewed inferiorly.*

The lower ſurface of the human brain exhibits four eminences, which correſpond to the foſſæ of the *baſis cranii*: one of theſe eminences is ſituated poſteriorly, and comprehends the inferior

ferior ſurface of the cerebellum, the medulla oblongata, and the pons Varolii: the two lateral and intermediate eminences form the middle lobes of the cerebrum: the two that are ſituated fartheſt forward, are called the anterior lobes.

Between theſe four eminences there is a deep depreſſion, which contains the infundibulum, the tubercula mammillaria, and the origin of the optic nerves, and above which, in this inverted poſition, we obſerve the pituitary gland.

The poſterior eminence is an irregular oval, the tranſverſe diameter of which is, to the longitudinal, nearly as 4 : 3 : this oval is deeply notched poſteriorly, in conſequence of the diviſion of the cerebellum; anteriorly, on the contrary, the pons Varolii forms a rounded projection, correſponding to the depreſſion in the middle of the baſe of the cranium.

The exterior outline of the *two lobes of the cerebellum*, is round; their ſurface is moderately convex, nearly equal, and has two remarkable eminences, viz. one a little without, and behind the place where the pons Varolii loſes itſelf in the ſubſtance of the brain; and another, which is larger and oval at the anterior part of the line by which the two lobes of the cerebellum join. Their whole ſurface is marked with ſlight, and nearly parallel furrows, about a line diſtant from each other; their direction is almoſt parallel to the edge of the lobes, except towards the anterior, which they cut obliquely.

The *proceſſus annularis*, or *pons Varolii*, repreſents a kind of creſcent; its anterior edge is convex, and almoſt ſemi-circular; its poſterior edge is concave.

Its ſurface exhibits a medullary ſubſtance, the fibres of which are parallel to each other, and to both edges; they approximate outwardly, to form the two horns of this kind of creſcent, and are loſt in the cerebellum, under, or rather upon the little round eminence. This annular protuberance correſponds to the baſilar foſſa of the os occipitis: its greateſt breadth is double its length.

The *medulla oblongata* appears immediately behind the pons Varolii, by which it ſeems to be bound, as with a collar; its baſe is broadeſt, and it contracts, by degrees, ſo as to repreſent a kind of bulb: we obſerve a longitudinal furrow on its middle, and another on each of its ſides; within each lateral furrow there is a ſlight oval eminence, which both together are called *corpora olivaria*: between each corpus olivarium, and the middle furrow, there are ſome longitudinal fibres, called *corpora pyramidalia;* there is a ſmall triangular depreſſion between the baſes of theſe pyramidal eminences, and the poſterior edge of the pons Varolii. Another depreſſion is alſo obſerved between the corpora olivaria, which ſeparates them from the ſame edge. The fibres of the portion of the medulla oblongata which is ſituated without each corpus olivarium,

rium, are directed obliquely outward and forward.

The two lateral eminences, or *middle lobes of the cerebrum*, are nearly of a triangular ſhape; they are marked by irregular furrows, like all the other parts of the ſurface of the cerebrum; they are ſeparated from the anterior lobes by a groove, called the *fiſſure of Sylvius*, which receives the poſterior edge of the ſmall wings of the ſphenoid bone.

All the parts before theſe two eminences belong to *the anterior lobes* of the brain; theſe are leſs convex, and leſs elevated; they likewiſe exhibit irregular furrows, and in this inverted poſition the olfactory nerves are ſituated upon them, parallel to the middle line which ſeparates them.

To diſtinguiſh the parts ſituated between theſe four eminences, the cerebellum, and the pons Varolii, muſt be preſſed backward, and the middle lobes towards the ſides: we then perceive the *crura* of the cerebrum, which are two cylindrical medullary bodies, and appear to the eye to be the continuation of the medulla oblongata, after its paſſage under the pons Varolii: they touch each other by their internal edges; after proceeding forward, and a little outward, they ſink each on its reſpective ſide, under the maſs of the cerebrum, between its anterior and middle lobes: at this place, each of the crura is croſſed by one of the optic nerves, which arife from the fame depreffion, and are directed forward, and obliquely inward, to unite in the middle line. Between the crura of the cerebrum, and the optic nerves, there is a fpace at the pofterior part, of which we obferve two round white eminences, called *tubercula mammillaria*. The remainder of this fpace is occupied by a cone, formed of an afh-coloured fubftance, and called *infundibulum* ; this cone is prolonged into a flender ftalk, that adheres to the union of the optic nerves, and terminates in the pituitary gland, which, in this inverted pofition, is uppermoft, and covers it.

D. *Developement of the Brain.*

To obtain a right knowledge of the internal parts of the brain, it is neceffary to divide the crura cerebri immediately before the cerebellum, and the pons Varolii : we then find that the cerebrum is connected to the reft of the brain, by only a crefcent, about 0,03 broad, which makes precifely the fection of the crura, and which occupies nearly the middle of the inferior furface of the cerebrum, thus feparated.

The continuation of its fuperior margin is interrupted by the fection of the *aqueduct of Sylvius*, of which we fhall fpeak hereafter. On feparating a little the crura of the cerebrum, we obferve a kind of fmall medullary bridge over this

this aquæduct: on the ſuperior ſurface of this bridge there are four eminences, which have been named *tubercula quadrigemina.*

The two ſuperior and anterior eminences, called *nates*, are of an oval form, and rather larger than the others; the inferior and poſterior, called *teſtes*, are round, but they are prolonged obliquely to the external ſides of the nates.

Where this prolongation meets the root of the optic nerve, which, as we have already obſerved, croſſes the crus, as it aſcends obliquely backward, we obſerve another eminence, which may be regarded as forming a third pair of tubercles*. Between the teſtes poſteriorly, there is a ſmall triangular frænum, which is of a greyiſh colour, and ſomewhat hard.

A little before the optic nerve reaches the lateral eminence of the *teſtis*, it is enlarged and divided by a furrow into two parts; the moſt external of which forms a ſmall oval tubercle, and afterwards ſeems to expand over the poſterior part of the large eminence, called the *thalamus nervi optici.*

The ſuperior ſurface of the two optic thalami, which is ſituated under the cerebrum, repreſents a triangular ſpace, having a notch poſteriorly, which contains the tubercula quadrigemina; the ſides of this ſpace are round, and the middle is depreſſed

* Vicq-d'azir, pl. XVI, No. 54.

depreſſed longitudinally: on ſeparating the thalami, we obſerve that they are intercepted by a cavity, called the *third ventricle*: this cavity is alſo divided: there is extended, from one of its ſurfaces to the other, a production of a pulpy and almoſt fluid ſubſtance, which is named the *ſoft commiſſure* of the *optic thalami*.

This ventricle communicates by the aquæductus Sylvii, which paſſes under the tubercula quadrigemina, with another which is under the cerebellum, and is called the *fourth ventricle*.

The anterior part of the third ventricle penetrates between the tubercula mammillaria, and the union of the optic nerves, to form a kind of funnel of a pulpy ſubſtance, which we have already noticed, under the name of *infundibulum*.

Each ſuperior edge of the third ventricle is marked by a white line, which is prolonged backward, to form the peduncle of the *pineal gland*, which is a ſmall oval aſh-coloured body, ſuſpended above the tubercula quadrigemina. The ſame white line extends forward towards the lower part, and then bends ſuddenly back, to join a thick medullary cord, which forms one part of the anterior pillar of the fornix.

A little more forward we obſerve a tranſverſe medullary cord, which paſſes from one ſide of the cerebrum to the other, and which is called its *anterior commiſſure*.

There is another commiſſure nearly ſimilar, over the entrance of the aquæductus Sylvii, and

under

under the peduncle of the pineal gland; it is named the *posterior commiſſure.* The entrance of the aquæduct is denominated the *anus.*

Between the anterior commiſſure, and the union of the optic nerves, there is a ſpace which is incloſed only by the pia-mater, and a very thin ſtratum of that pulpy ſubſtance which lines the inſide of the third ventricle: this is named the *vulva.*

On the outſide, and before the optic thalami, we find two eminences, which are alſo concealed under the cerebrum; theſe are called *corpora ſtriata,* on account of their internal texture, which we ſhall deſcribe in another place.

The corpora ſtriata are broad anteriorly, where they approach the middle line of the brain; they are contracted poſteriorly, and removed from each other to make room for the optic thalami; they end in a ſort of tail, which follows exactly the outline of the thalamus, and the root of the optic nerve, and are terminated inferiorly by a ſmall obtuſe enlargement; thus each corpus ſtriatum reſembles a horſe-ſhoe, with one of the branches conſiderably longer than the other. In the natural poſition of the brain, this horſe-ſhoe is ſituated on its narroweſt ſide, ſo that the large branch is uppermoſt, and a little more forward and inward than the other.

In the furrow, which ſeparates the corpus ſtriatum from the optic thalamus of the ſame ſide,

ſide, there is a band of medullary ſubſtance, which takes the ſame courſe as the furrow, and is named *linea ſemi-lunaris.*

All the part of the cerebrum that is viſible externally, is a kind of appendix of the corpora ſtriata, but an appendix which greatly ſurpaſſes them in ſize in man. The maſs of each hemiſphere is joined to the whole external margin of the corpora ſtriata. After proceeding downward and outward, it turns upward and inward, to reſt on that of the oppoſite ſide and join the corpus calloſum. The portion of this maſs which joins the inflected cauda of the corpus ſtriatum, forms what is called the *middle lobe.*

The poſterior part of the hemiſpheres, and the corpus calloſum itſelf, bend downward, and the inflected part penetrates under the former, covering the tubercula quadrigemina and the optic thalami. In this manner, but always contracting, it arrives above the anterior commiſſure of the cerebrum, where it is terminated by two medullary cords, which penetrate into the ſubſtance of each thalamus. This fold has obtained the name of the *fornix with three pillars*: poſteriorly it is united immediately to the inferior ſurface of the corpus calloſum; anteriorly this union is formed by two medullary laminæ, which form a very thin partition, called *ſeptum lucidum.* The margins of the fornix extend backward, ſeparating at the ſame time from each other ſo as to form a triangle, and deſcend

into

into the interior of the middle lobe, preferving nearly the fame curvature as the caudæ of the corpora ftriata. Behind each of thefe margins there is a fwelling of the breadth of a finger, which ftill keeps the fame curvature, and is called *cornu ammonis*, or *pes hippocampi:* under the fame edge there is a greyifh ferpentine band which appears fringed, and is named *corpus fimbriatum*.

The inferior furface of the fornix is marked by one or two longitudinal ftriæ on its middle and anterior part. Pofteriorly we obferve fome tranfverfe fibres, which are the continuation of thofe of the corpus callofum. The different folds of which the hemifpheres are compofed, do not join each other by their internal furfaces; they are intercepted by a large cavity in each hemifphere: thefe two cavities are the *anterior ventricles of the cerebrum*. With refpect to their form, they may be compared to an Italic capital *f* fituated thus ∾. The vault of their fuperior branch is formed by the corpus callofum, and its floor by the corpus ftriatum: the defcending branch contains the cauda of the corpus ftriatum anteriorly, and the cornu ammonis pofteriorly. The angle formed by the union of thefe two branches penetrates backwards into the portion of the hemifphere which is fituated above the cerebellum, where it forms a blind cavity which bends inwardly; it has received the name of the *digital cavity:* on its internal

furface

ſurface there is a ſmall eminence, called the *ergot* or *ſpur*.

The two ventricles are ſeparated anteriorly by the *ſeptum lucidum* only, and they would open into each other under the fornix, were it not for a production of the pia-mater, which we ſhall deſcribe hereafter under the name of plexus choroides, and which leaves them no communication except a ſmall hole near the anterior pillar. By the ſame paſſage they communicate with the third ventricle, and by that with the fourth: thus thoſe four cavities may be ſaid to form only one.

There is a fifth cavity between the two layers of the ſeptum lucidum, but it has no external communication. This is the *fifth ventricle*.

The cerebellum is connected to the reſt of the brain by two medullary trunks, one on the right and the other on the left, which ſeem to take root in its internal ſubſtance, in order to produce a crucial intermixture of their fibres with thoſe of the medulla oblongata. The fibres of the inferior plane of each of theſe trunks, are continued to form the pons Varolii, and to unite together on the middle line: thoſe of the ſuperior plane form a more ſlender faſciculus, which is directed towards the teſtes, and which is joined to the faſciculus of the oppoſite ſide, by a very thin medullary lamina, called *valvula cerebri*. The poſterior edge of this valve is united to the maſs of the cerebellum.

The cerebellum is not in contact with the superior furface of the medulla oblongata, but is placed over it like a bridge. The interftice between them is called the *fourth ventricle.*

This cavity communicates with the third by the aquæductus Sylvii. In the bottom of this ventricle we obferve an angular impreffion, called *calamus fcriptorius.*

The cerebellum itfelf is divided into three parts; the two lateral, which are moft confiderable, are called its lobes. The middle, which is the fmalleft, and concealed in the fiffure that feparates the two other parts, is named the *vermiform procefs.*

E. *Sections of the Brain.*

There are different methods of diffecting the brain, in order to fhew its ftructure. Some fections are vertical, others horizontal and oblique.

1. *Vertical Sections.*

The moft important of the vertical fections is that which divides the brain into two equal parts, leaving the two hemifpheres, as well as the corpora ftriata and optic thalami untouched; and bifecting the corpus callofum, the fornix, the three commiffures, the glandula pinealis,

nealis, the tubercula quadrigemina, the pons Varolii, and the medulla oblongata.

This ſection ſhows, 1ſt, that the corpus calloſum, has a curvature nearly parallel to that of the vault of the cranium, and that it folds under itſelf both anteriorly and poſteriorly. 2dly, That the fornix is a continuation of its poſterior fold. 3dly, That the ſeptum lucidum is a triangular ſpace, included between the corpus calloſum and the anterior fold of the fornix. 4thly, That the anterior commiſſure, the union of the optic nerves, and the mammillary tubercle, form a triangle which is almoſt equilateral. This ſection alſo affords a diſtinct view of the great ſpace in the middle of the brain, which commences anteriorly at the infundibulum, then forms the third ventricle, the aquæductus Sylvii, and the fourth ventricle. The ſection of the latter is triangular; that of the aquæduct is long and narrow; that of the third ventricle is nearly ſemi-circular, and its part which deſcends towards the infundibulum, is almoſt ſquare. The diviſion of the medulla oblongata and pons Varolii, exhibits crucial fibres more or leſs remarkable. We ſometimes obſerve a faſciculus ariſing near the fourth ventricle, which, after bending, gives origin to the third pair of nerves.

A ſection of the cerebellum diſplays ſome medullary lineaments, repreſenting a tree with five principal branches, which are ſub-divided twice

twice in fucceffion into fmaller ramifications. This is called *arbor vitæ.* All the parallel fections made more towards the fides exhibit the fame figure.

On penetrating the interior of this vertical fection, towards the external fide, we difcover feveral particulars worthy of notice: 1, That the peduncle of the anterior pillar of the fornix paffes into the fubftance of the optic thalamus, to terminate in the tuberculum mammillare. 2d, That another medullary fafciculus departs from this tubercle, and alfo traverfes the fubftance of the optic thalamus to near its fuperior furface. 3d, That the fibres of the crura cerebri are continued acrofs the optic thalamus to the corpus ftriatum, and acrofs the pons Varolii to the medulla oblongata. 4th, That a fmall greyifh line winds in a ferpentine manner round the corpus olivarium internally. As this line is feen in whatever direction that eminence is cut, it is obvious that it muft contain a body of a very irregular furface, and covered with a thin layer of a greyifh fubftance, the fections of which exhibit thefe linear appearances.

2. *Horizontal Sections.*

The horizontal fections may commence with the fuperior or inferior furface.

When we cut the two hemifpheres fuperiorly at the level of the corpus callofum, we difcover

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the greateſt medullary ſpace that can be demonſtrated in the brain. The grey ſubſtance appears on the edges only, all the reſt is white, and is named the *centrum ovale of Vieuſſens*.

If we diſſect farther downward, the two anterior ventricles ſoon appear. From this view we obſerve that their anterior cornua are approximated, while the poſterior are removed from each other.

The corpus calloſum being completely removed, the fornix is rendered viſible, and we can diſcern very diſtinctly its triangular form. After this we expoſe the fifth ventricle, by ſeparating the two lamina that form the ſeptum lucidum. Then cutting the anterior pillar of the fornix, and throwing the fornix itſelf backward, we lay entirely open the ſuperior ſurface of the optic thalami, the aperture of the third ventricle, the three commiſſures, and the tubercula quadrigemina. The eye may even penetrate into the infundibulum.

On making deeper ſections, we obſerve that the interior of the corpora ſtriata is filled with white ſtriæ, which ſeem to ariſe from the optic thalami, and through them from tho crura of the cerebrum. From the white ſtriæ being ſeparated by others of a cineritious colour, theſe eminences have obtained the name of *corpora ſtriata*.

Penetrating ſtill farther, we obſerve that the anterior commiſſure of the cerebrum extends on each

each ſide into the ſubſtance of the optic thalami, in a white line ſomewhat reſembling a bow. The poſterior commiſſure is loſt almoſt as ſoon as it enters the ſubſtance of the optic thalami.

The tubercula quadrigemina, divided horizontally, preſent an almoſt uniform greyiſh ſubſtance.

The horizontal ſections of the cerebellum exhibit ſome white lines paſſing from right to left, and which are preciſely thoſe that form the arbor vitæ in the vertical ſections.

The horizontal ſections of the medulla oblongata, and pons Varolii diſplay the ſame direction in the fibres as we have already deſcribed. Thoſe of the crura of the cerebrum have a dark brown ſpot internally.

On making horizontal ſections in the inferior ſurface, we diſcover ſeveral remarkable circumſtances; 1. The poſterior fold of the corpus calloſum, which forms inferiorly a large roll behind what is properly called the fornix. 2. The two corpora fimbriata, each of which proceeds from one of the extremities of this roll, and extends to the poſterior pillars of the fornix, the curvature of which they exactly follow. 3. The ſection of the crura of the cerebrum, in which we obſerve the black ſpot, which in this view appears ſemicircular. 4. In this manner we ſhew the inferior ſurface of the fornix and *lyra* in the natural ſituation. Laſtly, on removing the fornix, we diſcover the inferior ſurface of the corpus cal-

 loſum,

lofum, that is to fay, the roof of the lateral or anterior ventricles, to the middle part of which the feptum lucidum adheres by the two laminæ of which it is compofed.

F. *Of the Origin of the Nerves.*

1. *The Olfactory Nerve.*

The olfactory nerve lies under the anterior lobes of the cerebrum, in a furrow near and parallel to the middle line.

The anterior extremity, which is fituated upon the cribriform lamella of the os ethmoides, confifts of a grey fubftance. The remainder of the length of the nerve is white, and of a triangular prifmatic fhape. Its bafe is enlarged and divided into three roots, diftinguifhed by an equal number of white filaments, which terminate in the grey fubftance of the brain. That which is internal is directed outward, until it reaches the fiffura Sylvii, where it is loft. The external afcends upon the internal furface of the hemifphere as far as the corpus callofum. The middle one is much fhorter than the other two, and is even fometimes wanting.

2. *The Optic Nerve.*

The optic nerve evidently arifes by the fibres, which we obferve at the fuperior part of the optic

7 thalami.

thalami. It defcends outwardly, and furrounds, in the form of a ribbon, the crura of the cerebrum, from which it is feparated on its internal edge, but united to them by its external. It approaches to the middle line before the infundibulum, where it is intimately united with its correfpondent nerve, in fuch a manner that neither the eye nor the knife can difcover whether they crofs each other, or are only fimply joined. After this union, they feparate again to go out of the cranium by the optic foramina. The portion which is anterior to their union is cylindrical.

3. *The Oculo-mufcular Nerve.*

This nerve arifes near the middle of the crus of the cerebrum, a little before the pons Varolii, but its origin may be traced into the body of the crus. It is a medullary filament, which, in afcending, bends backward under the floor of the fourth ventricle. It has been erroneoufly fuppofed that this filament proceeded to the tuberculum mammillare. This nerve is directed a little towards the fide, in order that it may pafs out of the cranium by the fpheno-orbitar fiffure, after it has traverfed the dura mater.

4. *The Pathetic Nerve.*

Some filaments behind the teftes, at the fide of the little frænum, form the origin of this

 nerve.

nerve. Farther back, on the valvula cerebri, we obſerve ſeveral white fibres, ſome of which extend to the pons Varolii, and the others diverge, more or leſs, from that direction. Theſe fibres ſometimes appear to contribute to the formation of the nerve.

This nerve paſſes between the middle lobe of the cerebrum, and the adjacent part of the pons Varolii, and the crus. After a pretty long curve, it goes out of the cranium by the ſpheno-orbitar fiſſure, behind the poſterior clinoid proceſſes.

5. *The Tri-facial Nerve.*

Each nerve of the fifth pair ariſes from that part of the crus cerebelli which contributes to form the pons Varolii, very near where the crus paſſes out of the cerebellum. M. Soemmering aſſerts that it may ſometimes be traced into the ſubſtance of that crus, until it is loſt under the floor of the fourth ventricle. It is very ſoft at its origin, but it ſoon becomes very hard, and is divided into a number of filaments, arranged in the form of a flat ribbon. This ribbon is compoſed of three faſciculi, on which account the nerve has received the name of *trigeminous* or *tri-facial*. Theſe faſciculi themſelves have each a particular name, viz. nervus ophthalmicus, maxillaris ſuperior, and maxillaris inferior.

6. *The*

6. *The Abductor Nerve.*

The ſixth pair of nerves commence on the poſterior edge of the pons Varolii, by ſome filaments which come from the ſulcus that ſeparates that pons from the corpora pyramidalia. Some of the filaments appear to riſe from the pons itſelf. They proceed directly under the pons Varolii, advancing towards the ſpine of the os petroſum, where they penetrate the cavernous ſinus, whence they are tranſmitted to the orbit in the manner we ſhall hereafter explain.

7. *The Auditory Nerve, or Portio mollis of the Seventh Pair.*

The acouſtic or auditory nerve appears to commence by ſeveral white fibres, which we obſerve on the inferior ſurface of the fourth ventricle, and which vary in number from two to five. Theſe filaments approximate and deſcend to the ſides of the baſe of the medulla oblongata, and there form the origin of this nerve, which ſeparates from the maſs a little more outwardly than the preceding. It is conveyed into the internal ear, where we ſhall follow its diſtribution in the article on the ſenſe of hearing.

8. *The Facial Nerve, or Portio dura of the Seventh Pair.*

This nerve derives its origin from the ſulcus, which ſeparates the pons Varolii from the medulla oblongata, a little more outward than the corpora olivaria. It ariſes by a flat portion, and by another which appears ſomewhat more fibrous, but which is intimately united with the former. It enters the canal of the dura mater, which is common to it, and the portio mollis, with which it paſſes into the meatus auditorius internus.

9. *The Gloſſo-pharyngeus, par vagum, and nervus ſpinalis or acceſſorius, commonly called the Nerves of the Eighth Pair.*

The gloſſo-pharyngeus, and the vagum, ariſe from the ſulcus, which forms the external boundary of the corpus olivarium. The gloſſo-pharyngeus is ſituated fartheſt forward, and is compoſed of three, four, or five filaments. The vagum is formed by a far more conſiderable number, which occupy all the reſt of the ſulcus.

The ſpinal nerve is formed by ſeveral filaments which ariſe on the ſides of the medulla ſpinalis, as far down as the roots of the fourth, fifth, and ſometimes the ſeventh cervical nerves. It approaches the vagum, and paſſes with it and the gloſſo-pharyngeus through the foramen lacerum poſterius.

10. *The*

10. *The Great Hypogloſſal Nerves.*

Theſe form the twelfth pair, though they are generally demonſtrated as the ninth. Each nerve ariſes from the medulla oblongata, a little below and between the corpora olivaria and pyramidalia, by a great number of ſmall filaments which make a kind of circle. Theſe filaments preſently unite into two or three faſciculi, which paſs through the os occipitis by the anterior condyloid foramen.

ARTICLE V.

Of the Brain of Mammalia.

THE brain of the other mammiferous animals contains preciſely the ſame parts as that of man, and thoſe parts are diſpoſed in a ſimilar order: it varies, however, in the proportion it bears to the reſt of the body, to the cerebellum, and to the medulla oblongata; in its general form; in its circumvolutions; in its internal development; and laſtly, in the differences which its baſe and the origin of the nerves exhibit.

1. *Proportion of the Maſs of the Brain to the reſt of the Body.*

It is very difficult, if not impoſſible, to eſtabliſh this proportion in a comparative manner, becaufe the weight of the brain remains the fame, while that of the body varies confiderably according as the animal in whom the comparifon is made, is fat or lean. Thus the proportion of the weight of the brain to that of the reft of the body, has been ftated by one author to be in the *cat* as 1 to 56, and by another as 1 to 82; in the *dog* as 1 to 305, and as 1 to 47, &c.

The following is, however, a table of thefe proportions, collected from different authors, and from my own obfervations. It will appear that, all things confidered, the fmaller animals have the brain proportionally the largeft; that man is furpaffed in this refpect only by a fmall number of animals, all of which are lean and meagre, as mice, fmall birds, &c.; that among the mammalia, the Rodentia have in general the largeft brain, and the Pachydermata the fmalleft; and that cold blooded animals have it infinitely fmaller than the warm blooded.

Man - - - - - -	$\frac{1}{22}$ $\frac{1}{25}$ $\frac{1}{30}$ $\frac{1}{35}$
according as he is young or old.	
ORANGS.	
Long-armed ape, or gibbon - - - -	$\frac{1}{48}$
SAPAJOUS.	
Orange monkey (simia sciurea) - - -	$\frac{1}{22}$
Capucin monkey (simia capucina) - - -	$\frac{1}{25}$
Striated monkey (simia jacchus) - - -	$\frac{1}{28}$
Four-fingered monkey (simia paniscus) - -	$\frac{1}{41}$

GUENONS.

GUENONS.

Malbrouck (simia faunus) young	$\frac{1}{24}$
The green and red monkeys	$\frac{1}{41}$
Varied monkey (simia mona)	$\frac{1}{44}$
White eye-lid monkey (simia æthiops)	$\frac{1}{48}$

MAGOTS AND MACAQUES.

Hair-lipped monkey, or macaque	$\frac{1}{96}$
Barbary ape, or magot	$\frac{1}{105}$
Papion, or great baboon	$\frac{1}{104}$

MAKIS.

Ring-tailed maucauco, (lemur catta) young	$\frac{1}{61}$
Vari (lemur macaco)	$\frac{1}{84}$

CHEIROPTERA.

Great bat (vespertilio noctula)	$\frac{1}{96}$

PLANTIGRADA.

Mole	$\frac{1}{36}$
Bear	$\frac{1}{265}$
Hedge-hog	$\frac{1}{168}$

CARNIVORA.

Dog	$\frac{1}{47}$ $\frac{1}{50}$ $\frac{1}{57}$ $\frac{1}{154}$ $\frac{1}{161}$ $\frac{1}{305}$
Fox	$\frac{1}{205}$
Wolf	$\frac{1}{230}$
Cat	$\frac{1}{82}$ $\frac{1}{94}$ $\frac{1}{156}$
Panther	$\frac{1}{247}$
Martin	$\frac{1}{305}$
Ferret	$\frac{1}{138}$

RODENTIA.

RODENTIA.

Beaver		$\frac{1}{290}$
Hare		$\frac{1}{228}$
Rabbit	$\frac{1}{140}$	$\frac{1}{152}$
Ondatra, or Musk beaver		$\frac{1}{124}$
Rat		$\frac{1}{76}$
Mouse		$\frac{1}{43}$
Field mouse		$\frac{1}{31}$

PACHYDERMATA.

Elephant		$\frac{1}{500}$
Hogs: Wild boar		$\frac{1}{672}$
Hogs: Domestic hog	$\frac{1}{512}$	$\frac{1}{412}$
Hogs: Siamese hog		$\frac{1}{451}$

RUMINANTIA.

Stag		$\frac{1}{290}$
Roe, young		$\frac{1}{94}$
Sheep	$\frac{1}{351}$	$\frac{1}{192}$
Ox		$\frac{1}{860}$
Calf		$\frac{1}{219}$

SOLIPEDA.

Horse		$\frac{1}{400}$
Ass		$\frac{1}{254}$

CETACEA.

Dolphin	$\frac{1}{25}$	$\frac{1}{36}$	$\frac{1}{66}$	$\frac{1}{102}$
Porpoise				$\frac{1}{93}$ *

2. *Pro-*

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* To prevent the neceffity of returning to this fubject in the articles that treat of the brain of the other claffes, we fhall fubjoin

2. *Proportion of the Brain to the Cerebellum and Medulla oblongata.*

The proportion of the weight of the brain to the cerebellum and medulla oblongata, may be obtained

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join a table of its proportion to the reft of the body in fome birds and reptiles. It is taken partly from Haller, and partly from our own obfervations.

BIRDS.

Eagle	$\frac{1}{160}$
Falcon	$\frac{1}{102}$
Sparrow	$\frac{1}{25}$
Canary-bird	$\frac{1}{14}$
Sifkin	$\frac{1}{23}$
Chaffinch	$\frac{1}{27}$
Redbreaft	$\frac{1}{32}$
Blackbird	$\frac{1}{68}$
Cock	$\frac{1}{25}$
Duck	$\frac{1}{257}$
Goofe	$\frac{1}{360}$

REPTILES.

Land tortoife	$\frac{1}{2240}$
Sea tortoife	$\frac{1}{5688}$
Collar fnake	$\frac{1}{792}$
Frog	$\frac{1}{172}$

FISHES.

White fhark (fqualus carcharias)	$\frac{1}{2496}$
Great dog-fifh (fqualus canicula)	$\frac{1}{1344}$
Tunny (fcomber thynnus)	$\frac{1}{37440}$
Pike	$\frac{1}{1305}$
Carp	$\frac{1}{560}$
Silurus glanis	$\frac{1}{1882}$

obtained with precifion, becaufe no variation in the health, corpulence, &c. of individuals, has any apparent influence on thefe parts.

This proportion is more confiderable in man, than in almoft all the other mammalia, as will appear from the following table. The Rodentia have the cerebellum largeft, in proportion to the brain.

In man, the cerebellum is to the brain, as - - - - -	1 : 9
Orange-monkey - - - -	1 : 14
Capucin-monkey - - -	1 : 6
Magot - - - - -	1 : 7
Barbary ape, or Baboon - -	1 : 7
Varied monkey - - - -	1 : 8
Dog - - - - - -	1 : 8
Cat - - - - - -	1 : 6
Mole - - - - -	1 : 4½
Beaver - - - - -	1 : 3
Rat - - - - - -	1 : 3¼
Moufe - - - - -	1 : 2
Hare - - - - - -	1 : 6
Wild-boar - - - - -	1 : 7
Ox - - - - - -	1 : 9
Sheep - - - - - -	1 : 5
Horfe - - - - - -	1 : 7

The proportion of the brain to the medulla oblongata, is eftimated by the meafure of their diameters. M. Sœmmering and M. Ebel have

 fhewn,

ſhewn, that this proportion is more in favour of the brain in man, than in all the other animals, and that it is an excellent criterion of the degree of intelligence an animal enjoys; becauſe it is the beſt index of the pre-eminence which the organ of reflection preſerves over thoſe of the external ſenſes. There are, however, ſome exceptions to this rule; and that which the dolphin affords, is very remarkable.

We ſubjoin a table of the proportions between the breadth of the medulla oblongata, meaſured at its baſe, and the greateſt breadth of the brain in ſome animals.

In man, the breadth of the medulla oblongata, behind the pons Varolii, is to that of the brain as - -	1 : 7
Short-tailed Macaque - -	1 : 5
Chineſe-monkey - -	1 : 4
Dog - - - -	6 : 11
or - - - -	3 : 8
Cat - - - -	8 : 22
Rabbit - - -	3 : 8
or - - - -	1 : 3
Hog - - - -	5 : 7
Ram - - - -	5 : 7
Stag - - - -	2 : 5
Roe - - - -	1 : 3
Ox - - - -	5 : 13
Calf - - - -	2 : 5

Horſe

Horfe - - - -	8 : 21
Dolphin - - -	1 : 13*

3. *General Form.*

The differences in the general form of the brain, depend principally on a greater or lefs magnitude, and development of the two productions of the corpora ftriata, called the hemifpheres; thefe parts are thicker in every direction, in man, than in any other animal, and hence the peculiar rotundity of his brain.

The brain begins to appear flatter in the monkey kind; their hemifpheres are lengthened backward, like thofe of man, to form the pofterior lobes which lie on the cerebellum. In all the other quadrupeds, however, commencing with the Sarcophaga, the hemifpheres are not only fmall, and confequently the fiffure which feparates them of little depth and the upper furface of the brain flat; but the middle lobes are much lefs convex inferiorly, and the pofterior do not exift at all. The cerebellum appears uncovered behind the cerebrum.

With

* We fhall here add a ftatement of the proportion of the fame parts in fome birds.

Falcon - - - - -	13 : 34
Owl - - - - -	14 : 35
Duck - - - - -	10 : 27
Turkey - - - - -	12 : 33
Sparrow - - - - -	7 : 18

With reſpect to the external ſhape, the brain of monkies very much reſembles that of man, in conſequence of its oval form ; but in the Sarcophaga it is proportionally narrower anteriorly, and approaches more to the triangular ſhape. This is particularly apparent in the *dog* and the *oppoſſum*.

Some Rodentia, as the *hares* and the *rabbits*, have alſo this form; but others, as the *beaver* and the *porcupine*, have the cerebrum almoſt circular.

In the other herbivorous kinds, the brain is generally of an oval form, broader behind than before.

The cerebrum of the *dolphin* is of a very extraordinary ſhape ; it is very large, and covers the cerebellum ſuperiorly: it is rounded on every ſide, and almoſt twice as broad as long.

The cerebellum of man having its middle lobe concealed under the other two, ſeems at firſt ſight to have no more than two lobes, the general outline of which is nearly round.

In the other animals, even in monkies, this middle lobe is proportionally larger, and is viſible externally. It is equal to the other lobes in the Rodentia: we find it proportionally ſmaller in the dolphin than in monkies.

4. *Circumvolutions.*

The circumvolutions of the brain are deeper in man than in any other animal, and very few have them ſo numerous.

They are much fewer in the *monkey* kind, particularly in the *ſapajous*: the poſterior lobe has ſcarce any, except in the *jocko* and the *gibbon*, in which that lobe is ſeparated from the reſt anteriorly, by a very diſtinct tranſverſe fiſſure.

In the Sarcophaga, the furrows of the brain are pretty numerous, and exhibit a certain order, which is preſerved throughout the greater number of ſpecies; we obſerve, poſteriorly, two on each ſide, parallel to the middle line, and a ſhort one anteriorly, which croſſes it.

The Rodentia have, in general, no ſenſible circumvolutions; their hemiſpheres are almoſt entirely ſmooth, or exhibit only very ſlight furrows; but we find a number of convolutions in the hoofed animals, and particularly in the Ruminantia and the *horſe*.

The *dolphin* has numerous and deep circumvolutions.

All the other mammalia have, like man, the ſurface of the cerebellum marked by tranſverſe furrows, parallel and adjoining to each other; but they differ amongſt themſelves with reſpect to the other furrows, which divide the cerebellum into lobules, and which ſeem to form circumvolutions ſimilar to thoſe of the cerebrum.

They are ſomewhat numerous in the Sarcophaga, the Ruminantia, and the Solipeda: we obſerve fewer in the other orders.

5. *Develop-*

5. *Development of the internal Parts of the Brain in Mammalia.*

The tubercula quadrigemina are proportionally larger in the animals that are removed from man, and are very confiderable in the herbivorous kinds, whether Rodentia, Ruminantia, or Solipeda; all thefe herbivorous animals have the *nates* round, and much larger than the *teftes*; this renders it probable that thefe tubercles were fo named by the ancients, in confequence of their being firft obferved in animals of that order.

In the *monkies*, their refpective proportion is nearly the fame as in man; but in the Sarcophaga, the *teftes* are generally larger than the *nates*.

In the *dolphin*, they are at leaft triple the fize of the nates.

The tubercles which we have pointed out as forming a third pair in man, become, in the *lemur* and the *dog*, as large as thofe of the other pairs; but they are very little, or not at all, apparent in the Ruminantia.

The optic thalámi, the third and fourth ventricle, and the pineal gland, prefent no remarkable peculiarities.

The corpora ftriata do not differ, except a little more or lefs in breadth. The fame obfervation applies to the corpus callofum and the fornix. The cornua ammonis are in general

 propor-

proportionally larger in the quadrupeds; there is no ſwoln appearance on their ſurface, as in man.

The anterior ventricles have no digital cavity except in man and the monkies: that part exiſts in no other mammiferous animal; its preſence depends on that of the poſterior lobes.

6. *Of the Baſe of the Brain, and the Origin of the Nerves.*

The baſe of the brain preſents much fewer inequalities in quadrupeds than in man; the infundibulum is not ſo deep; the middle lobes, and the pons Varolii, are leſs prominent; the corpora pyramidalia are extended farther backward. With reſpect to the nerves, we obſerve no remarkable differences, except in the olfactory.

In the *monkies* only, the olfactory nerve is, as in man, diſtinct at its baſe from the maſs of the brain, and forming a medullary filament. In the other animals we perceive only ſome whitiſh marks, and, inſtead of the nerve, a large aſh-coloured eminence, which fills the ethmoidal foſſa, and contains a cavity which communicates with the anterior ventricle; this eminence was called, by the ancients, *caruncula mammillaris.*

The *dolphin* has no olfactory nerves, nor any thing that ſupplies their place. It is the ſame in ſeveral other Cetacea.

It

It refults from thefe obfervations, that the peculiar character of the brain of man, and the monkey, confifts in the exiftence of the pofterior lobe, and the digital cavity: that of the brain of the Sarcophaga, in the fmallnefs of the *nates*, in proportion to the *teftes*; that of the brain of the Rodentia, in the largenefs of the *nates*, and in the abfence or little depth of the circumvolutions; that of the brain of hoofed animals, in the great fize of the *nates*, and the numerous and deep convolutions; that of the brain of Cetacea, in its great height and breadth, and in the total abfence of the olfactory nerves. Thus it appears, that all the herbivorous animals have the *nates* larger than the *teftes*, and that it is quite the contrary in the carnivorous. Only man, and the quadrumana, have nerves, which, in propriety of language, can be called olfactory. In the true quadrupeds, they are replaced by the carunculæ mammillares; and they are entirely wanting in the Cetacea.

Article VI.

Of the Brain of Birds.

The brain of birds is diftinguifhed at the firft view, by being formed of fix maffes or tubercles, all vifible externally, viz. two hemifpheres, two optic thalami, a cerebellum, and a medulla oblongata.

The two hemifpheres reprefent the figure of a rounded heart, the point of which is directed forward: the optic thalami are two round tubercles, placed under the hemifpheres, but are not enveloped by them: the cerebellum is only a fingle lobe, compreffed laterally: the medulla oblongata has neither corpora pyramidalia nor olivaria, nor pons Varolii; it reprefents a large fmooth furface between the two optic thalami: the crura of the cerebellum pafs into it immediately, without forming any projection.

There are no circumvolutions on the hemifpheres, nor on the optic thalami; but the cerebellum has fome tranfverfe lines parallel, and clofe together, as in the mammalia.

Birds want the corpus callofum, fornix, and feptum lucidum. On feparating the two hemifpheres, we obferve that they are diftinct throughout the whole of their height, and that they do not unite to each other except pofteriorly towards the anterior commiffure of the cerebrum. The furface, by which they join, prefents fome white radiated lines, which are derived from this commiffure; that furface is formed by a thin partition, which ferves as the internal parietes to the anterior ventricles. This partition is, as ufual, a fold of the appendix of the corpus ftriatum, which appendix is very fmall in birds, in which the corpus ftriatum forms

forms in itfelf almoft the whole of the hemifphere. It takes the figure of a kidney, but has no cauda. The anterior ventricles alfo are not inflected downward, as in the mammalia, and confequently there is no cornu ammonis. Behind their internal partition there is a fiffure, by which they communicate together, and with the third ventricle, if the plexus choroides prefent no obftacle.

The anterior commiffure is prolonged on each fide into the fubftance of the hemifpheres, as in man and in quadrupeds.

The third ventricle is fituated between the optic thalami; the white lines which bound it fuperiorly are prolonged, as ufual, to form the peduncle of the pineal gland. There is an anterior and pofterior commiffure which are white.

The bottom of the third ventricle communicates with the infundibulum. Its pofterior part communicates likewife with the fourth ventricle, but the arch placed over the aquæduct of Sylvius does not fuftain the tubercula quadrigemina. It is a fimple thin lamina, which is merely the valvula cerebri extended farther forward.

The fourth ventricle refembles that of mammalia, and has alfo the longitudinal impreffion, called calamus fcriptorius.

The optic thalami contain each a ventricle which communicates with the others by the aquæductus Sylvii.

There are no mammillary tubercles or eminences. The corpora ſtriata do not exhibit alternate white and grey ſtriæ internally. The arbor vitæ is leſs complex than in the mammalia.

Between the corpora ſtriata, and the optic thalami, there are four round eminences which are better diſtinguiſhed in the *oſtrich* than in other birds. The firſt are ſituated before the anterior commiſſure, even in the anterior ventricles. The others are behind that commiſſure, and project into the third ventricle, nearly at the place where the ſoft commiſſure is ſituated in the mammalia. There is nothing analogous to theſe tubercles in the human brain, but we find ſimilar ones in that of fiſhes.

The olfactory nerves ariſe from the point of the hemiſpheres, and do not come from their baſe as in the mammalia; they appear to be a mere continuation of theſe bodies.

The other nerves of the brain do not differ in their origin.

ARTICLE VII.

Of the Brain of Reptiles.

ALL the parts of the brain of reptiles are ſmooth, and without circumvolutions. The optic

optic thalami are ſituated behind the hemiſpheres, but are not covered by them. They contain each, as in birds, a cavity which communicates with the third ventricle. At the extremities of this ventricle, we obſerve the anterior and poſterior commiſſure, but there is no ſoft commiſſure, nor tubercula quadrigemina.

In the *tortoiſe* the hemiſpheres form an oval. Their anterior part is ſeparated from the poſterior by a ſulcus, and repreſents a kind of bulb, which ſerves as a root to the olfactory nerves. The ſize of this bulb is about equal to one-third of the hemiſphere. The interior of the hemiſphere is, as uſual, excavated by a ventricle, and contains a ſubſtance analogous to the corpus ſtriatum, and which pretty much reſembles in its form that of birds.

The optic thalami are not larger than the bulbs of the olfactory nerves. Their form is nearly round. They extend downward and forward, under the hemiſpheres, to produce the optic nerve. The valve of the cerebrum is ſituated between them and the cerebellum. No tubercle is either placed above it or before it, and it gives origin, as uſual, to the fourth pair of nerves.

Before the optic thalami, and under the poſterior part of the hemiſpheres, there is a tubercle which correſponds to that we have remarked in birds.

The cerebellum is nearly hemiſpherical. The fourth

fourth ventricle penetrates a conſiderable way into its ſubſtance.

In the *frog* the hemiſpheres are longer and narrower. The optic thalami are larger in proportion to the hemiſpheres. Their ventricle is very diſtinct. It is the contrary in *ſalamanders*, which have the optic thalami very ſmall, and the hemiſpheres almoſt cylindrical.

The cerebellum of theſe two kinds of reptiles is flat, triangular, and lies poſteriorly on the medulla oblongata.

In the *ſerpents* the two hemiſpheres form together a maſs which is broader than long. The optic thalami are almoſt round, and one half leſs than the hemiſpheres behind which they are ſituated. The olfactory nerve has no apparent bulb. The cerebellum is exceedingly ſmall, flat, and in the form of a portion of a circle.

In all theſe animals the inferior ſurface of the brain is nearly ſmooth. The optic thalami make no projection downward, and the pons Varolii does not exiſt.

The olfactory nerves ariſe, as in birds, from the anterior extremity of the hemiſpheres. The optic nerves ſeem to derive their origin from a common eminence, ſituated under the middle of the hemiſpheres. The other nerves exhibit no particularities as to their origin.

Article VIII.

Of the Brain of Fishes.

The different lobes and tubercles which compofe the brain of fifhes, are fituated behind each other, in fuch a manner that the whole, inftead of appearing as one common mafs, more or lefs, approaching an oval form, refembles a kind of double chaplet. This comparifon is more properly applied to the brains of fifh, than to thofe which we have juft noticed, on account of the greater number of thofe tubercles or lobes.

The cerebellum is always fingle. It is proportionally larger than in warm-blooded animals. It even frequently furpaffes the hemifpheres in fize.

The two hemifpheres always exift. They are generally of an oval form, without any apparent circumvolution, and each contains a ventricle, the floor of which prefents an elevation analogous to the corpus ftriatum.

The optic thalami are conftantly fituated, as in birds, below the hemifpheres. They are fmaller than the latter, but each of them alfo contains a ventricle.

On the two fides of the origin of the medulla oblongata, behind the cerebellum, there are almoft always fome tubercles, which appear to form

form the origin of ſeveral pairs of nerves, and which are often as large as the hemiſpheres. There is ſometimes a ſingle tubercle between them, which ſeems to form a ſecond cerebellum.

The olfactory nerves, at their origin, form ſwellings or knots, the number of which varies, and which are frequently ſo large that ſome authors have miſtaken them for the real brain.

Finally, in ſeveral fiſhes there are under the common arch of the hemiſpheres, ſometimes two, ſometimes four tubercles, which vary in their figure and proportions, but which would preſent a ſtriking analogy to the tubercula quadrigemina, were they not like thoſe that reſemble them in birds, ſituated before and above the optic thalami.

The brain of fiſhes is always very ſmall in proportion to their body. It never completely fills the cavity of the cranium. The ſurface of the hemiſpheres is always ſmooth. The cerebellum and its lateral tubercles occaſionally appear rugous.

The brain may vary in the different kinds of fiſhes. 1ſt. In the number and form of the tubercles of the olfactory nerve. 2. In the number and form of the eminences contained within the hemiſpheres. 3. In the form of the cerebellum. 4. In the tubercles which are ſituated behind the cerebellum. We proceed to examine it under theſe different points of view.

1. *The*

1. *The Tubercles of the Olfactory Nerves.*

In the *rays* and the *ſharks* the tubercles are united into one maſs of various lengths, but which is more than double the ſize of the hemiſpheres. It contains no cavity, and its inſide is entirely formed of a homogeneous medullary ſubſtance. The olfactory nerve, properly ſo called, ariſes from each of the lateral parts of this maſs, which ſeveral authors have deſcribed as the cerebrum, and others as its anterior lobes.

Theſe tubercles are long and narrow in the *ſturgeon*: they are ſimple, oval, and ſmaller than the hemiſpheres in the *lump fiſh* and the *moon fiſh* (*Tetrodon mola Lin.*) The genus *gadus*, that is to ſay, *cod*, *whitings*, &c. have them ſimple and round. In the *cod* they are even almoſt as large as the hemiſpheres. The *wraſſes*, and all the genus *cyprinus*, that is to ſay, *carps*, *barbels*, *tenches*, &c. have them alſo ſimple and round, but diſtinguiſhed by a ſlight furrow, which gives them the form of a kidney. In the *pleuronectes*, the *herrings*, the *pikes*, the *perches*, and in all the *ſalmon* genus, which includes the *trouts* and the *ſmelts*, &c. there are two pair of tubercles, the anterior of which is ſmaller than the other, but they do not equal the hemiſpheres in magnitude. Finally, in the *eel* genus there are three pair of tubercles, which diminiſh in magnitude, beginning with the laſt. Their brain therefore preſents altogether ten eminences before the cerebellum, eight of which are ſuperior, viz. the ſix tubercles, and the two hemiſpheres; and two inferior, which are the optic thalami.

2. *The Eminences within the Hemiſpheres.*

a. The corpora ſtriata are not apparent in the *rays* and *ſharks*, and the interior of their ventricle preſents no eminences. In moſt of the other fiſhes the corpora ſtriata repreſent two ſegments of a circle, the concavity of which is turned inward. From the convex ſide ſome very fine medullary ſtriæ proceed, which are prolonged tranſverſely on the internal parietes of the ventricle. Theſe corpora ſtriata vary in breadth according to the ſpecies. They form two elevated oval bodies in the *whiting*. Their anterior extremity approaches nearer to the middle line than the poſterior. The anterior commiſſure of the brain is ſituated a little below them. Between them we obſerve a fiſſure, which leads into the third ventricle. The ſuperior portion of each hemiſphere is not, as in the other red-blooded animals, an appendix of the corpora ſtriata, which bends inferiorly to form a vault.

b. The tubercles, ſimilar to the quadrigemina, do not exiſt in the *rays* and the *ſharks*. There is only a ſingle pair in the *eels*, the *haddocks*, and the *herrings*, which produces a ſemi-oval eminence before the cerebellum, between the poſterior pofterior extremities of the corpora ftriata. The *pikes*, the *trouts*, and *falmon*, and the *perches*, have two pairs, which form four round fmall tubercles, the pofterior of which are rather the largeft.

In the *carp* genus there are alfo four eminences, but they are very unequal. The pofterior are fmall and round, the anterior are extremely long, cylindrical, and bent outward and backward, following the curvature of the lateral ventricles, all the cavities of which they occupy. Their pofterior furface is marked by a longitudinal furrow.

3. *The Cerebellum.*

The cerebellum of fifhes does not merely cover the fourth ventricle; that cavity rifes into its fubftance: it is fometimes rounded, and fometimes approaches more or lefs to a conical form. In the *rays* and the *fharks* it is irregularly furrowed. It is fmooth in almoft all the other fifh. Internally, we obferve no veftiges of the arbor vitæ, except fome indiftinct whitifh lines. Where its form is conical, as in the *cod* and the *carp*, its point is inflected a little backward, which gives it the form of a Phrygian cap.

4. *The Tubercles fituated behind the Cerebellum.*

Thefe tubercles are peculiar to fifhes, unlefs we we regard them as fupplying the place of the corpora olivaria.

In the *ray* they are large, irregularly furrowed, and evidently give origin to the greater part of the fifth pair of nerves.

The *carp* has them as large as the hemifpheres, and in the form of kidneys. Between them there is a large round tubercle, which may be called a fecond cerebellum, but which is immediately connected with the dorfal part of the medulla oblongata, and which enclofes no ventricle.

In the *whiting* and the *cod* the tubercles are oval, and fituated altogether above the medulla. It is nearly the fame in the *common eels* and *conger eels*.

Thefe parts are little apparent in the *pikes*, *trouts*, *falmon*, and *perches*.

5. *Origin of the Nerves.*

In fifhes the olfactory nerves are merely continuations of the tubercles fituated before the hemifpheres. They frequently take a long courfe before they arrive at the noftrils. The optic nerves arife under the cerebrum where the thalami are fituated. Thefe nerves are very large, and are compofed either of diftinct filaments, or of a fingle flat band which is fometimes folded longitudinally on itfelf. They crofs without being confounded, and we plainly

fee

fee that the nerve of the left fide proceeds to the right eye, and that of the right fide to the left.

The fifth pair of nerves arife fo near the auditory that they feem but one. The fafcial nerve, on the contrary, is very diftinct from the auditory. The nerve of the eighth pair is very thick; the others prefent no peculiarity.

ARTICLE IX.

Recapitulation of the Characters peculiar to the Brain in the Four Claffes of Vertebral Animals.

FROM the examination we have juft concluded, it refults,

1. That the character which diftinguifhes the brain of mammalia from that of the other red-blooded animals, confifts,

a. In the exiftence of the corpus callofum, the fornix, the cornua ammonis, and the pons Varolii.

b. In the tubercula quadrigemina being placed upon the aquæductus Sylvii.

c. In the abfence of ventricles in the optic thalami, and in the pofition of thefe thalami within the hemifpheres.

d. In the alternate white and grey lines within the corpora ſtriata.

2. The character peculiar to the brain of birds conſiſts,

a. In the thin and radiated ſeptum, which ſhuts each anterior ventricle on the internal ſide.

3. The character of the brain of reptiles depends,

a. On the poſition of the thalami behind the hemiſpheres.

4. The character belonging to the brain of fiſhes conſiſts,

a. In the tubercles of the olfactory nerves, and the tubercles ſituated behind the cerebellum.

5. The three laſt claſſes have, in common, the following characters, by which they are diſtinguiſhed from the firſt:

a. Neither corpus calloſum, nor fornix, nor their dependencies.

b. Some tubercles, more or leſs numerous, ſituated between the corpora ſtriata, and the optic thalami.

c. The thalami containing ventricles, and being diſtinct from the hemiſpheres.

d. The abſence of any tubercle between the thalami and the cerebellum, as well as the abſence of the pons Varolii.

6. Fiſhes have certain characters in common with birds, which are not to be found in the other claſſes: theſe are,

a. The

a. The poſition of the optic thalami under the baſe of the brain.

b. The number of the tubercles placed before theſe thalami, which are commonly four.

7. Fiſhes and reptiles have for a common character diſtinguiſhing them from the two firſt claſſes, the abſence of the arbor vitæ in the cerebellum.

8. All red-blooded animals have the following characters in common:

a. The principal diviſion into hemiſpheres, optic thalami, and cerebellum.

b. The anterior ventricles double, the third and fourth ſingle, the aquæductus Sylvii, the infundibulum, and a communication between all theſe cavities.

c. The corpora ſtriata and their appendices in the form of a vault, called hemiſpheres.

d. The anterior and poſterior commiſſures, and the valve of the cerebrum.

e. The bodies named pineal and pituitary glands.

f. The union of the great ſingle tubercle or cerebellum, by two tranverſe crura, with the reſt of the brain, which gives origin to the two longitudinal crura of the medulla oblongata.

9. It alſo appears that there exiſt certain relations between the faculties of animals and the proportions of their common parts.

Thus the intelligence they poſſeſs, appears more perfect in proportion to the volume of the appendix of the corpus ſtriatum, which forms the vault of the hemiſpheres.

Man has that part greater, more extended, and more reflected than the other animals.

In proportion as we deſcend from man, we obſerve that it becomes ſmaller and ſmoother on the ſurface, and that the parts of the brain are leſs complicated with each other, but ſeem to be unfolded and ſpread out longitudinally.

It even appears that certain parts aſſume, in all claſſes, forms which have a relation to particular qualities of animals: for example, the anterior tubercula quadrigemina of *carps*, which are the moſt feeble and leaſt carnivorous of fiſhes, are proportionally larger than in the other genera, in the ſame manner as they are in the herbivorous quadrupeds. By following theſe inquiries, we may hope to obtain ſome knowledge of the particular uſes of each of the parts of the brain.

Article X.

Of the Membranes of the Brain.

In all the red-blooded animals, the brain, as well as the other parts of the nervous ſyſtem, is covered by three membranes.

That which is next to it, is named the *pia-mater;*

mater; the external is called the *dura-mater*; and that which is intermediate, has been denominated *arachnoides*.

a. The *dura-mater* is a thick opaque membrane, which lines all the offeous cavity of the cranium, and the vertebral canal.

The greater part of the fibres of the external furface are longitudinal, and moft of thofe of the internal furface are tranfverfe; but a confiderable number of others run in various directions.

Within the cranium the dura-mater is intimately united to the bones, and fupplies the place of the periofteum. Its external furface is cellular and flocculent: its internal is fmooth and gloffy. In the vertebral canal it is more loofe, and is not intimately united to the bones; but its organization is the fame. This membrane is regarded by anatomifts as formed of two laminæ, though it is extremely difficult to feparate them. Blood veffels are diftributed between thefe laminæ, and the internal appears to be detached from the external, to form feveral reflections.

Seven of thefe reflections have been defcribed in man.

1. The *falx of the cerebrum*, which extends from the crifta galli of the ethmoid bone, to the internal fpine of the os occipitis. Its inferior edge is unattached. It is narrow anteriorly, broad pofteriorly, and is fituated between the

 two

two hemiſpheres, which it ſeparates from each other.

2. The *tentorium cerebelli*, which ſeparates the two poſterior lobes of the cerebrum from the cerebellum. It ariſes from the dura-mater, before the two branches of the occipital croſs, and extends towards the poſterior clinoid proceſſes, leaving a vacancy for the paſſage of the medullary prolongations of the cerebrum.

3. The *falx of the cerebellum*, which correſponds to the inferior line of the occipital croſs, and is extended ſome way between the lobes of the cerebellum.

4. The two folds which paſs from the anterior to the poſterior clinoid proceſſes, and in that manner circumſcribe the pituitary foſſa.

5. Finally, the two reflections which ſeparate the anterior from the middle lobes of the cerebrum, and ſurround the orbitar proceſſes of the os ſphenoides, called the little wings of Ingraſſias.

In the other mammalia, the falx of the cerebrum diminiſhes greatly both in length and breadth.

The tentorium cerebelli, on the contrary, is very conſiderable: it is even ſupported by an oſſeous lamina in thoſe that run ſwift, as we have pointed out in the Oſteology of the Head, Art. 3. This fold ſeems deſtined to prevent the friction of the two parts of their brain, in the ſame manner as the falx of the cerebrum prevents

vents the one hemifphere from preffing on the other, when the head repofes on one fide.

The falx of the cerebellum difappears entirely in all animals in which the vermiform procefs projects more than the lateral lobes, as is the cafe in all the real quadrupeds.

We find the falx of the cerebrum in birds. In the *turkey* it has the form of the fegment of a circle: it extends from the middle fpace between the openings for the olfactory nerves, to the tentorium of the cerebellum. The falx of the cerebellum is wanting. The tentorium, which is not extenfive, is fuftained by an offeous lamina, and there are befides two particular folds on each fide which feparate the hemifpheres from the optic thalami.

None of thefe folds are found in the animals that have cold red blood. The dura-mater of reptiles and fifhes adheres in every part to the internal furface of the cranium: it is even feparated from the brain by a mucous or oily fluid of more or lefs confiftence.

b. The *membrana orachnoidea* is thus named from its texture, which is extremely delicate and tranfparent, and which has therefore been compared to that of a *fpider's* web: it envelopes the pia-mater, but does not penetrate with it into the furrows of the brain: it is ftretched over thefe depreffions in the manner of a bridge, except at fome places where the internal lamina of the dura-mater is prolonged: it makes a large fun-

 nel,

nel, which receives the medulla ſpinalis. In man this ſac appears to commence immediately below the origin of the optic nerve.

The cold-blooded animals in which, as we have already obſerved, the brain does not fill the cavity of the cranium, have the arachnoides replaced by a lax cellular ſubſtance, which occupies all the ſpace included between the dura and pia-mater; it is commonly moiſtened by a gelatinous fluid, as in the cartilaginous fiſhes, and ſometimes coloured with blood. In the *carp* and the *ſalmon* this humour appears like an oily froth.

c. The *pia-mater* is the membrane which immediately envelopes the ſubſtance of the brain; it deſcends into all the furrows that appear on its ſurface, and which form its circumvolutions. It would appear to conſiſt altogether of blood-veſſels, but the arteries and veins only paſs through it. We obſerve that it is much more ſolid, and has a greater number of veſſels at thoſe places where it covers the cineritious parts of the brain, than where it envelopes the medullary ſubſtance and the nerves: it accompanies and inveſts the *ſpinal marrow*; it penetrates into the ſeveral ventricles, but is not attached to their parietes; it floats in their cavity where it ſupports the veſſels. Theſe productions are called *plexus choroides.*

The proceſſes of the pia-mater, which are reflected between the convolutions, are attached to the brain by a fine cellular ſtructure, which appears to be formed by blood-veſſels of an extreme tenuity.

In mammiferous animals the greateſt prolongation of the pia-mater is found in the part of the anterior ventricles correſponding to the lower edge of the fornix, and the ſuperior of the optic thalami. It is a vaſcular web, folded on itſelf, and forming a kind of cord. When extended, its figure is nearly triangular: the veſſels which penetrate it are very cloſely interlaced on the edges of this web, and thoſe parts have more particularly received the name of plexus choroides. There is a plexus ſimilar to the middle of the inferior ſurface of this web, placed exactly upon the aperture of the third ventricle.

In birds there are two narrow bands which paſs into the ventricles, and occupy the whole of their length.

There is alſo an analogous ſtructure in fiſhes; but the plexus adheres to the parietes of the ventricles, and does not float within them.

We find two other productions of the pia-mater, in the fourth ventricle, ſituated under the cerebellum, one on each ſide. They appear to be unattached.

They are wanting in birds.

Article XI.

Of the Veſſels of the Brain.

In man, ſix principal arteries enter the cranium, three on each ſide: one is diſtributed to the dura-mater, and is called *arteria ſpheno-ſpinalis*; the other two, which extend to the brain, are named *arteria carotis interna*, and *arteria vertebralis.*

The *ſpinal artery* is a branch of the internal maxillary, and paſſes into the cranium, through the ſmall foramen of the poſterior proceſs of the os ſphenoides. Upon reaching the interior of the cranium, it aſcends towards the internal ſurface of the parietal bone; it there ſpreads upon the body of the dura-mater, by a great number of ramifications, which anaſtomoſe together in a manner which may be compared to the nervures of a fig leaf.

This arrangement is the ſame in all the mammalia.

The *internal carotid* artery comes forth from the oſſeous conduit of the temporal bone, and proceeds for ſome time involved by the dura-mater, and bathed in the veinous blood contained in the cavernous ſinus: it afterwards paſſes into the cranium behind the anterior clinoid proceſſes; it is then named *arteria cerebralis*: it diſtributes ſeveral ſmall ramifications to the

the adjacent parts, and always ſends off a large branch poſteriorly, which is united with the trunk of the vertebral arteries, and is named *arteria communicans*.

Two ſmall branches, which extend to the plexus choroides, uſually ariſe from the cerebral artery when it has furniſhed the *communicans*. The trunk is afterwards bifurcated; and one of the branches goes forward above the corpus calloſum, whence it is named *arteria calloſa*. Like all the other branches, it gives off a number of ramifications to the neighbouring parts: the other branch is ſomewhat larger than the former; it is directed outward to the ſurface of the hemiſpheres, into the pia-mater, and fiſſure of Sylvius, where it is divided and ſub-divided without end, in order to be conveyed by extremely minute veſſels, even into the ſubſtance of the brain.

The *vertebral arteries*, after ſuffering numerous inflexions in the canal formed by the holes with which the five intermediate vertebræ of the neck are perforated, paſs into the cranium through the foramen magnum; they then go forward into the baſilar foſſa of the os occipitis, where they unite into one common trunk, called *arteria baſilaris*; but they previouſly detach two branches to each ſide of the pons Varolii, which ramify upon the inferior ſurface of the cerebellum: one of theſe ramifications is denominated *ſpinalis poſterior*, becauſe it penetrates the

the fourth ventricle, and accompanies the medulla ſpinalis poſteriorly, as far as the lumbar vertebræ. The ſame vertebral arteries furniſh the *ſpinales anteriöres*; theſe unite towards the great hypogloſſal nerves, into a ſingle trunk, which runs down the vertebral canal on the fore part of the ſpinal marrow, to the os ſacrum, ſending off a number of ſmall branches, which anaſtomoſe with other arteries.

The baſilar trunk is again bifurcated to produce the *arteriæ ſuperiores cerebelli*, ſituated between the cerebrum and cerebellum, and alſo the *arteriæ communicantes*, which, as we have already ſhewn, are united with the carotids.

There are no large trunks formed by the veins of the brain; they open into conduits of a particular nature, called *ſinuſes*; theſe are formed by duplicatures of the dura-mater, attached to the bones by ſtrong cellular ſubſtance, and provided internally with a compact texture and ligamentous fræna. The veins are inſerted into them in a manner contrary to the courſe of the blood. The object of this organization appears to be, to prevent the reflux of the venous blood, which might affect the brain.

All the ſinuſes diſgorge the blood they contain, either directly or mediately, into a dilated part called the foſſa of the *jugular veins*: this foſſa is ſituated above the poſterior foramen lacerum, by which the vein paſſes out of the cranium.

The

The ſinuſes of the human brain are, the *poſterior longitudinal*, which extends along the convex edge of the falx; the *inferior longitudinal*, ſituated on its concave edge; the *ſtraight*, which proceeds from the poſterior extremity of the preceding, and opens into one or other of the *lateral ſinuſes*: the lateral are diſtinguiſhed into the right and the left; the one commonly receives in itſelf alone the blood from the ſuperior longitudinal ſinus; the other uſually receives that which is contained in the right ſinus: each on its reſpective ſide follows the ſulcus, traced between the cerebrum and cerebellum, to the baſe of the os petroſum, along the poſterior edge of which they deſcend into the jugular foſſa.

The *circular ſinus* of the *ſella turcica* ſurrounds the pituitary gland; it empties itſelf into the two great reſervoirs, ſituated on the ſides of the ſella, called the *cavernous ſinuſes*, in which the carotid artery, and ſeveral pairs of nerves, are contained. A venous conduit, which extends from the cavernous ſinus to the jugular foſſa, is named the *inferior petrous ſinus*. Laſtly, we diſtinguiſh, under the name of the *ſuperior petrous ſinus*, another ſmall conduit, which accompanies the projecting angle of the os petroſum, and which opens into the right ſinus.

The blood-veſſels within the cranium of other mammiferous animals, do not differ from thoſe of man, except in their poſition. In the eighth

Lecture

Lecture we have pointed out the cavities of the interior of the cranium, and the furrows traced upon it, as these furrows are impressions made by vessels; they indicate to a certain degree the directions of those vessels: thus, by the description of the carotid canal, and the spinous and vertebral foramina, we are made acquainted with the points from which the arteries proceed. Those of the brain are disposed nearly as in man: but they assume other curvatures, which are determined by the form of the lobes.

There is, however, a particular arrangement of the vessels around the carotid artery, just at the part where that vessel passes into the cranium: this is what the ancient anatomists called *rete mirabile*, or *wonderful plexus*. It was formerly supposed that this disposition of vessels existed in man; but it is now well known to prevail only in a certain number of animals. The following is its most usual distribution: the rete mirabile is the produce of arterial ramifications, which proceed from the carotid artery, and which surround the pituitary gland: all these minute branches, in which the artery seems to be as it were dissolved, are re-united anew into one trunk. This at least appears to be the case in the greater number of the Sarcophaga. The *elephant* and the *beaver* do not present this arrangement of vessels.

The arterial and various vessels of birds are analogous to those of mammalia; but we have not

not yet examined them accurately. We propofe, however, to direct our enquiries to that fubject, both in them and in reptiles.

In fifhes, particularly in the cartilaginous kind, as *rays*, *fharks*, &c. the arterial veffels of the brain proceed from two recurrent trunks, of the firft pair of branchial veins: thefe two arteries afcend forward towards the cranium, which they penetrate inferiorly, near the point of its union with the vertebral column. Having reached the cavity of the cranium, they divide each into three branches, one of which defcends into the vertebral canal, to be united to its correfpondent of the other fide, and to a fmall middle trunk, of which we fhall fpeak hereafter. The union of thofe three branches forms a large artery, which accompanies the fpinal marrow inferiorly, and may be named the *fpinal artery*. A number of ramifications feparate from it, which follow the courfe of the nerves. The fecond branch of the vertebral artery extends obliquely forward, under the medulla fpinalis; it there meets the middle trunk, and the correfponding branch of the other fide. The third branch of the vertebral artery is more anterior; having arrived at the root of the medulla fpinalis, it fends off two branches, which extend to a vafcular ring, produced by the middle veffel, which runs acrofs it, fo as to form a kind of *capital Greek phi* ϕ, accompanied with two femi-circles affixed to it in in oppoſite directions, thus ɔ⊕c. The branch ſtill continues to advance until it reaches the nerves of the eighth pair; it there detaches two new trunks, which being rejoined, form the commencement of the middle veſſel, which we have ſeveral times mentioned, and which terminates by producing the ſpinal artery, following in this manner the inferior line of the brain: the anterior branch continuing its direction forward, furniſhes a number of ſmall arteries to the cerebrum; it paſſes under the origin of the nerve of the fifth pair, and finally arrives under the olfactory tubercle, where it expands, like the foot of a gooſe, and ſurrounds it on every ſide.

Such are all the principal branches in the brain of fiſhes: the venous veſſels are alſo very numerous, and are diſtributed into the greaſy or mucous liquor which covers the brain; they are not, however, ſufficiently known to us to enable us to deſcribe them.

Article XII.

Of the Medulla Spinalis.

The elongation of the brain, which comes out of the cranium by the foramen magnum, has been

been named *Medulla Spinalis* : it appears to be formed, as we have already ſhewn, by the union of the two medullary productions of the cerebrum and cerebellum.

The ſpinal marrow appears externally to be entirely compoſed of a white ſubſtance, but aſſumes a greyiſh tinge internally. Covered with its membranes, it has more conſiſtence than the brain, but it liquifies almoſt as ſoon as the envelope is removed. The form of this medullary prolongation, is that of a cylinder, ſomewhat compreſſed ; it ſeems to be compoſed of two cords, divided by two furrows, one on the ſide of the body of the vertebræ, and the other on that of its ſpinous proceſs : on ſeparating a little the edges of theſe furrows, we obſerve fibres which ſeem to croſs each other, and unite the two faſciculi of the medulla ; its thickneſs varies in different parts of the canal through which it paſſes. In general, the diameter of the ſpinal canal is greateſt in the inferior part of the neck. In this place the medulla ſpinalis is alſo largeſt : it again experiences a kind of enlargement towards the laſt dorſal vertebræ. In the lumbar region it contracts, and becomes conical, and finally terminates in a filament, which belongs to its envelope, and which is placed at the extremity of the vertebral canal. The ſtructure is nearly ſimilar in all the red-blooded animals.

The medulla ſpinalis gives origin to as many pairs of nerves as there are holes between the vertebræ; theſe nerves receive names from the region of the ſpine whence they proceed.

The cervical nerves are ſeven in number in moſt of the Mammalia; the three-toed ſloth and the Cetacea excepted. In birds this number is much greater. It is uſually ſmaller in the reptiles, and frequently there are none in fiſhes.

The nerves of the other regions likewiſe vary exceedingly: but we adduce no more examples here, becauſe they would be only repetitions of what we have ſtated in Lect. III. Art. 1.

The origin of all the vertebral nerves is nearly ſimilar; they appear to be produced by two roots, one of which ariſes before and the other behind the medulla. Theſe two roots are ſeparated from each other by a membranous production, which we ſhall notice when we treat of the membranes of the medulla ſpinalis. The nervous roots iſſue from the vertebral canal by two diſtinct holes which perforate the dura-mater before the intervertebral foramina. They afterwards unite and form a ganglion that produces the vertebral nerves, which we ſhall deſcribe in the next Lecture.

1. *Veſſels of the Medulla Spinalis.*

The arteries of the medulla ſpinalis are numerous: two are furniſhed by the vertebrales; one poſterior and the other anterior, which are diſtin-

diſtinguiſhed under the name of ſpinales: they are diſtributed in the pia-mater, and ſeveral minute ramifications penetrate into the ſubſtance of the medulla itſelf. The others proceed from the cervical, intercoſtal, lumbar, ſacral and coccygeal arteries. They enter the canal by the holes through which the nerves paſs out of it; and communicate with other arteries, and with each other, by a number of very fine anaſtomoſes.

The veins of the medulla ſpinalis are alſo very numerous. Their ſmall ramifications extend through the pia-mater, and empty themſelves into two longitudinal ſinuſes of the dura-mater that inveſts the vertebral canal; theſe two ſinuſes are united by veins which have tranſverſe communications correſponding to each of the vertebræ. The firſt of theſe communicating branches diſcharges the blood into the jugular foſſæ: the others empty themſelves in the following manner, viz. the cervical into the vertebral vein; the dorſal into the intercoſtal veins; and finally, the lumbar and ſacral into the veins of the ſame name.

2. *Membranes of the Medulla Spinalis.*

In the article on the envelopes of the brain, we obſerved that the membranes of that viſcus are prolonged into the ſpinal canal, and cover the medulla ſpinalis. The whole is contained in the oſſeous canal formed by the vertebræ, the number and articulations of which vary conſi-

 derably,

derably, as we have already ſhewn in the third Lecture, when we deſcribed the bones of the ſpine. We then omitted the ſtructure connected with the paſſage of the nerves, and ſhall now proceed to notice it.

The annular part of each vertebræ has a notch, which is ſituated inferiorly in the lumbar and loweſt dorſal vertebræ. It is common to both edges of the adjacent vertebræ in the firſt dorſal, and in the cervical. There is only a ſimple hole in the odontoid or ſecond cervical vertebræ.

This is the manner in which the nerves iſſue in the greater number of Mammalia and birds, and even in the crocodile. Some quadrupeds, however, as the *horſe*, have holes inſtead of notches. As the annular parts do not touch each other in fiſhes, they have neither holes nor notches.

The pia-mater has a peculiar formation in the interior of the vertebral canal; it is prolonged from each ſide of the medulla, between the roots of the vertebral nerves, in ſuch a manner as to make as many denticulations as there are pairs of nerves. This duplicature of the pia-mater has obtained the name of *Ligamentum denticulatum:* it commences about the margin of the foramen magnum, and its denticulations terminate towards the firſt lumbar vertebræ; it is there confounded with the pia-mater, to which it is applied. The ſame diſpoſition prevails in Mammalia and birds.

LEC-

LECTURE TENTH.

DISTRIBUTION OF THE PRINCIPAL NERVES IN ANIMALS WITH VERTEBRÆ.

The central part of the nervous fyftem was defcribed in the laft Lecture: we now proceed to follow its branches in their diftribution to the different parts of the body.

The moft remarkable circumftance this diftribution prefents, is the fidelity with which Nature follows one general plan, from which fhe departs as little as poffible in the different fpecies of animals.

This conftancy, of which we have already had repeated proofs in the fkeleton, and the mufcles, is ftill more remarkable in the nerves, though at firft fight it appears lefs neceffary.

Analogous parts always receive their nerves from the fame pair in all animals, whatever be the pofition of thofe parts, or however circuitous the courfe of the nerve may be in order to arrive at them. Analogous nerves have always a fimilar diftribution: they proceed uniformly to the fame parts: even the fmalleft pairs, the purpofes of which are moft limited, and which might be moft eafily fupplied by adjacent nerves, as the fourth and the fixth pairs, preferve their exiftence and their proper ufes.

 From

From this obſervation it ſeems reaſonable to conclude, that the nerves are not entirely ſimilar to each other, and are not like the arteries, every where the conductors of a fluid perfectly the ſame; but that there is, in the ſtructure, mode of action, and ſecretion of each, ſome peculiarity relative to the functions and nature of the organ to which they are diſtributed.

This is the principal conſideration, which renders the detailed compariſon of the nerves in the different claſſes intereſting to the phyſiologiſt.

ARTICLE I.

Of the Olfactory Nerve, or the Firſt Pair of the Brain.

A. *In Man and other Mammiferous Animals.*

WE have pointed out the manner in which the olfactory nerve ariſes in Man, in the Mammalia, and in the other claſſes of red-blooded animals; we ſhall now follow it through the cavity of the cranium, until it enters the organ of ſmell.

In man, when the olfactory nerve has reached the inferior ſurface of the brain, it proceeds forward above the membrana arachnoidea. It gradually approaches the nerve of the oppoſite ſide; and,

and, when they arrive at the cribriform lamella of the os ethmoides, the two nerves are ſeparated from each other only by the falx of the cerebrum. In this courſe the nerve is received in a ſlight furrow of the anterior lobe. When taken out of the furrow, it appears triangular. It is terminated anteriorly by a ſmall and very ſoft tubercle of a cineritious colour, the fibres of which enter the naſal foſſæ by the holes which pierce the cribriform lamella of the os ethmoides.

Theſe nerves have nearly the ſame diſpoſition in the *monkey* kind as in man; but thoſe are the only animals that preſent them diſtinct, and in an elongated form. In all the other families, inſtead of the whitiſh cord which conſtitutes the olfactory nerve, we perceive only a large aſh-coloured eminence which fills the ethmoidal foſſæ. This medullary part is hollow, and communicates with the cavity of the anterior ventricle. To this ſingular diſpoſition we muſt attribute the ignorance in which anatomiſts have ſo long continued reſpecting the olfactory nerve, and the error which induced the antients to conclude that theſe nerves, which they called *proceſſus* or *carunculæ mammilàres*, were the conduits which conveyed the pretended *pituita* of the brain into the cavity of the noſtrils.

Amongſt Mammalia, the *porpoiſes* and the *dolphins* have no olfactory nerves. It is probable that the other Cetacea likewiſe want them, as they have no ethmoidal holes.

B. *In Birds.*

The olfactory nerve of birds, after feparating from the brain in the manner we have defcribed, paffes into an offeous canal, where it is accompanied by a vein, and thus reaches the cavity of the nofe.

C. *In Reptiles.*

This nerve proceeds to the noftrils in this clafs nearly in the fame manner as in birds; but it is longer. The canal which receives it is partly offeous and partly cartilaginous. The two canals have only one common aperture within the cranium. The olfactory nerves of reptiles are generally much more folid than thofe of the preceding claffes.

D. *In Fifhes.*

Cartilaginous fifhes, as the *ray* and the *fharks*, have the olfactory nerve very foft. It is in them a bulb, which paffes obliquely forward towards the nares, which are at a greater or lefs diftance from the brain according to the fpecies. In the *galeated fhark* or *tope*, the nerve which is at firft flender, afterwards enlarges, and forms a grofs ganglion. In the *leffer dog-fifh* (the *fqualus catulus* of Linnæus) the nerve has much refemblance to that of the greater number of the Mam-

Mammalia. It is thick, ſhort, tubular, and ſurrounded with an aſh-coloured ſubſtance. It is terminated by a ſemilunar ganglion, which is ſeparated from the noſtril by a membranous ſeptum. This ſeptum contains various depreſſions, each of which is perforated by ſeveral holes, which afford a paſſage for the nervous ramifications into the membranes.

The ſpinous fiſhes have the olfactory nerves very long and ſlender. In thoſe which have the ſnout elongated, this nerve is received into a cartilaginous tube. In thoſe with ſhort noſes the nerve is ſurrounded by only a fine membrane, which appears to be the ſame as that which contains the fat or oily humour that covers the brain.

In moſt of theſe fiſhes the nerve is of equal breadth in its different parts. The genera *cyprinus* and *gadus*, however, have it enlarged at the naſal extremity into a round ganglion, which reſembles the cup of an acorn.

Article II.

Of the Optic Nerve, or the Second Pair of the Brain.

In this article we ſhall deſcribe the courſe of the optic nerve, merely from the point where it ſepafeparates from the correfpondent nerve after decuffation, until it enters the globe of the eye to form the retina. We fhall treat of its termination in the Lecture on Vifion.

In all red-blooded animals, without exception, the optic nerve arifes, as we have already fhewn, from a particular tubercle of the brain. After croffing the correfpondent nerve, it proceeds directly to the eye on the oppofite fide.

In mammiferous animals, birds and reptiles, it is very difficult to diftinguifh thefe nerves at their union: but in fifhes, particularly in thofe that have an offeous fkeleton, it manifeftly appears that thefe nerves crofs each other without being confounded. They are in fact connected to each other by cellular fubftance. We obferve, and very eafily demonftrate, that the optic nerve of the left fide proceeds to the right eye, and *vice verfa*. In the cartilaginous fifhes this decuffation is lefs apparent.

The optic nerve of large animals exhibits a very remarkable ftructure. Its neurilema, or the envelope furnifhed to it by the pia-mater, divides it internally into a great number of longitudinal canals which contain the medullary fubftance. This ftructure is rendered very apparent, when the medullary fubftance is diffolved by maceration, and the nerve inflated and dried.—Sections of this nerve, thus prepared, demonftrate the arrangement of the canals which traverfe it.

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These nervous filaments are, however, more separate in the optic nerves of fishes, in which they can be demonstrated without any particular preparation. They are commonly flat like the other nerves, and sometimes appear to be formed by a very thin medullary lamina, which is folded several times on itself, and contracted into the figure of a cord. This is particularly the case in the *cod* and the *sword fish*.

Article III.

Of the Nerves of the Third, Fourth, and Sixth Pairs.

1. *Of the Oculo-Muscular Nerve, or the Third Pair.*

After entering the dura-mater at the side of the posterior clinoid process, each of these nerves passes in the substance of that membrane until it reaches the broadest part of the spheno-orbitar fissure. When arrived in the orbit, the nerve divides into two branches; one, which is small, is distributed to the muscles called rectus superior oculi, and levator palpebræ superioris. It frequently contributes to the formation of the ophthalmic ganglion which produces the ciliary nerves. The other branch is somewhat more con-

confiderable. It divides into three ramifications; one is fent to the abductor oculi, another into the rectus inferior, and the third terminates in the obliquus major.

This brief defcription of the oculo-mufcular nerve in man, may be applied to almoft all red-blooded animals. In all of them it paffes into the orbit by a particular hole, when there is no fpheno-orbitar fiffure, either fingly, or accompanied by fome of the other nerves appropriated to the organ of vifion, and is diftributed in the fame manner. We fhall, however, have occafion to return to this nerve, and thofe that follow it, when we treat more particularly of the eye. We fhall merely remark here, that in the *rays* and the *fharks*, in which the globe of the eye is fupported upon a moveable peduncle, one of the branches of the oculo-mufcular nerve paffes acrofs that cartilaginous peduncle, by a particular hole, in order to be diftributed in the mufcles fituated below it.

2. *Of the Pathetic Nerve, or the Fourth Pair.*

Thefe nerves pierce the dura-mater behind the preceding, and a little more towards the middle line. They are more flender than the nerves which iffue from the bafe of the cranium. Lodged in the folds of the dura-mater, they extend towards the fuperior orbitar fiffure, and pafs into the orbit by the wideft part of it; then

then turning towards the roof of the orbit, they terminate in the obliquus major.

The diftribution of this nerve is the fame in moft of the red-blooded animals. We have had the opportunity of examining.

3. *Of the Abductor Nerve, or the Sixth Pair.*

The fingle trunk, or the two branches which compofe this nerve within the cranium, penetrate the dura-mater above the point of the os petrofum. They advance a fhort way between its lamina, and reach the cavernous finus, where they are united, and bathed in the blood of the finus. The nerve then becomes fomewhat thicker; it receives or gives a number of filaments, which communicate with the great intercostal nerve. It afterwards proceeds into the orbit by the fuperior fiffure, and terminates in the fubftance of the abductor oculi.

We have obferved that the fame difpofition prevails in other red-blooded animals.

Article IV.

Of the Tri-facial Nerves, or the Fifth Pair.

We have pointed out the manner in which the nerve of the fifth pair feparates in vertebral

animals;

animals; we ſhall now follow each of its branches, in the different claſſes, commencing with the *ophthalmic* branch, or that which proceeds to the eye.

I. *Of the Nervus Ophthalmicus, or Firſt Branch of the Fifth Pair in Man, and other Mammiferous Animals.*

A. *In Man.*

The firſt branch of the fifth pair comes out of the cranium, by the ſpheno-orbitar fiſſure, with the third, fourth, and ſixth pairs. It frequently detaches a very remarkable tranſverſe branch to the fourth pair. Before it reaches the interior of the orbit, and while it is ſtill covered by the dura-mater, it divides into three branches: one is directed towards the naſal edge of the orbit; the ſecond towards the arch or frontal edge; and the third towards the temporal edge. The ſecond is the thickeſt of the three.

The *naſal* branch is inferior and internal; it divides into two ſmaller ramifications.

One of theſe branches proceeds towards the optic nerve, unites with the ſmall branch of the third pair, which is ſent to the leſſer oblique muſcle, and by this union produces a nervous enlargement, called the *lenticular* or *ophthalmic* ganglion. This ganglion uſually ſends off the ciliary nerves diſpoſed in two bundles. They

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are each compoſed of ſeveral filaments, which enter the globe of the eye obliquely, where we ſhall have occaſion to examine them when we treat of that organ.

The other branch, called the *ethmoidal*, alſo frequently furniſhes one or two ſmall twigs, which unite to the bundle of the ciliary nerves. It proceeds along the naſal edge of the orbit, and divides near the anterior internal orbitar hole; one of the filaments enters that hole, follows the canal of which it is the aperture, re-enters the cranium below the dura-mater, comes out again towards the anterior edge of the cribriform lamella, penetrates the naſal membrane, and is loſt above the ſuperior ſpongy bones, and on the ſides of the vertical lamina. The ſecond filament proceeds towards the pulley of the obliquus major, and divides into a great number of fibres, ſome of which are diſtributed to the ſkin of the forehead, near the naſal angle of the orbit; others to the orbicularis palpebrarum; ſome to the frontal muſcle, the caruncle, and the membranes of the lachrymal canal. Some of theſe fibrillæ uſually unite to others which come from the facial and ſub-orbitar nerves.

The ſecond branch of the ophthalmic is called the *frontal*. It is ſituated between the perioſteum of the roof of the orbit, and the elevator of the ſuperior eye-lid. It is ſeparated almoſt from its origin into two branches; one, which is the moſt internal, is directed towards the obliquus major oculi, and unites with ſome filaments produced by the ſecond branch of the diviſion of the ethmoidal branch; the other, which is more external, proceeds to the outſide of the orbit by the ſupra-orbitar hole or notch, and expands on the forehead, giving filaments to the ſkin, the adjoining muſcles, and the perioſteum.

Laſtly, the third branch of the ophthalmic nerve is called the *lachrymal*. It is ſituated towards the temporal or external edge of the orbit, and proceeds towards the lachrymal gland. Before it reaches that gland, it is divided into ſeveral filaments; one paſſes through the gland, and is loſt in the tunica conjunctiva: another is diſtributed almoſt entirely in the gland; a third, and ſometimes a fourth, after alſo going through the gland, divides into ſeven or eight filaments, ſeveral of which paſs into the temporal foſſa by the ſpheno-maxillary fiſſure, and join with other filaments from the deep ſeated temporal nerve; one of theſe pierces the os-jugale, and unites on the cheek with branches of the facial nerve.

B. *In other Mammiferous Animals.*

The ophthalmic branch in Mammalia reaches the orbit by the ſpheno-orbitar fiſſure, or rather foramen, which is alſo the optic foramen. It is ſeparated into two other branches within the cranium,

cranium, and paſſes in the ſubſtance of the dura mater, with the third, fourth, and ſixth pairs. Upon reaching the interior of the orbit, it divides, as in man, into three branches.

That of the internal part of the orbit, which correſponds to the *naſal*, is the largeſt of the three. It is divided into five or ſix ſmall branches. Some penetrate the frontal ſinuſes, by ſmall holes in the vault of the orbit, which are very apparent in the *ſheep*, others which are conſiderably larger enter the naſal cavity by the internal orbitar foramen. Incloſed in an oſſeous canal, they aſcend into the cranium through the large holes in the os cribriforme, which we have already noticed, and then go out again by the ethmoidal foramina, to be diſtributed to the naſal membrane. They may be eaſily followed in the Ruminantia. One or two others go to the levator palpebræ ſuperioris muſcle. One of theſe twigs aſſiſts in forming the *lenticular ganglion*. In the *dog*, two ciliary nerves ariſe from this ganglion, which are afterwards divided: three or four filaments riſe from it in the *calf*. Finally, one or ſeveral of theſe filaments terminate in the obliquus inferior, and in the glandula Harderi, of which we ſhall ſpeak in treating of the Organ of Viſion, and the tears. Theſe nerves are particularly remarkable in the Ruminantia.

The middle branch of the ophthalmic nerve is ſuperior. It is ſituated under the oſſeous roof of

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the orbit, and is divided into two principal ramifications ; one, which is external, furnifhes two filaments, that are loft in the rectus fuperior oculi and elevator of the eye-brow, anaftomofing, at the fame time, with other filaments. The internal ramification tranfmits branches to the mufculus rectus internus, and one which is very remarkable, and frequently a very thick twig, paffing through the fuperciliary notch or foramen, fpreads under the fkin of the forehead, where it is loft in the mufcles.

The third branch of the ophthalmic nerve is compofed of a great number of filaments, which, though clofe to each other, are very diftinct. They are almoft all loft in the lachrymal gland.

II. *Of the Nervus Maxillaris Superior, or Second Branch of the Fifth Pair in Man and other Mammiferous Animals.*

A. *In Man.*

Having paffed out of the cranium through the round foramen of the os fphenoides, this nerve almoft immediately furnifhes a fmall branch, which enters the orbit by the inferior fiffure of that foffa. This branch unites with another belonging to the lachrymal nerve, with which it paffes, as we have already fhewn, into a fmall canal of the os jugale, to be diftributed on the

the cheek, anaſtomoſing at the ſame time with the facial and ſub-orbitar nerves, and ſometimes behind with the temporal filaments of the inferior maxillary.

The maxillaris ſuperior having reached the interval between the baſe of the pterygoid proceſſes, and the ſuperior part of the malar tuberoſity, ſends off one or two branches, which in the latter caſe almoſt immediately re-unite, and form a ganglion or enlargement, which is ſituated before the ſpheno-palatine foramen. Several filaments proceed from this ganglion in differen directions, and form very remarkable nerves: they are ſubject to variation in their number, but ſeldom in their diſtribution.

Four or five filaments proceed, in the firſt place, from the internal ſide: theſe enter the noſtrils by the ſpheno-palatine foramen, and are diſtributed to the olfactory membrane.

We next obſerve behind the ganglion, another ſmall filament, which entering the canal at the baſe of the pterigoid proceſs, proceeds poſteriorly to the point of the os petroſum. This has been named the *Vidian* nerve, from the author who firſt deſcribed its courſe. On leaving this canal, the nerve forms two branches; one of theſe branches returns into the cranium, paſſes through a ſmall hole of the os petroſum, which joins the canal of the portio dura, and in which it is united to the facial nerve. The other branch of the vidian nerve enters the canal of

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the carotid artery, and is united to the filaments of the fifth pair, which join the fympatheticus major. Sometimes this branch accompanies the carotid artery, and only unites with the great fympathetic nerve in the fuperior cervical ganglion.

Laftly, the largeft branch, which appears to be the continuation of the trunk, arifes from the inferior part of the ganglion; a great part of it enters the pterygo-palatine canal, and it is there divided into feveral filaments, which pafs through the bone: fome are diftributed in the olfactory membrane, and others lofe themfelves pofteriorly in the uvula and the fmall mufcles. The trunk comes out by the pofterior palatine foramen, and proceeding forward, is divided into two or three branches on the arch of the palate.

Having detached the two branches which produce the fpheno-palatine ganglion, the maxillary nerve proceeds towards the aperture of the fub-orbitar canal; but before it enters that canal, it furnifhes a fmall branch, called the *alveolar*, which is frequently divided into two others; one enters the maxillary finus, another proceeds to the alveoli, into which it penetrates. It furnifhes alfo a number of filaments to the gums and mufcles of the lips.

Having paffed into the fub-orbitar canal, this nerve takes the name of *fub-orbitar*: it detaches a confiderable branch, which proceeds in the fubftance ſubſtance of the bone, penetrates the ſinus, and is diſtributed to the roots of the teeth. The trunk iſſues from the bone through the ſub-orbitar foramen, and having reached the cheek, all its filaments are loſt in the muſcles of the face, a great number of them uniting with the ramifications of the facial nerve.

B. *In other Mammiferous Animals.*

We have already obſerved, that the maxillary nerves come out of the cranium, in the greater number of theſe animals, by the hole ſituated in the middle foſſa, before the ſpine of the os petroſum.

The ſingle trunk, when it arrives on the outſide of the cranium, becomes conſiderably enlarged, and its fibres ſeem to croſs each other in ſuch a manner, that the two branches which it ſoon after forms, appear to be produced by oppoſite filaments, viz. the poſterior, or ſub-maxillary branch, by the anterior filaments, and the anterior, or ſupra-maxillary branch, by the poſterior fibres. This diſpoſition is very remarkable in *dogs*, but is leſs conſpicuous in the Ruminantia.

The ſupra-maxillary nerve proceeds almoſt horizontally from behind, forward. Having reached the anterior and inferior parts of the temporal foſſa, it divides into a great number of faſciculi. One bundle, which conſiſts of

 four

four or five confiderable filaments, proceeds towards the fpheno-palatine foramen: this fafciculus then divides into two; one branch is fent into the cavity of the noftrils, and furnifhes a confiderable ramification, which is fpread out upon the flefhy fubftance of the palate. Sometimes, as in the Ruminantia, this branch feparates from the trunk, even before it enters the fpheno-palatine hole.

The other branch of the maxillaris fuperior, which enters by the fpheno-palatine foramen, paffes into the body of the os maxillare fuperius, detaches ramifications to all the teeth, and goes out by the fub-orbitar foramen; it then expands in the form of a goofe's foot over the face, and anaftomofes with the facial nerve.

But befides thefe two principal branches produced by the fuperior maxillary nerve, there are fome other very remarkable filaments, which are detached almoft immediately after it leaves the cranium.

The firft is a very fmall twig, which, after anaftomofing with a ganglion, of which we fhall fpeak hereafter, is fent into the body of the temporal mufcle, through which it paffes, affording it, at the fame time, a number of filaments; it afterwards perforates the inferior part of the orbit, and penetrates into the nofe.

Another, and far more remarkable filament, arifes from the fpheno-palatine branch; it forms a ganglion, which is joined by feveral twigs, and

and among others, by that which we have juft defcribed. A flat nerve afterwards feparates from this ganglion, which, though much larger, appears to be the continuation of the filament at prefent under confideration: it paffes into the body of the bones, between the palatine and the convexity of the pterygoid procefs: it furnifhes feveral filaments, one of which is very diftinct, and defcends to the floor of the noftrils.

Such is the general diftribution of the fuper-maxillary nerve in moft mammiferous animals. This fuccinct defcription, taken from the *dog*, the *rabbit*, the *fheep*, and the *calf*, proves that the diftribution does not differ from that which takes place in man, except in circumftances neceffarily refulting from the conformation of the bones of the face.

III. *Of the Nervus Maxillaris Inferior, or Third Branch of the Fifth Pair, in Man, and other Mammiferous Animals.*

A. *In Man.*

This is the largeft of the three branches furnifhed by the tri-facial nerve; it comes out of the cranium, as we have already obferved, by the oval foramen of the os fphenoides. It appears, at the bafe of the cranium, on the edge which feparates the temporal from the guttural foffa, on the inner fide of the external ptery-

goid

goid mufcle ; it is almoft immediately divided into two principal trunks, one fuperior, the other inferior. The firft is fubdivided into five branches, and the fecond into three. Thus there are eight divifions of this nerve.

1. The firft branch detaches fome filaments to the articulation of the jaw, and to the temporal mufcle ; then, proceeding upward to the notch between the two proceffes, it penetrates into the heart of the maffeter mufcle, through which it is diftributed.

2. and 3. The fecond branch of the firft trunk paffes into the pofterior and lower part of the temporal mufcle. The third alfo proceeds in the fame direction, but a little more anteriorly ; it frequently anaftamofes with a filament of the lachrymal nerve, as we have already obferved.

4. The fourth branch paffes between the two pterygoid mufcles, to which it detaches fome fmall filaments ; it then proceeds to the outfide of the buccinator mufcle, where it divides into a great number of filaments, fome of which are diftributed to that mufcle, and the mufcles of the lips in general, while others unite with the facial nerve.

5. The fifth branch is one of the fmalleft ; it is fent into the internal pterygoid mufcle, and thofe of the velum palati.

6. The fixth branch appears to be the trunk of the nerve itfelf ; it therefore retains the name of *maxillaris inferior* ; it paffes between the two pterygoid

pterygoid mufcles, and is directed towards the dental canal of the lower jaw; but before it enters it, fome filaments are detached to the mylo-hyoideus and digaftricus, and to the fub-maxillary glands. In paffing along the canal, it diftributes branches to each of the teeth, and iffuing from the jaw through the foramen mentale, is loft amongft the mufcles of the lower lip, anaftomofing occafionally with filaments of the facial nerve.

7. The feventh branch is deftined for the tongue; it advances, with the preceding, between the pterygoid mufcles; it there receives a fmall filament, which is derived from the facial nerve, and which has been named *chorda tympani:* it proceeds towards the tongue, and when arrived at the origin of the ftilo-gloffus mufcle, above the maxillary gland, it produces fome fibres, which are frequently united, and form a fmall ganglion, from which fome filaments that penetrate that gland are detached. The nerve afterwards paffes between the hyo-gloffus and the gland fituated below the tongue. It penetrates the body of that organ, and is diftributed in its fubftance, in the mufcles which fuftain it, and in the fkin which covers it.

8. Laftly, the eighth branch is the moft pofterior; it frequently arifes from two roots, between which a fmall artery is tranfmitted. The fingle trunk paffes behind the condyle of the jaw, before the meatus auditorius: it is fubdivided

vided into a number of ſmall filaments, many of which unite with the facial nerve on the external part of the temporal muſcle. On this account it has been called the *ſuperficial temporal nerve*.

B. *In other Mammiferous Animals.*

We have ſhewn the diſpoſition of this branch in the Mammalia, until its exit from the cranium by the foramen ovale. It furniſhes, almoſt immediately after its ſeparation, a pretty large branch, which is directed into the parotid and maxillary glands; it afterwards divides into two other branches, one internal, which loſes itſelf by ſeveral ſmall filaments in the body of the muſcles, and even in the ſubſtance of the tongue; the other, which is external, affords a number of ramifications to the pterygoid muſcles, and to thoſe of the cheeks and lips, which they traverſe in their progreſs towards the ſkin of the face, where they unite with the filaments of the ſub-orbitar and facial nerves. The largeſt filament, or the continuation of the branch itſelf, paſſes into the dental canal; it there ſupplies the teeth, and iſſuing from the foramen mentale, terminates in the muſcles of the lip, in the form of a gooſe's foot. The other ſmall filaments are diſtributed nearly as in man.

In the *calf* the inferior maxillary nerve divides into four principal portions, ſoon after it leaves

leaves the cranium. The moſt poſterior, which is the third, with reſpect to thickneſs, proceeds backward, and below the condyle of the jaw, where it forms two branches: one is ſlender, and penetrates the parotid gland, where it divides into a number of ſmall filaments, which unite with thoſe of the facial nerve; the other branch follows the circuit of the jaw, and advances to the front of the mouth; it unites, as it paſſes along the cheek, with the middle branch of the facial nerve, from which it previouſly receives ſeveral anaſtomoſing filaments.

The next branch of the maxillaris inferior is, the moſt ſlender of the four; it is very long, follows the ramus of the jaw, and is loſt in the buccinator muſcles and buccinal glands.

The third branch paſſes into the dental canal, and is there diſtributed, in mammiferous animals in general, as we have already pointed out.

Finally, the fourth is the lingual branch; this is the thickeſt and the moſt anterior; it is flat, in the form of a broad ribbon. It terminates like a fan in radii, which run into the muſcles of the tongue, and the parietes of the mouth.

IV. *Of the Nerve of the Fifth Pair in Birds.*

The fifth pair preſents nearly the ſame diſtribution in birds, as in Mammalia.

The ophthalmic nerve comes out of the cranium

nium by a particular foramen of the orbit on the outfide of the optic nerve. It proceeds fome way in the fubftance of the bone before it reaches its furface. It is thick, and defcribes a curvature which follows that of the arch of the orbit. Its divifion does not commence until it is beyond the foffa; it ufually penetrates into the body of the bones of the face above the nafal finufes. It divides into three branches, the fuperior, which is the fmalleft, is loft in the pituitary membrane. The fecond branch, which is the thickeft of the three and the longeft, is received into an offeous canal, paffes above the nares, and terminates at the extremity of the bill by a great number of filaments. The third branch appears to be entirely loft in the fkin which furrounds the aperture of the noftrils.

The fuperior maxillary nerve comes out by the fame hole with the inferior, precifely above the os quadratum. It proceeds from behind forward to the inferior part of the orbit. Two filaments are detached from it in its progrefs; one unites with the ramifications of the ophthalmic nerve; the other afcends towards the internal fide into the body of the pterygoid mufcles. It penetrates the maxillary bones, and lofes itfelf on the lateral parts of the bill. Its diftribution is very remarkable in *ducks*. Each of the denticulations with which their bill is furnifhed, appears to receive four or five filaments.

The

The inferior maxillary nerve ſeparates from the ſuperior, and is directed obliquely downward. It detaches at firſt ſome branches to the pterygoid muſcles, and to the quadratus, which we ſhall deſcribe when we treat of maſtication: The trunk afterwards deſcends outwardly, and when arrived at the inferior jaw, it divides into two branches, one internal and one external. The internal, which is the continuation of the trunk, penetrates the maxillary canal, and proceeds, in that manner, to the anterior extremity of the mandible. In birds that have denticulations, as ducks, each proceſs receives filaments from this nerve. The external branch ſeparates from the preceding, paſſes through the bone of the mandible, and ſpreads upon its outſide, under the ſkin or horny ſubſtance which covers the bill to its extremity.

V. *Of the Nerve of the fifth Pair in Reptiles.*

Reptiles have the three branches of the fifth pair. In the *ſea tortoiſes* the ophthalmic paſſes, ſome way, in the dura mater before it enters the orbit. It tranſmits filaments to the muſcles of the globe of the eye, and particularly to the two lachrymal glands. The ſuperior maxillary branch is the largeſt of the three. It is united to the inferior branch at its origin, but when it reaches the interior of the orbit, it ſeparates from it to take another direction. It paſſes along the floor

floor of the orbit, defcribing a very marked curvature, the convexity of which is external. A very great number of filaments proceed from the concave or internal fide, which are loft in the lachrymal gland. The trunk is afterwards divided into two branches:—one internal, which correfponds to the fpheno-palatine and fub-orbitar nerve. It furnifhes filaments to the palate and to the nerves; and when arrived at the anterior part of the orbit, it proceeds outwardly and fpreads upon the face. The other branch of the principal trunk is external; it paffes alfo upon the floor of the orbit, to which it gives many filaments, and at length iffuing from the inferior part of the orbit, it expands upon the face, anaftomofing with the other facial nerves.

The inferior maxillary branch proceeds almoft vertically downward to the pofterior part of the orbit, before the petrous and articular procefs of the os temporum. In its courfe towards the lower jaw, it paffes between the temporal and pterygoid mufcles, to which it fends feveral filaments. Having arrived at the lower jaw, before the articular furface, it enters the oblong aperture, and divides in the fubftance of the bone. It forms feveral branches on the inner part of the jaw, which are loft in the mufcles of the tongue, and on the outfide fome others which ramify under the fkin.

VI. *Of*

VI. *Of the Nerve of the Fifth Pair in Fiſhes.*

We alſo find in fiſhes the three branches of the fifth pair, which we obſerve in man.

The ophthalmic or moſt ſuperior branch ariſes in the cranium, and proceeds obliquely outward and forward towards the poſterior part of the orbit, into which it penetrates. Arrived there, it preſents ſome variations in different ſpecies with reſpect to its ſub-diviſion. It uſually furniſhes three principal branches as in the *carp*, the *ſalmon*, the *cod*, and probably in the other ſpinous fiſhes; but in the *ray*, and in the *ſaw-ſhark (ſqualus priſtis)* this diviſion takes place at a greater diſtance, and beyond the orbit, as we ſhall ſee in deſcribing theſe branches.

The firſt branch is the ſmalleſt and the moſt internal. It terminates at the margin of the cavity of the nares. In the *ray* the branch paſſes out of the orbit without dividing, ſoon after it detaches two filaments: one, which is thick, croſſes above the nares, to which it detaches ſeveral filaments, and paſſes on to loſe itſelf in the lateral parts of the ſnout. In the *ſaw-ſhark*, the part of the ophthalmic branch which proceeds to the nares, is not remarkable. It conſiſts of ſingle filaments which are detached from the branch we are about to examine.

The ſecond branch of the ophthalmic nerve of the internal ſide in ſpinous fiſhes, is the moſt con-

confiderable of the three. It divides into two branches, one of which ramifies in the flefhy parts of the upper lip, where its filaments unite with thofe of the maxillaris fuperior. The other is diftributed in the foft parts adjacent to the angle of the mouth. This, at leaft, is the difpofition in the *falmon*, and the *carp*. In *rays* the continuation of the trunk fupplies the place of this branch. It is directed forward towards the extremity of the fnout where it terminates. In the *faw-fhark*, the branch we are now tracing proceeds above the mufcles of the ball of the eye, and is fent forward into a groove formed above the fnout. It there divides at the external fide into an infinite number of filaments, in the form of network, the ramifications of which appear to proceed to the teeth or hooks with which the fnout of this fifh is armed.

The third branch of the ophthalmicus proceeds to the lateral parts of the face, and is diftributed to the mufcles of the jaws in fpinous fifhes. This branch does not exift in the *ray*, but in the *faw-fhark* it is very diftinct, and very large. It paffes through the orbit below the two fuperior mufcles of the eye, furnifhing fome filaments which extend to the bulb. It is then directed forward, and confounded with the preceding branch.

We ought not to omit noticing here one very remarkable peculiarity, to which we fhall, however, return in the article on Secretion. The two branches of the ophthalmic nerve appear to

6 change

change their nature at the place where they re-unite. They assume a black colour, and particular consistency. We have had occasion to make the same observation on this black colour of the nerve in the *tope*, (*squalus galeus*), in which it is still more conspicuous, and in which its distribution is highly important. In this species all the advanced part of the head, before the mouth, is perforated with numerous pores, through which a gelatinous humour exudes, on the slightest compression. When the skin is removed, we observe that this humour is contained in certain cells, formed by a very compact white fibrous substance. A great number of the extremities of the nerves are distributed to the parietes of these cells. We shall return hereafter to the presumed uses of this liquor. It is sufficient at present to notice its existence.

The second branch of the fifth pair of nerves, which represents the maxillaris superior, is intermediate. It passes below the optic nerve, towards the middle and inferior part of the cranium. Having arrived below the nares, it divides into two, three, or several branches, some of which proceed towards the angle of the mouth, and terminate in the cirri, when these appendages exist; others proceed towards the middle part, where they are distributed into the substance of the lips. This, at least, is the case in the ſpinous fiſhes we have had the opportunity of examining.

The *ſaw-ſhark* and the *ray* exhibit different appearances. In the firſt of theſe fiſhes, the maxillaris ſuperior is divided, almoſt immediately after it leaves the cranium below the orbit, into three principal branches. The firſt, which is directed forward, and is very thick, paſſes below the muſcles of the eye, to which it tranſmits ſome filaments. It in particular detaches one which proceeds into the globe of the eye; it then paſſes to the inferior ſurface of the root of the ſnout, ſends ſome filaments to the margin of the nares, and afterwards penetrates into the longitudinal canal of the muzzle, which receives the ophthalmicus. The middle branch conſiſts of ſeveral filaments, which are diſtributed to the muſcles of the mouth, and principally towards its angle, where they are loſt in the ſkin which forms the lips. In the *thornback (raja clavata)* the diſpoſition is nearly the ſame, but we obſerve that the filaments which in the *ſaw-ſhark* appear to terminate in the hooks of the ſnout, terminate in the tubercles or ſpines, with which the different ſpecies of rays are armed.

The third branch of the fifth pair, or maxillaris inferior, preſents no peculiarity. In the oſſeous fiſhes, when it arrives towards the angle of the jaw, it is loſt in the bones which form it by by very fine filaments; the number of which varies. In the chondropterygii, this nerve is directed much more backward, and is distributed among the mufcles of the lower jaw.

ARTICLE V.

Of the Facial Nerve, or Sympatheticus Minor of Winflow.

A. *In Man.*

WE have explained the origin of this nerve, and fhewn that it is almoft always diftinct from the portio mollis. Having entered the meatus auditorius internus, it paffes into the canal named the *aquæduct* of *Fallopius.*

It follows the different curvatures of that canal, and receives in it the filament of the vidian nerve, which we pointed out in treating of the fpheno-palatine ganglion of the fupra-maxillary branch. It afterwards furnifhes, in the cavity of the tympanum, two fmall twigs to the officula auditus; and another more confiderable one, fome lines before it paffes out, through the ftylo-maftoid foramen. This filament enters a fmall offeous canal, which conducts it into the cavity of the tympanum. It paffes under the incus on the tendon of the internal mufcle of the

 malleus.

malleus. It goes out by a ſmall hole in the baſe of the tympanum to communicate with the lingual portion of the third branch of the tri-facial nerve, or fifth pair, to which it unites by a very acute angle.

Having left the baſe of the cranium, the facial nerve divides into ſeveral branches, which vary in number, but which frequently amount to fourteen or fifteen.

The moſt poſterior is called the *occipital.* It proceeds behind the maſtoid proceſs, unites to a ſuperior cervical pair, and is afterwards divided into two ſmaller branches, one of which is loſt on the concha of the ear, and the other in the ſkin, and ſuperior part of the muſcles of the neck.

The ſecond branch communicates by one or two filaments with the ſuperior part of the cervical ganglion of the ſympatheticus major. It terminates in the muſcles which ariſe from the ſtyloid proceſs, and on that account has been named the *ſtylo-hyoidean* branch.

The third branch is ſent to the digaſtric muſcle.

The trunk of the facial nerve paſſes afterwards into the parotid gland, which it croſſes, and to which it affords a great number of filaments.

The fourth branch produced by the facial nerve is diſtributed to the anterior part of the concha of the ear, and to the aponeuroſis of the temporal muſcle.

The

The fifth and sixth branches are disposed of nearly in the same manner, and form with each other very numerous anastomoses. They are called the *temporal* or *jugal* nerves.

The seventh branch very much resembles the preceding. It unites with them and with the adjacent branches, and proceeds to the orbicularis palpebrarum muscle, where it terminates in a kind of plexus.

The eighth branch is divided almost immediately after its origin into three others, which also extend to the orbicularis, but terminate in its inferior part.

The ninth branch passes between the duct of the parotid gland and the zygomatic and masseter muscles. It proceeds towards the internal angle of the eye, forming a large plexus on the face, and uniting with a great number of filaments of the sub-orbitar nerve.

The tenth, eleventh, twelfth, and thirteenth branches also go to the face, one under the other. They furnish filaments to all the muscles, and form a real nervous net under the skin.

The fourteenth branch follows the edge of the lower jaw. It is lost in the muscles of the lower lip, and unites with the nervous plexus of the face.

Lastly, a number of filaments come from the parotid gland, which have arisen from the division of the facial nerve. Some unite with the branches we have defcribed ; others are loft in the mufculus cutaneus, and in the fkin.

It follows from this defcription of the facial nerve, that it covers the whole of the face, the temples, the ears, and a portion of the occiput and neck, and that it communicates with a great number of other nerves ; this induced Winflow to name it *fympatheticus minor.*

B. *In other Mammiferous Animals.*

We find almoft all thefe branches in the other Mammalia ; the variations depend entirely on the different forms of the parts to which they are diftributed, and the extent of the mufcles. In animals, for example, that have the concha of the ear very long, the branch which unites with the firft cervical pair is much larger, and may be more eafily traced on the furface of the cartilages, where it accompanies the blood-veffels. In the fame manner, we find that the branches which proceed to the temporal mufcle, are very large in the Sarcophaga. It may in general be remarked, that the facial plexus is more complicated.

As we have particularly examined this nerve in the *calf*, it will not be improper in this place to prefent a fuccinct defcription of it.

It leaves the cranium by the fiffure at the bafe of the maftoid procefs ; it croffes the parotid gland, to the fubftance of which it tranfmits

mits a number of filaments. It in particular detaches one very remarkable branch, which, as we have already ſhewn, unites with another from the maxillaris inferior. Upon leaving the parotid gland, the facial nerve divides into four branches; two aſcend before the ear, and proceed to the ſuperior lateral and poſterior parts of the face; the other two branches are ſent to its anterior parts. The moſt inferior of theſe branches divides, ſub-divides, and anaſtomoſes in every direction with the filaments of the nerve of the chin. The ſuperior receives a large branch from the maxillaris inferior, which paſſes behind the condyle of the jaw; thus united in a ſingle trunk, they form an expanſion like a gooſe's foot, which anaſtomoſes with the ſub-orbitar nerve.

This facial nerve preſents a very remarkable peculiarity at its origin: it has two roots; one is the portio dura of the auditory nerve, which enters the internal meatus, from which it eſcapes by the fiſſura Glaſſeri, or foramen ſtylo-maſtoideum, which are in this animal the ſame aperture; the ſecond root appears to proceed from a conſiderable ganglion of the poſterior part of the par vagum. This ganglion is ſituated in a particular depreſſion of the inferior ſurface of the bone of the tympanum: it alſo appears to unite with the ſympatheticus major, which aſſumes almoſt a cartilaginous conſiſtence. Two or three ſhort filaments concur in the formation of this root; it afterwards becomes thicker, and penetrates into the fiſſure, where it meets the other root of the facial nerve; it tranſmits a filament to that root, and continues to proceed outward, before and below the ear.

In *rabbits* the facial nerve comes out of the cranium immediately under the cartilage of the ear, and the meatus auditorius externus, from which it is ſeparated by only a ſmall boney ridge.

C. *In Birds and Reptiles.*

The facial nerve exiſts in birds and reptiles, but its ſize is ſmall, becauſe theſe animals have no lips, and becauſe their mouth, as well as a great part of their face, is covered with a horny or ſcaly ſubſtance, in conſequence of which theſe parts have but little motion or ſenſibility. We find, however, ſome of the branches: they are not indeed eaſily followed in diſſection, but their trunk always exiſts.

D. *In Fiſhes.*

The facial nerve is very conſiderable in cartilaginous fiſhes; it is detached from the brain by a ſingle trunk, very diſtinct from the auditory nerve, which belongs alſo to the fifth pair; but ſoon after, and even in the cavity of the cranium, it ſeparates into two branches, one aſcends the cranium, and paſſes out through a particular

particular hole, and is diſtributed under the ſkin; the other, which is thicker, proceeds horizontally towards the cavity of the ear, which it enters alſo by a particular foramen. Arrived in that cavity, it proceeds under the veſicle which contains the amylaceous or calcareous matter of the ear, where it unites with the auditory portion of the fifth pair: the common trunk afterwards penetrates the cavity of the ear, to proceed outwardly, and to be diſtributed in a great number of ramifications to the ſoft parts which envelope the head.

Article VI.

Of the Auditory Nerve, or Portio Mollis of the Seventh Pair.

In the Article on the Origin of the Nerves in the different claſſes of animals, we have pointed out the manner in which the auditory nerve ariſes from the brain. As it is very ſhort, and as it paſſes into the organ almoſt immediately after its origin, we have at preſent only to deſcribe, in the cerebral cavity, its connections with the facial nerve, or portio dura.

In Man, and the other Mammalia, it proceeds, with the facial nerve, into the cavity of the os temporum, which forms the meatus auditorius

ditorius internus, and enters into the labyrinth by ſeveral holes, the number and the magnitude of which vary in different animals. In the Article on the Ear, we ſhall point out its farther diſtribution in that organ; it is very ſoft, and we do not diſcover fibres in it, as in all the other nerves, the olfactory excepted.

In birds, the two nerves have nearly the ſame connection. The auditory is very large, ſoft and reddiſh; it is received into a deep conduit, on the internal ſurface of the cranium, whence it penetrates into the labyrinth by ſeveral ſmall foramina.

In reptiles, it is nearly the ſame as in birds.

But in fiſhes, the auditory nerve is very much ſeparated from the facial; it even approaches ſo near to the origin of the fifth pair, that it may be regarded as a branch of it. In the cartilaginous fiſhes, as the *rays*, it paſſes into the cavity of the ear, by a particular foramen, and not by a number of holes, as in the other claſſes. In the ſpinous fiſhes, as the ear is free, and even ſituated in the ſame cavity with the brain, the nerve is diſtributed directly into that organ.

Article VII.

Of the Pneumo-gaſtric Nerve, or Par Vagum, vulgarly called the Eighth Pair.

A. *In Man.*

The numerous filaments which compoſe this nerve, at its origin from the brain, approximate and form a kind of compreſſed cylinder; they then paſs out of the cavity of the cranium by an oblong aperture of the dura-mater, ſituated below the poſterior foramen lacerum.

Another nerve, which aſcends from the canal of the ſpine, where it ariſes by ſeveral filaments from the ſpinal marrow, comes out through the ſame hole, on which account it is named the *acceſſorius* of the eighth pair.

Having reached the baſe of the cranium, theſe nerves ſeem to receive a different deſtination. The par vagum, properly ſo called, is tranſmitted to the lungs and the ſtomach. The acceſſorius is directed towards the ſhoulder.

The principal trunk communicates, in the firſt place, with the hypogloſſal, the great ſympathetic, the ſuperior cervical, and the gloſſo-pharyngeal nerves.

It afterwards deſcends almoſt vertically on the fore part of the neck, to the breaſt, and is placed near

near the carotid artery, and great ſympathetic nerve; but in its courſe, it furniſhes the neighbouring parts with a number of branches, which we ſhall notice.

One is intended for the larynx, and is diſtributed to the muſcles and glands of that part; another is detached towards the middle of the neck, and, forming an arch internally, it aſcends towards the great hypogloſſus. Several filaments are given off from the convexity of this arch, and deſcend into the breaſt; they then proceed to the pericardium, and are ramified in its ſubſtance, forming the plexus called the *ſuperior cardiac*.

When arrived near the clavicles, the par vagum of the left ſide ſends forward ſome filaments which unite with the plexus we have juſt mentioned. The analogous filaments on the other ſide are produced by the recurrent nerve; after this, the trunk proceeds inwardly, and paſſes into the thorax, between the veins and the arteries: it preſently divides into two large branches; the moſt external is the continuation of the trunk; the internal is called *nervus recurrens*, becauſe it re-aſcends, and partly returns again out of the thorax.

This recurring branch turns round the arch of the aorta on the left ſide, and the ſub-clavian artery on the right.

The left recurrent nerve detaches ſome branches, which, uniting with ſome others, produced by by the great ſympathetic, form a *pulmonary* plexus round the pulmonary artery and the aorta, and having entered the pericardium, where they form the *inferior cardiac plexus,* they are diſtributed to the heart. The recurrent branches having arrived near the trachea arteria, divide into filaments, ſome of which aſcend to the larynx, and are diſtributed to the ſmall muſcles of that organ, under the name of the *laryngeal nerves.*

The trunk of the pneumo-gaſtric, after furniſhing the recurrent branches, paſſes behind the pulmonary veſſels, and detaches a number of filaments which ſurround the bronchia, and produce a plexus, denominated the *pulmonary:* this plexus receives a filament from the great ſympathetic nerve.

The branches of the par vagum afterwards continue to deſcend in the thorax, along the œſophagus, to which they afford a number of filaments; one nerve of the pair paſſing before the œſophagus, the other behind: in this manner they both arrive in the abdomen, where they form a conſiderable plexus under the envelope of the ſtomach, produced by the peritonæum: they alſo furniſh ſome filaments to the hepatic, ſplenic, and ſolar plexuſes, as we ſhall ſhew when we treat of the great ſympathetic nerve.

The trunk of the acceſſorius ſeparates from the par vagum, as it leaves the cranium; it is directed a little backward, as it deſcends along the neck; it paſſes along the ſuperior portion of the ſterno-maſtoid muſcle, to which it gives ſome branches. It afterwards proceeds to the trapezius muſcle, in which it terminates, after detaching ſome filaments to the two ſplenii, between which it paſſes.

B. *In other Mammiferous Animals.*

This diſtribution of the par vagum was found nearly ſimilar in four or five ſpecies of Mammalia, which we examined for the purpoſe of tracing it. The *calf* only preſented one peculiarity, which we have pointed out in the Article on the Facial Nerve; but the anaſtomoſes, with the great ſympathetic, the recurrent nerves, the cardiac and pulmonary plexus, exhibited no difference, except in the number of the filaments, ſo far as the accuracy of the Diſſector may be relied on. The ſpecies we diſſected were the *dog*, the *raccoon*, the *hog*, and the *porcupine*.

C. *In Birds and Reptiles.*

We have likewiſe nothing remarkable to ſtate reſpecting this nerve in birds and reptiles, though we have made preparations of it in ſeveral ſpecies. We obſerve evidently that it is diſtributed to the lungs, the heart, the œſophagus, and ſtomach, and that it forms plexuſes on theſe organs, in the ſame manner as the great

great ſympathetic nerve produces them round all the arteries of the trunk. On leaving the cranium, the par vagum forms decuſſations with the lingual and *gloſſo-pharyngeal* nerves; they afterwards ſeparate from each other: the gloſſo-pharyngeus is poſterior, the par vagum in the middle, and the lingual anterior. The par vagum does not always come out of the cranium by a ſingle hole; it is formed of two or three filaments, which afterwards rejoin, upon receiving a communicating filament from the gloſſo-pharyngeus, and one farther down from the lingual; the nerve then augments ſomewhat in diameter, and deſcends into the breaſt.

D. *In Fiſhes.*

The par vagum preſents a very peculiar diſpoſition in fiſhes; this difference depends on the nature of the organs of reſpiration, for which that nerve appears to be ſpecially intended. As the lungs or branchiæ of fiſhes are ſituated immediately below the cranium, it is obvious that the courſe of the nerves muſt be very ſhort; and as the diſtribution of the nerve takes place almoſt immediately after it leaves the cranium, it may be ſaid to have no common trunk.

We ſhall deſcribe, in a general manner, what is common in the diſpoſition of this nerve, and afterwards point out particularities in different ſpecies.

The

The branches of the pneumo-gaſtric are diſtributed to three diſtinct parts: the firſt, or anterior, which are the largeſt, and uſually four in number on each ſide, proceed to the branchiæ; they repreſent the par vagum of Mammalia: the ſecond, which are much ſmaller, and two or three on a ſide, are diſtributed to the muſcles, which move the tongue in the baſe of the gills, and to the ſurface of the œſophagus: laſtly, the third are ſingle on each ſide; they form a very thick nerve, which extends along the whole body of the fiſh, under the *lateral line*.

The *branchial nerves* paſs out of the cranium by one common foramen, and ſeparating from each other, proceed towards each of the branchiæ: before they arrive at them, they are divided into two; the poſterior branch paſſes into the gutter which runs along the convexity of the bone that ſuſtains the branchiæ, and, in its courſe, furniſhes a conſiderable number of ſmall ramifications to the pectinated laminæ of the gills.

The anterior branch is directed into the correſpondent gutter in the concavity of the bone, and is there divided in the ſame manner: the anterior branch of the firſt ramification re-enters the cranium, and appears to be tranſmitted to the ear.

The middle branches of the par vagum, which we have diſtinguiſhed with reſpect to their diſtribution, ariſe ſometimes from the ſame

ſame trunk as the laſt branchial, and afterwards divide into two or three branches; but more commonly they come out of the cranium, as an equal number of diſtinct branches by one common hole: one of theſe ramifies upon the muſcles that move the branchiæ, and thoſe which act on the teeth of the palate. Another, which is much larger, proceeds along the œſophagus, to which it is diſtributed; it may be traced to the ſtomach. The third branch unites with the cervical nerves which proceed to the ſhoulder, or pectoral fin.

The laſt branch of the par vagum, and which appears peculiar to fiſhes, is the long nerve of the lateral line of the body. We have conſtantly met with it in every one of the fiſhes we have examined, and its diſtribution is nearly the ſame in all. When we trace it to its origin, it is eaſy to diſcover that it is the moſt poſterior branch of the nerve, which, inſtead of deſcending towards the gullet, proceeds almoſt horizontally backward and outward, in ſuch a manner as to become almoſt ſuperficial. It is merely covered by the ſkin, and retained by a looſe cellular ſubſtance. This nerve is nearly of an equal thickneſs throughout the whole of its length, and may therefore be very readily miſtaken for a tendon; it does not appear to anaſtomoſe with the other nerves, or, if it unites with the inter-vertebral, the filaments are exceedingly ſlender. When it arrives at the tail, it it terminates by very ſmall radiated filaments, which are diſtributed to the rays of the fin.

This is the general diſtribution of the pneumo-gaſtric nerve in fiſhes. The varieties which it preſents reſult from the ſtructure of the ſpecies. Thus, in the Chondropterygii, as *rays*, *ſharks*, &c. this nerve is much longer, and all its ramifications proceed from a ſingle trunk, which does not divide until it reaches the part into which it is diſtributed. In the ſame fiſhes, the two longitudinal nerves are ſituated towards the back, and nearer each other.

The other differences are not ſufficiently remarkable to merit a particular deſcription.

Article VIII.

Of the Gloſſo-pharyngeal Nerve.

We have already deſcribed the manner in which the filaments which compoſe this nerve ariſe from the brain, and explained the motives which induce modern anatomiſts to conſider them as a diſtinct pair. We ſhall now purſue its diſtribution.

It makes its exit from the cranium, through a hole in the dura-mater, very different from that of the eighth pair. The jugular foramen, into which

which the vein of the ſame nerve paſſes, ſeparates theſe two nerves. Still enveloped by the dura-mater, it exhibits a ſmall enlargement, from which two branches are detached: one is directed poſteriorly towards the meatus auditorius; another perforates the dura-mater, and unites with the par vagum.

Having reached the baſe of the cranium, it receives filaments from the facial and pneumogaſtric nerves; it afterwards divides into ſeveral branches—one is partly diſtributed to the muſcles attached to the ſtyloid proceſs, and terminates in the tongue—another unites with the hypogloſſus major:—laſtly, others are diſtributed to the muſcles of the pharynx, along with ſome filaments of the great ſympathetic nerve, and form a plexus which envelopes the carotid arteries; but the principal deſtination of this nerve is to the tongue and the pharynx.

Such is the deſcription of this nerve in man. The other mammalia, birds and reptiles, preſent no remarkable difference. We have not indeed carried our reſearches, with reſpect to this particular part, ſo far in them as in the human body. We have, however, obſerved, that this nerve proceeds to terminate in the tongue, after having furniſhed filaments to the muſcles which move it. In the *ſtork*, for example, it comes out of the baſe of the cranium, by the hole ſituated below the ear, which correſponds to the poſterior foramen lacerum. It leaves this hole

 in

in two filaments, which unite almoſt immediately, and form a long quadrangular ganglion, from which a ſmall filament is ſent inward to the anterior muſcles of the neck: the ſame ganglion detaches a ſmall branch backward, which unites with the eighth pair; and a large branch downward, on the front of the neck: the laſt is the continuation of the nerve itſelf; it deſcends along the œſophagus, and divides into two principal branches; one aſcends upon the anterior part of the neck, and is diſtributed to the muſcles of the os hyoides, which include it, in the form of cornua; the other deſcends on the lateral parietes of the œſophagus, and furniſhes a branch to the lingual nerve, with which it anaſtomoſes; the remainder of the nerve continues its courſe upon the œſophagus. From this deſcription it appears that the diſtribution of the gloſſo-pharyngeus is nearly the ſame as in man.

The nerve which ſupplies the place of the gloſſo-pharyngeal in fiſhes, is plainly that branch of the pneumo-gaſtric which is detached moſt anteriorly from the firſt branchial nerve: it is divided into a great number of filaments, which penetrate the muſcles of the tongue, in which they are ſubdivided. The trunk itſelf is loſt in the inferior part of the throat, before and between the branchiæ.

ARTI-

Article IX.

Of the Great Hypogloſſal Nerve, or Twelfth Pair.

These nerves leave the cranium, as we have already ſhewn, through the anterior condyloid foramen. As ſoon as they get on the outſide of the cranium, they become cylindrical, and form communications with the par vagum, the two firſt cervical pairs, and eſpecially with the great ſympathetic nerve: after this they proceed forward, and a little outward, until they arrive behind the ſterno-maſtoid muſcle. At this place they give off a large branch, which accompanies the jugular vein almoſt to the middle of the neck, where it forms an arch, and aſcends on the anterior part of the neck, and terminates by uniting with ſome filaments from the firſt cervical nerves.

Some ſmall branches proceed from the convexity of this arch, and terminate in the muſcles.

About two fingers breadth from this firſt branch, the hypogloſſal nerves detach another branch, which is entirely loſt in the ſubſtance of the thyro-hyoideus muſcle.

Finally, the trunks paſs between the hyogloſſus, and mylo-hyoideus muſcles, and receive ſome filaments from the lingual branch of the inferior maxillary nerve: they at laſt loſe themſelves by minute ramifications in the ſubſtance of the muſcles of the tongue.

In the other Mammalia this nerve preſents the ſame diſpoſition as in man. In the *calf* it is of a bluiſh colour, and may at firſt ſight be taken for a vein. It retains this colour until it arrives near and within the ramus of the inferior jaw. It is diſtributed in the muſcles, and even in the ſubſtance of the tongue towards its middle part.

In birds, the hypogloſſus comes out of the cranium, through the condyloid foramen, behind the par vagum: it is ſlender at its origin, paſſes before the par vagum, which it croſſes, and with which it partly unites. At this place a ſmall filament is detached from it, which proceeds towards the breaſt, accompanying the jugular vein.

Continuing its courſe forward, the trunk of the hypogloſſus croſſes the gloſſo-pharyngeus: it then paſſes under the cornu of the os hyoides, and proceeds towards the ſuperior larynx, where it terminates; but it is previouſly divided into two branches, the inferior of which is ſent forward and downward from the tongue, and the ſuperior upward and inward from the tongue.

We have not obſerved any nerve analogous to the hypogloſſus in fiſhes.

ARTI-

ARTICLE X.

Of the Sub-Occipital and Cervical Nerves.

A. *In Man.*

THE trunk formed by the union of the two roots of the *ſub-occipital* nerve, pierces the dura-mater below the curvature of the vertebral artery. It runs for a ſhort way in the ſubſtance of that membrane, and comes out on the edge of the foramen magnum, behind the condyles: it is then turned towards the notch in the articular proceſs of the firſt vertebra, where it paſſes below the vertebral artery. It then forms a ganglion, from which ſome filaments are diſtributed to the ſtraight and oblique muſcles of the head. The trunk afterwards turns before the tranſverſe proceſs; it communicates by an anterior branch with the ſympatheticus major, the par vagum, and the hypogloſſus, and by a poſterior branch with the firſt cervical pair: it then proceeds towards the triangular interval of the ſmall muſcles of the head, and is diſtributed to almoſt all the muſcles which are attached to the os occipitis by their ſuperior part.

The *firſt cervical pair* ariſes in the ſame manner as the preceding. After paſſing through the

 notch

notch between the firſt and ſecond vertebræ, this pair forms a ganglion which ſends off two principal branches. The anterior of theſe communicates with the inferior branch of the ſub-occipital nerve, the ſympatheticus major, the hypogloſſus, and the ſucceeding cervical pair. The poſterior branch, which is more conſiderable, detaches ſome filaments which unite with the poſterior branch of the ſub-occipital, and with that of the next cervical pair. The remainder of the nerve is diſtributed to the muſcles of the back part of the neck. One of the filaments goes forward, communicates with the hypogloſſus, and is loſt in ſome of the muſcles of the os hyoides, and in the glands of the larynx.

The *ſecond cervical pair* is divided, like all the others, into two branches: the anterior is the largeſt; it communicates upwards and downwards with the two adjacent cervical pairs, with the ſympatheticus and hypogloſſus, and laſtly, with the branch of the following cervical pair or pairs, which produce the diaphragmatic nerve; after which it divides into ſeveral branches.

One branch is ſent backward into the muſcles of the neck; another forward and obliquely into the lateral parts of the ear, where it communicates with the facial nerve; a third proceeds towards the aſcending ramus of the jaw, and is diſtributed partly into the parotid gland, and partly into the teguments of the ear; a fourth is loſt

loſt in the anterior part of the neck, in the muſculus cutaneus. All the other branches are united with each other, and with the acceſſary nerve of the eighth pair. By this union they form a plexus, which produces a great number of filaments to the lateral parts of the neck, ſome of which communicate with the ſympatheticus major.

With reſpect to the poſterior diviſion of the trunk of this nerve, it unites with the adjacent cervical nerves, and is loſt in the muſcles named ſplenius, complexus, longiſſimus dorſi, and tranſverſalis colli.

The notch between the third and fourth vertebræ of the neck affords a paſſage for the *third cervical pair*. It is divided, as the others are, into two branches.

The anterior branch ſeparates into two. The firſt receives a filament from the preceding pair, and is then diſtributed to the trapezius muſcle, and the ſterno-maſtoideus. The ſecond forms two filaments; one of which unites with the following pair: it detaches alſo ſome others which join the facial nerve, and one very conſpicuous branch which conſtitutes the diaphragmatic nerve. The other filament joins the fourth pair, and partly unites with the great ſympathetic.

The poſterior branch is diſtributed to the teguments and muſcles of the back of the neck.

The

The *fourth pair of cervical nerves*, on leaving the medullary canal, divides into two branches, in the fame manner as all the vertebral nerves. The pofterior branch is partly loft in the mufcles of the back. The anterior, which is the thickeft, communicates with the branch of the preceding pair, which forms the diaphragmatic nerve: it communicates likewife with the great fympathetic, and is divided into three branches; two unite with the fucceeding pair, and affift in forming the brachial plexus. The third proceeds towards the fhoulder, and is diftributed to the mufcles of the fcapula.

The fifth, the fixth, and the feventh pairs of cervical nerves may be confidered generally: they all communicate with the adjacent pairs, and with the great fympathetic. The *fifth* pair tranfmits filaments to the pofterior mufcles of the neck, and to thofe of the anterior part of the thorax: fometimes one of its filaments concurs in the formation of the diaphragmatic nerve; it is, at laft, fent into the brachial plexus. The *fixth* is chiefly tranfmitted by two large trunks to the brachial plexus: the firft trunk receives that of the preceding pair, and detaches fome filaments to the latiffimus dorfi. The fecond likewife fends a filament to the great pectoral mufcle. Finally, the *feventh* pair produces, in the fame manner, two large trunks for the brachial plexus, which are united fooner or later

later to that of the fixth. The inferior branch furnifhes two filaments to the fubclavian and leffer pectoral mufcles.

B. *In other Mammiferous Animals.*

The fub-occipital and cervical nerves exhibit no remarkable differences in any of the Mammalia. They all arife in the fame manner as in man. The bulk and extent of the nervous filaments which they produce, depend upon the relative magnitude of the parts to which they are refpectively diftributed. They all have the fame number of nerves, the *three-toed floth* excepted, which ought to have two pair more; fince, as we have fhewn in the Third Lecture, that animal has nine cervical vertebræ.

C. *In Birds.*

The number of the cervical nerves varies greatly in this clafs. The known extremes are ten and twenty-three, equal to the number of the vertebræ. Their difpofition is analagous to that obferved in man. They are, however, refpectively much larger, and undergo many flexures. They are loft, in a great meafure, under the fkin of the neck, where they may be very eafily followed. In general only the laft cervical pair contributes to the brachial plexus: the two laft pairs feldom concur in its formation.

D. *In Reptiles.*

Tortoifes have eight pair of cervical nerves, which are diftributed nearly in the fame manner as in Mammalia. The three laft pairs join in forming the brachial plexus. The *green lizard* has four pair of cervical nerves, but only the two laft enter into the compofition of the plexus. In *falamanders* and *frogs* the cervical nerves cannot be properly diftinguifhed from the dorfal, as thefe animals have no ribs. A pair comes out between the firft and fecond vertebræ, which is fent to the mufcles of the inferior part of the neck, and under the fkin that covers them. Thefe nerves alfo afford fome filaments to the fhoulder. From this diftribution they may be regarded as real cervical nerves. In *frogs* only two pairs enter into the compofition of the plexus. In the *falamander* there are diftinctly four.

E. *In Fifhes.*

As the cervical vertebræ of fifhes cannot be pofitively diftinguifhed from the dorfal, it is very difficult to explain the diftribution of their cervical nerves. There are never more than four that merit this name, and frequently there are none to which it can be applied. When thefe nerves exift, they are diftributed to the parts about the throat, or rather to the pectoral fin, over

which

which they are ſpread, as we ſhall ſhew when we deſcribe the brachial nerves.

Article XI.

Of the Diaphragmatic Nerve.

This nerve is produced chiefly by the fourth pair of cervical nerves; but it alſo receives, as we have ſhewn, a conſiderable branch from the ſucceeding pair, and ſometimes a ſlender filament from the ſixth; beſides, very commonly, a ſmall branch, which is given off from the convex ſide of the arch, formed on the fore part of the neck by the hypogloſſus.

Thus compoſed, this nerve deſcends before the neck in a large trunk, to which ſome filaments from the two laſt cervical pairs, and the cervical ganglion of the great ſympathetic, are united. It detaches ſome fibrillæ to the ſcaleni muſcles, and the thymus gland, when it exiſts; after which it proceeds into the thorax, between the ſubclavian artery and vein. It is involved in the middle reflection of the pleura, paſſes anterior to the pulmonary veſſels and veins in the lateral parts of the pericardium, in order to arrive at the diaphragm.

Here the nerve terminates: it is diſtributed by radiated fibres in the ſubſtance of the muſcle.

Some

Some filaments, however, paſs to the abdominal ſurface, and communicate with the ſubgaſtric plexus of the great ſympathetic nerve.

The diaphragmatic nerve of the other Mammalia is in every reſpect ſimilar to that of man. It has not always the ſame origin, but that is alſo ſubject to variation in man. It proceeds, however, moſt commonly, from the fourth cervical and the two following pairs. It alſo receives the branch from the hypogloſſal and great ſympathetic nerves. The other circumſtances in its diſtribution do not merit a detail.

We have not been able to diſcover the diaphragmatic nerve in birds. It is poſſible, however, that the muſcles which are attached to the lungs, and which form ſo large an aponeuroſis, receive ſome nervous filaments: we muſt confeſs, however, that they have eſcaped our obſervation.

Reptiles have no diaphragmatic nerve, unleſs we regard as ſuch the cervical pairs which are loſt in the muſcles of the neck in thoſe reptiles that want ribs, as *ſalamanders* and *frogs*. In them theſe muſcles produce the effect of the diaphragm, as will appear in the Article on Reſpiration.

Fiſhes having no lungs alſo want the diaphragmatic nerve. We find, however, ſome analogy in the probable function, and particularly in the diſtribution of one of the firſt vertebral pairs, which is diſtributed to the muſcular

cular ſeptum that ſeparates the cavity of the branchiæ from that of the abdomen. This nerve is particularly remarkable in the *ray* and the *carp*.

ARTICLE XII.

Of the Dorſal and Lumbar Nerves.

A. *In Man.*

THE *dorſal* nerves leave the canal of the medulla ſpinalis through the holes which are formed by the correſponding notches of each two contiguous vertebræ.

The firſt pair comes out between the firſt and ſecond dorſal vertebræ, and the laſt between the twelfth vertebra of the back and the firſt of the loins.

All theſe nerves divide into two branches upon leaving the intervertebral holes; the poſterior, which is the ſmaller branch, is diſtributed to the muſcles and ſkin of the back. The anterior branch, which is the larger, communicates by one or two filaments with the great ſympathetic nerve, detaches ſome ramifications to the intercoſtal muſcles, and thoſe of the anterior part of the thorax, and abdomen, and afterwards paſſes along the intercoſtal ſpaces towards the ſternum.

The

The firft pair of dorfal nerves is diftinguifhed by its contributing to the formation of the brachial plexus in conjunction with the laft cervical pair.

The two following pairs produce fome branches which pafs through the lateral parts of the breaft, and proceed from within outwardly to the teguments of the arm on the internal fide.

The twelfth pair is partly diftributed to the mufcles of the abdomen, and under the teguments; and partly into the mufcles called quadratus lumborum longiffimus dorfi, and ferratus pofticus inferior, and to the fkin of the buttocks.

The *lumbar* nerves vary in number. They are ufually five, fometimes four, and feldom fix. They are large in proportion as the vertebra from which they proceed is more inferior. The fifth therefore is ufually of the greateft fize.

On leaving the intervertebral holes, they divide into two branches, one anterior, the other pofterior. The firft branch detaches a number of filaments which unite with each of the lumbar ganglia of the great fympathetic nerve, and with each of the preceding and following pairs: it alfo tranfmits fome branches to the mufcles of the abdomen, to the quadratus lumborum, the iliacus, and the fkin. The laft ramifications are commonly flexuous, in order that they may follow the parts in their extenfion.

The pofterior branch is loft in the mufcles of the

the inferior part of the ſpine. The number of its ramifications vary conſiderably.

The *firſt* lumbar pair furniſhes a ſmall branch, which is diſtributed to the cremaſter muſcle, and the teſticles in men. In women this branch goes partly to the uterus, and partly to the external organs of generation.

The *ſecond* pair alſo furniſhes ſome filaments which are diſpoſed of in the ſame manner as thoſe of the preceding: one of them is very remarkable, and ſometimes deſcends to the knee.

The diſtribution of the *third*, *fourth*, and *fifth* pairs is nearly analogous.

The principal branches of each of theſe nerves unite together, and form three very remarkable trunks, which we ſhall demonſtrate hereafter.

The firſt is the *anterior femoral* nerve, commonly called the *crural.*

The ſecond is the *ſub-pubic* nerve, uſually named the *obturator.*

The third, which is produced by a plexus of the lumbar with the anterior ſacral nerves, is the *iſchiatic.*

B. *In other Mammiferous Animals, and in Birds.*

In theſe animals the dorſal and lumbar nerves are exactly ſimilar to thoſe of man. They vary only with reſpect to their number, an idea of which may be formed by conſulting the tables of the Vertebræ which we gave in the Third Lecture.

C. *In Reptiles.*

We ſhall alſo refer to the tables which indicate the number of the vertebræ in reptiles, in order to ſhew the number of the nerves which iſſue from their foramina. The diſtribution of theſe nerves is the ſame as in the other animals, and to point it out would only be repeating what we have already deſcribed in man.

D. *In Fiſhes.*

In this claſs there is no diſtinction between the different nerves of the vertebral column. They are all diſtributed in the intercoſtal ſpaces, and preſent no peculiarity.

ARTICLE XIII.

Of the Pelvic and Caudal Nerves.

THE pelvic or ſacral nerves come out of the vertebral canal, by the holes which are commonly called the *ſacral*, and which are uſually five in number, ſometimes more, ſometimes leſs. The poſterior branches which come out by the poſterior foramina are the leaſt conſiderable. On their

their appearance without the holes they unite with the adjoining branches, and are diſtributed by a number of filaments to the ſkin of the buttocks, and to the lateral parts of the anus. The anterior branches are thoſe which produce the ſacral or pelvic nerves, properly ſo called.

The *firſt* pair proceeds within the pelvis towards the iſchiatic notch. Having furniſhed ſome filaments to the inferior ganglia of the great ſympathetic nerve, it is united and confounded with the ſucceeding ſacral pair. Advancing a little farther, it receives the large trunk formed by the fourth or fifth pairs of the loins: it beſides detaches a branch, which ſeparates from the iſchiatic portion, while it paſſes through the notch, and is diſtributed to the muſculus gluteus medius.

The *ſecond* pair gives off ſome branches which are diſtributed nearly in the ſame manner as the firſt; but it is divided within the pelvis into two portions, the ſuperior of which unites with the trunk of the firſt pair, as we have already ſhewn; and the ſecond is confounded with the third pair in order to form the iſchiatic nerve. Two filaments are detached from the poſterior part of this pair, which accompany it into the notch, but ſeparate from beyond it. The one is loſt in the gluteus maximus; the other unites with a branch of the following pair, and forms a ſmall ſingle trunk, which is again diſunited, to be diſtributed to the poſterior part of the thigh, and the leg beneath the ſkin, and to the teguments of the hip, the anus and the penis, or the vulva.

The *third* pair alſo unites, as we have ſtated, to the inferior branch of the ſecond. It is much ſmaller; at firſt, it gives ſome filaments to the great ſympathetic nerve, and afterwards furniſhes a great number which are diſtributed within the pelvis on the neck of the bladder in man, and on the lateral parts of the vagina in women. In this place they unite with ſome filaments from the great ſympathetic nerve, and form a very conſiderable plexus. This pair alſo furniſhes a number of other branches, ſome of which are ſent to the poſterior parts of the thigh, and others beneath the ſkin of the buttocks.

The *fourth* pair of ſacral nerves is diſtributed nearly in the ſame manner as the preceding. It beſides detaches ſome filaments to the muſcles of the anus, and a large branch which unites with others that come from the ſciatic nerve, thus forming a very remarkable trunk. This trunk paſſes between the two ſacro-ſciatic ligaments, and afterwards divides into two branches; one of which is loſt in the muſcles of the anus, and the obdurator internus; the other proceeds to the muſcles and teguments of the penis in man, and to thoſe of the vulva in females.

Laſtly, the *fifth* pair, which is the ſmalleſt of the whole, is diſtributed nearly in the ſame manner as the fourth.

There

There are no *caudal* or *coccygeal* nerves in man. The other Mammalia, and the birds, prefent no difference worthy of notice in their *pelvic* nerves. There are *caudal* nerves in the Mammalia. They iffue from the vertebral canal, by holes which are formed in the vertebræ of the tail. We fhall defcribe them from the *rabbit*.

The *firft* pair comes out between the laft piece of the os facrum and the firft caudal vertebra. It proceeds from the pelvis before the mufculus ifchio-coccygeus by the ifchiatic notch. It then divides into two branches: one is united to the fciatic nerve; the other continues to advance between the pelvis and the tail until it enters a gland fituated under the fixth caudal pair of nerves, where this branch terminates; but, in its courfe, it unites with a number of nerves, and gives origin to others, thus forming a very remarkable plexus, which we fhall name the *caudal*.

The firft filament which is detached from this branch, paffes under the glutei mufcles, to which it is diftributed; the branch is afterwards joined on the internal fide by a fmall anaftomofing filament, which appears to be derived from the fecond caudal pair, and on the external fide by three or four filaments, which form a reticular plexus, from whence feveral branches go to the mufcles; one which is very confiderable, paffes into the pelvis, and is loft upon the penis, where it may be eafily followed, as its fize continues undiminifhed: again, the third, fourth, and fifth pair of caudal nerves fend filaments to the internal fide; after which five or fix branches are given off from the external fide of the mufcles of the penis, and thofe which arife from the ifchium. Finally, the trunk of the firft caudal pair is terminated in the gland we have already mentioned.

The facral and caudal nerves are not diftinct in reptiles and fifhes. We have pointed out the diftribution of thofe which are fent to the pofterior feet, or ventral fins. Thofe of the tail refemble the intercoftals, and are loft in the mufcles.

ARTICLE XIV.

Of the Brachial Plexus, and the Nerves of the Thoracic Member.

A. *In Man.*

WE have defcribed the manner in which the cervical nerves produce the brachial plexus by their union. The nature of this nervous intertexture renders it very difficult to follow each of the four pair of nerves which form it, when they feparate to be diftributed to the arm.

All thefe nerves pafs into the interval included between the fcaleni mufcles, and are there

there ufually united to the firft dorfal pair. When thefe nerves féparate, they form three principal fafciculi, from which all the nerves of the arm arife.

The middle fafciculus produces the *median* and *ulnar* nerves.

The pofterior fafciculus detaches the *radial* and the *axillary*.

Laftly, the internal fafciculus gives origin to the *thoracic*, *fcapular*, *external* and *internal cutaneous* nerves.

This difpofition is, however, fo liable to variations, that nothing pofitive can be eftablifhed refpecting it; but whatever may be the origin of the nerves we have enumerated, their number is conftantly found the fame. We fhall now follow them in their diftribution.

1. *Of the Median Nerve.*

This nerve is one of the largeft of the arm; at the middle and anterior part of which it is fituated on the internal edge of the brachial artery; it defcends in this manner, without producing any remarkable branches, as far as the articulation of the fore-arm; it afterwards paffes between the tendon of the brachialis internus, and the pronator teres mufcles, to which it tranfmits filaments, as well as to the fkin. It produces, at this place, fome other very remarkable branches; one is loft in the radialis externus, and may even be followed a confiderable way in that mufcle. The others are fent to the palmaris longus, and to the flexor profundus; but the moft conftant of all is the branch called *inter-offeous*, which, after receiving an anafto-mofing branch from the radial nerve, tranfmits filaments to the flexor longus pollicis, and the profundus mufcles; perforates the interoffeous ligament, to which it furnifhes a filament; re-appears on the external furface of the fore-arm, and is loft in the flexor longus pollicis and pro-nator quadratus.

The trunk of the median nerve accompanies the flexor mufcles of the fingers, and reaches the palm of the hand along with the tendons. It detaches feveral branches to the mufcles, the aponeurofis palmaris, and the fkin. Laftly, it divides into four or five principal branches near the digital extremity of the metacarpal bones; the firft of thefe branches is loft in the mufcles of the thumb; the fecond divides into two branches, which, after having given off fome filaments to the adductor pollicis, run along the edges of the thumb, and at its extremity re-unite, forming an arch, from which a con-fiderable number of filaments are detached. The third branch alfo produces two fmaller portions, which are fent in the fame manner along the fides of the fore-finger. The fourth is fimilarly diftributed to the middle finger. Sometimes, however, it furnifhes only one of the

the lateral filaments, that on the radial ſide of the finger having been ſupplied by the third branch. Finally, the fifth branch is diſtributed on the radial ſide of the ring finger. The four digital ramifications tranſmit filaments to the muſculi lumbricales, to the ſheath of the tendons, and to the teguments, which it is impoſſible to trace, although they are exceedingly numerous.

2. *Of the Ulnar Nerve.*

This nerve deſcends along the internal part of the arm, until it approaches the elbow, where it is received into a particular furrow of the epitrochlea of the humerus. It affords ſome filaments to the olecranon, and to the muſcles inſerted in that part. The trunk of the nerve croſſes the origin of the flexor ulnaris muſcle, and proceeds along the palmar ſurface of the fore-arm on its ulnar margin. In its courſe to the wriſt it detaches ſeveral branches to the articular capſule of the fold of the arm, and to the flexor muſcles of the fingers. At the annular ligament of the carpus, or a little before it, the trunk divides into two branches; one is named the *dorſal*, and the other the *palmar*.

The dorſal branch ſubdivides into filaments, which, after uniting among themſelves, and with others from the radial nerve, are loſt in the ſkin of the back of the hand.

The

The palmar branch furnifhes the two lateral branches of the little finger, and alfo that which anaftomofes with the fifth branch of the median nerve, at the extremity of the ring finger; it likewife fends down fome filaments to the lumbricales and interroffei mufcles.

3. *Of the Radial Nerve.*

The radial is the thickeft nerve of the arm. Soon after it feparates from the plexus, we find it fituated between the ulnar nerve and the axillary artery; it furnifhes almoft immediately fome filaments, which are loft in the fkin, and in the triceps brachialis. The trunk of the nerve paffes afterwards behind the humerus, round which it turns to re-appear on the external furface between the brachialis externus, fupinator longus, and brachialis internus. It alfo produces, at this place, a fub-cutaneous branch, which accompanies the cephalic vein to the wrift, and feveral other branches to the radial and fupinator mufcles. The trunk of the nerve then croffes the fupinator brevis, above the articulation of the radius with the humerus, and continues to proceed on the external furface of the fore-arm. It gives a number of branches to the mufcles, and then divides into two branches, one of which, having paffed under the annular ligament of the convexity of the carpus, is loft in the fkin, and the parts which cover

cover the back of the hand: the next branch, which is the largeſt, divides into two others before it reaches the annular ligament of the wriſt. One produces two ramifications; the firſt terminates on the dorſal ſurface of the thumb, and on that of the fore-finger; the ſecond is alſo diſtributed to the fore-finger, the middle, and frequently to the ring-finger. The other ramification alſo proceeds to the convexity of the hand and the fingers, and is diſtributed nearly in the ſame manner as the former. It is, however, commonly the ſmaller of the two.

4. *Of the Axillary Nerve.*

This has alſo been named the *articular* nerve. It is frequently only a branch of the radial covered by the deltoid muſcle under which it paſſes. It tranſmits ſome filaments to that muſcle, and to the other muſcles near the articulation of the humerus, as the teres-major, the latiſſimus dorſi, the ſerratus major, and the ſubſcapularis. One of its branches, which is the moſt remarkable, is loſt in the articular capſule of the humerus.

5. *Of the Thoracic and Scapular Nerves.*

The thoracic nerves in ſome inſtances ariſe ſeparately from the brachial plexus. They are diſtributed chiefly to the pectoral muſcles, and are loſt in the mammary glands, and in the ſkin of of the breaſt. There is frequently a poſterior branch which is loſt in the ſubſtance of the latiſſimus dorſi, (or *lumbo-humeralis*) muſcle.

The ſcapular nerve paſſes behind the notch in the coracoid proceſs, and gives branches to the ſupra-ſpinatus and infra-ſpinatus muſcles, and to the ſub-ſcapularis.

6. *Of the External Cutaneous, or Muſculo-Cutaneous Nerve.*

This nerve perforates the coraco-brachialis muſcle. It is afterwards ſituated between the biceps and the brachialis internus, to both of which it furniſhes numerous filaments. Having reached the middle part of the humerus, it divides into two branches; one ſuperficial, and the other deep ſeated.

The ſuperficial branch is the larger: it deſcends with the cephalic vein above the tendon of the biceps muſcle in front of the fold of the fore-arm, where it divides into a number of ramifications. Some of theſe are partly loſt in the ſupinator longus, and in the ſkin, where they anaſtomoſe with other filaments from the radial nerve. Other ramifications deſcend to the hand, and divide and ſub-divide in the ſkin.

The deep ſeated branch of the external cutaneous nerve is almoſt entirely loſt in the brachialis internus muſcle; one of the filaments penetrates, with the humeral artery, properly ſo called, into the medullary cavity of the bone.

7. Of

7. *Of the Internal Cutaneous Nerve.*

This nerve comes ſometimes from the ulnar; it proceeds along the poſterior and internal ſide of the humerus, between the ſkin and the muſcles. When arrived at the fore-arm, it divides into a number of branches which enter the ſkin, and may be traced as far as the hand.

B. *In other Mammiferous Animals.*

The brachial plexus is produced in the other Mammalia by the three laſt pair of cervical nerves, and by the firſt dorſal pair.

The *articular* nerve is excluſively formed by the fifth cervical pair in the *rabbit*, and only one of its filaments enters into the compoſition of the plexus.

The *thoracic* nerves are detached from the plexus, and are diſtributed to the muſcles of the axilla. We alſo find a nerve analogous to the *ſcapular*.

The *internal* and *external cutaneous* nerves are not diſtinct, but only branches of the three principal cords which repreſent the *median*, *ulnar*, and *radial* nerves.

At the middle part of the arm the *median* produces a branch which is diſtributed to the muſcles and the ſkin, and may be regarded as a *muſculo-cutaneous* nerve. Having arrived before the bend of the fore-arm, it detaches a number of of filaments which paſs deeply along with the tendon of the biceps, and are diſtributed to the muſcles. The trunk continues to accompany the muſcles of the palmar ſurface of the fore-arm. It divides into two branches, which paſs through two particular grooves in the ligaments of the carpus, and are each diſtributed to the fingers, nearly as in man.

The *ulnar* nerve is the moſt external and the ſlendereſt of the three. About the middle of the arm it gives off a branch to the extenſor muſcles of the elbow and to the ſkin. This branch appears to ſupply the place of the *external cutaneous* nerve. The trunk of the ulnar having arrived before the articulation of the arm, penetrates the aponeuroſes of the muſcles which are inſerted in the external condyle: it paſſes along the ulna on the inter-oſſeous ligament, gives branches to the flexor muſcles of the fingers, and terminates in two very long filaments, one of which goes to the external ſurface of the paw, where it is loſt in the ſkin; the other follows the palmar ſurface, and is diſtributed nearly as in man.

The *radial* nerve is alſo the thickeſt of the three cords: it winds round the humerus, and furniſhes ramifications to the extenſor muſcles of the fore-arm: having reached the external part of the arm, it glides between the biceps and triceps muſcles, and divides into ſeveral branches; one becomes ſuperficial, and proceeds to to the front of the fore-arm under the ſkin; the others are loſt in the muſcles of the anterior part of the fore-arm.

Laſtly, the trunk, after ſupplying the muſcles, divides into ſeveral filaments, which are loſt in the ſkin on the convex part of the fingers.

C. *In Birds.*

The brachial plexus in birds, is formed excluſively by the laſt cervical and the two firſt dorſal pairs. Their intermixture produces only one faſciculus, from which all the nerves of the arm are derived.

The firſt cords detached from the plexus, are intended for the pectorales major and medius, and the ſub-clavius muſcles: they are large, and four in number.

A branch, analogous to the *articular* nerve, is afterwards diſtributed to the muſcles which ſurround the head of the humerus and its articular capſule.

Two large principal cords then ariſe, which are ſent to the wing.

One is directed under the internal or inferior ſurface of the wing. It firſt detaches filaments to the biceps and deltoid muſcles, then following the internal edge of the biceps, it arrives at the bend of the fore-arm without affording any remarkable branches. Having advanced above the articulation of the fore-arm, immediately

ately under the ſkin, it divides into three branches; the external is the moſt ſlender, and is partly loſt in the radial muſcles, and the ſkin which covers the pollex, or the baſtard wing. The middle branch paſſes deeply under the muſcles to which it is diſtributed; one of its filaments perforates the inter-oſſeous ligament to get to the ſuperior ſurface. Laſtly, the third or internal branch, proceeds, as the ulnar nerve, on the internal condyle of the humerus, amongſt the tendons of the muſcles which are there inſerted. At this place it ſeparates into a number of filaments: one paſſes to the articular capſule of the fore-arm with the humerus, and into the ſkin that covers the elbow; ſome proceed to the flexor muſcles of the metacarpus. Two others, which are more remarkable and longer, follow the inferior margin of the wing under the ſkin, and are loſt in the ſkin which covers the inner ſurface of the digiti. This nerve appears to ſupply the place of the *median*, the *ulnar*, and the *muſculo-cutaneous*.

The other principal cord of the brachial plexus turns round the humerus to arrive at its ſuperior ſurface, producing, at firſt, ſome very conſpicuous filaments for the extenſors of the ulna; then two other alſo very remarkable filaments, which are diſtributed in the form of a gooſe's foot under the ſkin, and the membranes ſituated between the humerus and the fore-arm. Theſe branches appear analogous to the *nervus* *cutaneus internus.* The trunk of the nerve continues to defcend along the humerus; and, on reaching the articulation with the ulna, is found fituated on the internal furface, but towards the radial edge of the fore-arm: it paffes through the tendon of the radialis externus mufcle, and upon arriving at the outer, or fuperior furface, divides into two branches; one, which is fhort, is loft under the fkin that covers the external furface of the fore-arm; the other, which is longer, is fituated between the two bones on the inter-offeous membrane. When it reaches the articulation of the carpus, it paffes through a particular groove, and is feen divided into three filaments; a fhort one for the pollex, and the other two for the external fide of each of the digiti, upon which they are diftributed under the fkin as far as the laft joint.

It is evident that this cord correfponds to the *radial nerve*, and that one of its branches fupplies the place of the *cutaneus internus.* This defcription is taken from the *duck* and the *ftork.* We prefume it is not different in the other birds.

D. *In Reptiles.*

In the *tortoife*, the three laft pairs of cervical nerves, and the firft of the dorfal, proceed to the thoracic member, where they form a plexus in the following manner: the fifth cervical pair paffes behind the other four pairs, croſſes them in their courſe, and unites with them in its paſſage. It then turns round the ſcapula, which in this animal is articulated with the firſt dorſal vertebra. We ſhall return to the deſcription of this nerve. The ſixth cervical pair proceeds directly along the ſcapula on its internal ſurface: it is croſſed poſteriorly by the fifth, and towards the lower third of the ſcapula receives the ſeventh cervical pair. The ſeventh is ſlender, croſſed by the fifth and the firſt dorſal pair, and united with the ſixth, in the manner we have pointed out. The firſt dorſal pair partly joins the ſeventh cervical, almoſt at the point where it comes out of the vertebral canal; it is then ſent to the muſcles of the ſhoulder.

We ſhall now purſue each of the cords we have mentioned to their termination.

The large nerve produced by the fifth cervical pair, having arrived behind and near the true articulation of the ſcapula with the ſpine, divides into three branches; one, which is but a filament, appears to be diſtributed to the articular capſule; a ſecond, which is very flat, and from the ſides of which a vaſt number of leſſer branches extend to the muſcles of the ſkin, appears to take the place of the *muſculo-cutaneus*; the third branch, which accompanies the muſcles of the ſcapula under the ſkin, deſcends to the humerus, without producing any remarkable branches. At this place, however, it ſends off ſeveral

ſeveral ramifications to the extenſor muſcles of the fore-arm. The trunk continues its direction forward, expands and loſes itſelf under the ſkin, and may be followed as far as the hand: it may, perhaps, be regarded as ſupplying the place of the *ulnar* nerve.

The ſixth pair of cervical nerves having, as we have ſhewn, aſſiſted in forming the brachial plexus, paſſes along the internal ſurface of the ſcapula; about the lower third of that bone it receives the ſeventh pair; the nerve then becomes thicker, but ſoon after divides into two branches; one, which is ſlender, paſſes into the groove, between the furca and the clavicle, and then ſpreads over the articular capſule of the humerus, after furniſhing numerous filaments to the muſcles which ſurround it; this nerve may be regarded as analogous to the *articular* in man. The trunk of the nerve, which evidently ſupplies the place of the *median*, upon reaching the articulation of the humerus with the ſcapula, tranſmits filaments to the adjoining muſcles. On arriving at the palmar ſurface of the fore-arm, it divides into three portions, two of which are on the ulnar ſide, and ſink deeply into the muſcles; the third, which is much larger, follows the radial ſide of the fore-arm, and at the baſe of the thumb proceeds to the palm of the hand, and detaches filaments to each of the fingers.

The ſeventh cervical pair unites, as we have

 ſtated,

ftated, to the fixth, at the pofterior part of the fcapula, to form the median and articular nerves. We have therefore no occafion to return to its defcription. The firft dorfal pair is loft in the mufcles of the fhoulder, and is not continued throughout the arm.

The brachial plexus of the *lizard* differs a little from that of the tortoife; it is formed by two dorfal, and the two laft cervical pairs; the firft of the cervical furnifhes only one of its branches to the plexus; the other going to the neck.

In the *frog*, the nerves which are to be diftributed to the arm, proceed from a very thick cord, which comes from between the fecond and third vertebræ: this makes the largeft nerve in the whole body; it is foon after joined by a filament from the fucceeding pair, with which it intimately unites; this cord proceeds towards the axilla—it fends off a branch, which paffes above the fhoulder, and is loft in the mufcles of that part. The trunk continues its courfe to the arm, and very foon forms two principal branches; and befides thefe, it alfo fends fome filaments to the extenfors of the fore-arm, and the articular capfule of the head of the humerus.

Of thefe two nervous cords, one is directed forward upon the humerus, and reprefents the *median* nerve; it detaches fome filaments to the mufcles and the fkin. Arrived at the fold of the

the fore arm, the nerve plunges amongſt the muſcles, along with the tendon of the *ſterno-radialis*, which ſupplies the place of the biceps; it afterwards divides into two branches, placed one above the other: the moſt ſlender is ſituated between the flexor muſcles of the fingers; the larger upon the furrow, which indicates the union of the two bones of the fore-arm; theſe paſs under the ligaments of the carpus; having reached the palm, the ſuperficial branch is loſt in the ſkin which covers that part, and the deep ſeated is diſtributed to each of the fingers, nearly as in man. It alſo furniſhes ſome filaments to the muſcles of the hand.

The other cord repreſents the *radial* nerve; it turns round the humerus, and furniſhes, in the firſt place, ſome branches to the extenſor cubiti: continuing to deſcend round the humerus, it arrives before the articulation with the bone of the fore-arm, on the radial ſide—it paſſes through the ſubſtance of the muſcles to the external part of the fore-arm: it is afterwards divided; one of the branches is loſt under the ſkin, the other paſſes under the back of the hand, and terminates on the convexity of the fingers. From this deſcription it will appear, that the nerves of the arm in frogs very much reſemble thoſe of the wing in birds.

In the *ſalamander* the nerves of the arm are diſtributed as in the frog, but the brachial plexus is formed by two cervical, and two dorſal pairs, if we may regard as dorſal vertebræ thoſe which ſuſtain rudiments of the ribs.

There are no brachial nerves in *ſerpents*.

E. *In Fiſhes.*

The nerves of the pectoral fin of ſpinous fiſhes proceed from the two firſt vertebral pairs; theſe two nerves ariſe at a conſiderable diſtance from each other, and traverſe the firſt muſcle placed between the ſpine and the firſt rib, which ſeems analogous to the ſcalenus.

In the *ſalmon* the anterior nerve approaches the par vagum, of which it might be regarded as a branch, were it not obſerved that it comes out through a particular foramen. In the *carp* it is ſeparated by the laſt branchial bone. The ſecond vertebral pair, intended for the ſhoulder, is ſituated more poſteriorly, and nearer to the middle line of the body, behind the œſophagus. Theſe two nerves proceed directly downward to the internal lamina of the ſcapula, where they re-unite, but are not confounded. The firſt vertebral pair then divides into two cords, from which anaſtomoſing filaments are detached to form a kind of plexus. A number of theſe filaments are diſtributed to the adductor muſcles of the fin. The cord, which is given off from the firſt vertebral pair, likewiſe appears to terminate in theſe muſcles; but it previouſly produces a remarkable filament, which is diſtri-

buted

buted to the membrane that feparates the branchial from the thoracic, or abdominal cavity, which are here confounded. May not this filament be regarded as analogous to the *diaphragmatic* nerve? we are much inclined to this opinion.

The two brachial nervous cords pafs through the hole fituated before, and without the articulation of the fin with the fhoulder; they unite there, and produce an irradiation of nervous filaments, feveral of which are loft in the mufcles of the external furface of the fhoulder, and in the oblong articular capfule which receives the fmall carpal bones. Laftly, one of the filaments extends under the fkin, which forms the membrane of the radii of the fins.

In cartilaginous fifhes, as the *rays*, both the diftribution and number of the brachial nerves are very various. The firft twenty vertebral pairs are received in a cartilaginous canal, behind the cavity of the branchiæ; they unite there, and form a large fingle cord, which extends towards the middle part of the fin, crofsing the cartilaginous bar, on which the radii are articulated.

This firft cord continues its direction forward, along the cartilaginous bar, defcribing an arch, the concavity of which is anterior, and gives origin to a number of filaments, equal in number to the radii of the fin. All thefe filaments are loſt in the muſcles, and may be followed to the margin of the fin.

The four or five vertebral pairs, which ſucceed the firſt twenty, likewiſe unite into a thick cord, which is afterwards ſubdivided into ſeven or eight filaments, for the middle radii of the fin. Theſe are almoſt perpendicular to the medulla ſpinalis.

The pairs of vertebral nerves which follow to about the forty-fourth, unite two and two, and form a cord, which perforates the cartilaginous bar of the poſterior part of the fin; they divide in the muſcles in the ſame manner as the preceding.

The nerves of the pectoral fin, or wing of the *ray*, therefore, preſent a very ſingular diſtribution.

ARTICLE XV.

Of the Nerves of the Abdominal Member.

A. *In Man.*

IN deſcribing the lumbar and ſacral nerves, we pointed out the formation of the principal trunks that are diſtributed to the inferior extremity: we now proceed to trace them particularly.

1. *Of*

1. *Of the Subpubic, or Obturator Nerve.*

This nerve arifes from the plexus of the lumbar pairs. The place at which it is feparated varies; it proceeds into the fmall pelvis, along the inner fide of the tendon of the pfoas mufcle, and is directed towards the fubpubic foramen: it furnifhes fome filaments to the internal obturator mufcle; it then paffes through the fubpubic foramen, and fends off fome filaments, which go to the external obturator mufcle; after which, it divides into two branches, one anterior, the other pofterior.

The firft is loft in the pectineus, gracilis, and cruralis mufcles; it defcends almoft to the knee.

The pofterior branch is diftributed nearly in the fame manner, but is more deep feated.

2. *Of the Anterior Femoral, or Crural Nerve.*

This cord is commonly formed by the plexus of the four firft pairs of lumbar nerves; it accompanies the femoral artery in its courfe through the fmall groove, which the iliacus and and pfoas mufcles leave between them, to which it gives fome filaments. When under the inguinal arch, it divides into a confiderable number of branches deftined for the mufcles.

One branch is ufually fent to the rectus mufcle; four or five to the triceps femoris; fome to the fartorius, feveral of which afterwards proceed under the fkin. Laftly, others are diftridiſtributed to the faſcia lata, the pectineus, the gracilis, and the ſemi-tendinoſus.

Two longer filaments proceed under the ſkin of the thigh, on the internal ſide: one, which nearly follows the direction of the femoral artery, ſpreads out at the knee; the other is conſiderably thicker; it deſcends to the foot, nearly accompanying the vena ſaphæna, and is called *nervus ſaphenus*; it frequently receives a branch from the ſubpubic nerve towards the middle of the thigh; it is chiefly diſtributed to the ſkin.

3. *Of the Iſchiatic, or Sciatic Nerve.*

This is the largeſt nerve in the body; it is uſually produced by the two laſt lumbar, and the three firſt ſacral pairs: it iſſues from the pelvis, between the gemini and pyriformis muſcles, through the iſchiatic notch; it there produces ſome filaments for the obturator internus, the gemini, and quadratus femoris. In this poſterior ſituation, it deſcends from the iſchiatic tuberoſity towards the trochanter. Having reached the middle of the thigh, or ſomewhat lower, it divides into two cords, which continue to deſcend and paſs into the ham; they then aſſume the names of the *popliteus internus*, or *tibial* nerve, and the *popliteus externus*, or *peroneal* nerve.

In its courſe along the thigh, the iſchiatic nerve furniſhes alſo a number of ſmall branches

to

to the ſemi-tendinoſus, ſemi-membranoſus, and biceps, and to the adductors of the thigh.

When in the ham, it ſends filaments to the popliteus, ſemi-tendinoſus, biceps, and gaſtrocnemii muſcles.

It alſo frequently produces a branch which ſometimes ariſes from the lower part of the peroneal nerve. This branch proceeds under the muſcles of the tendo Achillis, on the ſide of the fibula. It is diſtributed to the ſkin of the foot, and is ſometimes continued on the back of the foot, as far as the extremities of the toes.

4. *Of the Tibial Nerve, or Popliteus Internus.*

This is the internal portion of the trunk of the ſciatic nerve, after it reaches below the ham: the cord, which it forms, paſſes under the muſcles which compoſe the calf of the leg, to which it ſends ſome ramifications. It likewiſe furniſhes ſome to the popliteus muſcle, and its filaments accompany the tibial artery, properly ſo called, or that which enters the bone; it likewiſe detaches filaments to the tibialis poſticus, flexor longus pollicis pedis, and flexor communis digitorum pedis. The trunk, continuing to deſcend, proceeds towards the internal malleolus; it enters the groove formed between the tibia and the os calcis, along with the tendons of the flexor muſcles. When arrived under the ſole of the foot, it is divided into the *internal* and *external plantar nerves*; the firſt firft tranfmits filaments to the fmall mufcles of the foot, as the fhort flexors, tranfverfales pedis, and the abductors and adductors of the great toe, and afterwards divides into four branches, which are diftributed to the lumbricales and interoffei mufcles, and to the fkin: the ramifications which go to the latter, are difpofed of in the fame manner as the branches of the median nerve in the hand, forming alfo an arch with the external plantar.—The external plantar nerve fupplies the fifth toe, and external fide of the fourth.

5. *Peroneal Nerve, or Popliteus Externus.*

The external branch of the fciatic nerve affumes this name below the ham: at firft it detaches fome filaments, which are extended forward under the fkin of the leg and foot, and which unite with the cutaneous ramifications of the tibial nerve. It afterwards glides along the fibula, and making a curve at the fuperior third of that bone, is there divided into three branches, two of which are fuperficial, and the other deep feated.

The deep-feated branch is diftributed to the mufcles of the anterior part of the leg; it extends under the fkin of the knee and foot, tranfmitting filaments to the extenfor brevis, and the fuperior interoffei mufcles.

Both the fuperficial branches proceed under the aponeurofis of the leg: the firft rifes from it it towards its middle part, and paſſes in the ſkin as far as the foot ; the ſecond likewiſe pierces the aponeuroſis, about the middle of the leg, and proceeds under the ſkin, towards the malleolus externus : when it reaches the foot, it divides into ſeveral filaments, which, like the preceding, terminate on the lateral part of each of the toes.

B. *In other Mammiferous Animals.*

The lumbar and pelvic nerves, deſtined for the abdominal member, form a plexus previouſly to their diſtribution. In general it is the ſame as that which takes place in man, or the differences are unimportant. The nervous cords are preciſely alike in number, and divide in the ſame manner.

The anterior crural nerve ariſes moſt commonly before the ſubpubic. In the groin it produces an irradiation of muſcular filaments ; one, which is very remarkable, accompanies the vena ſaphæna under the ſkin, and may be traced to the foot.

The ſubpubic nerve alſo paſſes through the foramen obturatorium ; it is diſtributed to the muſcles of the thigh.

The ſciatic nerve is alſo produced by the ſacral pairs ; it commonly receives anaſtomoſing filaments from the caudal pairs. In general, it

6 preſents

prefents no effential difference from the fame nerve in man.

C. *In Birds.*

The *obturator* nerve alfo arifes, in birds, from the plexus, formed by the lumbar pairs; it goes through the fubpubic hole, with the tendon of the obturator internus; foon after it leaves the pelvis, it divides into a great number of branches, which terminate in the mufcles that furround the os femoris, and chiefly in thofe about its articulation, and in the adductor mufcles.

The *femoral* nerve is evidently formed by the three laft lumbar pairs, which compofe a plexus above the pelvis, from which the obturator nerve proceeds. On reaching the groin, the crural nerve feparates into three principal branches, which afterwards divide and fub-divide in the different mufcles of the anterior and internal furface of the thigh. A confiderable number terminate in the fkin, on which they may be very eafily traced.

The *fciatic* nerve is produced in birds, chiefly by the four fuperior pelvic pairs; it proceeds towards the fciatic notch of the pelvis, behind the cotyloid cavity. Having left the pelvis, it divides into two principal portions; the pofterior is a fafciculus, compofed of feven or eight branches, which are loft in the glutei mufcles and

and adductors of the thigh. The other portion is a ſimple and very thick cord, which appears to be the trunk of the nerve itſelf. It takes the direction of the former, and detaches ſome ſlender branches, which are diſtributed to the flexor muſcles of the leg. When arrived at the middle and poſterior part of the thigh bone, the trunk divides into two branches; the larger correſponds to the *tibial* nerve, and the other, which is ſmaller and nearer the bone, appears to be the *peroneal* nerve.

When the tibial gets into the ham, it divides into two branches: the thicker of the two ſeparates into ſix or ſeven filaments, deſtined to the muſcles of the poſterior part of the leg, and chiefly to the gemelli and the ſoleus; the other branch continues to proceed behind the bone of the leg; having reached the heel, it enters a groove, and paſſes under the bones of the metatarſus, at the digital extremity of which it divides into four, three, or two portions, according to the number of the bird's toes: theſe filaments are ſent to the peroneal edge of each of the toes.

The *peroneal nerve*, or the ſecond principal branch of the ſciatic, is, as we have obſerved, neareſt the bone. When it arrives under the knee, it paſſes towards the peroneal edge of the leg, and divides into a number of filaments, which are loſt in the anterior part of the leg. Two filaments, which are much thicker and longer,

longer, accompany the bones of the leg; one on the peroneal edge, the other on the tibial; in this manner they paſs above the articulation of the tarſus, in two grooves, which are proper to themſelves: they approach each other afterwards, and are ſituated in the anterior gutter of the metatarſal bone, after which they again ſeparate. The tibial branch paſſes between the ſecond and third toe, and the peroneal between the third and fourth, when the latter exiſts; they proceed along the edges of the toes, and terminate under the ſkin, near the nail. This deſcription is taken particularly from the *ſtork*, though we have made ſimilar reſearches in ſeveral other birds; it ſhews that the nerves of the abdominal member are nearly the ſame in birds as in man.

B. *In Reptiles.*

In *lizards* there is only a ſmall nervous filament, which proceeds from the femoral nerve, and ſupplies the place of the *ſubpubic*. The *femoral* nerve is itſelf formed of the two laſt lumbar pairs, and paſſes above the bones of the pelvis, to be diſtributed in the muſcles of the anterior part of the thigh. The *ſciatic* nerve is produced by the three pairs of nerves which follow, and which alſo receive a filament from the laſt lumbar pair; the only cord they form, proceeds along the inſide of the thigh, ſubdividing

dividing in the mufcles, and extending to the toes.

The diftribution of the nerves in the abdominal member is nearly the fame in the *falamander:* there are no differences except in the manner in which the plexus is formed. The *femoral* nerve is produced by a fingle lumbar pair, which tranfmits a branch to the fciatic plexus, formed by the two fucceeding pairs.

In the *frog*, three pair of nerves enter into the compofition of the femoral plexus, before which they run the whole length of the offa ilii, which are very long: when arrived at the thigh, the plexus fends off a nerve which correfponds to the *anterior femoral;* it is diftributed in radiated filaments to the fore part of the thigh. The reft of the plexus proceeds into the pelvis, and forms a large cord, which paffes to the pofterior part of the thigh, and may be regarded as the *fciatic* nerve. A great number of filaments are afterwards detached from it to the mufcles; about the middle and pofterior part it divides into two branches, which pafs under the ham, and reprefent the two *popliteal* nerves, the *external* and *internal:* thefe are afterwards diftributed to the foot of the pofterior leg, nearly in the fame manner as to the human foot.

E. *In Fifhes.*

The ventral fin, which, in fifhes, reprefents the poſterior extremity, receives nerves from the vertebral pairs.

In the cartilaginous fiſhes, as the *ray*, eight or nine pairs proceed directly outward towards the ventral fin; the four or five firſt pairs unite into one trunk, which paſſes through a particular hole in the cartilage that ſuſtains the radii. The other pairs proceed immediately above the radii. All theſe nerves are diſtributed to the muſcles, preciſely in the ſame manner as in the pectoral fin.

In the ſpinous fiſhes, of which we ſhall mention the genus *Silurus*, the vertebral pairs, which are diſtributed to the intercoſtal muſcles, detach filaments to the muſcles that move the fin. Some of theſe may be diſtinctly followed to the membrane which covers the radii.

Article XVI.

Of the Great Sympathetic, alſo called the Great Intercoſtal or Tri-ſplanchnic Nerve.

A. *In Man.*

This nerve cannot be conſidered as proceeding immediately from the brain. It communicates with the fifth and ſixth pairs of the encephalon, with the thirty pairs of vertebral nerves, with the

the gloſſo-pharyngeus, and with the par vagum. At all theſe points of communication it exhibits very remarkable enlargements.

The portion of the great ſympathetic, which is neareſt the brain, appears in the carotid canal of the os temporum, where it forms a plexus round the carotid artery. We have already pointed out the filaments which unite this nerve to the ſixth pair, and that which it appears to receive from the ſpheno-palatine ganglion of the maxillaris ſuperior, under the name of the vidian nerve.

The nervous filaments of the carotid plexus form, at the baſe of the cranium, a ſingle trunk, which produces an elongated enlargement of a reddiſh colour; it extends nearly to the third vertebra, and is called the *ſuperior cervical ganglion.*

This ganglion receives filaments at its origin from the firſt and ſecond cervical pairs; ſometimes from the gloſſo-pharyngeus and the pneumo-gaſtric; to which, as well as to the carotid artery, it is always joined by a very compact cellular ſubſtance. Its figure is an oblong oval, more pointed inferiorly.

After this enlargement, the trunk of the nerve, which becomes more ſlender, deſcends along and behind the carotid artery, as far as the inferior part of the neck, where it forms a new ganglion, named *the inferior cervical.* In its courſe it receives or detaches filaments to each

 of

of the cervical nerves at its poſterior part. It gives off others from its anterior part to the pharynx and the fat, the fibrils of which uniting together, produce very delicate plexuſes round the carotid arteries; the muſcles of the anterior part of the neck alſo receive many filaments. Laſtly, among the other ramifications, which, in conſequence of their tenuity, cannot be readily traced, we obſerve ſome which, uniting with filaments from the par vagum, paſs into the thorax, and form the inferior cardiac plexus, as we have ſhewn in deſcribing the pneumo-gaſtric nerve.

The *inferior cervical* ganglion is flat. Its figure varies. It is oblong, triangular, or ſquare in different individuals. It is uſually ſituated before the tranſverſe proceſs of the ſeventh vertebra of the neck. It is ſometimes wanting, and then it is confounded with the firſt thoracic ganglion. It commonly receives filaments from the four laſt cervical pairs, but ſeldom any from the dorſal. It appears to produce others which, proceeding to the internal ſide, join the recurrent branch of the par vagum, the diaphragmatic nerve, and the nerves which form the ſuperior and inferior cardiac plexuſes.

The trunk of the ſympathetic nerve enters the thorax behind the vertebral artery. Having arrived upon, or a little below the head of the firſt rib, and ſtill covered by the ſub-clavial artery, it experiences a new enlargement, called the

ſuperior

superior thoracic ganglion. A number of nervous filaments run into this ganglion from the inferior cervical pairs, among which there is always a very remarkable one from the firſt dorſal pair, and even ſometimes another from the ſecond. It produces three orders of branches. The firſt unite with the cardiac plexus; the ſecond form a plexus round the ſub-clavial and vertebral arteries; the others are loſt in the muſculi ſcalcni and longus colli.

The remaining part of the great ſympathetic nerve, in the cavity of the thorax, is ſomewhat thicker than in the neck. It is attached inferiorly to the pleura, and paſſes above the heads of the ribs. In its courſe, as far as the diaphragm, it receives filaments from the dorſal pairs, at acute angles; at each of the points of union it forms enlargements or ganglia, which are named in numerical order. They vary both in form and ſize.

At the ſixth ganglion five or ſix branches are uſually detached from the nerve. They proceed downward and inward towards the bodies of the vertebra. They are there united, and form a particular cord, which paſſes into the abdomen, through an aperture of the diaphragm, to which muſcle it affords filaments. This cord is called the *ſplanchnic nerve.*

Upon getting into the abdomen, the ſplanchnic nerve becomes almoſt immediately flat, and forms a kind of nervous creſcent before the

 aorta,

aorta. From its form this has been named the *ſemi-lunar ganglion.* It is joined inferiorly to that of the oppoſite ſide. It ſends off a great number of filaments. Some go to the diaphragm, a number of others form a plexus round the aorta, and the renal, cœliac, and ſuperior myſenteric arteries.

That which envelopes the cœliac artery is particularly named the *ſolar plexus.* It receives a number of filaments from the par vagum. The others, from their ſituation with reſpect to the arteries, are called the *coronary ſtomachic*, the *ſplenic*, and the *hepatic plexuſes.*

The trunk of the great ſympathetic, which we left in the thorax, continues to deſcend to the diaphragm, but it detaches, at the ninth and tenth thoracic ganglion, and ſometimes at the laſt but one, a filament called the little *ſplanchnic nerve*, which unites with the great ſplanchnic in its paſſage through the diaphragm.

The ſituation of the great ſympathetic within the abdomen is nearly the ſame as in the thorax. It forms enlargements at each lumbar vertebra, which receive two or three filaments from each of the lumbar pairs. It alſo ſends filaments to the plexuſes already deſcribed; there are then plexuſes formed round the inferior myſenteric, ſpermatic, and hypogaſtric arteries, which are termed *inferior myſenteric, ſpermatic*, and *hypogaſtric plexuſes.* The laſt of theſe tranſmits branches to all the adjoining arteries,

teries, to the colon and rectum, to the ureters, the bladder, and the parts of generation.

Having reached the pelvis, the great ſympathetic proceeds to the os ſacrum. Arrived at the caudal vertebræ, the two trunks, which are now very ſlender, unite and form the laſt ganglion. In this courſe there are as many enlargements as there are ſacral nerves. It happens, however, ſometimes, that there is no ganglion.

In this manner the great ſympathetic nerve terminates in man.

B. *In other Mammiferous Animals.*

The great ſympathetic nerve of the other Mammalia is nearly ſimilar to that of man. We ſhall give a deſcription of it, taken from accurate diſſections in the *wolf*, the *racoon*, the *porcupine*, the *ſheep*, and the *calf*.

The great ſympathetic evidently unites, within the cranium, and in the folds of the dura-mater, with the fifth and ſixth pair of nerves. This anaſtomoſis is very remarkable.

On entering the cranium through the foramen lacerum, it is very diſtinct from the par vagum, but it adheres cloſely to the perioſteum of the temporal bone. When we ſtretch the cord which it forms, we obſerve that it is divided into ſix or ſeven filaments, which make together a very compact net-work. Two or three lines farther, according to the ſize of the animal, all

 theſe

thefe filaments approach each other, and are again united fo intimately, that the ganglion which they produce appears, by its fection, cartilaginous. Numerous filaments proceed from this ganglion, fome of which are very fhort, and are fent to the nerve of the fifth pair. Others, which are longer and fmaller, form a kind of reddifh coloured net, interlaced with blood veffels. This is the net which Willis regarded as a little *rete mirabile.* It appears that the communication with the fixth pair takes place by means of this net, which envelopes the nerve on every fide, and from which it is feparated with great difficulty. We have not remarked any particular anaftomofing branch in the *calf,* or in the *ram.*

In its courfe through the foramen lacerum, the great fympathetic nerve detaches a nervous filament which enters the cavity of the tympanum. It is alfo there intimately united with the eighth pair, from which it feparates at the bafe of the cranium to form a thick cord.

Having advanced fome lines from the cranium, the great fympathetic fwells into a large reddifh ganglion of an elongated oval form. This is the *fuperior cervical ganglion.* It unites with the neighbouring nerves in the fame manner as in man.

After communicating, by filaments, with the adjoining nerves, the fuperior cervical ganglion proceeds to the anterior part of the neck, before

 the

the longus colli muſcle, as far as the ſeventh vertebra. In its courſe it receives very ſlender nervous filaments from all the cervical pairs.

In the front of the laſt vertebra of the neck, it forms a curve, which is directed from within outward towards the firſt rib, on the head of which it unites with the firſt thoracic ganglion.

Several filaments which go from the convexity of this curve, proceed along the mediaſtinum to the pericardium, where they are loſt. Others form a plexus around the ſubclavial artery.

The firſt thoracic ganglion is of a ſemi-lunar figure, more or leſs elongated according to the ſpecies. Its concavity is inward. On its conical edge it receives or tranſmits four or five filaments. The moſt ſuperior paſſes along the vertebral artery, accompanies it into the canal, and forms around it a plexus which may be followed very high up, and which probably enters into the cranium with the artery. The other filaments unite with the laſt cervical, and with the two firſt dorſal pairs.

From the concavity or ſuperior and internal edge of this firſt thoracic ganglion, one, two, or three filaments are detached, which proceed tranſverſely or obliquely downward towards the pulmonary arteries at their entrance into the lungs; they there unite with the par vagum, to form the *pulmonary* and *inferior cardiac plexuſes*.

The trunk of the great ſympathetic continues

nues to defcend in the thorax as far as the diaphragm. In its paffage it forms a ganglion upon the head of each rib, which receives a nervous filament from each of the vertebral pairs. Laftly, it paffes through the diaphragm, forming a fingle cord, which is the real *fplanchnic nerve.*

On entering the abdominal cavity, the fplanchnic nerve proceeds towards the middle line under the ftomach: it is there frequently divided into two cords, which afterwards rejoin. From this kind of nervous ring there arifes either a principal trunk, or four or five filaments, which uniting together near the cœliac artery, form a ganglion which is frequently of a femi-lunar figure. A number of filaments proceed from the edges of this ganglion, and envelope the ftomachic, fplenic, and hepatic arteries, and fupply the place of the folar plexus; others envelope the renal artery, round which they alfo form a plexus,

The trunk of the great fympathetic ftill defcends in the abdominal cavity, on the lateral parts of the bodies of the vertebræ: each of its ganglia is nearly of an elongated quadrangular form; one of the fuperior angles receives the continuation of the trunk; the other the vertebral pair. The internal inferior angle tranfmits a branch to the aorta, which affifts in forming fome of the plexufes that furround each of the arteries which rife from that veffel. The

other

other angle produces the continuation of the trunk.

In other refpects the great fympathetic appears to be difpofed in all mammiferous animals as in man: it produces the fame plexufes, with fome differences as to the number of filaments and the fhape of the ganglia: but even thefe circumftances are fubject to variation.

C. *In Birds.*

The great fympathetic in birds has many refemblances to that in mammalia: It enters the cranium by the fame aperture as that through which the par vagum and gloffo-pharyngeus come out; it alfo unites with the fifth and the fixth pairs. The firft ganglion, or that which correfponds to the fuperior cervical, is of a lenticular form; it is fituated immediately below the cranium, and communicates with the ninth pair, and particularly with the eighth, with which it appears to be altogether confounded.

We find no trace of the great fympathetic in the neck of birds; but within the thorax we obferve that it detaches to the pulmonary plexus, formed by the par vagum, a very thick nervous filament, which is united to the firft thoracic ganglion.

Here the great fympathetic of birds begins to affume an appearance truly remarkable.

The

The firft nervous ganglion becomes a centre from which eight different diverging filaments proceed. The firft unites to the plexus of the brachial nerve; the fecond defcends the neck in the vertebral canal along with the artery, and at the middle of each vertebra forms a fmall ganglion, from which filaments are fent off to each of the cervical pairs. We have found it impoffible to follow it as far as the head, in the *coot*, the *duck*, the *fwan*, and the *buzzard*. The third filament is confounded with the cardiac plexus formed by the par vagum. The three next filaments proceed from the internal fide towards the projection made by the bodies of the vertebræ, and produce a particular cord, to which we fhall return. Laftly, the feventh and eighth filaments ferve to unite this ganglion with the fucceeding one; the one paffing below, and the other above, fo as to form a curvature of a lozenge-like fhape, in which the head of the rib is received.

Each fucceeding ganglion produces, in this manner, a nervous irradiation, compofed of five, fix, or feven filaments; four of which, two fuperior and two inferior, communicate with the preceding or following ganglion. By one or two a nervous cord is formed, which fupplies the place of the fplanchnic nerve: the laft filament unites with the dorfal pair fituated inferiorly.

The cord which is produced by all the internal branches of the great fympathetic, and which

is

is analogous to the ſplanchnic nerve, accompanies the aorta on each ſide. Having reached the part where the cœliac artery divides into three, it is united to nervous filaments derived from the thoracic ganglion, and thus forms one, two, or three enlargements, which detach an immenſe number of branches to envelope the arteries on all ſides. The ganglia here obviouſly ſupply the place of thoſe named ſemi-lunar in man, and the filaments which proceed from them anſwer to the ſolar plexus. There are alſo other plexuſes formed on the renal and inferior myſenteric arteries.

The trunk of the nerve continues to follow the bodies of the vertebræ, but the ganglia become leſs conſpicuous when there are no longer any ribs, and we there perceive only a ſmall enlargement at the point where the vertebral pair is united. But from the internal ſide of each of theſe ſmall enlargements, two or three filaments are detached, and produce a plexus on the aorta, anaſtomoſing with thoſe of the oppoſite ſide.

We clearly perceive the continuation of the great ſympathetic nerve to the laſt vertebra of the tail. It is very eaſily traced in the *ſwan*.

D. *In Reptiles.*

We have had no opportunity of diſſecting the great ſympathetic nerve of reptiles, except in the

the *mud-tortoiſe*. It is only diſtinct in the interior of the back ſhell: it has a diſpoſition analogous to that of the cervical ganglion. The pneumo-gaſtric nerve, however, adheres ſo cloſely to it, that they cannot be ſeparated: we did not perceive any filament on the neck which could be regarded as the trunk of the nerve.

On the peritoneum, and on the bodies of the vertebræ, there appear very diſtinct nervous ganglia, which are manifeſtly produced by the great ſympathetic.

The ganglia are exactly ſimilar to thoſe of birds. There are two ſuperior and two inferior filaments which paſs under the tranſverſe proceſs of the vertebra that is united to the back ſhell; from the internal edge of each ganglion, a ſplanchnic nerve proceeds, which forms plexuſes round each of the arteries produced by the aorta: one is alſo ſent to aſſiſt in forming the pulmonary plexus.

This nerve may be very eaſily traced to the lateral parts of the firſt vertebra of the tail.

E. *In Fiſhes.*

We alſo find the great ſympathetic nerve in fiſhes, but it is exceedingly ſlender: it is a ſimple nervous filament, ſituated on each ſide of the vertebral column in the abdominal cavity. It evidently furniſhes filaments to the peritoneum, which extend round the arteries that are

are loſt on the inteſtines. We alſo obſerve that there are communicating filaments for each of the vertebral pairs, but there are no apparent ganglia at the points where this union takes place.

The great ſympathetic nerve appears to enter the cránium by the canal of the firſt vertebra; it there accompanies the blood veſſels.

LECTURE ELEVENTH.

DESCRIPTION OF THE NERVOUS SYSTEM OF ANIMALS WHICH HAVE NO VERTEBRÆ.

ANIMALS without vertebræ are not formed on a common plan either with reſpect to the nerves or the muſcles: they preſent diſparities ſo great that we are compelled to adopt a mode of deſcription different from that purſued in the three laſt Lectures. It is neceſſary to proceed in the ſame manner in which we have treated the organs of motion in theſe animals. We muſt conſider the nervous ſyſtem in their different claſſes, and in their principal genera. As the characters common to each of theſe claſſes are very few, what we have ſaid on that ſubject, in Lect. I. Art. 3 and 5, and in Lect. IX. Art. 3, will ſuffice, and we now proceed to enter into details.

ARTICLE I.

Brain and Nerves of the Cephalo-podous Molluſca.

IN the *eight-armed ſepia*, the *cuttle fiſh*, and the *calmars*, the nervous ſyſtem appears to reſemble in in ſome reſpects that of red blooded animals. The brain is incloſed in a particular cavity of the cartilage of the head, which is pierced by a number of holes to give paſſage to the nerves.

The cartilage of the head has the form of a hollow and irregular ring; its poſterior part is the thickeſt, and contains the brain; its anterior part contains the ears, and a ſemi-circular canal which communicates on each ſide with the cavity of the brain, and includes the medullary collar. The œſophagus paſſes through the centre of this cartilaginous ring, and is conſequently, as in all white blooded animals, ſurrounded by the medullary cord. The lateral parts of the cartilaginous ring have eminences which form a kind of orbit on each ſide.

The brain is divided into two diſtinct parts; one next the œſophagus, the ſurface of which is ſmooth; and the other towards the back, which is round, and marked by longitudinal ſtriæ.

The medullary collar ariſes from the lateral parts of both portions: in the *octopus* it is in the form of a lamina; the anterior part of which produces four large nerves, which, with the four correſponding nerves, proceed forward into the eight feet which crown the head: we ſhall return to their diſtribution. Theſe laminæ join inferiorly, and thus encircle the œſophagus.

Two other principal pairs of nerves ariſe from each ſide, near the origin of the collar. The

 firſt

firſt is the optic pair: it extends directly into the orbit; after a ſhort courſe it paſſes through the ſclerotic coat, and is there dilated into a ganglion larger than the brain, and which has the form of a kidney with its concave ſide turned towards the brain. The ſubſtance of this ganglion appears to be the ſame as that of the brain; its convexity produces a multitude of ſmall nerves, as fine as hairs, which paſs through the choroides, by an equal number of ſmall holes, to form the retina.

The ſecond pair belongs to the muſcles of the ſac; it originates a little above the preceding pair: theſe nerves deſcend obliquely; and, after leaving the cerebral cavity, each ſlips between the muſcles which ſuſtain the head, and is ſent to the lateral part of the ſac, near its ſuperior edge, between the body and the branchiæ; it there divides into two branches, one of which deſcends directly towards the bottom of the ſac, and the other dilates into a roundiſh ganglion, which produces a multitude of nerves, diſpoſed like radii. Theſe nerves are diſtributed to all the fleſhy fibres of the ſac and the fins.

The anterior and inferior part of the collar gives origin to two pairs of nerves. The firſt pair is the auditory nerves; they are very ſhort, as they only traverſe a cartilaginous lamina to penetrate the ear, where they are diſtributed.

The ſecond pair iſſues from the cartilage, by two holes placed very near each other, and beneath

neath the ears: the two nerves which compofe it defcend within the peritoneum to the bottom of the fac. When they arrive near the heart, they form a complicated plexus, from which all the nerves of the different vifcera proceed.

Each foot has a nerve, which paffes from one extremity to another, like an axis, and is fituated in a canal, which we defcribed when we treated of the Mufcles of the Feet. This nerve is enlarged, at different fpaces, by numerous ganglia, which have the appearance of tubercles, and from each of which ten or twelve nervous filaments proceed: thefe filaments diverge and perforate the mufcles of the interior of the foot to which they diftribute branches; but they proceed chiefly to the fuckers.

This defcription of the nervous fyftem is taken from the *fepia octopus*. The other Cephalopoda differ only in having a brain lefs diftinctly divided, and prefenting lefs confpicuous furrows.

ARTICLE II.

Brain and Nerves of the Gasteropodous Mollusca.

A. *In the Snail (Helix Pomatia.)*

THE brain of the Snail is situated upon the œsophagus, behind an oval mass of muscles, which envelopes the mouth and the pharynx, and which we shall describe in the Article on Mastication; its shape is nearly semi-lunar, with its concave part directed posteriorly. The angles of the crescent are prolonged on each side into a branch, by which the œsophagus is encompassed in a collar. The salivary glands, and the muscle which retracts the mouth and brain, pass likewise through this collar.

The two cords produced by the brain unite below the œsophagus and the muscle, in a large round ganglion, which is more than one half the size of the brain. All the nerves proceed from one or other of these two masses.

Those furnished by the brain proceed from the lateral parts of its convex side.

There are, in the first place, two nerves for the fleshy part of the mouth; next, one on each side for the small horns; then two for each great horn, one of which proceeds to the base of that horn, and passes into its muscular substance; the

the other goes to the eye. The latter is folded confiderably on itfelf, when the horn is drawn inward. There are, befides, fome other filaments which extend to the bafe of the parts of generation, and to the mufcles which move the head.

The large inferior ganglion produces, at firft, three great nerves, one for the penis, another for the vifcera, and the third for the mufcles, which draw the whole animal into its fhell : the inferior furface of this ganglion afterwards produces two great fafciculi, which proceed backward, and which, after paffing between the two mufcles before mentioned, are diftributed to all the flefhy parts of the foot.

The figure which Swammerdam gives of the nerves of the fnail, appears to have been taken from the flug, rather than from the fhell fnail.

B. *In the Slug (Limax Rufus.)*

The brain is alfo fituated behind the œfophagus in this animal, but it has the form of a narrow ribbon lying crofs ways : it enlarges a little at its lateral parts, each of which produce a filament to encircle the œfophagus. The ganglion which is formed by the union of thefe two filaments is larger than the brain.

Two principal trunks proceed, each on its refpective fide, in a ftrait line from this ganglion ; they extend along the lower part of the body,

 throughout

throughout its whole length, preferving nearly a parallel direction; on the external fide they each detach a number of filaments, which penetrate into the flefhy fubftance of the fkin.

A great number of other filaments alfo proceed immediately from the inferior ganglion to the fkin.

Further, the inferior ganglion fends off two nerves on each fide, which go to the vifcera, and take the diftribution of the arteries.

With refpect to the brain, properly fo called, it furnifhes, in the firft place, a nerve from each fide, for the flefhy mafs of the mouth; then two for each of the great horns, one of which extends to the eye, and becomes the optic nerve. The nerves of the fmall horns arife more outwardly.

C. *In the Aplyfia.*

This is a fmall marine animal, very like the flugs, but refpiring through branchiæ, which form a kind of tuft on the back, and which are covered by a particular operculum.

The brain is fituated as in the fnail; but the branches which furround the œfophagus produce two ganglia, one on each fide, which are conjoined by a fmall filament.

The brain furnifhes, at its anterior part, two flender filaments, which encircle the flefhy mafs of the mouth, and unite under it in a fmall ganglion,

ganglion, whence the nerves of the lips are detached. The brain afterwards affords nerves to the horns and the eyes, which are, in this animal, ſituated between the horns, and to the male parts of generation. The two lateral ganglia tranſmit a multitude of nerves to all the fleſhy parts of the foot and ſkin; they alſo produce each a long cord, which unites to its correſponding cord on the aorta, near the part where it riſes from the heart; they there form a lenticular ganglion, from which all the nerves of the different viſcera proceed.

D. *In the Clio borealis.*

This ſmall animal has no foot, and can only ſwim. It reſpires by two branchiæ, in the form of wings, ſituated on the neck; but in other reſpects it very much reſembles the ſlug. Its nervous ſyſtem is analogous to that of the aplyſia.

Its brain is formed of two roundiſh lobes; it furniſhes, immediately, nerves to the tentacula, and gives origin to a double collar; the anterior extends, as in the aplyſia, under the mouth, to form a ſmall ganglion. The poſterior has a ganglion on each ſide, which furniſhes nerves to the muſcular ſkin that ſurrounds the body; each of theſe produce one or two other ganglia, which ſend nerves to the viſcera.

E. *In the Doris.*

This is alſo a ſmall marine animal ſimilar to the ſlug, but it reſpires by external branchiæ, diſpoſed like ſtars round the anus. The brain is very large in proportion to the reſt of the body, and particularly in compariſon with that of other gaſteropoda: it is contracted at its middle part, and ſeems to form two united lobes; it is elongated tranſverſely, and of a ſquare form. It is ſituated immediately above the origin of the œſophagus, behind the orbicular maſs of muſcles which form the parietes of the mouth.

Six nerves proceed from the brain on each ſide; one pair is deſtined for the muſcles of the mouth, another for the tentacula. The third is a cord, which paſſes below the œſophagus, and is loſt in the muſcles of the foot, where it may be very diſtinctly obſerved on the lateral parts of the internal ſurface. The fourth and the fifth are directed above the maſs of the inteſtines, and proceed to the ſkin of the back. Laſtly, the ſixth terminates in the parts of generation.

F. *In the Scyllæa.*

This is another marine animal ſimilar to the ſlug, but which reſpires by branchiæ, in the form of wings ranged in pairs on the back; it

crawls

crawls on a furrow in its belly. The collar which furrounds the œfophagus is a fimple cord, and does not enlarge into a ganglion, as it proceeds downward. The brain, which is above it, is of an oval form: it fends nerves to the mouth, and to the horns, but there are no optic nerves, as this animal has no eyes.

The nerves of the vifcera arife from the inferior part of the collar, and thofe of the mufcles from its fides.

G. *In the Sea Ear* (*Halyotis Tuberculata.*)

This animal has no ganglion above the œfophagus to fupply the place of the brain. We find merely a nervous filament, fituated tranfverfely above the œfophagus, behind the mouth. Four fmall ramifications proceed from the middle and anterior part of this filament, two on each fide, and are loft in the parietes of the mouth.

At each extremity of the tranfverfe nervous filament there is a very large flat ganglion, from the circumference of which a number of nerves are detached to the adjacent parts. Thefe we fhall defcribe.

Three filaments pafs off on each fide; from the external furface of this ganglion one is fent to the fetiform tentaculum, fituated above the mouth, the other two proceed to the flat tentaculum, like a buckler, placed more pofteriorly,

riorly, and on the ſides. The moſt poſterior appears to be intended for the eye. It is the thickeſt; the other ſeems loſt in the muſcular parts.

A very remarkable filament is detached from the ſuperior part; it proceeds above the œſophagus, and joins the correſponding one of the other ſide. There is a ſmall enlargement at the point of union, from which four nerves proceed, two on each ſide of the middle line. The moſt external is loſt in the muſcles of the tongue; the other purſues the middle line of the œſophagus, and is ramified over the inteſtines.

Several ſmall branches are detached inferiorly, and terminate in the fan-like muſcles that ſuſtain the tongue.

Laſtly, the ganglion is prolonged poſteriorly into a thick nervous cord, ſituated on the ſides and below the œſophagus, which becomes flat as it proceeds backward: it deſcribes a ſemilunar curve, ſo that the two nerves of each ſide are approximated, and finally touch each other at the baſe of the tongue, and below the anterior part of the large muſcle which attaches the animal to its ſhell.

The contact of theſe two nerves produces a ganglion, from which two very remarkable trunks, intended for the inteſtines, proceed; they may be followed to above the ſtomach, and we can perceive that ſome of their ramifications enter the liver.

After

After the formation of the ganglion, which furnifhes nerves to the vifcera, the two trunks penetrate by two different holes into the fubftance of the mufcle of the foot. Thefe two holes are the origin of two canals, which run throughout the whole length of the foot, on the fides of another middle canal, which appears deftined to diftribute the blood of the animal.

The two nerves, lodged in the lateral canal, are diftributed by a great number of lateral holes into the fubftance of the flefhy mufcles of the foot, and of the fhell, where they may be followed with facility.

H. *In the Bulimus of Ponds* (*Helix Stagnalis* Lin.) *and in the Planorbis Cornea* (*Helix Cornea* Lin.)

In thefe animals the brain confifts of two lateral maffes, feparated by a cantraction. The recent fubject is remarkable for having thefe maffes of a lively red colour. The diftribution of the nerves differs very little from what we obferve in the common fnail.

Article III.

Brain and Nerves of the Acephalous Mollufca.

The nervous fyftem of Acephalous Mollufca is formed on a plan far more uniform than that

of

of the Gafteropoda. In all the teftaceous acephala, from the *oyfter* to the *pholas*, and the *teredo*, there appears no effential difference; it confifts always of two ganglia, one on the mouth, reprefenting the brain, and another towards the oppofite part. Thefe two ganglia are united by two long nervous cords, which take the place of the ufual collar, but which occupy a much greater fpace—as the foot, when it exifts, and the ftomach and liver, always pafs in the interval between them. All the nerves arife from the two ganglia.

A. *In the Anodontites, or Frefh-water Mufcles, in Cockles, in the Venus, the Mactra, and the Mya.*

In thefe, and in general all the bivalves, which have two cylindrical mufcles, one at each extremity of their valves, for the purpofe of bringing them together; the mouth is placed near one of thofe mufcles, and the anus near the other. The foot appears about the middle of the fhell; and the tubes for the excrements and refpiration, when they exift, go out at the end of the fhell, oppofite to that in which the mouth is fituated. The brain is placed upon the anterior edge of the mouth; it is oblong tranfverfely; it fends off two cords anteriorly, which go to the adjacent mufcles, and turning towards each fide, penetrate the lobes of the

cloak,

cloak, paſſing through the whole extent of their edge. The brain furniſhes alſo, on each ſide, ſome filaments to the membranous tentacula, which ſurround the mouth, and detaches, from its poſterior edge, the two cords, analogous to the medullary collar in other invertebral animals. Theſe cords proceed, each on its ſide, under the muſcular ſtratum, which envelopes the liver and the other viſcera, and which becomes thicker, as it is continued to form the foot, which is frequently conſtructed for ſpinning.

When arrived at the poſterior muſcle which cloſes the valves, theſe cords approach each other, and enlarge as they unite, to form the ſecond ganglion. This ganglion has the form of two lobes. It is at leaſt as large as the brain-ganglion, and always much more eaſily diſtinguiſhed. It detaches two principal nerves on each ſide, and the four together repreſent a kind of St. Andrew's croſs. The two anterior nerves, as they aſcend, proceed a little towards the ſide of the mouth, and, after having deſcribed an arch, penetrate into the branchiæ. The other two paſs on the poſterior muſcle, preciſely in the ſame manner as thoſe of the brain on the anterior. After detaching ſome filaments, they proceed into the cloak, the edge of which they follow, until they join thoſe of the brain; they thus form a continued circle. We do not yet know

know the origin of the nerves of the vifcera in thefe animals.

The teftaceous acephala, in which the foot is protruded by an extremity of the fhell, that always remains open, and the tubes, by the oppofite extremities, that is to fay, in *razor-fifh* and *piddocks*, the mouth, and confequently the brain, is always near one extremity. The nerves, which proceed from the brain, take therefore a longer courfe before they diverge to join the cloak. The cords of the collar, however, have a much fhorter diftance to pafs before they unite. There is a confiderable fpace, particularly in the razor-fifh, between the mafs of vifcera fituated in the bafe of the foot, and the pofterior mufcle. The fecond ganglion is fituated in the middle of this fpace, between the branchiæ of each fide: it is round, and much more diftinct than in the other fpecies; the nerves it produces are however exactly fimilar.

In the *oyfter*, which has no mufcle at the anterior part, the brain and mouth are fituated under the kind of hood which the cloak forms towards the hinge. The nerves go directly into the cloak itfelf. The ganglion is fituated on the anterior furface of the fingle mufcle, immediately behind the mafs of vifcera. The nerves it produces are the fame as in the preceding genera.

B. *In the Afcidia.*

Thefe fmall marine animals are enveloped in an immoveable coriaceous, or gelatinous cafe, which has two apertures; one for the expulfion of the excrements, the other for the admiffion of the water to the branchiæ. The branchiæ are in the form of a large fac, and are enclofed, as well as the other vifcera, in another membranous bag, of the fame form as the external cafe, but fmaller, and completely adhering to that cafe at the two apertures only. The inferior ganglion is fituated on this membranous fac: its pofition is between the two apertures, but neareft that which correfponds to the anus; it produces four principal nerves; two afcend towards the fuperior, or refpiring aperture; the other two defcend towards that of the excrements. There are fmaller nerves which are difperfed throughout all the membranous fac. We have not yet difcovered thofe produced by the brain, nor the brain itfelf, which is doubtlefs fituated as ufual on the mouth. The mouth is in the bottom of the branchial fac.

C. *In the Tritons of* Linnæus *which inhabit the Anatiferous and Balanite Shells.* (*Lepas* Lin.)

Thefe animals approach, perhaps, nearer to the Cruftacea, and particularly to the monoculi, than

than to the Mollufca. Their nervous fyftem is of a fort of middle kind between that of the Mollufca and that of the Crùftacea and Infects.

The brain is placed acrofs the mouth, which is itfelf fituated in the part of the body correfponding to the ligament, and at the bottom of the fhell. It produces four nerves to the mufcles fituated in that place, and to the ftomach, and two others which embrace the œfophagus, and proceed into that elongated portion of the body which bears the numerous articulated and ciliated horny tentacula which the animal protrudes from its fhell. Thefe two filaments approach and form a ganglion, and then proceed clofe to each other among thefe tentacula, furnifhing a correfponding pair of nerves for each pair of tentacula, but there are no apparent ganglia at the origin of thefe nerves.

From what we have ftated in this and the two preceding articles, it refults,

That the nervous fyftem of Mollufca confifts in a brain placed on the œfophagus, and in a variable number of a ganglia, fometimes approximated to the brain, and fometimes difperfed in the different cavities, or placed under the mufcular envelopes of the body; that the ganglia are always connected to the brain and to each other by nervous cords, which eftablifh a general communication between thefe different medullary maffes; that the nerves all arife either from the brain or the ganglia; and finally, that

that there is no part which can be compared to the medulla oblongata and the medulla ſpinalis.

Article IV.

Brain and Nerves of the Cruſtacea.

The Cruſtacea, which, in their organs of motion, very much reſemble inſects, though thoſe of circulation and reſpiration are exceedingly different, have alſo a nervous ſyſtem ſimilar to that claſs, at leaſt in the eſſential parts.

In the *long-tailed cray-fiſh*, the middle part of the ſyſtem is a knotted cord, which extends from one extremity of the body to the other. The *ſhort-tailed* kind, commonly called *crabs*, have a medullary circle in the middle of the abdomen, from whence the nerves of the body proceed like radii.

In theſe animals the brain is placed at the anterior extremity of the ſnout, and conſequently at a conſiderable diſtance from the mouth, which opens under the corſelet. On this account the cords which make the collar of the œſophagus are more elongated than in other animals.

A. *Brain of the common Cray-Fiſh, (Aſtacus Fluviatilis,* Fab.)

The brain of this animal forms a maſs which is broader than long, and diſtinctly divided on the ſuperior ſurface into four round lobes. Each of the middle lobes produces an optic nerve from its fore part. This nerve proceeds directly into the moveable tubercle which ſuſtains the eye, and is there dilated and divided into a multitude of filaments, which form a pencil, and unite to all the ſmall tubercles of the eye.

Four other nerves ariſe from the inferior ſurface of the brain; theſe proceed to the four antennæ, and detach ſome filaments to the neighbouring parts. The cords which form the collar, ariſe from the poſterior part of the brain. About the middle of its length each detaches a large nerve which extends to the mandibles and their muſcles. Theſe cords unite under the ſtomach in an oblong ganglion, which furniſhes nerves to the different pairs of jaws. On leaving this part the two cords remain near each other throughout the whole length of the corſelet, where they form five ſucceſſive ganglia, placed between the articulations of the five pairs of feet: each foot receives a nerve from its correſponding ganglion, which penetrates to the extremity of the foot: the nerve of the forceps is the largeſt. The medullary cords extend into the tail, where they

they are ſo intimately united that it is not poſſible to diſtinguiſh them. They form ſix ganglia, the five firſt of which produce each two pairs of nerves; the laſt produces four, which are diſtributed as radii to the ſcaly fins that terminate the tail.

The *hermit crab*, (*Pagurus*, Fabr.) the tail of which is not covered by articulated ſcales, appears to have much fewer ganglia than the *crayfiſh*. We have obſerved only five.

In the *ſquilla* Fabr. there are ten ganglia without reckoning the brain: that at the union of the two cords which form the collar, tranſmits nerves to the two forceps, and to the three pair of feet which immediately ſucceed them, and which in theſe animals are ranged almoſt on the ſame tranſverſe line; this ganglion is therefore the longeſt of all. Each of the three following pairs has a particular ganglion. There are afterwards ſix ganglia in the length of the tail, which diſtribute their filaments to the thick muſcles of that part. The brain produces immediately four trunks on each ſide, viz. the optic, thoſe of the two antennæ, and the cord which forms the collar. As the antennæ are placed more poſteriorly than the brain, their nerves are directed backward.

3. *In the Common Crab (Cancer Mænas*, Lin.)

The brain of the crab reſembles that of the

cray-

cray-fiſh in its form and ſituation; it alſo furniſhes analogous nerves, but they are directed more towards the ſides in conſequence of the poſition of the eyes and the antennæ. The medullary cords which form the collar, detach each a nerve to the mandibles, but the cords are prolonged much farther backward than in the cray-fiſh before they unite. They join only in the middle of the thorax, at which place there is produced a medullary maſs of an oval ring-like figure, which is eight times the ſize of the brain. The nerves which proceed to the different parts ariſe from the circumference of this ring. It furniſhes ſix nerves on each ſide to the jaws and the five feet, and there is a ſingle nerve which ariſes from the poſterior part, and proceeds to the tail. This medullary ring may be ſaid to repreſent the uſual knotted cord, but if it has any ganglia they are not viſible.

C. *In the Oniſcus Aſellus.*

The two cords which compoſe the middle part of the nervous ſyſtem in this animal, do not perfectly join. We can diſtinguiſh them throughout the whole of their length. There are nine ganglia, excluſive of the brain; but the two firſt and the two laſt are ſo cloſe together, that the number may be reduced to ſeven.

D. *In*

D. *In Monoculi.*

We know not the nervous fyftem of the *molucca crab (limulus gigas,* Fab. *monoculus polyphemus,* Lin.) In the *monoculus apus* of Linnæus, however, the indiftinct nature of that fyftem, joined to fome other peculiarities of organization, would almoft induce us to clafs the animal with the inarticulated worms. The brain is a fmall globule, nearly tranfparent, fituated under the interval of the eyes. The medullary cord is double, and has an enlargement at each of the numerous articulations of the body; but the whole is fo thin and tranfparent that the real nature of the cord can fcarcely be afcertained.

Article V.

Brain and Nerves of the Larvæ of Infects.

A. *Coleoptera.*

1. *Larva of the Scarabæus nafícornis.*

We fhall give a particular defcription of the nerves of this larva, becaufe their diftribution is effentially different from that which takes place in the other coleoptera.

The brain is ſituated under the great ſcale which covers the head immediately above the origin of the œſophagus: It conſiſts of two approximated lobes, which are very diſtinct at the front and back part. Four nerves ariſe from the anterior part, two on each ſide, which are loſt in the cirri and parietes of the mouth.

From the lateral and ſomewhat poſterior parts of the brain, there ariſes a pair of nerves, which, embracing the œſophagus, proceeds inferiorly to form the nervous cord we ſhall preſently deſcribe.

Another pair departs from the inferior ſurface of the brain, or that part which reſts upon the œſophagus: theſe are firſt directed forward; they afterwards turn inward, and proceed above the middle and ſuperior part of the œſophagus, in order to approach each other. When they come in contact, they unite and form a ſmall ganglion, which produces a ſingle nerve; this nerve continuing to proceed poſteriorly, paſſes below the brain, and accompanies the œſophagus to the ſtomach. It there enlarges again into a ganglion, which furniſhes ſome ſmall nerves that are ſent to the ſtomach, and one more conſiderable, which is continued along the inteſtinal canal, and ſends off, at regular diſtances, lateral filaments, which are loſt in the coats of this tube. This nerve is analogous to that which Lyonnet has deſcribed under the name of *recurrent*, in the caterpillar of the *coſſus*.

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The medulla ſpinalis, which, as we have ſhewn, is formed by the poſterior pair of nerves of the brain, is very thick at its origin: it forms a large fuſiform ganglion about 0,005 metre long, and half a millimeter broad. Four or five contractions appear on its anterior part, but they are ſo ſlight that they ſeem only tranſverſe furrows. The poſterior part of this ganglion is ſmooth.

From the lateral parts of this large ganglion, which extends very little beyond the third ring of the body, a great number of diverging nervous filaments are produced. Thoſe which are neareſt the head aſcend a little; thoſe which ſucceed them proceed almoſt tranſverſely; and the laſt are directed more and more poſteriorly: the length of each is in proportion to its diſtance from the anterior part of the ganglion. The two moſt poſterior filaments are therefore the longeſt.

2. *Larva of the Stag Beetle (Lucanus cervus.)*

The nerves of this larva differ greatly from thoſe of the preceding, although the perfect inſects are ſo nearly allied in genera.

The brain conſiſts of two contiguous and almoſt ſpherical lobes; theſe produce four nerves anteriorly for the antennæ and the parietes of the mouth: two inferiorly, which firſt proceed forward, then turn back, paſs again under the brain, and form the nerve known under the name of *recurrent*. Laftly, two pofteriorly, which form a collar round the œfophagus, and join underneath, to compofe the nervous cord of the body.

This cord is formed of eight ganglia, which extend to the ninth ring of the body. The diftances between thefe ganglia are very unequal; they are joined by very flender and clofely approximated nervous filaments.

The firft ganglion, from the head, is very large, and almoft fpherical; it is followed almoft immediately by the fecond, which is one half lefs, and which is diftinguifhed from it only by a kind of contraction; the firft produces four pairs of nerves on each fide; one afcends to the head; the other three diverge, and are loft in the mufcles of the abdomen, and in thofe that move the head. The fecond ganglion, befides the two nerves that unite it to the third, produces two other nerves, which are alfo directed backward, and loft in the mufcles of the fourth ring.

The third ganglion, and thofe that follow as far as the eighth, are fimilar to the fecond; with this difference, that they are much more diftant from each other, and that they produce longer filaments, in proportion as they are fituated more inferiorly. Laftly, the eighth and ninth ganglia are fo clofe together, that they feem to form but one, with a flight contraction in the middle. This double ganglion produces three pairs

pairs of nerves, which are much elongated, and extend to the parts near the anus.

3. *Larvæ of the Cerambyx, Hydrophilus, Carabus, and Staphylinus.*

The nerves of thefe larvæ being very fimilar, it will be fufficient to defcribe them in one genus only. We fhall take for our example the larva of the *great diver* (*Hydrophilus piceus.*)

The brain in this animal is fituated in the head, above the origin of the œfophagus; it is formed of two lobes, which lie very clofe together. From its anterior part it detaches fome filaments to the palpi, the antennæ, and the parietes of the mouth. Its lateral parts produce two cords which furround the œfophagus, and which are the origin of the nervous cord fituated inferiorly. It is probable that recurrent nerves alfo arife from this inferior part, but we have not yet been able to difcover them.

The chief nervous cord is compofed of ten ganglia, each of which produce three pairs of nerves that are loft in the mufcles of the abdomen, and without any diftinct appearance of their being diftributed to the inteftines. This induces us to believe that there is a recurrent nerve.

The firft ganglion is very large; it is prolonged pofteriorly into two nervous filaments, confiderably removed from each other; the fecond is almoft fimilar; but the third is very near

near the fourth, which produces only a ſingle filament poſteriorly. All the others, as far as the tenth, preſent no particularity. The laſt is divided by a ſenſible contraction; from the firſt portion a ſingle filament ariſes on each ſide, and from the ſecond, three pairs of nerves are detached: thus four pairs of nerves ariſe from this ganglion. The fourth pair is directed to the rudiments of the parts of generation, which are very diſtinct in theſe larvæ in the laſt period of their growth.

4. *Larva of the Water-beetle (Dytiſcus Marginalis.)*

The brain of this larva is ſpherical, and conſiſts of a ſingle lobe, ſituated in the head above the origin of the œſophagus; its anterior part produces ſome filaments for the mouth; and its lateral parts the two optic nerves: the latter are compoſed of two parts, which are very diſtinct as to form. The firſt portion, or that which is next the brain, is of an oval figure, pointed at the extremity which joins the brain: the other extremity is rounded, and produces a ſlender nerve, which goes directly to the eye. It is nearly of the ſame thickneſs throughout the whole of its extent; but it is enlarged at its free extremity into a bulb, from which the nervous filaments of the eye ariſe.

The two cords which embrace the œſophagus are ſhort and thick; they ariſe from the inferior

ſurface

ſurface of the brain, and immediately unite below the œſophagus, in a large ſquare-ſhaped ganglion, which produces anteriorly the nerves of the mandibles, and poſteriorly two cords, which paſs from the head into the corſelet.

There is a greater diſtance between this firſt ganglion of the nervous medulla and the ſecond, than between any of the others. It is more than double that which exiſts between the two next ganglia. The ſecond ganglion is round; it produces two pair of nerves laterally; the anterior for the muſcles which act upon the head, the poſterior for thoſe which move the anterior feet. There are two cords poſteriorly, which are directed into the breaſt.

The third ganglion is ſimilar in every reſpect to the ſecond; it furniſhes nerves to the intermediate pair of feet.

The fourth ganglion is alſo produced by the two cords which come from the preceding; it is ſituated on the union of the abdomen with the breaſt; it is more broad than long. Laterally it produces two pair of nerves, which run tranſverſely parallel, and are loſt in the muſcles.

The other eight ganglia are placed cloſe behind each other, and the ſpace between them is ſo ſmall, that we can ſcarcely perceive the two nervous filaments which unite them; they alſo decreaſe in thickneſs, without diminiſhing in breadth, as they extend poſteriorly. They all furniſh laterally a pair of very long nerves, which

which float in the abdomen, and for the moſt part terminate in the muſcles that move the wings. One pair, however, proceeds to the rudiments of the parts of generation.

B. *Orthoptera and Hemiptera.*

The nerves of the larvæ of orthoptera and hemiptera preſent no ſenſible difference from thoſe we obſerve in the perfect inſects. It will be ſufficient therefore to deſcribe the nerves of the latter.

C. *Hymenoptera.*

In the larva of the *ſaw-fly* (*Tenthredo*, Lin.) which has a large head furniſhed with eyes, the brain is very broad and ſhort; it ſeems to form four bulbs of equal magnitude, and nearly ſpherical; the two external ſerve as the baſe of the optic nerves, which are ſlender, and which enlarge a little at their other extremity.

The firſt ganglion is produced by two very ſmall nerves, which ariſe from the inferior ſurface of the brain, and which, after having embraced the œſophagus, unite under the firſt ring of the body; it furniſhes filaments to the muſcles of the feet, and terminates poſteriorly in two other nerves, which, at the diſtance of one line, produce a ſecond ganglion, and ſo on in ſucceſſion: the nervous cord is in this manner formed of eleven ganglia, without reckoning the

the brain; the farther the ganglia are removed from the head, the more they diminiſh in thickneſs; they are all nearly of a round form.

D. *Neuroptera.*

In the larva of the *lion-ant (Myrmeleon Formicarius)* the nervous ſyſtem has ſome relation to that of the larva of the dipterous inſects, which we ſhall afterwards deſcribe.

There is a brain ſituated in the head; it produces nerves analogous to thoſe we have already pointed out in the other larvæ.

The nervous medulla conſiſts, in the firſt place, of two ganglia, which are compoſed of two lobes, ſituated cloſe together; theſe two firſt ganglia are ſeparate from the others, and contained in the part correſponding to the feet, or in the thorax.

The remainder of the nervous medulla is encloſed in the abdomen; it conſiſts of eight ganglia, placed in an exceedingly cloſe ſeries, and each formed of two lobes; the firſt is nearly double the ſize of the other ſeven. This ſucceſſion of ganglia appears to the eye like the extremity of the tail of a rattle-ſnake; the laſt is round; the others are more broad than long. All theſe ganglia furniſh nerves to the muſcles. It is probable that this diſpoſition and approximation of the ganglia have a relation to the changes which take place in the inſect at the moment

moment of its metamorphofis, as its abdomen then occupies fix times the fpace it does in the larva ftate.

In thofe larva of Neuroptera, which are nearly as long as the perfect infect, we find that the ganglia are feparated in the ufual manner.

The larva of the *ephemera* has eleven ganglia, without including the brain, which furnifhes two large optic nerves. There are three ganglia in the thorax, and feven in the abdomen: the firft fix, reckoning all the ganglia, furnifh more nerves than the five laft.

The larvæ of the *dragon-flies* have a fmall two-lobed brain, which produces optic nerves, larger or fmaller according to the fpecies. The genus *aëfhna* has them the largeft. The reft of the nervous fyftem forms a feries of ganglia of different fizes. In the *aëfhna*, the corfelet contains fix, the two laft of which are the largeft of all. There are feven fmall and equal ganglia in the abdomen.

E. *Lepidoptera.*

The nervous fyftem of *caterpillars* confifts of a feries of thirteen principal ganglia, which furnifh filaments to all the other parts of the body.

The firft of thefe thirteen ganglia is fituated in the cavity of the head; it lies above the œfophagus, and fupplies the place of the brain: it it appears formed ſuperiorly by the union of two round tubercles. Inferiorly it is concave, and correſponds to the convexity of the œſophagus.

This ganglion communicates with the reſt of the nervous cord by two thick filaments, which embrace the œſophagus, and which are united below it to the anterior and lateral part of the next ganglion; it beſides produces eight pairs of nerves.

The firſt partly unites with other filaments; produces ſome for the œſophagus, and forms ſeveral remarkable ganglia below the upper lip. The largeſt and moſt poſterior, which Lyonnet has named the *firſt frontal ganglion*, is prolonged poſteriorly into a thick *recurrent* nerve, which is continued the whole length of the body, near the back; this recurrent nerve furniſhes filaments to the œſophagus and its muſcles; it penetrates into the dorſal veſſel, and it afterwards re-appears, and glides along the œſophagus as far as the ſtomach. This nerve produces, at certain diſtances, very ſolid filaments, which keep the œſophagus attached to the ſkin of the back.

Beſides the recurrent nerve we have juſt noticed, ſeveral filaments are furniſhed by the poſterior frontal ganglion to the muſcles of the œſophagus, and two to the *ſecond frontal ganglion*: the latter alſo detaches ſeveral filaments to the œſophagus, and, in particular, a very remark-

remarkable one, which, by a fudden enlargement, conftitutes the *third frontal ganglion.* This ganglion likewife affords feveral filaments to the œfophagus.

The fecond pair of the brain appears chiefly intended for the antennæ, though it furnifhes feveral filaments to the neighbouring parts.

The third pair terminates particularly in the antennæ, and the mufcles which move them.

The fourth pair is proper to the eye of each fide; it accompanies the air tube which goes to that part, and is divided into fix branches, that penetrate into the fix eyes, which, by their union, form that of the caterpillar.

The fifth is directed a little backward, where it divides into two branches; one pofterior, for the adductor mufcles of the jaw; the other anterior, which is loft in the membranes that cover the frontal fcales.

The fixth and feventh pair unite to form a ganglion, from which feveral filaments are detached to the œfophagus and its mufcles.

Finally, the laft pair of the brain is entirely loft on an air tube.

But befides thefe nerves produced by the firft nervous ganglion, feveral others are detached from it, which we fhall briefly notice. In the firft place, we obferve, that it furnifhes feveral filaments to the dorfal canal: it afterwards gives origin to a pretty long filament, which terminates on the air veffels, between the fecond and third

third ganglion. Laſtly, it produces a nervous ring, which embraces the œſophagus inferiorly, like a girth, and ſupplies it with ſeveral filaments.

The ſecond ganglion is intimately united with the third, and is diſtinguiſhed from it only by a contraction. The nerves which proceed from the anterior part appear to be produced by the ſecond ganglion, and thoſe which ariſe from the poſterior part, ſeem to belong to the third.

Beſides the two filaments which form the collar round the œſophagus, and which unite the firſt to the ſecond ganglion, the latter has four pairs of very diſtinct nerves.

The moſt anterior pair is ſent forward to the mouth, but in its courſe it divides into two branches: one terminates in the tongue and the adjacent parts; the other branch proceeds to the lateral parts, where it ſub-divides, to ſupply the mandible, the jaw, and upper lip, communicating, at the ſame time, with the firſt ganglion, and with the ſecond frontal.

The ſecond pair proceeds to the jaw, but detaches a number of filaments to the muſcles of the neighbouring parts.

The third pair is deſtined for the ſpinning apparatus; in its courſe it gives filaments to the ſilk veſſels and muſcles of the head.

The fourth pair ariſes near the contraction, which indicates the union of the two ganglia, between the head and the firſt ring; it is loſt in

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the fat, in the ſkin of the neck, and in the muſcles inſerted into the head.

The third ganglion, which, as we have obſerved, is united to the ſecond, produces only three pairs of nerves: the poſterior is merely the continuation of the nervous trunk of the other two pairs; the anterior is entirely loſt in the muſcles and the ſkin; the intermediate pair ſupplies that part alſo; but it is diſtributed chiefly to the muſcles, which move the articulations of the leg.

We have already ſtated, that each ganglion communicates with that which precedes, and that which follows it, by two filaments, that are diſtinct from their origin, and are the bifurcation of a ſingle trunk. The middle of this bifurcation, from the third to the eleventh ganglion, produces a ſmall nerve, which Lyonnet has named the *ſpinal frænum*: this ſingle nerve is ſituated in the middle line; it preſently divides into two branches, which follow the diviſions of the air tubes, and penetrate with ſome of them into the longitudinal veſſel.

The fourth and fifth ganglia produce the ſame number of nerves, the diſtribution of which is alſo nearly ſimilar; their anterior pair proceeds to the muſcles, and to the ſkin of the rings to which it correſponds; the intermediate pair furniſhes, more particularly, filaments to the muſcles of the leg.

The ſixth ganglion, which correſponds to the

the fourth ring of the body, alſo furniſhes two pair of nerves, which are loſt in the muſcles and the ſkin.

The nerves of the five following ganglia are diſtributed nearly in the ſame manner.

The twelfth ganglion, and the thirteenth, which is the termination of the nervous cord, are very cloſe to each other, though diſtinct. The diſtribution of the nerves, produced by the firſt, preſent nothing remarkable. Thoſe furniſhed by the ſecond are very long, being ſent to the laſt rings, in the ſkin and muſcles of which the firſt pair is partly loſt. The ſecond pair is only ſub-divided when it has reached the firſt ring; it there produces a plexus, from which a number of filaments are detached to the great inteſtine. The trunk appears to end on the parietes of the rectum towards the anus.

F. *Diptera.*

The nerves of the larva of the *ſtratyomis* have ſome reſemblance to thoſe of the larva of the *ſcarabæus naſicornis.*

The brain is formed of two lobes, placed cloſe together, and almoſt ſpherical; it is ſituated above the œſophagus, on a level with the ſecond ring of the body. A number of ſmall nervous filaments ariſe from its anterior part, and are diſtributed to the parietes of the mouth, to the mandibles, and to all the adjacent parts.

 Theſe

Thefe nerves are very diftinct, particularly thofe which are removed from the middle line.

The pofterior part of thefe two lobes fends off two thick branches, which embrace the œfophagus, and form the origin of the nervous medulla.

This nervous cord is very fhort, and its diameter is one half lefs than that of the brain; it confifts of eleven ganglia placed very near each other, each of which produces one pair of nerves.

Thefe nerves proceed directly backward. Swammerdam has erroneoufly reprefented this cord as twifted, like the tail of a fcorpion, and producing nerves on the left fide only. It is true, that thofe which arife from the right fide are parallel to the cord, while thofe of the left fide remove farther from it. The ganglia, thus approximated, are eleven in number, and in a ftraight direction; they produce long nerves, which are loft in the mufcles.

The nerves of the *cheefe-worm (mufca putris* Lin.) are diftributed in a very curious manner.

The brain is fituated immediately above the origin of the œfophagus, behind the head; it is very large in proportion to the reft of the body; it is rounded pofteriorly, and notched anteriorly, as if it were formed of two lobes.

A pair of nerves arife from the anterior part of the brain, proceed forward, and are diftributed to the mouth, and even to the parietes of

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that cavity. It ſhould be remarked, that theſe nerves experience a very conſpicuous enlargement previouſly to their diſtribution.

Poſteriorly the brain preſents an aperture, which affords a paſſage for the œſophagus: the nervous part, ſituated on its ſides, may be regarded as the cords which produce the medulla, and all below the œſophagus as the medulla itſelf.

Two pairs of nerves ariſe from the origin of the nervous medulla; theſe are directed forward, and principally diſtributed to the viſcera, and to ſome of the muſcles of the anterior rings.

The third pair of nerves which this medulla produces, is the moſt remarkable; it comes from the part which nearly correſponds to the third ganglion; I ſay nearly, becauſe in this inſect the ganglia are ſo cloſe to one another, that the medulla ſeems to form only one piece on the ſurface, of which we merely perceive twelve tranſverſe wrinkles, which indicate the number of ganglia. This third pair extends almoſt tranſverſely. At a certain diſtance from its ſeparation it ſwells into a ganglion, and then divides into ſeveral filaments; theſe are the ganglia which Swammerdam ſuppoſes are intended for the muſcles of the wings, when they ſhall exiſt in the perfect inſect.

Another pair of nerves, which go to the muſcles of the body, ariſe from each of the other contractions ; but they require no particular remark.

ARTICLE VI.

Brain and Nerves of Perfect Insects.

A. *Coleoptera.*

1. *In the Stag-beetle (Lucanus Cervus.)*

WE find in this insect, as in its larva, a brain composed of two approximated spherical lobes, situated above the œsophagus ; its anterior part produces two pair of nerves, which terminate in the palpi, and other parts of the mouth. There is probably a recurrent nerve, but our researches have not yet discovered it.

There are two ganglia on the lateral parts of the brain, which are almost as large as each of the lobes. In their form they resemble a pear, and rest upon the brain by their base ; they are prolonged transversely into a large nerve on each side, chiefly intended for the eye. Before the nerve arrives at that part, we observe it detach a slender filament, which enters into the great mandible ; then, more externally, another filament which enters into the cavity of the antennæ ;

tennæ; laſtly, the nerve itſelf having reached the eye, ſwells again into a bulb, and produces a number of nerves, which we ſhall deſcribe when we treat of the Organ of Viſion.

Poſteriorly the brain produces two very long and ſlender nerves, which accompany the œſophagus to the point where the head unites to the thorax, immediately above the articular condyle. The two nerves ſituated above the œſophagus, then produce a ganglion of a long oval form, from which ſeveral nervous filaments are detached to the muſcles that move the mandibles, and thoſe that act on the head. This ganglion terminates poſteriorly in two parallel nerves, which proceed to the middle of the thorax, above the origin of the two pair of feet, and there form a ſecond ganglion of an hexagonal figure; this ganglion furniſhes filaments to the muſcles of the feet, and likewiſe terminates poſteriorly in two nerves, which extend above the union of the corſelet, with the pectus; they there unite and form a third ganglion, which is creſcent-ſhaped, with the convexity poſterior: two other nerves proceed from this convexity, which almoſt immediately produce another ganglion of the ſame form, but ſmaller. This ganglion gives origin to five nerves: two lateral, deſtined to the muſcles of the intermediate feet, into the coxæ of which we obſerve them enter: poſteriorly two, which are ſlender, and diſtributed to the muſcles of the hind feet and the wings. The fifth is ſituated in the middle line; it is alſo thicker: it ſwells almoſt immediately into an oval ſhaped ganglion, which is divided poſteriorly into two exceedingly ſlender filaments. Theſe filaments, which paſs into the abdomen, form a kind of bridge in the breaſt, in which they occupy the middle line, and leave between them the muſcles of the feet and wings of either ſide.

2. *In the Scarabæus naſicornis.*

With reſpect to the nerves, this inſect differs in the perfect ſtate from the deſcription we have given of its larva.

The optic nerves, which are very diſtinct and large, proceed to the eye, into which we obſerve them enter by a multitude of filaments when we make a horizontal ſection of that organ.

The nervous cord preſents a very conſpicuous difference. In the larva there is only a ſingle ganglion; but the perfect inſect has ſeveral, which are very diſtinct.

The firſt is ſituated above the condyle; it proceeds from the two poſterior filaments of the brain, and is diſtributed to the muſcles which move the head on the corſelet. Its poſterior part produces two filaments, which paſs into the breaſt, where they unite towards the middle part, and form a triangular ganglion; from the ſides of which three pairs of nerves ariſe, and are diſtributed to the muſcles. Its poſterior angle detaches

detaches two parallel nerves, which proceed into the breaſt, where they form a third and a fourth ganglion, ſituated very near each other, and apparently divided into two lobes by a longitudinal furrow. All the other nerves of the body depart from thoſe two ganglia by an irradiation, precifely in the ſame manner as in the larva.

3. *In the Water Beetles (Dytiſcus) and the Ground Beetles (Carabus.)*

The nervous ſyſtem is entirely ſimilar in theſe inſects. The brain is formed of two large hemiſpheres, ſeparated from each other by a longitudinal furrow. The anterior part produces the nerves of the mouth, and the lateral parts thoſe of the eyes and the antennæ. The nerves of the eyes are ſhort, and differ greatly from thoſe of the ſtag beetles; they are of a pyramidal form: their baſe correſponds to the eye, and their apex to the brain. We have not obſerved any recurrent nerves.

The two filaments which produce the nervous cord depart from the brain, not poſteriorly, but inferiorly, on the ſide of the optic nerves; they are very ſhort, as they paſs immediately under the œſophagus. They furniſh ſome filaments to the muſcles and the œſophagus.

The firſt ganglion they form lies under a kind of bridge, formed of horny ſubſtance, which is ſituated in the middle of the head, and which affords a point of attachment to the muſcles of the

the jaws; it is of an elongated and quadrangular figure, and occupies almoſt the whole ſpace that correſponds to the condyle above which it is placed.

It is terminated poſteriorly by two filaments which proceed in a parallel direction, and form a ſecond ganglion in the middle part of the corſelet. This ganglion furniſhes nerves to the muſcles of the anterior feet. We obſerve them enter into the cavity of the coxæ.

The third ganglion appears bilobed, or formed of two oval bulbs, the union of which is marked by a longitudinal furrow. This ganglion is ſituated longitudinally above the anterior inferior edge of the breaſt. It ſends filaments to the muſcles of the intermediate feet.

The fourth ganglion is very near the preceding; it is of a roundiſh form, and is diſtributed to the muſcles of the poſterior feet and the wings.

The ſpace between the fifth and the ſixth ganglion is very ſmall: their form is round; and they furniſh filaments to the muſcles that move the abdomen on the breaſt.

The remainder of the medullary cord is formed by a ſeries of five ganglia, ſituated ſo cloſe to one another, that they appear to the naked eye to form only one; but with a glaſs they may be obſerved very diſtinctly. We even perceive the two filaments produced by each to form the ſucceeding ganglion. The fifth preſents a tranſverſe

verſe furrow, which ſeems to indicate the union of two ganglia. The end of the medulla appears to float in the abdominal cavity, but above the inteſtines.

4. *In the Great Diver (Hydrophilus piceus* Lin.)

The brain of this inſect, which is ſituated in the head, and above the origin of the œſophagus, conſiſts of two ſpherical bulbs cloſely united. The lateral parts give origin to the optic nerves which proceed towards the eyes without changing their diameter, but which terminate there by a triangular bulb that produces a vaſt number of filaments externally.

The anterior part of the brain detaches ſome filaments intended for the parietes of the mouth. We alſo remark, at the ſame place, a ſmall ſpherical ganglion, which appears to belong to the *recurrent* nerve that accompanies the œſophagus.

Two filaments, which ſhould produce the medullary cord, ariſe inferiorly: they embrace the œſophagus at their ſeparation, unite immediately below it, and again, in the cavity of the head, to form a ſmall ganglion, which furniſhes nerves for the muſcles of the mandibles and the palpi.

Two nervous cords are detached from the poſterior part of this firſt ganglion. Almoſt immediately after their origin, they paſs under a horny a horny arch, which is produced by the internal ſurface of the *ganache*. We obſerve that they re-appear poſteriorly, and proceed into the corſelet.

They form a ſecond ganglion exactly in the middle of the corſelet; its figure is quadrangular. The anterior and poſterior angles produce the nerves of the medulla, and the lateral thoſe intended for the muſcles of the anterior feet.

The interval included between the ſecond and third ganglion of the medulla is very great. The third ganglion correſponds to the inſertion of the intermediate feet: it is large, and of a round form; it furniſhes nerves to the wings, and to the intermediate pair of feet. Poſteriorly it produces two cords, which, at the diſtance of about half a line, ſwell and form a fourth ganglion, almoſt as large as the preceding. This ganglion detaches, from its inferior part, a number of filaments for the muſcles of the poſterior feet, which are ſpecially appropriated to ſwimming. Two other very ſhort cords produced by the poſterior part of this ganglion ſwell into a fifth, which is one half leſs than the former, and which furniſhes a ſingle cord poſteriorly. This cord paſſes into a kind of longitudinal groove, formed above the horny appendix, that furniſhes attachments to the muſcles of the coxæ, and which we have deſcribed in the firſt volume.

A ſixth ganglion is ſituated at the poſterior and wide part of this appendix: at a certain

diſtance,

diſtance, and exactly above the union of the abdomen with the breaſt, a ſeventh appears. Theſe two ganglia produce only one pair of nerves, which are diſtributed to the muſcles.

There are only two ganglia in the abdomen; one correſponds to the middle part of the ſecond ring; the other, which is the laſt and ninth, is ſituated above the union of the ſecond ſegment with the third. The laſt ganglion but one is in every reſpect ſimilar to the two preceding; but the ninth is one half larger, and produces poſteriorly four pair of nerves, which are diſtributed on both ſides to the parts of generation.

B. *Orthoptera.*

In the Cockroach (Blatta Americana.)

The brain of this inſect is compoſed of two lobes, ſeparated by a very diſtinct notch anteriorly. The optic nerves ariſe on the ſides, and its anterior part detaches ſome filaments to the parietes of the mouth, and to the inſtruments of manducation.

The nervous cords which form the medulla ariſe from its inferior ſurface. They proceed directly downward, and cloſely embrace the œſophagus. They afterwards proceed in a parallel direction, but very diſtinct from each other, towards the corſelet. When they reach its middle, they form a very large ganglion, which produces

duces three pairs of nerves laterally, and one poſteriorly. The firſt lateral nerves aſcend obliquely towards the head, and furniſh filaments to the muſcles that move it on the thorax, and which act on the antennæ and the parts of the mouth. The others are diſtributed to the muſcles of the firſt pair of feet.

The poſterior nerves proceed in a parallel direction backward. At the middle of the pectus they produce a ſtill more conſiderable ganglion than the ſecond, which furniſhes laterally nerves to the intermediate and poſterior feet, as well as to the muſcles of the wings. It alſo ſends off two cords poſteriorly, which, by their union at the junction of the abdomen and the breaſt, form a fourth ganglion, ſituated on a projecting horny ſubſtance to which the muſcles of the coxæ are attached.

After this fourth ganglion there is only a ſingle nerve, which has, at certain ſpaces, ſmall enlargements. Five of theſe ſwellings may be counted. Each produces a pair of nerves for the muſcles of the rings of the abdomen: the fifth is the largeſt, and furniſhes beſides two nerves which ramify in the parts near the anus.

In the Great Green Graſshopper (Gryllus Viridiſſimus, Lin.)

The brain is ſituated in the head above the œſophagus: it conſiſts of two lobes, which have the form of pears, united at their baſe, and pro-

 longed

longed at the other extremity into an optic nerve for the eye of each ſide.

The anterior part alſo produces two nerves of a pyramidal form, the baſe of which reſts upon the brain. Some filaments ariſe from the apex of the pyramid, which are loſt in the mandible, the jaw and its *galea*, as well as in the upper lip.

Between theſe two anterior nerves we obſerve a ſmall ganglion, which is produced by the union of the two filaments of the inferior ſurface of the brain. This is the recurrent nerve which follows the inteſtinal canal.

Poſteriorly, and a little inferiorly, we obſerve the origin of the two cords which form the nervous medulla. They embrace the œſophagus, below which they are immediately directed, and form a ganglion.

This firſt ganglion is protected and covered by a kind of horny bridge of a reddiſh colour. It furniſhes nerves to the muſcles of the mouth, and to thoſe of the head within which it is incloſed. Poſteriorly it produces two long nervous cords, which penetrate into the corſelet.

Theſe two cords unite about the middle of the thorax before the appendix, which gives attachment to the muſcles of the coxæ and the anterior pair of feet. At this union they form a large bilobed ganglion, of an irregular quadrangular figure, the ſides of which produce ſeveral filaments for the muſcles of the anterior feet.

The

The pofterior part of this fecond ganglion furnifhes two filaments, which penetrate into the breaft. The folid appendices of the coxæ, which afford infertions for the mufcles, pafs between thefe two filaments. They form a third ganglion, which correfponds to the middle fpace included between the two intermediate feet. This ganglion fends nerves to the mufcles of the wings and the feet.

The fourth ganglion is alfo contained in the breaft. It is fituated before and between the pofterior pair of feet. It is produced by two nervous cords from the preceding ganglion; and furnifhes two pofteriorly, which are fo clofe to each other that they appear to the naked eye to make only one cord. This nerve is received and contained in a kind of groove formed above the triangular piece, which affords an attachment for the mufcles of the feet.

The other ganglia, which are all fituated in the abdomen, are fix in number. They are, the laft excepted, of the fame fize and form, placed at equal diftances, and produced by two fimilar and clofely approximated cords. Each furnifhes two pair of nerves for the mufcles of the abdominal rings.

The laft ganglion of the medulla is one half larger than the five preceding. It is fituated below the parts of generation, to which it is diftributed by four pair of filaments.

In

In the Mole-cricket (Acheta gryllo-talpa.)

The brain of this infect is alfo compofed of two rounded lobes, which are particularly diftinct at the pofterior part.

We can clearly perceive the origin of the nerves of the palpi, of the antennæ, of the fmooth eyes, and the eyes properly fo called.

In general the nerves of the principal medulla are fimilar to thofe we have defcribed in the cockroach. The two firft ganglia are produced by two nerves. The firft, which is in the corfelet, fupplies the mufcles of the head, breaft and anterior feet. The fecond, which is larger, and in the breaft, gives filaments to the mufcles of the wings, and the intermediate and pofterior feet. It alfo fends two nerves pofteriorly, which produce the abdominal ganglion. The cord then becomes fingle and flat, like a ribband, and contains only four ganglia, occurring at different diftances. Each produces two pair of nerves, which are directed pofteriorly, and diftributed to the mufcles. The firft correfponds to the middle part of the firft abdominal ring; the fecond to the third, the third to the fifth, and the laft to the ninth.

This laft ganglion is the moft remarkable of all. It is of an oval fhape, and produces, from the whole of its circumference, nerves which are diftributed to the neighbouring parts. Two, which are longer than the others, diverge as they

they proceed backward, and thus reprefent a bifurcation of the medullary cord. Thefe branches furnifh filaments to the parts of generation.

C. *Hemiptera.*

In the oval Water Scorpion (Nepa Cinerea, Lin.)

The nervous fyftem of this infect confifts of three ganglia.

The firft, which fupplies the place of the brain, is fituated in the head. It is formed of two approximated lobes. Thefe lobes are pyriform, and touch each other at their bafe. Their fummits are directed obliquely forward towards the eyes, in which they terminate, and thus anfwer to the optic nerves by their anterior extremity. The middle and anterior part of thefe lobes alfo produce fome filaments for the parts of the mouth.

Pofteriorly, the brain detaches two cords which embrace the œfophagus as they pafs below it. They unite at the origin of the breaft in a tetragonal ganglion; each of the angles of which produces or receives feveral nerves. The anterior receives the two cords which come from the brain; the pofterior, the two which are the continuation of the medullary cord.

Each lateral angle produces a fafciculus, compofed of four nerves, which are directed to the mufcles of the breaft and anterior feet. We obferve obſerve one of them enter into the cavity of the coxa.

The two nerves produced by the poſterior angle of the ſecond ganglion proceed in a parallel direction backward. Having arrived in the breaſt above the horny appendix, to which the muſcles of the coxæ of the intermediate and poſterior feet are attached, they ſwell into a large round ganglion, conſiderably more voluminous than the brain. A vaſt number of nerves are detached from the edges of this ganglion, like ſolar rays.

The two moſt remarkable filaments are exceedingly long and ſlender. They extend from the breaſt nearly as far as the anus: we have obſerved them to terminate by three minute branches in the parts of generation of the male, furniſhing, at the ſame time, ſome filaments to the adjacent parts.

All the other filaments, which proceed from this third and laſt ganglion, are deſtined to the muſcles. We can very plainly diſtinguiſh thoſe that belong to the middle and intermediate feet, as they are ſomewhat larger than the others.

D. *Lepidoptera.*

In the Zig-Zag Moth (Phalæna Diſpar, Lin.)

The brain in this ſpecies is almoſt ſpherical. We, however, perceive a longitudinal furrow on the middle line. Its anterior part produces

 ſome

ſome exceedingly ſlender nerves. There are two large optic nerves on the ſides, which proceed into the concavity of the eye, where they terminate by a bulb, which produces a great number of filaments.

The œſophagus paſſes immediately behind the brain, through a ſmall triangular interval, the poſterior ſides of which are formed by the two cords of the medulla. Theſe cords afterwards unite, and proceed in the form of a ſingle trunk, on the middle part of which we perceive only a longitudinal furrow. Arrived in the corſelet it forms a ganglion, the ſurface of which is reddiſh. This ganglion produces two nerves poſteriorly, which leave between them an interval that affords a paſſage for the horny appendices to which the muſcles of the coxæ are attached. The two cords again unite behind theſe appendices in the ſame cavity of the breaſt, and produce a much larger ganglion, the lateral parts of which furniſh nerves to the muſcles of the wings and feet. It is prolonged poſteriorly into a ſingle cord, which again enlarges when it arrives above the articulation of the breaſt with the abdomen into a third ganglion.

It ſhould be remarked, that this large ganglion, which has the form of a heart, is the only one, beſides the brain, of a completely white colour. All the others exhibit darker ſhades, and, when viewed by a glaſs, we obſerve in them reddiſh points more or leſs elongated and ſinuous,

ous, that resemble the blood vessels of injected glands.

The third ganglion is prolonged into a single cord, which produces a fourth ganglion above the first ring of the abdomen. The latter, as well as those that succeed it, detach on each side a long slender nerve which passes under the muscular fibres, precisely in the same manner as the threads of the woof pass through the warp in cloth. Their direction is completely transverse.

The fifth ganglion does not differ from the preceding. It is prolonged into a single cord, upon which we can still very distinctly perceive the longitudinal furrow. It is situated in the middle part of the third ring of the abdomen.

The sixth ganglion is, in every respect, similar to the preceding; it is placed in the middle of the fourth ring.

Finally, the seventh and last ganglion is much larger than those that precede it in the abdomen. It is of an oval form, and situated upon the lunula that terminates the fifth abdominal ring posteriorly. Besides the nerves intended for the muscles of the fifth ring, which are detached from this ganglion in two distinct parts, it produces four other pairs posteriorly. These nerves appear to be distributed to the parts of generation, and to the muscles of the last abdominal rings, which, in the female, are elongated like a tail to assist in laying eggs.

E. *Neuroptera.*

The infects with naked wings, that is to fay, the Hymenoptera, Neuroptera, and Diptera, which have frequently very large eyes, have alfo the optic nerves of a proportional fize. This is particularly obfervable in the *dragon flies.* Their brain is formed of two very fmall lobes; but their optic nerves are dilated into the form of two large plates, which have the figure of a kidney, and which is fpread upon all the inner furface of the eye next the head. The remainder of their medullary cord is exceedingly flender, and furnifhed with twelve or thirteen fmall ganglia, the laft of which is, as ufual, connected with the parts of generation.

F. *Hymenoptera.*

The brain of the *bee* is fmall, and divided into four lobes. It produces immediately the nerves which are diftributed to the different parts of the mouth, and the two large optic nerves which are dilated and applied behind each eye as in the *dragon flies.* There are afterwards feven ganglia, three of which are in the corfelet, and four in the abdomen. The nerves of the laft chiefly fupply the parts of generation.

G. *Diptera.*

The *apiform fly* (*mufca tenax*, Lin.) has a fmall brain, formed of two lobes, which are fituated

very

very close together, but distinguished by a longitudinal furrow; the anterior part produces a large nerve, which is afterwards distributed to the antennæ and the proboscis.

The optic nerves are very thick, cylindrical, and equal in diameter to the length of the brain, on the lateral parts of which they rest; they terminate at their extremity in a very large bulb, which corresponds to the breadth of the eye.

The first ganglion of the medulla is produced by two cords, which come from the posterior part of the brain, and embrace the œsophagus as a collar; it is very slender, and situated in the breast; it furnishes a pair of filaments to the muscles of the anterior feet.

The second and the following ganglia, in all three in number, are united to each other merely by a single cord. The last ganglion is one half larger than that which precedes it. Posteriorly it produces eight or nine filaments, which are intended for the parts near the anus; the first of the three is situated in the breast, where it furnishes nerves for the muscles of the wings and the feet; the other two ganglia are in the abdomen; the last but one is placed above the union of the third ring with the fourth; and the last on the interior and inferior edge of the fifth ring.

In the *hornet-fly (asilus crabroniformis)* we also observe a single cord uniting the abdominal ganglia, which are six in number.

The brain is ſimilar to that of the *Syrphus*; but the bulbs, formed by the optic nerves, are ſtill broader, in proportion to the extent of the eyes they have to inveſt.

II. *Gnathoptera.*

In the *great ſcolopendra (ſcolopendra morſitans)* the brain has a very ſingular form: it is, as uſual, compoſed of two lobes, which are almoſt ſpherical; it produces laterally the optic nerves, which are very ſhort, and may be obſerved to divide long before they reach the eye. The filaments are four in number; but two nerves ariſe anteriorly, which are ſo very thick, that they appear a part of the brain, to which they are equal in diameter. Theſe nerves are particularly intended for the antennæ, into which we obſerve them enter, and in which they may be followed, on account of their magnitude.

The two cords which embrace the œſophagus proceed directly downward, and form a large ganglion at the union of the firſt ring with the head. The firſt ganglion produces two nerves poſteriorly, and ſeveral towards the ſides. A ganglion, preciſely of the ſame ſhape, is placed above each of the articulations: thus there are, in all, twenty-four very diſtinct ganglia; the laſt of all is ſmalleſt, neareſt the preceding, and ſeems to float in the abdomen; each detaches three pair of nerves; one which afcends towards the head, a fecond which runs tranfverfely; both thefe are diftributed to the mufcles of the abdomen: the third defcends, and then proceeds backward and upward; it furnifhes filaments to the lateral mufcles, and to thofe of the back.

ARTICLE VII.

Brain and Nerves of Worms.

SOME genera of worms prefent a very diftinct nervous fyftem, organized nearly like that of the Cruftacea and infects. In others, however, that fyftem becomes fo obfcure, that we can fcarcely recognize its exiftence. Thus the clafs of worms which, in feveral of its genera, ranks above infects, with refpect to the organs of circulation, is reduced almoft to a level with the zoophytes, when confidered with regard to the organs of fenfation.

1. *In the Aphrodita Aculeata.*

The nervous fyftem is very diftinct in this animal. Immediately behind the tentacula, fituated above the mouth, we obferve a large nervous ganglion, which is the brain; it has the form of a heart, the broadeft and bilobed part of which is directed backward. The pointed ed and anterior part produces two ſmall filaments for the tentacula; and the lateral parts ſome other filaments, which are ſtill more ſlender for the parietes of the mouth. This ganglion is ſituated immediately above the origin of the œſophagus.

The two cords which ariſe from the brain, and form the collar, are very long and delicate; they gradually increaſe in thickneſs, as they approach the point of their union. Each then produces a large filament, which we ſhall call the *recurrent* nerve; theſe nerves are very diſtinct; they are directed forward towards the part where the œſophagus, which is very ſhort, joins the ſtomach; they may be eaſily followed by the naked eye to the lateral parts of that viſcus, which is very long and muſcular; before they reach the inteſtines that follow the ſtomach, they ſwell into a ganglion, which produces a great number of nervous fibrils.

The two nerves of the collar produce a very large ganglion at their union; it is bifurcated anteriorly, and ſituated immediately behind the mouth, and above the œſophagus; it is the anterior extremity of the chief nervous cord. We do not obſerve any filaments proceeding from it. To this firſt ganglion another ſucceeds, which is diſtinguiſhed from it by only a ſmall contraction; the latter produces two nervous filaments, which go forwards into the muſcles of the abdomen. A ſeries of ganglia, the ſpaces

2 between

between which are confiderably greater, afterwards fucceed ; each of thefe fends off fix nerves, three on a fide, which are loft in the mufcles. Thefe ganglia are twelve in number.

The nervous cord which fucceeds, and which occupies the pofterior third of the body, no longer exhibits any apparent enlargement ; but pairs of nerves are ftill detached at certain fpaces. Finally, this cord may be followed to the extremity of the body.

2. *In the Leeches,*

The nervous fyftem is a longitudinal cord, compofed of twenty-three ganglia.

The firft is fituated above the œfophagus ; it is fmall and rounded ; anteriorly it produces two flender filaments, which proceed above the difk of the mouth. The lateral parts furnifh a thick pair of nerves, that form a collar round the œfophagus, as they proceed downward, and unite at the fecond ganglion.

This ganglion is of a triangular figure ; it appears to be formed by the union of two tubercles. Two of thefe angles are anterior and lateral ; they receive the nerves that proceed from the firft ganglion. The other is pofterior ; it is prolonged into a nerve rather more than half a line long, which produces the third ganglion : the anterior part of the triangular ganglion which we defcribe, detaches two fmall

nerves

nerves that are loſt on the œſophagus, around the mouth.

The nine ſucceeding ganglia are preciſely of the ſame form, and produce each two pair of nerves; they differ only in the greater or leſs diſtance at which they are placed with reſpect to each other.

The third, as we have obſerved, is very near the ſecond. The three following are at the diſtance of nearly a line and a half: but thoſe which ſucceed, from the ſeventh to the twentieth, are at the diſtance of three or four lines: finally, the three laſt are very cloſe together.

All theſe ganglia are ſituated longitudinally below the inteſtinal canal, to which they furniſh, from their ſuperior ſurface, a number of nervous filaments; they produce on each ſide two nerves, which paſs into the longitudinal and tranſverſe muſcles, in the ſubſtance of which they are loſt. Theſe nerves run in oppoſite directions, ſo that they repreſent the figure of an X.

The coat of theſe nerves is black, and very ſolid: on this account, before the parts have been immerſed in alcohol, the nerves appear like a ſyſtem of veſſels.

3. *In the Earth Worm,*

The nervous cord derives its origin from a ganglion ſituated above the œſophagus; this ganglion

ganglion is formed of two clofe, but very diftinct tubercles; it produces a pair of fmall nerves, which proceed to the parietes of the mouth, and two large cords, which embrace the œfophagus in the form of a collar; thefe unite to form the nervous cord, the origin of which, therefore, appears bifurcated. Three pair of fmall nerves are detached at this place; one from the cord itfelf, and the others from its lateral parts. They all proceed into the mufcles of the mouth.

The nervous trunk is continued to the anus, along the inferior part of the inteftine; its fize is not fenfibly diminifhed, and the contractions are not very remarkable: there are, therefore, no real ganglia.

A pair of nerves arifes between each of the rings of the body; thefe nerves pafs under the longitudinal mufcles, and difappear between them and the fkin.

When the nervous cord reaches the anus, it terminates by forming a plexus, which is loft on the parietes of that aperture.

4. *In the Gordius Argillaceus.*

There is only a fingle nervous cord in this animal, fimilar to that of the earth worm, but its contractions are ftill lefs apparent.

5. *In the Nereis and Terebella.*

In thefe animals we find, within the fkin of the

the belly, a longitudinal cord, which may be regarded as nervous: it has as many contractions as there are rings in the body. We have obferved no nervous filament proceeding from this cord.

6. *In the Sea Worm, (Lumbricus Marinus* Lin.)

Which, by its external characters, approaches nearer to the nereis than the lumbricus. The nervous fyftem is the fame as in the nereides, but the cord gradually increafes in thicknefs towards the middle of the body, where it is much more diftinct.

7. *In the Afcaris Lumbricoides of Man and the Horfe.*

This animal appears to have two nervous cords; they are obfervable throughout the whole length of the body, on the lateral parts of the abdomen.

They unite above the œfophagus exactly at its origin on the mouth; they are very flender, and produce no remarkable ganglion; they are fmaller at their origin than towards their extremity, that is to fay, towards the anus; but they are equal, and precifely fimilar to each other with refpect to their different parts. We at firft obferve fome fmall granular points, which enlarge in proportion as the nerve defcends. When it has reached the middle of the body longitudinally, it forms fquare ganglia, at a fhort ſhort diſtance from each other. Laſtly, towards the termination, for the length of nearly ſix lines, the nerve becomes more and more ſlender, and ends in a very ſmall filàment, which unites with that of the other ſide.

The details into which we have entered in Articles IV. V. VI. and VII. of this Lecture, evidently demonſtrate that there exiſts an analogy in the organization of the nervous ſyſtem of the three claſſes of Cruſtacea, Inſects, and Worms, no leſs ſtriking than that which prevails in the external forms, in the diſpoſition of the muſcles, and in the ſingular diviſion, into a ſeries of rings or ſegments, which we obſerve in thoſe animals. This analogy muſt prevent us from eſtabliſhing, between theſe three claſſes, limits equally diſtinct with thoſe that ſubſiſt between them and the Molluſca.

The uniform diſtribution of nearly equal ganglia upon a cord, extending throughout the whole length of the body, ſeems deſigned to furniſh each ſegment with a brain peculiar to itſelf. Thus we are gradually conducted to that general diffuſion of the medullary ſubſtance which takes place in zoophytes.

ARTICLE VIII.

Of Animals, in which no diftinct Nervous Syftem has yet been difcovered.

WE do not include, in this divifion, the animals of the clafs of Worms, or the Mollufca, in which the minutenefs or foftnefs of the parts have not yet permitted us to trace the nervous fyftem. Analogy will not allow us to doubt its exiftence, when the parts, which accompany it, uniformly exift. Thus the *flukes (fafciola)* having veffels, or liver, &c. muft alfo be fuppofed to have nerves, though we have hitherto been unable to demonftrate them.

We even doubt not the exiftence of a nervous fyftem in feveral inteftinal worms, particularly thofe which have a cylindrical form, which we fuppofe to have a medulla nearly fimilar to that we have defcribed in the large afcarides. It is found in the *gordius*. Why fhould it not exift in the *echinorhinchus*, *ftrongylus*, &c. &c.?

But there are animals in which analogy will not ferve us, and to which we cannot attribute a nervous fyftem, unlefs we diftinctly obferve it; thefe are fome inteftinal worms, very different in form from thofe we have mentioned, and the greater part of zoophites.

We fhall examine fome of them.

1. In

1. *In the Sea Stars, (Afterias.)*

Thefe animals have parts which may be regarded as very fimilar to nerves; but galvanic experiments ought to be made on living individuals, to prove completely their nature. Round the œfophagus we obferve a girth of a foft whitifh fubftance, which produces ten filaments, two to each of the branches, which form the body of the ftar; the two filaments belonging to each branch having arrived at the bafe of the offeous and articulated ftalk, which ferves for the principal fupport of the animal, unite to form a fhort cord, which extends directly from the one to the other; they afterwards both continue along the ftalk to the extremity of the branch, diminifhing always in thicknefs. At the place where they are united, each produces a fafciculus of filaments, which are diftributed to the ftomach, which, in thefe animals, is fituated in the midft of the body, between the five branches.

The appearance of all thefe filaments is rather tendinous than nervous, and that circumftance has hitherto chiefly prevented us from forming a decided opinion of their nature.

2. *In the Holothuria.*

In the Holothuria, properly fo called, among which we do not include either the *thalia*, or the *holothuria phyfalus* of Linnæus, we find fomething fimilar to what we have defcribed in the fea ftar, but the appearance of the cord is much more nervous, and this we confider a ftrong confirmation of our conjectures.

The parts of which we fpeak appear moft diftinctly in the fpecies of holothuria, which have five longitudinal pairs of mufcles, as the *priapus* and the *pentacta*. Between the two mufcles which compofe each pair, there is extended a white cord, flightly ferpentine, and marked by tranfverfe rings, precifely like common nerves. The five cords enlarge as they proceed towards the œfophagus, where it appears to us they unite to furround that canal.

3. *In the Sipunculus.*

Thefe are more fimilar to the holothuria than to any other animal, though naturalifts have hitherto placed them next the Lumbricus; they have only a fingle whitifh cord, but it completely refembles thofe of the holothuria, and it proceeds in the fame manner to embrace the œfophagus by its anterior extremity.

If thefe obfervations apply to real nerves, it will be neceffary to feparate the *echinodermata* from the other zoophytes, and eftablifh them as a diftinct clafs.

4. *In the Sea Urchins (Echinus Marinus.)*

We have not obferved in thefe animals any thing that refembles nerves, but analogy will

 not

not permit us to ſeparate them from the ſea ſtars and holothuria. One ſpecies of this genus has been formerly very properly named the *coriaceous urchin.*

5. *In the Actinia and the Medusa.*

Theſe animals form, in the claſs of zoophytes, a ſecond family, which approaches pretty near to the preceding, and particularly to the genus *holothuria*, with reſpect to the arrangement of the parts; but it is impoſſible to perceive any thing in them like nerves.

6. *In the Polyps with Arms, (Hydra.)*

With reſpect to theſe and the neighbouring genera, which form, with the animals of the coral kind, the third and the moſt ſimple family of zoophyta, we have already had occaſion ſeveral times to obſerve, that we diſcover in their bodies only a gelatinous and homogeneous pulp, which exhibits no apparent organization.

All theſe animals have however very diſtinct ſenſations: their ſenſe of touch is very delicate; they not only perceive the motions which agitate the water in which they live, but they completely feel the degrees of heat and light. The expanſion of the actiniæ correſponds preciſely to the ſerenity of the atmoſphere. The hydra perceives very diſtinctly the preſence of light; it prefers it, and conſtantly turns towards it.

The microſcopic animals appear to approach,

 in

in ſome meaſure, the nature of polyps, by their uniform and gelatinous ſtructure. There are ſome, however, in which we obſerve a more complicated organization, and ſeveral kinds of internal viſcera; but it will be readily imagined that we have not even thought of aſcertaining whether they poſſeſs a nervous ſyſtem.

LECTURE TWELFTH.

Of the Organ of Sight, or of the Eye.

Article I.

General Idea of Viſion.

By ſight we diſtinguiſh the quantity, the colour, and the direction of the luminous rays which ſtrike our eye. The difference of colours marks the limits of bodies in height and breadth; and the difference in the intenſity of light, joined to the experience acquired by the ſenſe of touch, enables us to recognize their cavities and inequalities. Laſtly, from the direction of the rays, we form an opinion as to the line in which theſe bodies are ſituated.

We cannot obtain an immediate knowledge of real diſtance by ſight only. We muſt in this caſe alſo avail ourſelves of the experience acquired from the ſenſe of feeling, and judge of the diſtance of objects, according to their known magnitude, compared with their apparent magnitude and degree of illumination.

As viſion can only immediately afford ideas

 of

of the quantity, quality, and motions of the rays of light, we are ſubject to make erroneous concluſions with reſpect to the objects from which theſe rays proceed. Thus rays reflected by a mirror, exhibit objects in a direction in which they do not exiſt. Rays refracted by glaſſes, change the apparent magnitude of bodies: when we know not the real ſize of an object, we are deceived with reſpect to its diſtance, and *vice verſa*: a very luminous body appears neareſt to us, when thoſe which are between us and it are in the ſhade, &c. &c.

Rays do not excite any ſenſation, unleſs they fall upon a nervous membrane of the eye, called the *retina*; and they communicate no ſenſation conformable to the body which tranſmits them, unleſs they fall upon the retina preciſely in the order in which they are detached from that body. To produce this effect it is neceſſary that all the rays which proceed from any one point of a body, ſhould be collected in one point of the retina, and that all the points of union thus formed ſhould be diſpoſed in the ſame manner as in the body of which they form the image.

This neceſſity is a matter of ſimple experience; for it is eaſy to conceive that we are no better acquainted with the intimate nature of ſight, than with that of all the other ſenſes, and that we ſhall never be able to learn why theſe are the conditions of the ideas it procures us.

Rays which proceed from any point, neceſſarily

ſarily diverge as they advance, and therefore cannot re-unite in another point unleſs they are refracted by ſome tranſparent body through which they paſs. This takes place in the eye, in the ſame manner as in the optical inſtrument called a *camera obſcura*. The eye is perforated by a hole named *pupil*, behind which there is a tranſparent body of a lenticular form called *cryſtalline*, more denſe than the medium in which the animal exiſts, and than the other fluids contained in the eye. The cone of rays which proceeds from any luminous point to the pupil, forms, after paſſing through the cryſtalline, another cone, the apex of which falls upon the retina. Theſe two cones have their axes almoſt in a ſtraight line. That which is perpendicular to the middle of the cryſtalline proceeds directly to the bottom of the eye; that which comes from above, falls inferiorly; that of the left proceeds to the right, and ſo on with reſpect to the others. Thus an inverted image of the object is formed on the retina; but as we judge of the ſituation of each luminous point by the rays it tranſmits, it follows that we muſt ſee bodies, as we really do ſee them, in their proper poſition.

If the rays were parallel, they would unite in the point which is called, in Dioptrics, the *focus of parallel rays*; but as thoſe which come from a point, the diſtance of which is finite, diverge, they unite in a point a little more removed from the cryſtalline than this focus; and as thoſe which proceed from a very near point, diverge ſtill farther, they alſo unite ſtill more remotely.

A particular eye therefore ſees diſtinctly only objects placed at a certain diſtance. If its cryſtalline has much refractile power, that is to ſay, if it is very denſe and very convex; or, if its retina is removed from the cryſtalline, it can only diſtinguiſh near objects: if its cryſtalline is flat and leſs denſe, or its retina too cloſe to the cryſtalline, it will only diſtinguiſh diſtant objects.

This produces different extents of ſight in one man compared with another, and ſtill greater differences in the various kinds of animals.

The ſame man may, with ſome attention, diſtinguiſh the ſame object at different diſtances, the limits of which may be aſſigned with reſpect to each individual.—Certain animals can diſcern objects, the diſtances of which are extremely variable. Birds, for example, perceive their prey from immenſe heights in the air, and ſtill retain it in view until they ſeize it: it muſt follow therefore, that the eye is capable of changing the poſition of its parts, by approximating and removing the retina with reſpect to the cryſtalline; or that it is capable of augmenting its refractile power by increaſing the convexity of ſome of its tranſparent parts; or finally, that, in viewing very near objects, it only admits the rays which are neareſt to the axis, and which are

are confequently the leaft diverging. We fhall point out hereafter the means by which each of thefe changes is fuppofed to take place. None of thefe means however completely refolve the problem. Perhaps the limits of diftinct vifion are much more confined than we imagine them to be; and it is probable that, in many cafes, it only appears diftinct, becaufe it is affifted by the recollection we have of the object.

Before the cryftalline there is ufually an humour, called *aqueous*, equal in denfity to pure water; and behind it there is always another, which is much more abundant, and a little more denfe, named the *vitreous*. The *aqueous* is only wanting in fome animals which live always in water. It is fuppofed that the union of thefe three bodies, of different denfities, muft produce the fame effect as the three objective glaffes in achromatic telefcopes, that is to fay, they correct the difference of refrangibility in the rays. Thefe rays are indeed ufually compound. The white confift of feven fimple rays; and as they are not all refracted at the fame angle, the images formed on the retina would, as in thofe produced by common telefcopes, be bordered by an iris, if this difpofition of the three humours did not exift.

The eye, however, fometimes fees what are called *accidental colours*. When the retina is too much fatigued by certain colours, it becomes lefs fenfible of them. If we then behold a colour

lour which admits in its compofition that which had fatigued the eye, the latter will ceafe to be vifible.

Thus when we fix the eye on a white fpot, and afterwards turn it towards white bodies, we obferve on them a dark fpot of the fame fhape as that to which the eye was firft directed. If the fpot on which the eye was fixed was black, the eye, wherever it turns, will perceive one of a lighter colour. If it was red, we obferve a greenifh fpot on white bodies; if yellow, a bluifh; if green, a reddifh, &c. &c.

It muft not be forgotten, that the aqueous humour has alfo, by its convexity, a great influence on the refraction of rays, particularly in animals which live in air. That convexity, joined to what is poffeffed by the vitreous, probably fupplies the effect of the cryftalline in eyes which have undergone the operation of the cataract, that is to fay, when the cryftalline has been removed on account of its opacity.

A number of animals can only fee the fame object with one eye at a time. Man alfo employs only one when he wifhes to fee very diftinctly. In ordinary vifion, when the images fall on the correfponding points of both retinæ, and when both eyes are nearly equal, we do not diftinguifh thefe feparate images, and we fee objects fimple: but if one eye be turned in a different direction from the other, or if they be very unequal, we fee double.

Article II.

Of the Number, Mobility, relative Magnitude, Poſition and Direction of the Eyes in different Animals.

All red-blooded animals, without exception, have two moveable eyes placed in the cavities of the cranium, called orbits, and compoſed of the ſame eſſential parts as thoſe of man. None have either more or leſs. There are merely ſome apparent exceptions, when the eyes are concealed by the ſkin, as in the *zemni (mus typhlus)*, or when the ſame eye, having two pupils, appears double, as in the fiſh called *cobitis anablebs*.

The ſame obſervation applies to the *molluſca cephalopoda*, or *cuttle fiſh*.

The greater part of the *gaſteropoda* have alſo two eyes, but very ſmall, and placed either on a level with the head, or on ſome of the fleſhy and moveable tentacula. In ſome they are ſituated at the baſe of theſe tentacula; in others, at the middle or the point, as may be learned from the writings of naturaliſts. In all this order, only the genera *clio*, *ſcyllea*, and *lernea*, want the eyes.

In the molluſca of the order *acephala*, no eyes are found.

The eyes of inſects appear to be of a different nature

nature from thofe of the animals we have hitherto mentioned. They are divided into the *compound* or *fhagrined*, the furface of which, when viewed by the microfcope, prefents a multitude of tubercles; and the *fimple*, which prefents only one tubercle.

All the *coleoptera* and the *butterflies* have only two compound, without any fimple eyes. Thefe eyes are fometimes divided by a bar, and then appear double. This takes place in the *water fleas*; it is faid that fimple eyes have been obferved in fome *moths*.

The *orthoptera*, the *hemiptera*, the *hymenoptera*, the *neuroptera*, and the *diptera*, have, with fome exceptions, two compound eyes, and three fimple, placed between the former. Among the exceptions are the *ephemeræ* and the *phryganeæ*, which have two fimple eyes exceedingly large in fome fpecies of the firft genus; and the *hemerobii* and *lion-ants*, which have only two fimple eyes.

All winged infects have compound eyes.

Among thofe that want wings fome have them compound, as the *onifci*; others have them fimple, viz. the *phalangii*, four; the *fpiders* and *fcorpions*, fix or eight; the *julus* and *fcolopendra*, a confiderable number; laftly, others, as the *lepifma* and the *limulus*, have them of both kinds.

Cray-fifh have almoft all their eyes compound, and placed on moveable peduncles.

The larvæ of infects, which undergo a femimetametamorphoſis, have their eyes ſimilar to thoſe of the perfect inſects, but the larvæ of inſects that are completely metamorphoſed, always have ſimple eyes, which vary greatly as to number in the different ſpecies. The *caterpillars*, for example, have ſix on each ſide. The *falſe caterpillars*, or larvæ of the *ſaw flies*, have only two: thoſe of the *bees*, *ſtratyomes*, &c. have the ſame number. Several of the larvæ which undergo a complete metamorphoſis, have no eyes at all.

An infinite number of other obſervations might be made, reſpecting the form, poſition, and direction of the eyes of inſects, and of their larvæ, and on the effects thereby produced on their viſion; but as theſe circumſtances are external appearances, we ſhall leave the deſcription of them to naturaliſts.—See Article XIII.

Among the articulated worms, there are ſometimes found ſmall tubercles, which have been regarded as ſimple eyes, in conſequence of their reſemblance to thoſe of inſects. Some *leeches* have two, four, ſix, or eight. In ſome of the *nereides* we find two or four. In ſome *naides* only two, &c.

No parts that can be compared to eyes, have hitherto been obſerved in any zoophyte.

The eyes are always ſituated in the head, except in ſome inſects that have no wings, in which the head is confounded with the corſelet, that is to ſay, in the *ſpider*, *phalangium*, *ſcorpion*, &c.

The

The relative magnitude of the eye varies, without any relation to the claſſes, or even to the natural genera. Large animals, however, have, in general, the eye proportionally ſmall: this is obſervable in the Cetacea, and in the *elephant*, *rhinoceros*, and *hippopotamus*.

It is alſo very ſmall in the animals that live conſtantly under ground, as the *moles*, *ſhrews*, *mole-rats*, and ſome *field-mice*.

The frugivorous mammalia, that climb trees, have in general the eye large, as the *makis*, *ſquirrels*, *dormice*, *&c.*

A very large eye moſt commonly indicates that the animal can ſee in the dark. *Bats* form no exception to this rule, becauſe it appears that they are not directed by their ſight in flying, as we ſhall ſhew when we treat of the ſenſe of feeling.

Almoſt all fiſhes have large eyes; doubtleſs becauſe they live in a medium which is more obſcure than the atmoſphere.

The cephalopodous molluſca have them very large, particularly the *calmar*: on the contrary, in ſuch of the Gaſteropoda as poſſeſs eyes, they are ſcarcely viſible.

If we examine all the *chagrined* and *ſmooth* eyes of inſects, we will find that they preſent larger ocular ſurfaces to the light, than any animal of the other claſſes, though each particular eye is very ſmall.

The eyes of man and monkies are directed forward.

forward. The *tarſier* (*Lemur tarſius* Pall. *Didelphis macrotarſus* Gmel.) is of all the Mammalia that in which the eyes are ſituated neareſt each other.

In the other quadrupeds the eyes are always more ſeparate, and ſituated towards the ſides. They are directed a little downward in the Cetacea. In birds their poſition is lateral, except in the *owls*, in which they look forwards as in man.

In all reptiles they are on the ſides of the head.

Fiſhes vary greatly with reſpect to the poſition of the eyes. Some have them turned ſtraight upward, as in the *ſtar-gazer*; in others they are directed obliquely, as in the *callyonymus* and the *ray*. Some have them both ſituated on the ſame ſide of the body, as the *pleuronectes*. In the greater number of fiſhes, however, the eyes are placed laterally.

All animals, in which the ſituation of their organs is perfectly lateral, can contemplate objects only with one eye at a time.

ARTICLE III.

Of the entire Figure of the Globe of the Eye; of the Form and Proportion of its Chambers; and of the Denſity of its tranſparent Parts.

BEFORE we proceed to conſider the eye as a dioptric inſtrument, it is of importance to acquire a knowledge of the circumſtances which may determine the general effect that organ produces. Theſe conſiſt in the forms, proportions, and denſity of the cryſtalline lens, and of the two humours which accompany it.

A. *Form.*

The general form of the eye depends on the nature of the medium, in which the animal it belongs to exiſts. It is almoſt ſpherical in man, and in the quadrupeds that live on the ſurface of the earth; that is to ſay, in the loweſt and moſt denſe part of the atmoſphere. The cornea forms a ſlight projection at its anterior part, becauſe its convexity is the portion of a ſphere, which is ſmaller than that of the reſt of the eye; this difference, however, is not apparent in the *porcupine*, *opoſſum*, &c. The globe is in ge-

 neral

neral a little more convex anteriorly, than pofteriorly *.

In Fifhes, and the Cetacea, which inhabit the water, the flatnefs of the anterior part of the eye is much more confiderable. Indeed, in a great number of fifhes, the eye reprefents a femi-fphere, the plane part of which is forward, and the convex backward. In the *ray*, the fuperior part is alfo flattened, fo that the eye ap-

* To afcertain with ftill more precifion how far the globe of the eye approaches to, or departs from a true fphere, we may form a table of the proportion of its axis to the tranfverfe diameter, in the following manner:

	Axis.	Tranfverfe diameter.
Man	1 :	1
or	137 :	136
Monkey	The fame.	
Dog	24 :	25
Ox	20 :	21
Horfe	24 :	25
Whale (meafured internally)	6 :	11
Porpoife (meafured externally)	2 :	8
Owl	13 :	12
Vulture	13 :	16
Oftrich	4 :	5

As fome eyes depart from the circular form, in their fection from right to left, we might alfo form a table of the proportion of their vertical diameter, or height, to their tranfverfe diameter, or breadth. The following are two examples:

The height is to the breadth—	
In the ox, as	37 : 38
In the ray, as	1 : 2

pears like a quarter of a ſphere, divided by two great circles, perpendicular to each other. Some fiſhes, particularly the *gadus lota* Lin. form exceptions to this rule, and have alſo the cornea very convex.

In birds, which are always more or leſs elevated in the atmoſphere, the eye departs from the ſpherical form, in a direction contrary to that of fiſhes. On its anterior part, which is ſometimes flat, ſometimes in the form of a truncated cone, a ſhort cylinder is engrafted: this cylinder is terminated by a cornea, which is very convex, and ſometimes completely hemiſpherical, but which always belongs to a much ſmaller ſphere than the poſterior convexity.

In *owls*, in particular, the conical part is moſt conſiderable; its axis is double that of the poſterior part; but in the other birds, the cone is commonly very flat. In the *vulture*, its axis is one half of that of the poſterior part, or the ſegment of the ſphere.

This difference in the eyes of the three claſſes depends on the proportional denſity of the media the animals inhabit, compared to that of the aqueous humour of the eye. As this humour is equal in denſity to water, it cannot refract rays in that medium, and would therefore be of no uſe to fiſhes. Thus we find, either that it does not exiſt at all in theſe animals, or that they poſſeſs it in a very ſmall quantity.

In

In air which is very much rarefied, as that in which birds fly, the refrangibility of the aqueous humour is confiderable. It is therefore abundant in them, and prefents a very convex furface. Quadrupeds occupy a middle place between thefe two claffes, both with refpect to the ftructure of their eye, and the medium they inhabit. The aqueous humour is entirely wanting in the *cuttle-fifhes*.

The convexity of the cryftalline lens is in an inverfe proportion to that of the cornea; and confequently its thicknefs bears an inverfe ratio to that of the aqueous humour.

The cryftalline of fifhes is almoft fpherical, and fometimes even perfectly fo; it projects through the pupil, and leaves fcarce any fpace for the aqueous humour. We alfo find the convexity of the cryftalline very great in the Cetacea, and in fome quadrupeds, and birds that dive frequently, as *feals*, *cormorants*, &c. It is likewife very convex in reptiles.

The form of the cryftalline in birds, is that of a flat lens. In the Mammalia it is more convex. Of all mammiferous animals, man has it moft flat. In all thefe animals it is compofed of two fegments of a fphere, the pofterior of which generally belongs to a fmaller fphere *: its

* The following table of the proportion of the axis to the diameter, affords an opportunity of comparing the convexities of different cryftallines. It is founded partly on the obfervations

its dimenfions and proportions are not entirely conftant in each fpecies; it is generally more convex in young fubjects than in old.

It is obvious that this convexity of the cryf-

tions of Petit, (Memoires de l'Academie des Sciences, 1727,) and partly on our own.

The axis is to the diameter—

In Man, as	1 : 2 generally
the Monkey	The fame
Ox	5 : 8
Horfe	2 : 3
Dog	7 : 9
Hare	4 : 5
Otter	4 : 5
Porpoife	9 : 10
Whale	13 : 15
Owl	3 : 4
Parrot	7 : 10
Vulture	8 : 11
Tortoife	7 : 9
Frog	7 : 8
Salmon	9 : 10
Sword-fifh	25 : 26
Shad	10 : 11
Pike	14 : 15
Barbel	11 : 12
Carp	14 : 15
Mackrel	12 : 13
Whiting	14 : 15
Shark	21 : 22
Ray	The fame
Herring	10 : 11
Tench	7 : 8
Eel	11 : 12
Congre	9 : 10

talline

talline is capable of ſupplying the deficiency of that of the cornea. In animals which have the cornea convex, when the already converging rays arrive at the cryſtalline, it is not neceſſary that they ſhould be greatly approximated by that lens: the contrary is the caſe in thoſe which have the cornea flat.

B. *Proportions.*

To aſcertain the ſpace occupied by the cryſtalline, and the two humours, the eyes muſt be congealed, and divided in that ſtate by a plane paſſing through their axis. This experiment is, however, attended by the inconvenience of producing an unequal dilatation in the different parts of the eye; but it enables us to diſcover that the cryſtalline occupies leaſt ſpace in the human eye, and moſt in that of fiſhes.

The portion of the axis occupied by each of the three parts of the eye, may be repreſented by the following fractions; the length of the axis being conſidered the unit:

	Aqueous humour.	Cryſtalline lens.	Vitreous humour.
Man	$\frac{3}{22}$	$\frac{4}{22}$	$\frac{15}{22}$
Dog	$\frac{5}{21}$	$\frac{8}{21}$	$\frac{8}{21}$
Ox	$\frac{5}{37}$	$\frac{14}{37}$	$\frac{18}{37}$
Sheep	$\frac{4}{17}$	$\frac{11}{17}$	$\frac{12}{17}$
Horse	$\frac{9}{43}$	$\frac{16}{43}$	$\frac{18}{43}$
Owl	$\frac{8}{27}$	$\frac{11}{27}$	$\frac{8}{27}$
Herring	$\frac{1}{7}$	$\frac{5}{7}$	$\frac{1}{7}$

 It

It would be alſo intereſting to learn the proportion of the total ſpace occupied by each of theſe tranſparent parts. Among the mammiferous animals, the eye of man has the vitreous humour moſt abundant; it is twenty times greater than the aqueous: in the ox, it is ten times; and in the ſheep, nine times greater.

C. *Denſity.*

If the following table, given by Monro, of the ſpecific gravity of the different tranſparent parts of the eye in the *ox* and the *cod* be correct, we may conclude that the differences with reſpect to denſity between the mammalia and fiſhes are not conſiderable. Diſtilled water is here ſuppoſed a thouſand.

SPECIFIC GRAVITY.

	In the Ox.	In the Cod.
Of the aqueous humour	1000	1000
Of the vitreous humour	1016	1013
Of the whole cryſtalline	1114	1165
Of its external part	1070	1140
Of its nucleus	1160	1200

It ſhould be remarked, however, that the power of refraction is greater than the denſity indicates, in conſequence of the partly inflammable nature of the humours of the eye. It is alſo poſſible that theſe humours contain more inflammable parts in ſome ſpecies than in others, and that their refrangibility cannot, therefore, be preciſely in the ratio of their denſity.

D. *Con-*

D. *Consistence.*

The cryſtalline is hardeſt in thoſe animals in which it is moſt convex. The human cryſtalline is one of the ſofteſt: that of the other mammiferous animals and birds may be eaſily bruiſed; its middle part is, however, hard. In fiſhes, that part forms a nucleus, which cannot be divided without ſome difficulty. The cryſtalline is alſo very hard in the *cuttle-fiſh*: its induration increaſes with age in all animals.

The external and ſofteſt parts of the cryſtalline are alſo the leaſt denſe; it is probable that this diſpoſition prevents that reflection of the rays which would in a certain degree take place, were they ſuddenly tranſmitted through three different media; this happens in the paſſage of the rays, through the objective glaſſes of the achromatic teleſcope; and the milky cloud which reſults from theſe repeated reflections, is one of the principal defects of this inſtrument.

The aqueous humour, which is very fluid in warm-blooded animals, is viſcous and filamentous in fiſhes.

The conſiſtence of the vitreous humour is in general ſimilar to that of the white of an egg: as it is contained in cells, it has the appearance of a body which is circumſcribed, and not fluid. This has induced a great number of anatomiſts to name it the *vitreous body*.

The preceding data are not ſufficient to enable us to calculate the effect of the eye accurately. It is alſo neceſſary that we ſhould know the exact length of the radii of the ſpheres, to which the anterior and poſterior curvatures of the cornea and cryſtalline belong in each animal; and likewiſe the length of the axis of the aqueous, cryſtalline, and vitreous humours. Laſtly, the refractile power of theſe three tranſparent bodies compared with that of diſtilled water.

We might then determine the focus of parallel rays, and the diſtance at which the animal can eaſily diſtinguiſh objects. By adding to theſe principal points the obſervations we ſhall preſently make reſpecting the means poſſeſſed by the different claſſes of animals, for changing the figure of their eye, we would aſcertain the limits of their viſual faculty.

But the dimenſions I require are very imperfectly known to us: the following is, however, a table of them, drawn up from the writings of Petit, Monro, and my own obſervations:—

Man

	RADIUS of the curvature of the cornea.	RADIUS of the anterior curvature of the cryſtalline.	RADIUS of the poſterior curvature of the cryſtalline.	AXIS of the aqueous humour.	AXIS of the cryſtalline lens.	AXIS of the vitreous body.
Man	0,017	0,016	0,012	0,003	00,045	0,014
Dog	....	0,014	0,012	0,005	0,008	0,008
Ox	....	0,025	0,021	0,006	0,014	0,017
Sheep	....	....	....	0,004	0,010	0,012
Horse	....	....	....	0,009	0,116	0,019
Rabbit	....	0,014	0,014	....	0,011	....
Porpoise, 1,5	....	0,016	0,014	....	0,012	....
Turkey	....	0,012	009	....	0,005	....
Horn Owl	....	0,014	0,016	....	0,012	....
Salmon, 0,5	....	008	004	....	00,045	....
Pike, 0,65	....	0,010	0,009	....	0,008	....

We are almoſt entirely ignorant of the refractile power of the three humours. To calculate that of the cryſtalline, the curvatures of which are well known, it is neceſſary to meaſure at what diſtance it collects the parallel rays. According to Monro, in the cryſtalline of an *ox*, the radius of the anterior curvature of which was $\frac{21}{40}$ of an inch, and that of the poſterior $\frac{15}{40}$, the focus was $\frac{13}{40}$ behind the poſterior ſurface; and in the cryſtalline of a *cod-fiſh*, where the radii of the curvatures were $\frac{14}{40}$, and $\frac{13}{40}$ and a half, the focus was only $\frac{3}{40}$ when in the air, and $\frac{16}{40}$ in water: but he does not ſtate the thickneſs of the cryſtallines, nor explain what meaſure he uſed.

ARTI-

ARTICLE IV.

Of the First Coat of the Eye, or the Sclerotica.

THE Sclerotic covers the whole globe of the eye, the anterior part excepted, where it leaves a large vacancy, which is filled up by the cornea.

The sclerotic determines the shape of the eye; it therefore can be really soft and flexible only in animals that have the eye nearly globular, that is to say, in men and quadrupeds, because their sclerotica assumes of itself that shape, in consequence of the nearly uniform resistance made by the fluids contained in the eye to the pressure of its coats: but in all animals that have the eye more removed from a spherical form, as the Cetacea, fishes, and birds, that membrane is supported by hard accessary parts, or by a greater solidity of texture, and a more considerable thickness.

In man, and in most mammalia, the sclerotica is a whitish opaque membrane, somewhat soft, moderately thick, and presenting, at first sight, no apparent organization. It is resolved, however, by maceration, into a cellular texture, composed of filaments interwoven in every direction. This structure may be discovered without preparation in the eye of Cetacea, and particularly in that of the *whale*; in this animal

mal the lateral parts of the ſclerotica are nearly an inch thick, and its bottom nearly an inch and a half; the lateral parts are very hard. On cutting into them, we obſerve that their ſubſtance conſiſts of fibres which have a tendinous appearance, and which form a kind of net-work, the meſhes of which contain another ſubſtance of a fungous nature, browner and more flexible than theſe fibres: the poſterior part is much ſofter, becauſe the meſhes are there larger, and partly filled by an oily ſubſtance; theſe two ſubſtances, the ſoft and the hard, are ſeparated in a very abrupt manner, and do not run gradually into each other.

The optic nerve paſſes through the poſterior portion of the ſclerotic, by a canal an inch and a half long, the parietes of which are formed by the dura-mater; and it is very viſible that the white fibres which form the baſe of the ſclerotic, are ſucceſſively detached from the external ſurface of the dura-mater, of which they appear to be an expanſion. This ſeems to decide the queſtion, whether the ſclerotica be a continuation of the dura-mater, in favour of the ancients. The queſtion is, however, very difficult of ſolution in other animals, in which theſe two membranes touch only by a very thin portion. The ſclerotic of the *porpoiſe* is only two or three lines thick, but it preſents the ſame ſtructure as that of the *whale*. In the true quadrupeds, this membrane differs in nothing eſſential effential from that of man ; in both it is generally thickeft at the anterior part, which is occafioned by the tendons of the mufcles of the eye being inferted there.

In the *feal* the fclerotic is thick anteriorly, and ftill more pofteriorly, but the middle zone is thin and flexible.

The fclerotic of birds is thin, flexible, and rather elaftic pofteriorly ; it has a bluifh and brilliant appearance, but we perceive in it no diftinct fibres ; it does not receive the optic nerve by a fimple hole, but by a canal, which paffes obliquely through its fubftance ; its anterior part is divided into two laminæ, the interval of which receives a circle of fmall thin hard oblong bones, which lie over each other like tiles, and which give to the anterior part of the edge a great degree of firmnefs, and a fixed form. Thefe officula are almoft flat in the greater number of birds, in which they form only an annular difk of little convexity ; they are flightly arched and concave externally in the *horned owl*, in which they form a fhort tube, in the fhape of a truncated cone. They are ufually twenty in number.

The *tortoife* has, at the anterior part of the fclerotic, the fame offeous laminæ as birds ; thefe laminæ are enclofed in that membrane, without being continued into its fubftance, and may be eafily feparated from it.

There are fimilar laminæ in the fclerotic of the

the *camelion*, and in that of ſeveral other *lizards*; but they do not form the anterior diſk; they merely ſurround the lateral part.

In fiſhes the ſclerotic is cartilaginous, homogeneous, ſemi-tranſparent, elaſtic, and ſufficiently ſolid to preſerve its form of itſelf, though very thin in ſome ſpecies. In the *ray* it ſwells poſteriorly into a tubercle, by which the eye is joined to a particular ſtalk, of which we ſhall ſpeak hereafter. The ſclerotic of the *ſturgeon* is thicker than the cavity of the eye; it repreſents a kind of cartilaginous ſphere, a part of which contains a ſmall cavity, covered by the other membranes.

The *ſalmon* has the ſclerotica, of the thickneſs of a line poſteriorly, and of an almoſt bony hardneſs before. This induration of the anterior portion is obſerved in a number of other ſpecies.

The ſclerotic of the *ſepiæ* is ſingular. Poſteriorly it is much removed from the globe of the eye. The large ganglion of the optic nerve and ſeveral other glandular parts are ſituated between them. The ſclerotica, therefore, forms poſteriorly a truncated cone, the pointed part of which is directed to the bottom of the orbit; to this portion the muſcles are attached: the anterior part nearly ſhuts the globe of the eye; it is very ſoft and viſcous; it is eaſily ſeparated, and preſents a coarſe felt-like texture, which becomes firmer in ſpirits of wine. In ſome ſpecies it has a metallic brilliancy. As there is no cornea, the ſclerotic is wanting oppoſite to the cryſtalline; but the hole is not ſufficiently large to admit a view of the iris, without diſſection.

In all animals, the ſclerotic is double: a very thin, and uſually blackiſh membrane, cloſely adheres to its internal ſurface, and is believed to be a prolongation of the pia-mater. In the *lion* we have been able to follow it with eaſe under the cornea, where it becomes firm and tranſparent, and from which it may be detached with facility.

The ſclerotica not only affords inſertions for the ſtraight and oblique muſcles of the eye, but alſo for thoſe of the third eye-lid in birds, and and in a number of reptiles. In all the claſſes it tranſmits, through holes which perforate it, the optic nerve, the ciliary nerves, and the internal veſſels of the eye.

From its flexibility in man and quadrupeds, it is believed that the muſcles compreſs it, and that the humours being thus puſhed forward, ſwell the cornea, and render the eye capable of diſtinguiſhing very near objects. It cannot, however, have this uſe in animals, in which it is wholly or partly inflexible, as in the Cetacea, birds and fiſhes: yet their powers of diſtinct viſion are, in a number of ſpecies, at leaſt greater than thoſe of man.

ARTI-

ARTICLE V.

Of the tranſparent Cornea, and of the Conjunctiva.

THE *cornea* is that tranſparent part which ſeems encaſed in the vacancy left by the ſclerotic at the fore-part of the eye. We have ſtated, in Article III. its varieties with reſpect to convexity: it alſo preſents ſome differences in its ſhape.

It is not always completely circular: in man, and other mammalia, it is more broad than long, and contracted a little towards the ſide of the noſe.

Its tranſverſe diameter or breadth is, to its height,

In the ox, as - - - - - 27 : 23.

In all animals the cornea is compoſed of thin tranſparent laminæ, glewed together by compact cellular matter, and forming, by their union, a plate which is thicker in the middle than towards the edges. This part is, therefore, of itſelf calculated to produce a convergency of the luminous rays; its laminæ are eaſily ſeparated by the ſcalpel, eſpecially after a little maceration.

According to the experiments of Home, the cornea becomes more convex when we examine near objects, and more plain when we look at thofe that are diftant: in the firft cafe it approximates more powerfully the moft diverging rays.

Some have attributed this effect to the contraction of the ciliary proceffes, others to that of the iris. It is more probable that it is produced by the ftraight mufcles of the eye; but it is not fufficient to explain diftinctnefs of vifion at very different diftances.

The cornea is the only part to which we find an analogy in the eyes of infects; it even appears in them to fupply the place of the cryftalline. It is entirely hard and fcaly.

The cornea was long fuppofed to be a continuation of the fclerotic, but is now acknowledged to be a particular membrane. It is not, however, always attached to the fclerotic, fimply by cellular fubftance: the edges of the two membranes fometimes penetrate reciprocally into each other. This is particularly obfervable in the *whale.* The fibres of the fclerotic in that animal, pafs into the fubftance of the cornea in the form of very delicate white lines, but pretty long and confpicuous. Thefe lines are alfo eafily diftinguifhed in the *rhinoceros.*

The line of feparation of thefe two membranes is fometimes ftraight, as in the *whale*, *rhinoceros*, &c.; at other times it forms a kind of bevel or flope, and the cornea flides under the edge of the fclerotic. This is the cafe in *man*, the

the *ox*, &c. in ſome other animals the edge of the ſclerotic is double, and embraces that of the cornea in the manner of a forceps. The *hare* affords an inſtance of this kind of connection.

The ſeparation of the cornea from the ſclerotic, may in particular be diſtinctly obſerved in the *tope (ſqualus galeus.)* Theſe membranes form a ſlope or bevel, but in ſuch a manner that it is the ſclerotic which becomes thin behind the cornea, and not the latter as is commonly the caſe. The ſclerotica is white, the cornea yellowiſh, and there is beſides, between the two, a compact but very conſpicuous cellular texture. This ſubſtance appears to be a production of the conjunctiva, which penetrates the eye, to unite with the ciliary ligament and the iris.

The *ſepiæ* have no cornea, and the anterior aperture of the ſclerotic is not filled up. The cryſtalline projects acroſs it, and there is no aqueous humour. We find, however, under their conjunctiva, a particular membrane which is dry, fine, and tranſparent: it envelopes the ſclerotica itſelf, and the anterior part ſupplies the place of the cornea.

The *conjunctiva* is that part of the ſkin which, after being reflected, to line the internal ſurface of the eye-lid, where it aſſumes a finer texture, and receives more numerous veſſels, folds back again in the contrary direction, and, becoming ſtill finer, covers the anterior part of the eye.

It adheres very clofely to the cornea, from which it cannot be feparated, except by maceration. The part of the conjunctiva which covers the cornea, is tranfparent; that which fpreads over the fclerotic, is what we call the white of the eye, and is, in fact, of that colour when its blood-veffels are not diftended, or rendered too vifible by inflammation.

This defcription, taken from man, applies to all animals which have eye-lids, with the exception of the colour of the part analogous to the white of the eye, which fometimes varies; but in the fpecies which have no eye-lids, as in the greater number of fifhes, the fkin paffes directly before the eye without forming any fold: fometimes it even does not adhere very clofely to the eye. This is particularly obfervable in the *eel*, which may be fkinned without producing any hole in the fituation of the eye, the fkin only exhibits at that place a round tranfparent fpot. It is the fame cafe in the *ferpents* and *cuttle-fifh*.

In the *trunk-fifh* (*oftracion*) the conjunctiva is fo fimilar to the reft of the fkin, that we obferve lines upon it which form the fame compartments as on the body of the fifh.

Among the mammalia we find a kind of *rat* in which the fkin is not even tranfparent over the eye, but is there covered with hairs, as on the reft of the body. The eye, which is fcarcely the fize of a poppy-feed, is perfectly ufelefs.

6 This

This rat is the *zemni* (*mus Typhlus.*) An *eel* (*murena cæcilia,*) and the *myxine* (*gaſtrobranchus cæcus.*) are blind in the ſame manner, in conſequence of the opacity of the conjunctiva.

Article VI.

Of the Second Coat of the Eye, or the Choroides and its Appendages.

A. *In Man.*

The choroides lines all the ſclerotica interiorly; in the concavity of which it is formed. In the greater part of their extent, theſe two membranes are only attached by a very looſe cellular ſubſtance, but they are connected by nerves and veſſels which perforate the ſclerotic to proceed to the choroides, or to paſs through it. Their anterior part, that which is next the cornea, is more intimately united by a circle of a cotton-like cellular ſubſtance moiſtened by a whitiſh mucus. This is called the ciliary ligament. It is thicker and more compact anteriorly: it becomes thinner and diſappears poſteriorly. At the ſurface oppoſite to this ligament, that is to ſay, on the concave ſurface and around the anterior edge of the choroides, we obſerve its internal lamina forming very fine folds, diſpoſed in radii; they have ſome reſemblance to the diſk of a radiated flower, and are named altogether *corpus ciliare*. The projecting laminæ which reſult from theſe folds, have their anterior extremity a little turned towards the axis of the eye as they retreat from the cornea. Thus all the extremities of theſe laminæ intercept a circular ſpace, which is preciſely the poſition of the cryſtalline. It even appears that theſe extremities, which are called *ciliary proceſſes*, are attached to the front of all the more acute border of the capſule of the cryſtalline, and contribute to render it fixed. The laminæ which compoſe the corpus ciliare, make hollow impreſſions on the anterior ſurface of the vitreous humour which occupies all that part of the eye ſituated behind them.

After having produced, by theſe internal projecting folds or laminæ, the beautiful wreath which we have juſt deſcribed, the choroides proceeds to form an annular veil, placed between the cornea and the cryſtalline, which is called the *uvea*: it is perforated in its middle by a hole named the *pupil*, and its anterior ſurface covers another membrane, which is alſo annular, and which is viſible through the cornea. This membrane is the *iris*, which we ſhall deſcribe in the next article.

That part of the ſecond tunic which is ſituated before the cryſtalline, is almoſt plain in man. It ſometimes has a degree of convexity in other

other animals, but always lefs than the reft of the coat, which has precifely the fame curvature as the fclerotica.

The firft chamber of the eye is fituated between this flat part of the fecond tunic, and the greateft convexity of the cornea. The aqueous humour fills this chamber.

The fubftance of the choroides is very thin and delicate; good injections fhew that it is almoft entirely compofed of a triple vafcular texture. Its arteries form, in the firft place, the external part: the greater number pafs through the fclerotic, very near the optic nerve, and are diftributed over the whole choroides, where they divide at very acute angles: they are named the *fhort ciliary arteries*, to diftinguifh them from two trunks which almoft reach the iris without dividing, and which are named the *long ciliary arteries*. The internal texture is formed by the extremities of the fame arteries, which having pierced the choroides, form on its internal furface a net-work fo uniform and fo fine, that the reticular interftices cannot be diftinguifhed except by a very ftrong magnifying glafs. The third texture is intermediate; it is formed by the veins, the courfe of which is very fingular. They reprefent irregular arches, which meet at certain points, and form a kind of circle. Thefe are the veffels which we fee moft diftinctly without injection.

The internal furface of the choroides is lined,

 in

in man, by a dark-coloured, or even perfectly black mucus, which may be removed or washed off with the finger or a pencil. It serves to prevent the rays, reflected by the internal parietes of the eye, from disturbing vision, which is effected by direct rays. For the same reason all dioptric instruments are blackened internally. When this pigment is removed, we can see by a magnifying glass a slight villosity. The internal lamina of the choroides seems of a more solid texture than the rest of its body, and is particularly named *membrana Ruyschiana.*

The ciliary processes and the uvea have the same vessels, the same villous surface, and the same black varnish as the rest of the choroides. The ciliary processes even leave a remarkable impression of this varnish on the anterior part of the vitreous body, when they are separated from it. This cannot be done by the rest of the membrane, on account of the position of the retina.

B. *In other Animals.*

The choroides exists in the eyes of all animals which are known to us. It is always vascular, and at least partly covered on its concave surface by a particular mucous substance; it varies with respect to the ciliary processes, the colour and texture of its posterior part, the separation more or less easy of the membrana Ruyschiana, and the disposition of its blood-vessels.

1. *Of*

1. *Of the Ciliary Proceſſes.*

The mammalia and birds have all the ciliary proceſſes: we find them alſo in ſome reptiles, and even in the *cuttle-fiſh*, but they are wanting in almoſt all fiſhes.

In man, each of the laminæ of the ciliary proceſſes repreſents a long irregular triangle; the ſide by which the lamina joins the reſt of the choroides, is convex; another, which touches the vitreous body, is concave; and the third, which is next the iris, is much ſhorter than the other two. The angle which touches the capſule is rounded, all the three edges are ſlightly denticulated. This denticulation is much more apparent, and even changes into a real fringe in the large animals, as the *ox*, the *horſe*, and the *rhinoceros*. It is alſo ſimilar in the *whale*, in which the angle that retains the capſule, is prolonged more into a point than in the preceding ſpecies. In the Sarcophaga, particularly in the *lion*, the ſide which forms the baſe of the laminæ, is ſhorter in proportion to the other ſides than in the preceding animals, ſo that the oppoſite angle projects moſt: we perceive no denticulation on its edges. In all theſe ſpecies, one lamina out of two or three, is ſhorter than the others; but in this reſpect a regular order is not obſerved.

In birds the ciliary proceſſes project little; they are almoſt merely ſerrated ſtriæ, a little undu-

undulating. There are, however, differences in the ſpecies.

In the *horn-owl* they are fine, compact and numerous. In the *oſtrich* they are larger and more looſe, but in all birds their extremity adheres very firmly to the capſule of the cryſtalline.

In the *tortoiſe* the ciliary proceſſes project ſo very little, that we could ſcarcely recognize them, were it not for the elegant impreſſion they leave on the vitreous body; but in the *crocodile* theſe proceſſes are very beautiful, and very conſpicuous; they are each terminated by a nearly right angle. I have obſerved theſe proceſſes in the form of elongated threads, but few in number, in a large foreign *tree-frog*; they are alſo ſuch, though not diſtinct, in the *toad*. I have not obſerved them in the common *lizards*, nor in the *ſerpents*.

There is a very conſpicuous body and ciliary proceſſes in the *ſqualus, galeus*: the laminæ project almoſt as much as in birds, and, after forming a ſhort point, which joins the capſule of the cryſtalline, they are continued with the ſtriæ of the uvea. I have not been able to perceive the ſame ſtructure in the *ray*, but it is certain that there is nothing ſimilar in the oſſeous fiſhes; their uvea paſſes on, without interruption, with the membrana Ruyſchiana, and forms with it an uniform tunic, no part of which projects inwardly.

The uſe of the ciliary proceſſes, in retaining the

the cryſtalline, is no where ſo diſtinctly ſeen as in the eye of *cuttle-fiſhes* and *pulps*: their ciliary proceſſes form a large zone or diaphragm, in the aperture of which the cryſtalline is truly encaſed. A deep circular furrow paſſes completely around the cryſtalline, and divides it into two unequal hemiſpheres. The ciliary proceſſes penetrate into this furrow, where they are ſo firmly fixed, that they cannot be removed without being torn. The proceſs is not formed of projecting laminæ, but of a continued membrane, the two ſurfaces of which are marked by a circle, conſiſting of a vaſt number of very fine radiated ſtriæ, which preſent a very agreeable ſpectacle to the eye.

2. *Of the Membrana Ruyſchiana.*

This membrane can ſcarcely be diſtinguiſhed from the choroides in *man*, *monkies*, *ſmall quadrupeds*, and *birds*; but in the *large quadrupeds*, although we cannot ſeparate it without injuring both membranes, it is diſtinguiſhed by its finer, more compact, and ſeemingly homogeneous texture. The ſection of the choroides preſents to the microſcope only the open mouths of the ſmall veſſels which compoſe it. That of the Ruyſchiana is ſolid, and reſembles the ſection of a ſimple membrane; for example, of the epidermis. This is particularly obſervable in the eye of the *whale*, where the apertures of the veſſels fels are vifible to the naked eye, and where the three layers are eafily difcovered.

The lateral and anterior parts of the Ruyfchiana are, as we have obferved, covered with a mucous pigment, more or lefs dark; it is of a purple red colour in the *calmar*, which, with the other *fepiæ*, form probably the only exception to this rule. Some birds have it of a deep-brown red. This varnifh is fometimes wanting in certain fpecies, in confequence of a difeafe which alfo whitens their hair: the *white rabbits*, *white negroes*, and *white mice*, form examples of this variety: their Ruyfchiana is then tranfparent, and all the parts of the choroides would be of a white colour, if it were not for the numerous veffels diftributed in that membrane, which give it a lively red appearance.

3. *Of the Tapetum.*

The bottom of the Ruyfchiana is frequently covered with a very flight coat of this pigment, through which we can perceive its colour, which varies remarkably in different fpecies. *Man* and *monkies* have it brown or blackifh. *Hares*, *rabbits*, and *hogs*, of a chocolate brown colour; but the Sarcophaga, the Ruminantia, the Pachydermata, the Solipeda, and the Cetacea have lively and brilliant colours in this part. The *ox* has it of a beautiful green, changing into azure blue. The *horfe*, the *goat*, the *buffalo*, the

ftag,

ſtag, of a ſilver blue, changing to violet. The *ſheep*, of a pale yellow green, ſometimes blueiſh. The *lion*, the *cat*, the *bear*, and the *dolphin*, have it of a pale golden yellow. The *dog*, the *wolf*, and the *badger*, of a pure white, bordered with blue. This coloured part of the Ruyſchiana is named the *tapetum*: it does not occupy all the bottom of the eye, but merely one ſide, that which the optic nerve does not perforate.

It is difficult to account for the uſe of this brilliant ſpot in a place ſo little viſible. Monro, and others before him, have ſuppoſed that the tapetum of the ox is green, in order to repreſent to him, more ſtrongly, the colour of his natural food; but this explanation does not apply to the other ſpecies.

Birds and fiſhes have no tapetum; their Ruyſchiana is uniformly blackiſh, and covered every where by mucous ſubſtance; there is even much more on its bottom than any where elſe in fiſhes. The *ray* forms an apparent exception to this rule; there is at the bottom of its eye a beautiful ſilver colour, produced by the tranſparency of the Ruyſchiana, which allows the colour of the choroides to be ſeen through it.

4. *Of the Choroid Gland of Fiſhes.*

The Ruyſchiana and choroides of fiſhes form two membranes, which are very diſtinct, and eaſily ſeparated. The Ruyſchiana is black, and compoſed of an interlacement of innumerable veſſels.

veſſels. The choroides is either white, ſilvery, or gold coloured; it is very thin, and little vaſcular.

Between theſe two membranes there is a body which ſome have named a gland, others a muſcle, and which deſerves to be deſcribed: it is uſually of a lively red colour; its ſubſtance is ſoft, and rather glandular than muſcular; at leaſt we diſtinguiſh no fibres in it, though the blood-veſſels form deep and almoſt parallel lines on its ſurface; its form is uſually that of a thin cylinder, formed like a ring round the optic nerve: the ring, however, is not complete; a ſegment of a certain length being always wanting. Sometimes, as in the *perca labrax*, it conſiſts of two pieces, one on each ſide of the optic nerve: at other times it is not quite circular, but preſents an irregular curvature; this takes place in the *ſalmon*, in the *moon-fiſh (tetraodon-mola,)* and in the *cod*. But in *carps*, and moſt other fiſhes, its figure is nearly circular.

Thoſe who are of opinion that the eye changes its figure according to the diſtances of the objects that are viewed, ſuppoſe that the body we have deſcribed is a muſcle, intended to produce that effect, by contracting the choroides; but it would appear, that the numerous veſſels which paſs through it, ought to make us rather regard it as a gland, deſtined to ſecrete ſome of the humours of the eye. Theſe veſſels are white, fine, much twiſted, and appear to paſs through the Ruyſ-

Ruyſchiana; they may be ſeen very diſtinctly in the *moon-fiſh*, and the *labrax*. In the *cod* they are exceedingly large; they anaſtomoſe together, and are all covered by a white and opaque mucus.

Haller deſcribed theſe veſſels as a third or intermediate lamina of the choroides, which he named the *vaſcular*: the glandular body itſelf receives a number of veſſels and nerves, which are branches of the ophthalmic nerve, the trunk of which proceeds for ſome time in a ſheath, which is common to it and the optic nerve; its own ſheath opening into that of the latter, as a ſmall vein into a larger one.

This gland does not exiſt in the Chondropterygii, as the *rays* and *ſharks*, the eye of which approaches nearer to that of the Mammalia, as we have already ſhewn, with reſpect to the *tapetum* and ciliary proceſſes. The choroides of theſe two genera conſiſts, as uſual, of a triple texture of veſſels, which has ſome thickneſs and conſiſtency. The Ruyſchiana is very thin and tranſparent; between the two there is a layer of ſilvery matter.

The *ſepiæ*, which have ſeveral glandular bodies between their ſclerotica and their choroides, have none between the latter and the Ruyſchiana; the ſeparation of theſe two membranes is even ſometimes difficult: the choroides is more thick, ſoft, and vaſcular; the Ruyſchiana is thin and dry; there is no tapetum; all the eye is lined internally by a deep purple varniſh.

ARTICLE VII.

Of the Iris and Pupil, and of their Motions.

WE have already ſhewn, in the preceding Article, that the *uvea*, or that production of the choroides which forms an annular veil or diaphragm before the cryſtalline, is covered on its anterior ſurface by a particular ſubſtance named the *iris*.

A. *Structure of the Iris.*

The *iris* is a half-fibrous, half-ſpungy body, united in the moſt intimate manner to the uvea, from which it cannot be ſeparated without a great deal of trouble, and in the largeſt animals. It is thickeſt and moſt looſe at its greateſt circumference, towards the ciliary ligament, where it ſeems to terminate; it is there moſt eaſily ſeparated; but towards the edges of the pupil it becomes gradually thinner, and cannot be diſtinguiſhed from the uvea.

When the long ciliary arteries arrive at the great circumference of the iris, they are bifurcated, and form a circle around it: the arteries which belong to the iris, proceed from this circle; they are numerous and radiated, and anaſtomoſe together to form a ſecond ſmaller circle.

It receives a great number of ſmall ramifications

tions from the ciliary nerves, which, after having perforated the fclerotica, and paffed round the choroides longitudinally, like ribbons, but without penetrating it, are loft in the iris.

The ftriæ, which we remark on the iris of man, are diftinguifhed by their colour, rather than by their elevations; they refemble little rays of light, which converge as they proceed towards the pupil: on the edge of this hole there is a circle, which is narrower and deeper than the external circle: thefe lines, which are ftraight when the iris is dilated, and the pupil contracted, are curved when the contrary difpofition takes place.

It is well known that the total colour of the iris varies in different men, from blue to yellow, and to deep orange. Some domeftic animals alfo prefent varieties in the colour of their eyes, as horfes, dogs, &c.; but wild animals have, generally, a fixed colour for each fpecies.

In the Mammalia this colour is frequently a deep chocolate or brown; they have fewer coloured ftriæ than man. In thofe in which the pupil is not round, we frequently obferve unequal folds, which are occafioned by the motions of the iris.

Birds have the iris generally of a fmooth furface, and a dark colour; it varies, however, greatly in different fpecies, and is frequently very lively, as bright yellow, bright red, fky blue, &c.; its texture appears, by the microfcope, ſcope, to conſiſt of meſhes, formed by the decuſſation of a multitude of very fine fibres. The membrane of the uvea is ſo fine in birds, that when the varniſh is wiped off, it is completely tranſparent, and the iris appears of the ſame colour on both ſides.

In fiſhes, on the contrary, the iris is ſo fine a membrane, that we ſee the uvea through it, which, by its golden and ſilvery brilliancy, ſhews at firſt ſight that it is a continuation of the choroides, which is of the nature we have already ſtated.

The iris of reptiles reſembles that of fiſhes in its golden colours, but the veſſels are more viſible; they form a beautiful net-work on the iris of the *crocodile*.

B. *Fibres of the Uvea.*

The poſterior ſurface of the uvea preſents ſome compact ſtriæ, which are continued with the ciliary proceſſes; theſe ſtriæ, though little apparent in man, are of a conſiderable ſize in the large Ruminantia, particularly in the *ox*, which has them more conſpicuous than the *horſe*, though the eye of the former is ſmaller; they are ſtill larger in the *whale*.

The *rhinoceros* has them alſo very large, and extended almoſt to the edge of the pupil. In other genera they leave a ſmooth ſpace towards that edge. In general, theſe ſtriæ do not appear

pear either in birds or fiſhes; we obſerve, however, veſtiges of them in the eyes of the large *ſharks*, as the *tope*, *white ſhark*, &c.

Theſe fibres were long regarded as muſcular; they are now underſtood to be ſimple folds of the membrane.

C. *Motions of the Iris.*

The uſe of the iris is to guard againſt the admiſſion of too many rays from one point into the eye, and to prevent too great intenſity of light from producing a painful ſenſation in the retina. For this purpoſe, when the objects we look at are very luminous, the iris dilates, and the pupil is contracted; but when theſe objects are obſcure, the contrary motion takes place. As the cone of rays has its apex at the luminous point, and its baſe at the pupil, that baſe is conſequently larger, in proportion as the rays it contains are leſs approximated; but the abſolute quantity of the rays remains nearly the ſame, unleſs the differences in the intenſity of light be very conſiderable.

The motion of the iris is uſually involuntary; it depends merely on the rays which ſtrike the retina. Light falling on the iris itſelf, cauſes no motion; that membrane is not irritable, and as it has no immediate connection with the retina, the cauſe of their ſympathy can only be ſought for in the brain: when one eye receives the

 light,

light, it alone contracts: in ſleep the pupil is diminiſhed, and the iris dilated. In ſome caſes great attention to the examination of certain objects, or a ſudden fright, produce motions in the iris, independent of any change in the intenſity of light.

The motion of the iris is, however, completely voluntary in ſome animals. The *parrot* has long been known to poſſeſs this power; it is entirely wanting, or at leaſt ſcarcely exiſts, in fiſhes.

When we regard an object very cloſely, our pupil is contracted; firſt, becauſe the light tranſmitted by near objects is more abundant: ſecondly, becauſe that contraction admits into the eye only the leaſt diverging rays, and excludes a part of thoſe which would prove too numerous to be united on the retina.

Hunter has, however, proved, that this contraction of the pupil is not ſufficient to explain the facility with which the ſame eye ſees diſtant and near objects, and that recourſe muſt be had to another theory, though Haller and Sabbatier admit of no other means of reſolving the problem.

D. *Figure of the Pupil.*

The form of the pupil varies in different ſpecies; when it is dilated, it is generally round; it alſo remains round when contracted, in man, monkies, a number of Sarcophaga, and in the birds; but it approaches a vertical line in the *cat* genus, forming different lozenges, always more narrow, according as the light is more intenfe. In the *ox*, and the other Ruminantia, it is tranfverfely oblong, and in its greateft contraction, becomes a tranfverfe line. In the *horfe* it is alfo tranfverfely oblong, and its fuperior edge forms a convexity, which has five feftoons, thicker than the reft of the margin. In the *whale* it is alfo tranfverfely oblong. In the *dolphin* it approaches to the figure of a heart.

The *crocodile* has the pupil fimilar to that of the *cat*. It is rhomboidal in *frogs*.

The *tortoife*, the *camelion*, and common *lizards* have it round. The *gecko* has it rhomboidal.

The *ray* exhibits a very remarkable peculiarity; the fuperior edge of its pupil is prolonged into feveral narrow ftripes, difpofed in radii, and reprefenting together a palm leaf; thefe fhreds, or ftripes, are gilded externally, and black internally. In their ordinary ftate they are folded between the fuperior edge of the pupil and the vitreous humours: but when we prefs the fuperior part of the eye with the finger, they unfold themfelves, and cover the pupil like a window-blind. It is probable that in life they clofe the pupil in this manner, either at the pleafure of the animal, or in confequence of the action of intenfe light. The *torpedo* can completely fhut its pupil by means of this veil. No other fifhes, not even the *fhark*, poffefs any thing fimilar to this conformation.

In the *cuttle-fiſh*, the pupil is in the form of a kidney.

E. *Membrana Pupillaris.*

In the human fœtus, before the ſeventh month, the pupil is cloſed by a very fine membrane contiguous to the uvea, from which it receives its veſſels; it is torn, and afterwards completely diſappears, ſo that no veſtige of it is found in the new-born infant. This membrane is obſerved in the fœtuses of other mammalia; but it is pretended that it does not exiſt in birds.

Article VIII.

Of the Entry of the Optic Nerve into the Eye, and of the Origin, Nature, and Limits of the Retina.

A. *Of the Entry of the Optic Nerve.*

In Lecture IX. we demonſtrated the origin of the optic nerve; and in Lecture X. we followed it to its entrance into the eye; it is neceſſary that we ſhould now deſcribe the manner in which it penetrates that organ, and produces the retina.

1. *In*

1. *In Mammiferous Animals.*

When the optic nerve of mammalia reaches the ſclerotica, it begins to decreaſe in diameter; in paſſing through that tunic, it forms a truncated cone, which varies in length, according to the thickneſs of the ſclerotic. When it arrives at the choroides, it paſſes through it by a round hole, which is filled with a ſmall membrane, full of minute foramina. The medullary ſubſtance, tranſmitted through the long canals which compoſe the optic nerve, ſeems to flow through theſe ſmall holes, in order to be intimately mixed, and to form that nervous expanſion which lines all the concavity of the choroides, and is named the retina.

This point of the optic nerve forms ſometimes a ſlight projection within the eye. In the *hare* and the *rabbit*, inſtead of a ſmall round and cribriform diſk, the extremity of the nerve projects within the eye, and forms a kind of oval cupola, which is ſlightly concave in the middle, and from the edges of which the retina ariſes.

In the greater part of mammalia we obſerve whitiſh fibres around this point, which are ſomewhat more opaque than the reſt of the retina, and are diſpoſed in radii.

In the *hare* and the *rabbit* theſe fibres make two long pencils, one to the right, the other to the left: their fineneſs, and their pure white colour, enliven the brown ground of the choroides, which appears through the reſt of the retina, thus affording a pleaſing appearance to the eye.

In man we obſerve, near the entry of the nerve, and almoſt at the point which correſponds to the axis of the eye, a ſmall fold of the retina, which forms a ſlight convexity when the more external membranes are removed. In the midſt of this fold there is a tranſparent point, which, at firſt ſight, appears like a hole; the edges of this point are tinged with yellow, in adults, but not in the new-born infant. This peculiarity of the human eye, which had eſcaped the obſervation of all anatomiſts before Sœmmering, is found in no other animals except in *monkies*. We have obſerved it in the *cynocephalus*, in the *white-noſed guenon*, &c. &c. In the firſt, the tranſparent part is conſiderably larger than in man, and of an oval form; there is ſometimes a yellow ſpot at its ſide.

The *maki*, which of all mammalia approaches neareſt the monkies, has only a ſlight fold, without any ſpot or tranſparent point. The other ſpecies have nothing ſimilar.

2. *In Birds.*

In birds, when the optic nerve has arrived at the ſclerotica, it is continued obliquely in a long conic cauda, which paſſes into a ſheath of the ſame ſhape, formed in the ſubſtance of that membrane, and directed downward, and obliquely

liquely forward. The lamina of this sheath, which is in contact with the eye, is cleft throughout its whole length, by a narrow line, which allows a passage for the substance of the nerve. This fissure also exists in the corresponding part of the choroides, and is even longer there, because the point of the nerve preserves its obliquity, after it penetrates the sclerotic. In consequence of this disposition, the optic nerve does not form a round disk within the eye, as in the mammalia, but a round, narrow, and very white line, the two edges and two extremities of which produce the retina.

But there is a still more remarkable peculiarity; it consists in a folded membrane, suspended the whole length of this white line, which some have named *marsupium nigrum*, and others the *pecten of the eye of birds*.

This membrane appears to be of the same nature as the choroides, though it nowhere adheres to it; it is very fine, very vascular, and covered with the black pigment; its vessels come from a particular branch of the ophthalmic artery, distinct from the two which belong to the choroides; they descend along the folds of the black membrane, and form tufts, which are very agreeable to the eye when injected.

This membrane penetrates directly into the interior of the vitreous body, and appears like a wedge sunk into it; it is situated in a vertical plane, directed obliquely forward: the angle neareſt the cornea, in the ſpecies in which it is very broad, and the whole of its anterior edge in thoſe in which it is very narrow, comes very near the inferior edge of the capſule of the cryſtalline; in ſome ſpecies it is applied ſo cloſely to the capſule, that it is difficult to determine whether it is not attached to it. Such is the caſe in the *vulture*, the *ſtork*, and the *turkey*, according to Petit, &c. But there are other birds in which it remains at ſome diſtance, and appears attached to ſome of the numerous laminæ which divide the vitreous body into cells.

In the *ſtork*, the *heron*, and the *turkey*, this membrane is broader in the direction parallel to the cauda of the optic nerve, than in the contrary direction. In the *oſtrich*, the *caſſowary*, and the *horn-owl* it has oppoſite dimenſions. It is folded like a ruffle in the direction perpendicular to the cauda of the optic nerve; the folds are rounded in moſt ſpecies. In the *oſtrich* and the *caſſowary* they are compreſſed, ſharp-edged, and ſo high in the direction perpendicular to the plane of the membrane, that at firſt ſight it has the appearance of a conical purſe, rather than that of a ſingle membrane. It was from theſe two ſpecies that the firſt academicians of Paris, who diſcovered it, named it the *black purſe*. The folds vary as to number: there are ſixteen in the *ſtork*, ten or twelve in the *duck* and the *vulture*, fifteen in the *oſtrich*, and ſeven in the *great horn-owl*.

It

It is difficult to form an opinion of the real ufe of this membrane. From its pofition, a part of the rays tranfmitted by objects fituated laterally with refpect to the bird, may fall upon it. Petit conjectured that it abforbed thefe rays, and prevented them from injuring the diftinct vifion of objects fituated anteriorly: others have fuppofed, and this opinion has lately been repeated by Home, that it poffeffes a mufcular power, and that its ufe is to approximate the cryftalline to the retina, when the bird wifhes to fhorten its axis of vifion, in order to obtain a better view of diftant objects. We however do not obferve any flefhy fibre in it, and the experiments, which prove that it contracts after death, are not entirely conclufive. Befides, as it is attached to the cryftalline laterally, it could only move it obliquely. Haller confiders it as a fimple fupport of the veffels intended for the capfule of the cryftalline.

3. *In Reptiles and Fifhes.*

In all reptiles the optic nerve paffes through the membranes of the eye directly, and by a round hole, as in quadrupeds; it forms internally a fmall tubercle, from the edges of which the retina proceeds.

It is fimilar in a great number of fifhes, as in the *ray*, in which the tubercle is papillated, in the *fhark*, all the *carps*, and a number of others. The radiating fibres, which arife from the edges of this diſk, are even more apparent in this claſs than in moſt quadrupeds; but there is a certain number of fiſhes, in which the formation of the retina reſembles, in ſome reſpects, that which takes place in birds.

I cannot yet name all the genera in which this arrangement may be found. I have obſerved it in *ſalmon* and *trouts*, in *herrings*, *mackrel*, *perches*, the *cod*, the *zeus faber*, and in the *moon-fiſh*; it probably exiſts in a number of others. It is formed thus: the optic nerve really perforates the membranes through a round hole, but after having traverſed the Ruyſchiana, it forms two long white caudæ, which follow the contour of that membrane; theſe caudæ, though parallel, are not contiguous; a production of the Ruyſchiana paſſes between them, in order to penetrate into the vitreous body. The retina is produced from the oppoſite edges of theſe caudæ of the nerve, in the ſame manner as it ariſes in birds, from the ſingle white line. The production of the Ruyſchiana has a triangular curvilinear form, and Haller has compared it to a bell; it is black, vaſcular like the reſt of the membrane, and attached, by its extremity, to one ſide of the capſule of the cryſtalline, preciſely in the ſame manner as the pecten of the eye of birds. It alſo appears to furniſh blood-veſſels to that capſule.

4. *In the Sepiæ.*

In *cuttle-fiſhes*, after the numerous optic filaments have perforated the choroides, they are confounded in a ſingle membrane, which is the retina.

B. *Of the Retina.*

This membrane has, perhaps, the leaſt conſiſtency of any in the animal body; it is ſemi-tranſparent, ſoft, and liable to tear by its own weight; but it becomes a little harder, and more opaque, in ſpirits of wine; it is merely applied to the choroides, without adhering to any part of it.

In all animals that have ciliary proceſſes, it terminates around, and at the root of theſe proceſſes, where it is diſtinctly interſected. In birds it even forms a kind of roll or burr at that part.

It may be ſuppoſed that it is more intimately attached to the anterior ſurface of the vitreous body, and that it is this adheſion which occaſions it to break at that place, on raiſing that body. The impreſſion which the ciliary proceſſes leave on the ſame ſurface, favours this opinion, and ſome have gone ſo far as to believe that the retina even covers the anterior part of the cryſtalline: they doubtleſs ſuppoſe that this portion of the retina remains adherent in the furrows which theſe proceſſes produce on on the vitreous humour, and that it is covered by the pigment which is left there.

But, in animals which have no ciliary proceſſes, the retina terminates ſuddenly towards the commencement of the uvea, and nothing prevents us from obſerving that the anterior ſurface of the vitreous body retains no portion of it.

The internal ſurface of the retina is interſected by numerous veſſels which come from the central artery of the optic nerve; theſe veſſels produce more conſiſtency in the internal lamina, than in the external, which is merely pulpy. In fiſhes, in particular, it is eaſy to diſtinguiſh, and even to ſeparate, theſe two laminæ; the internal, which is named the *arachnoid*, preſents very delicate, but very conſpicuous fibres.

The retina is the moſt ſenſible part of the whole animal body, ſince light, which affects no other organ, cauſes there great pain when it is too intenſe: this is not aſtoniſhing, for, independent of the completely nervous nature of that membrane, the parts, which are ſituated before it, do not tend to diminiſh the impreſſion of light, as the integuments which cover other nerves blunt their ſenſations; but, on the contrary, increaſe the effect of the luminous rays, by collecting them into a ſmaller ſpace.

ARTI-

ARTICLE IX.

Of the Nature of the Tranſparent Parts of the Eye, of their proper Membranes, &c.

A. *Of the Vitreous Humour.*

THIS humour, which occupies the greateſt part of the eye, is incloſed in its proper membrane, which is itſelf incloſed in the retina, but without adhering any-where to the latter membrane, unleſs, perhaps, by ſome veſſels.

The membrane of the vitreous body, which is alſo named *hyaloides*, is very fine, and completely tranſparent. Spirit of wine does not render it opaque; its anterior ſurface is divided into two laminæ, which cloſely adhere to the capſule of the cryſtalline. Between theſe membranes air may be introduced, which exhibits a circular canal with unequal inflations, called the *bullular canal* of Petit.

The interior of the vitreous body is divided into a vaſt number of cells, by ſepta, of the ſame nature as the external membrane, which are extended in every direction: in conſequence of this diſpoſition, the membrana hyaloidea cannot be emptied when perforated, as the vitreous humour will not flow at once from all theſe cells.

The vitreous humour is of an albuminous nature,

ture, like the white of an egg; when it has remained long in ſpirits of wine, it ſometimes becomes completely concrete. We preſerve the vitreous humour of birds indurated in this manner; at other times the vitreous humour diſſolves in alcohol, and only its almoſt empty membranes remain. We know not the cauſe of this difference.

When hardened by alcohol, or by freezing, the vitreous humour is eaſily divided into a multitude of lenticular laminæ, which probably receive that form from the cells in which the humour is contained.

Theſe obſervations are common to all the animals whoſe eyes we have deſcribed.

B. *Of the Cryſtalline.*

The cryſtalline lens is incloſed, without being attached, in a membranous capſule, which is ſoft and tranſparent, and ſtrongly fixed in a depreſſion of the anterior ſurface of the vitreous body; this capſule appears to be a ſimple cell; its anterior half is harder than the other; it retains its tranſparency even more ſtrongly than the cryſtalline.

The lens is harder in its centre than on its ſurface; it is indurated, and becomes opaque by boiling, and by alcohol; but the central part ſtill retains ſome tranſparency, and aſſumes only a yellow colour.

In

In the large animals, the cryſtalline, thus prepared, is divided into an infinite number of laminæ, which are all incloſed within each other; the moſt internal are the moſt difficult of ſeparation.

Theſe laminæ are themſelves divided into extremely fine radiated fibres, which proceed from two centres, ſituated at the two extremities of the axis, in the ſame manner as the meridians extend from the two poles of a geographical globe.

This ſtructure is very apparent in the *ox*, the *whale*, &c.

Sometimes the cryſtalline divides rather in the direction of the fibres, than in that of the laminæ; it then forms ſectors or quarters of the lens; this takes place in the mammalia and birds, but leſs ſo in fiſhes.

The cryſtalline of the *ſepiæ* divides eaſily into two hemiſpheres, the limits of which are marked externally by a deep furrow; each hemiſphere conſiſts alſo of a number of concentric caps, compoſed of radiated fibres.

Theſe fibres, which exiſt in all cryſtallines, have been, by ſome anatomiſts, regarded as muſcular, and capable of varying the convexity of that lens, according to the diſtance of the objects the animal wiſhes to behold; but thoſe eyes, from which the cryſtalline has been removed, have not the limits of diſtinct viſion more confined than others.

Between

Between the cryſtalline and its capſule, we generally find a ſmall quantity of a particular fluid.

In man, and the other mammalia, that capſule is nouriſhed by an artery which comes from the optic nerve; this artery paſſes through the vitreous humour, which it alſo ſupplies by ſome branches, and forms, on the poſterior ſurface of the capſule, a very complicated net, the branches of which extend to its anterior ſurface.

In birds it receives its veſſels from the folded membrane, commonly called the *pecten*: theſe veſſels ariſe themſelves from the central artery of the optic nerve.

We believe that the cryſtalline lens itſelf receives ſome branches; certain anatomiſts have ſuppoſed that it is nouriſhed by abſorption.

C. *Of the Aqueous Humour.*

This is a limpid fluid, ſimply diffuſed in all that part of the eye which is before the cryſtalline; the greateſt quantity is ſituated before the iris; the quantity behind that membrane has been the ſubject of much diſpute; it is certain, however, that it is very ſmall: it is ſuppoſed that the aqueous humour in man is ſomewhat lighter than diſtilled water, that is, as 975 : 1000. It emits no ſmell; its taſte is ſlightly ſaltiſh; it is not rendered opaque by alcohol; it exhales through

through the pores of the cornea, and its lofs renders that membrane flat after death. Thefe circumftances are common to all vertebral animals.

ARTICLE X.

Of the Sufpenfion of the Globe of the Eye, and of its Mufcles.

IN all red-blooded animals, the eye is fituated in a cavity of the face called the orbit, the form and ftructure of which have been defcribed in different Articles of Lecture VIII. The eye, being capable of various degrees of motion, is fupported in different ways.

The orbit is moft commonly conical or oblong, and a fpace is, therefore, left pofteriorly, unoccupied by the globe of the eye.

In all warm-blooded animals, this fpace is filled with fat; it forms a kind of cufhion, on which the globe refts and moves without being injured: the finking of the eye in the orbit of old people, is occafioned by the diminution of this fat.

The orbit of birds being proportionally lefs deep than that of mammalia, the fat behind their eye is fmaller in quantity; on which ac-

 count,

count, there is but little motion perceived in the eye of birds.

The *rays* and *sharks* have a particular difpofition ; their eye is joined to the extremity of a cartilaginous ftalk, which is itfelf articulated in the bottom of the orbit. In this manner, the mufcles act on a long lever, and have therefore great power in moving the eye.

In other fifhes the eye repofes on a mafs, more or lefs extenfive, of gelatinous matter, contained in a loofe cellular texture : this trembling elaftic mafs affords the eye a point of fupport in all its motions.

The *fepiæ* having a conical fclerotic attached to the bottom of the orbit, it is not between it and the orbit, but between it and the choroides, that the glandular bodies, which ferve to fupport the globe, are fituated. The part fixed to the edges of the optic hole, is pointed ; it preferves, therefore, fome degree of mobility.

The mufcles of the eye, in man, are fix in number : four are ftraight ; thefe are attached to the borders of the optic foramen, and inferted into the anterior part of the globe of the eye, as far as the edge of the cornea, where they increafe the thicknefs of the fclerotic.

The other two are oblique. The *obliquus fuperior*, or *trochlearis*, arifes alfo from the bottom of the orbit ; it fends its tendon into a cartilaginous pulley, fituated near the vault of that cavity,

cavity, and proceeds upward, backward, and outward, to its infertion on the fclerotic, under the rectus externus, or abductor. The *obliquus inferior* arifes from the internal part of the orbit, and paffes under the eye, into which it is inferted, on the external fide.

Monkies have the fame mufcles as man; but the other mammalia have at leaft one more.

This is called the *fufpenfory*, or *choanoid mufcle*, that is to fay, in the form of a tunnel. In the Ruminantia and the horfe it really forms a tunnel, or elongated cone, the point of which is attached at the optic foramen, and the extended part is inferted in the whole of the interval between the four ftraight mufcles, a little pofterior to their infertion. Several fpecies, as moft of the Sarcophaga and Cetacea, have this mufcle divided into four, fo that they have eight mufculi recti.

In the *rhinoceros* it is only divided into two.

The oblique mufcles prefent no variety in mammiferous animals.

Birds and fifhes have, in all, only fix mufcles; four ftraight, which arife, as in man, from the edges of the optic foramen; and two oblique, both of which come from the anterior parietes of the orbit: they are attached very near each other; and one is inferted above, and the other below the globe of the eye; but the fuperior does not pafs through a pulley, as in the mammalia.

In birds, all thefe mufcles are attached to the foft part of the fclerotic, and we cannot follow their tendons to its offeous part, without lacerating them ; they are, in proportion, much fhorter than in the other claffes.

In the *tortoife* we find the fix common mufcles difpofed like thofe of fifhes, and befides, four fmall ones, which clofely embrace the optic nerve, and fpread over the convex portion of the fclerotic, after being interrupted by the mufcle of the third eye-lid, of which we fhall fpeak hereafter.

The difpofition is precifely fimilar in the *crocodile*.

In *frogs* and *toads* there is a great tunnel-like mufcle, which embraces the optic nerve, and is divided into three portions ; its inferior fibres advance more towards the edge of the eye than its fuperior. There is only a fingle ftraight mufcle on the inferior part, and confequently only one depreffor. There is one very fhort oblique mufcle, which is attached to the anterior part of the orbit, and inferted directly into the adjoining part of the globe. The mufcle of the third eye-lid is fo clofe to the inferior part of the choanoides, that it becomes ftretched when the latter fwells ; this accounts for the elevation of the third eye-lid, when the eye is lowered, as we fhall foon explain more fully.

The eye of the *cuttle-fifh* has only two fmall muſcles, one ſuperior, and one anterior; the head being ſuppoſed upward.

ARTICLE XI.

Of the Eye-lids and their Motions.

THE eye-lids are membranous veils, formed by the folds of the ſkin; they cover the eye in a ſtate of repoſe, and cleanſe its ſurface by their motions; by ſuddenly cloſing, they prevent the entrance of ſmall bodies which might irritate the eye, and even, in certain caſes, aſſiſt viſion, by diminiſhing the too great influx of luminous rays.

A. *In Man.*

Man has only two eye-lids, the commiſſure of which is tranſverſe; their ſubſtance is compoſed of muſcles, and a compact cellular texture, which ſome have regarded as a ligament. The ſurface next the eye is very fine, and contains numerous veſſels; the external ſurface is ſimilar to the reſt of the ſkin; the edge of each is ſtrengthened by a cartilage, called *tarſus*, which extends from one end of the commiſſure to the other; it is rounded, and produces, with the oppoſite *tarſus*, a conduit, on the ſide next the eye, by which the tears flow towards the nofe; thefe edges of the eye-lids are, befides, furnifhed with a row of hairs, called *cilia*, or *eye-lafhes*.

The eye-lids of man have only two mufcles, the *orbicularis palpebrarum*, which clofes them, and the *levator palpebræ fuperioris*, which raifes the upper eye-lid; the inferior is lowered by its own elafticity. The *orbicularis* furrounds the eye-lid with concentric and circular fibres, which are attached to the internal or nafal angle, where there are fome other fibres which have a tranfverfe direction.

The *levator palpebræ fuperioris* arifes from the bottom of the orbit, above the mufculi recti, and fpreads in the fubftance of the fuperior eye-lid.

In the internal angle of the eye-lids there is a fmall fold, in the form of a crefcent, which is only apparent when the eye is turned from the fide of the nofe. This is a rudiment of the third eye-lid, which is developed in other animals.

B. *In other Mammiferous Animals.*

Monkies do not differ from man, in refpect to the eye-lids.

In the quadrupeds, the third eye-lid becomes more and more confiderable, though it has no proper mufcle, and cannot completely cover the eye;

eye; it is ufually femi-lunar, as we obferve it in the Ruminantia, the Edentata, and the Pachydermata.

The *rhinoceros* has it thick and flefhy. In the *hare* its loofe edge is convex. It is the fame in *rats*, *agoutis*, &c.

In almoft all fpecies we remark a row of pores, which doubtlefs afford a paffage for fome unctuous humour; a part of its body is frequently occupied by a cartilaginous lamina; this part is named *unguis* by hippotomifts. The *hare* has it triangular, and very large.

In fome mammalia, befides the ordinary mufcles of the two eye-lids, we obferve two ftrata of fibres, which proceed from the paniculus carnofus, one of which ferves to deprefs the inferior eye-lid, and the other to raife the fuperior.

The Cetacea have their eye-lids fo much thickened by the oily fat fituated between the two laminæ, that they are almoft immoveable; they have no cilia, nor any veftige of the third eye-lid.

C. *In Birds.*

Birds have three eye-lids. The two common eye-lids have the commiffure horizontal; the third eye-lid is vertical, and fituated in the nafal angle of the eye; it can cover that organ entirely like a curtain. The two firft contain, between their external fkin and the internal, or conjunctiva, a ligamentous membrane, which is continued into the orbit, and lines the whole of that cavity. It is particularly the inferior eye-lid which covers the eye by elevation; it is larger than the fuperior, and much thicker; its internal furface prefents an oval plate, almoft cartilaginous, and perfectly fmooth. The orbicularis palpebrarum paffes under this plate, but in the fuperior eye-lid it immediately touches the edge. The levator palpebræ fuperioris is only inferted towards the external angle; its origin is at the roof of the orbit: the inferior eye-lid has a particular depreffor, which arifes from the bottom of the orbit; there is no cartilage at the edge of thefe eye-lids, and only a fmall number of birds have cilia: indeed, thefe are rather feathers, with fhort barbs, than real cilia; thefe feathers are remarkable in the *horn-bill.*

Very few birds have the fuperior eye-lids capable of being depreffed, as much as the inferior can be raifed. Among others, in which, however, this may be obferved, are the *owls* and the *goat-fuckers.*

The third eye-lid, or *membrana nictitans,* has a certain degree of tranfparency; for birds fometimes look at objects through it; and by it the *eagle* is enabled to look at the fun. It contains no mufcle internally; and this renders the fingular apparatus which moves it neceffary.

Two mufcles have their fixed attachments in the

the globe of the eye, at the poſterior part of the ſclerotica; one, called *muſculus quadratus palpebræ tertiæ*, is fixed towards the upper and back part of the eye; its fibres deſcend towards the optic nerve, and terminate in a tendon of a ſingular nature; it is no where inſerted, but forms a cylindrical canal, which bends a little round the optic nerve, croſſing the direction of the fibres of the muſcle. The ſecond muſcle, called *pyramidalis*, is fixed towards the ſide and poſterior part of the globe, which is next the noſe a little inferiorly; its fibres are collected into a tendon, which forms a long cord, and which paſſes through the canal of the preceding muſcle, as if it were the neck of a pulley: having thus deſcribed more than a ſemi-circle, it proceeds in a cellular ſheath of the ſclerotic, below the eye, to the inferior part of the free edge of the third eye-lid, into which it is inſerted.

It will be eaſily underſtood, that the united action of theſe two muſcles muſt pull very forcibly this tendinous cord, and thus draw the third eye-lid over the eye; it returns into the angle of the two other eye-lids by its own elaſticity.

D. *In Reptiles.*

Reptiles vary ſingularly with reſpect to the number and diſpoſition of their eye-lids: *ſerpents* have none: *crocodiles* and *tortoiſes* have three, and the third is vertical, as in birds: there

there are alſo three in *frogs*, but the third is horizontal like the other two.

The horizontal eye-lids of *crocodiles* and *tortoiſes* cloſe exactly; they have each an enlargement at their edge, but no cilia; their third eye-lid is ſemi-tranſparent; it moves from behind forwards, and may cover the whole eye; it has only one muſcle, which is analogous to the pyramidalis of birds; it is fixed in the ſame manner to the poſterior part of the globe inferiorly. After having turned round the optic nerve, it re-paſſes under the eye, to ſend its tendon to that eye-lid; but there are neither the muſculus quadratus, nor its ſheath, as in birds.

In the other lizards there are alſo very remarkable varieties.

The common *lizards* have, for eye-lids, a kind of circular veil, extended before the orbit, and perforated by a horizontal fiſſure, which is capable of being cloſed by a ſphincter muſcle, and opened by a levator and depreſſor; its inferior part has a ſmooth round cartilaginous diſk, as in birds; there is, beſides, a ſmall internal eye-lid, but it has no proper muſcle; it is entirely wanting in the *camelion*, in which animal alſo the ſlit of the eye-lids is ſo ſmall, that the pupil can ſcarcely be obſerved through it. The *gecko* has no moveable eye-lid; its eye is protected by a ſlight margin of the ſkin, as in *ſerpents*. A ſimilar diſpoſition appears to prevail in the *ſcink*.

In

In *frogs* and *toads* the ſuperior eye-lid is only a projection of the ſkin, and almoſt immoveable; the inferior is more moveable, and has a ſwoln edge; but the third, which moves from below upward, is moſt employed by theſe animals; it is very tranſparent; it has one muſcle ſituated tranſverſely, behind the globe, which forms a thin tendon on each ſide of the eye, to be inſerted into the free edge of the third eye-lid.

The *ſalamanders* have only two eye-lids, which are horizontal, fleſhy, and little moveable; it appears that they may entirely cover the eye.

E. *In Fiſhes.*

In moſt fiſhes there is no moveable eye-lid; in ſome, as we have already obſerved, the ſkin paſſes before the eye, without even producing a fold. Others have only ſlight projections, which form a kind of eye-brows, rather than eye-lids. Moſt oſſeous fiſhes have, at each angle of the orbit, a vertical and immoveable veil, which covers only a ſmall part of it. This may be eaſily obſerved in the *ſalmon, mackrel,* &c.

The *moon-fiſh* (*Tetraodon Mola*) exhibits a peculiarity, which we have obſerved in no other animal; its eye may be entirely covered with an eye-lid, perforated circularly, and which may be cloſed by means of a real ſphincter.

Five

Five mufcles, difpofed in radii, and attached to the bottom of the orbit, dilate the aperture.

F. *In Mollufca.*

The *fepiæ* and other mollufca, which have not the eyes at the extremity of their tentacula, have no eye-lid; the fkin covers the eye, as in ferpents and eels: but the *flugs*, the *fnails*, &c. have an organization, which is far more complicated, and much better calculated for the protection of their eye.

This organ is fituated at the extremity of a flefhy tube, called a *horn*, or *tentaculum*, which may be drawn completely within the head, and protruded by a motion fimilar to the evolution of the finger of a glove. In Vol. I. page 433, we defcribed the mufcles that draw the fnail into its fhell. At the external edge of each of thefe mufcles, the particular mufcle of the eye is attached; this mufcle penetrates to the infide of the horn, to the extremity of which it is fixed; when it contracts, therefore, but ftill more when affifted by the contraction of the great mufcle of the body, it draws the extremity of the horn inwardly, in a manner which refembles the turning in of a ftocking. The annular fibres, which encircle the horn throughout the whole of its length, unfold the internal part by fucceffive contractions, and thus bring

back

back the eye to its external pofition. In the naked fnail, the retractors of the eyes are fimply attached to the flefhy mafs which forms the foot. In the inferior horns, or tentacula, which have no eyes, the mechanifm is alfo the fame.

Article XII.

Of the Glands that furround the Eye.

A. *In Man.*

In animals that live in air, the anterior furface of the eye would foon become dry, and be rendered foul, by duft, were it not conftantly bathed by a limpid fluid.—It would alfo be frequently injured by infects, and a multitude of other fmall bodies, were not unctuous fubftances depofited on the edges of the eye-lids, and between the cilia: thefe purpofes are accomplifhed by the glands, with which the eye is furrounded, and which, in man, confift of three kinds—the *glandula lachrymalis*, *glandulæ Meibomii*, and *caruncula lachrymalis*.

The *lachrymal gland* is fituated towards the upper part of the orbit, above the fuperior eyelid, a little towards the temple; it appears to be compofed of whitifh grains, and formed of two fmall lobes. It has fix or feven very fmall canals,

canals, which defcend in the fubftance of the eye-lid, and open on its internal furface, a little above the cartilage which forms its margin.

The fluid, called tears, continually exudes through thefe minute apertures; it is diffufed over the front of the eye; and when the eye-lids clofe, they prefs a part of it into the fmall triangular canal, which is formed by their edges and the globe, towards their internal or nafal angle.

The *glandulæ Meibomii* fecrete a fatty matter, which anoints the edges of the eye-lids, and prevents the tears from wetting, or paffing over them; thefe glands are fituated in the fubftance of both eye-lids, at their edges; they are compofed of fmall follicles, ranged in vertical and parallel lines; their number exceeds thirty in the upper eye-lid, and twenty in the lower: their apertures are fmall round holes, which appear along the edge of each eye-lid.

When the lachrymal fluid reaches the nafal angle of the eye, it is abforbed by two fmall pores, called *puncta lachrymalia*, which are contained in two eminences fituated at that extremity of the eye-lids. Each pore leads into a fmall canal, and both canals into the *lachrymal fac*, which opens into the nofe by the duct we already defcribed in page 89 of this volume.

The *caruncula lachrymalis* is fituated in the internal, or nafal, angle of the eye-lids, and is apparent without diffection; it is a fmall, round, reddifh reddiſh maſs, compoſed of ſeven diſtinct follicles, which produce a thick whitiſh humour. The uſe of this humour appears, in particular, to be the protection of the lachrymal pores, by arreſting light ſubſtances which might be introduced into them.

B. *In other Mammiferous Animals.*

Quadrupeds have, in general, the ſame glands as man, and ſeveral of them have one more.

The lachrymal gland, properly ſo called, is ſub-divided into two or three bodies in the Ruminantia. Some ſeparate grains have each a very ſhort excretory duct.

In the *hare* and the *rabbit* the lachrymal gland is very large; it extends above and below the eye, and occupies the interval between the cranium and the proceſs, which, in theſe animals, ſuſtains the eye-brow; it paſſes behind the eye, ſinks under the zygomatic arch, comes out from the orbit, on the ſide of the noſe, and terminates there by a conſiderable enlargement; it appears to me to have only a ſingle excretory canal, which perforates the upper eye-lid towards the poſterior angle.

The gland peculiar to certain ſpecies of quadrupeds, and which is wanting in man, is named *glandula Harderi*, though it was ſeen and deſcribed by more ancient anatomiſts; it is always ſituated in the internal or naſal angle, and ſecretes a thick a thick whitiſh humour, which is poured out by an orifice under the rudiment of the third eyelid. In the Ruminantia it is oblong, and of a pretty hard conſiſtency. In the *hare* it appears to be formed of two parts, merely united by cellular ſubſtance, and each ſub-divided into a great number of lobes: the ſuperior part, which is the leaſt, is whitiſh; the inferior, which is much larger, is reddiſh. It is large and double in the *water-rat*.

It alſo exiſts in the Sarcophaga, in the *elephant*, in the *hog*, in which it is oval, in the *ſloths*, &c.

The caruncle exiſts in the Ruminantia, as well as in man; but in them it is formed of a greater number of follicles.

I have not been able to perceive it in the *hare*, nor in ſeveral other Rodentia.

There are alſo differences in the manner in which the tears flow.

The Ruminantia have the lachrymal points and ducts as in man. Some genera of that order are rendered remarkable, by the *receptacles for the tears*, or *foſſæ lachrymales*; theſe are ſmall cavities in the cheek, one below each eye, near its naſal angle, and communicating with that angle by a ſmall furrow. They are found in *deer*, and in *antelopes*.

The *hog* has two lachrymal points. We alſo find them in the *ſloths* and *ant-eaters*.

In *hares*, *rabbits*, and doubtleſs in all the genera allied to theſe, there are no lachrymal points,

)oints, but a crefcent-fhaped fiffure under the nferior edge of the third eye-lid, which leads nto a fingle lachrymal duct. The edges of that iffure are furnifhed with cartilages. There is . fmall femi-lunar valve in the canal, which)revents the fluid from returning to the eye.

The Cetacea, like moft animals that live con-tantly in water, have neither gland nor lachry-nal points. We merely obferve, under the ıpper eyé-lid, fome lacunæ, from which a hick mucilaginous humour flows.

C. *In Birds.*

We find, in birds, the lachrymal gland, and :hat of Harderus. There is no caruncula. The Harderian gland is much larger than the other, ıfually of an oblong form, and of a flefh co-lour; it is fituated between the levator and ad-ductor mufcles, or fometimes, as in the *turkey*, between the adductor and the obliquus inferior: it produces a fingle excretory duct, which paffes through the fubftance of the third eye-lid, and opens on its internal furface. This gland fur-nifhes a thick yellow humour. The lachrymal gland of birds is ufually very fmall, almoft round, very red, and fituated at the pofterior ıngle; it difcharges itfelf by two or three fmall but confpicuous canals, precifely at the angle of the two horizontal eye-lids.

Birds of the *duck* genus, and other fwimming and wading birds, have a glandular, hard, and granulated body, which occupies all the fuperior part of the orbit, and turns backward, to follow the curvature of the eye. In the *tufted duck (anas fuligula)* it is fo broad that it touches the correfpondent body, above the cranium: this body appears to fupply the place of the lachrymal gland; but I have not yet difcovered its excretory canal.

All birds have two holes, for the paffage of the tears, placed in the interior angle between the two firft palpebræ and the third: they are broad, but have no cartilaginous border, being foft like the reft of the furrounding fkin; they lead almoft immediately into the nafal fac, fituated at the bafe of the nofe.

D. *In Reptiles.*

Reptiles vary as much with refpect to their lachrymal glands, as to their eye-lids.

The *fea tortoifes* have a very confiderable gland at the pofterior angle; it is reddifh, granulated, divided into lobes, and extends under the arch which covers the temple.

In the *frefh water tortoifes* we find two fmall blackifh glands, which alfo exift in *toads* and *frogs*; but I have not yet accurately obferved their excretory ducts.

Serpents, like fifhes, have no gland in the eye.

ARTI-

Article XIII.

Of the Eye of Insects and Crustacea.

What we have to fay in this article, will relate hiefly to *compound eyes;* the fimple eyes are too mall for diffection.

The ftructure of the eye of infects is fo very lifferent from that of other animals, even the nollufca, that it would be difficult to believe it n organ of fight, had not experiments, purofely made, demonftrated its ufe. If we cut ut, or cover with opaque matter, the eyes of he *dragon-fly*, it will ftrike againft walls in its light. If we cover the compound eyes of the *vafp*, it afcends perpendicularly in the air, ntil it completely difappears; if we cover its imple eyes alfo, it will not attempt to fly, but vill remain perfectly immoveable.

The furface of a compound eye, when viewed y the microfcope, exhibits an innumerable nultitude of hexagonal facets, flightly convex, nd feparated from one another by fmall furows, which frequently contain fine hairs, more r lefs long.

Thefe facets form altogether a hard and elaftic membrane, which, when freed of the fubtances that adhere to it pofteriorly, is very ranfparent.

Each of theſe ſmall ſurfaces may be conſidered either as a cornea, or a cryſtalline; for it is convex externally, and concave internally, but thicker in the middle than at the edges; it is alſo the only tranſparent part in this ſingular eye.

Immediately behind this tranſparent membrane there is an opaque ſubſtance, which varies greatly as to colour in the different ſpecies, and which ſometimes forms, even in the ſame eye, ſpots or bands of different colours. Its conſiſtence is the ſame as that of the pigment of the choroides; it entirely covers the poſterior part of the tranſparent facets, without leaving any aperture for the paſſage of the light.

Behind this pigment we find ſome very ſhort white filaments, in the form of hexagonal priſms, ſituated cloſe to each other, like the ſtones of a pavement, and preciſely equal in number to the facets of the cornea; each penetrates into the hollow part of one of theſe facets, and is only ſeparated from it by the pigment mentioned above. If theſe filaments are nervous, as in my opinion they appear to be, we may conſider each as the retina of the ſurface, behind which it is placed: but it will always remain to be explained, how the light can act on this retina, through a coat of opaque pigment.

This multitude of filaments, perpendicular to the cornea, have behind them a membrane which

which ferves them all as a bafe, and which is confequently nearly parallel to the cornea: this membrane is very fine, and of a blackifh colour, which is not caufed by a pigment, but extends to its moft intimate texture; we obferve in it very fine whitifh lines, which are tracheæ, and which produce ftill finer branches, that penetrate between the hexagonal filaments, as far as the cornea. By analogy, we may name this membrane the *choroides*.

A thin expanfion of the optic nerve is applied to the pofterior part of the choroides. This is a real nervous membrane, perfectly fimilar to the retina of red-blooded animals; it appears that the white filaments, which form the particular retinæ of the different ocular furfaces, are productions of this general retina, which perforates the membrane I have named choroides, by a multitude of fmall and almoft imperceptible holes.

To obtain a diftinct view of all thefe parts, it is neceffary to cut off the head of an infect that has the eyes large, and diffect it pofteriorly: each part will then be removed in an order the reverfe of that in which I have defcribed them.

In the *cray fifhes*, in general, the eye is fituated on a moveable tubercle. The extremity, which is rounded on every fide, and fometimes elongated into a cone, when viewed by a glafs, prefents the fame furfaces as the eyes of infects. When we cut this tubercle longitudinally, we

 obferve

obſerve that the optic nerve paſſes through it in a cylindrical canal, which occupies the place of its axis. Arrived at the centre of the convexity of the eye, it forms a ſmall button, which detaches very fine filaments in every direction: at a certain diſtance theſe filaments meet the choroides, which is nearly concentrical with the cornea, and covers the ſpherical bruſh of the extremity of the nerve, like a hood. All the diſtance between the choroides and the cornea is occupied, as in inſects, by white filaments, cloſely arranged in a perpendicular direction to each other, and which have the extremity next the cornea alſo coated with a black pigment.

Theſe filaments perforate the choroides, and are continuations of thoſe produced by the button, which terminates the optic nerve.

LEC-

LECTURE THIRTEENTH.

Of the Organ of Hearing, or, Of the Ear.

Article I.

Of Sound, and Hearing in general.

Sound is the ſenſation we experience, when certain bodies, called *ſonorous*, vibrate, and communicate their tremulous motion to the atmoſphere around us, or to any other body in contact with our ear. The *ear*, being affected by this motion, tranſmits the impreſſion it receives to the brain. In this manner we exerciſe the ſenſe of *hearing*.

The qualities which belong to ſound, may be diſtinguiſhed into different kinds, independent of each other, viz.

1. *Force*, which depends upon the extent of the vibrations of the body from which the ſound proceeds. The greater the vibrations, the *ſtronger* is the ſound: the extent of the vibrations is determined by the degree of impulſe which produces them.

2. *Tone*, which depends upon the *velocity* of the vibrations. The vibrations made by a sonorous body in a given time, produce a *tone* which is *high* or *acute* in proportion as these vibrations are more numerous, and *low* or *grave* in proportion as they are less numerous. The laws of this velocity, and the circumstances which determine it, are well known. All things equal it is in the inverse ratio of the length, and the direct ratio of the tension, whether that tension be the effect of external agency, or of the particular nature of the sonorous body itself.

3. *Resonance*, which arises out of the intimate composition of the sonorous body: in it we distinguish different tones, as the *clear*, the *soft*, the *dull*, the *crackling*, &c. &c. with the laws of which we are not yet acquainted.

4. *Simple modulations of voice*, the different kinds of which are expressed by the letters called vowels, *a*, *e*, *i*, *o*, *u*, *ai*, *ou*, *eu*, &c. We are completely ignorant of the real nature of these modifications of sound, though we are pretty well acquainted with the motions which man and other animals give to their vocal organs in producing them.

5. *Articulations*, the different kinds of which are expressed by the consonants, *b*, *c*, *d*, &c. We know as little of them, as we do of the *vowel sounds*. The imitations of either of these modifications of sound, which we produce by our instruments, are, therefore, very imperfect.

The human ear can diſtinguiſh all theſe different qualities with relation to one ſound: this diſtinction is made with wonderful accuracy, by perſons who frequently exerciſe that faculty, and particularly by profeſſional muſicians. The other mammalia exhibit proofs that they are capable of diſtinguiſhing the qualities of ſound which relate to ſpeech, that is to ſay, *ſimple vocal modulations* and *articulations*; for we may obſerve daily, that they remember the ſound and ſignification of ſeveral words. Some are ſtrongly affected by certain ſounds. Acute tones produce a painful ſenſation in *dogs*, and we alſo obſerve that theſe animals are terrified by violent noiſes: they therefore diſtinguiſh theſe two properties. Birds have a feeling, no leſs exquiſite, of *voice*, *tone*, *articulation*, and even *reſonance*, ſince they learn to ſing with great correctneſs, and, when their vocal organs permit them, can completely counterfeit the human ſpeech, with all the modifications practiſed by the individuals they imitate.

As to cold-blooded animals, it is well known that ſeveral of them call each other by certain ſounds, and that others, which are incapable of producing ſounds, can at leaſt underſtand them, as *carps*, which appear when the noiſe of a bell indicates to them that they are to be fed, &c. &c.: but we know not what qualities of ſound they diſtinguiſh, and how far, in this reſpect, the delicacy of their ſenſe of hearing extends.

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We are ſtill more ignorant reſpecting the ſtate of this ſenſe in the white-blooded animals. It is evident, however, that ſeveral of them are not deſtitute of the faculty of hearing.

It would be of importance to determine the limits within which the ear of each animal perceives each of the qualities of ſound. Thus, with reſpect to *force*, ſounds, which are ſo weak as to be loſt to the human ear, are diſtinctly heard by certain animals. Other animals alſo may, perhaps, endure ſounds which would deafen us. With regard to tones, ſome are too grave, and others too acute for the human ear. Muſicians have even fixed the limits of theſe tones at two numbers of vibrations, which are to each other in the ratio of 1 : 1024: perhaps theſe limits are not the ſame in all animals. There are great differences between the individuals of the human ſpecies, with reſpect to the faculty of diſtinguiſhing two very proximate tones. The difference is, perhaps, ſtill greater between one animal and another.

With regard to *modulation* and *articulation*, the people of one country diſtinguiſh, in their pronunciation, certain letters, between which thoſe of another perceive no difference. The ſame obſervation applies to the other qualities.

It alſo appears, that an ear of ſimilar ſtructure is not equally perfect with reſpect to all the different qualities of ſound: one ear may be found to poſſeſs great delicacy of hearing,

as

as to the weakeſt ſounds, and yet be altogether incapable of diſcriminating between different tones; on the contrary, a very fine muſical ear may be deaf to other low ſounds: if ſuch differences are obſerved between one man and another, we may reaſonably conclude that they exiſt in a far greater degree in the various kinds of animals.

It is evident that there muſt take place in the ear, at the moment of hearing, ſome change which correſponds to each of the qualities of ſound we diſtinguiſh; but far from being acquainted with its nature, we are even ſtill ignorant of the requiſites, on the exiſtence of which, *general hearing*, or the *ſimple perception of ſound*, depends.

This conſideration ſuggeſts to us the advantages that may be derived from Comparative Anatomy. It is natural to ſuppoſe that the parts, which are conſtantly found in all animals that hear, are thoſe abſolutely neceſſary to the mere perception of ſound in general; and that thoſe parts muſt have a more particular relation to certain qualities of ſound, which are found more developed in the animals that perceive more perfectly theſe qualities.

But this is the point which preſents the chief difficulty, becauſe it is almoſt impoſſible for us to aſcertain the kind and degree of the perceptions of other animals.

As to the parts eſſential to hearing, the examination

mination we are about to make, of the organs of that ſenſe, in all the animals in which it has been diſcovered, will ſhew that the only part conſtantly exiſting is a gelatinous pulp, which is covered by a fine and elaſtic membrane, and in which the laſt ramifications of the auditory nerve are loſt: this pulp fills the labyrinth in all ſpecies from man to the cuttle-fiſh. The organs of hearing of thoſe animals which are placed below the cuttle-fiſh in the ſcale of being, are not yet known, though ſeveral of them afford manifeſt proofs of poſſeſſing that ſenſe.

It is then almoſt demonſtrated, that the ſeat of hearing reſides in this pulp, or rather in the nervous filaments that float or are diſtributed in it. We may form a very natural idea of the connexion of this ſubſtance with the external movements which are the cauſe of ſound: this quivering gelly will receive, with facility, the concuſſions tranſmitted to it by the vibration of ſonorous bodies, and communicate them to the nervous filaments. Thus far may the motion of ſound be traced; but the proceſs, which is afterwards neceſſary to produce perception, eſcapes the anatomiſt as well as the metaphyſician.

The other parts, which are not found in all ears, can only be regarded as acceſſory ſubſtances, calculated each in a particular manner to augment or to modify the ſenſation. Very plauſible conjectures may be made with reſpect to to the effect of some of those parts. It appears evident, for example, that the external ear, which is so large in some quadrupeds, serves to increase sound, in the same manner as the trumpets used by persons who are deaf: it is very probable that the large cavities with osseous parietes which surround the labyrinth in a number of animals, produce a similar effect by the resonance of their solid and elastic vaults. It is supposed that the thin and tense membrane of the tympanum, by means of the ossicula attached to it, transmits the vibrations of the external air with considerable force to the labyrinth. It is also supposed that the will produces, through the medium of the muscles which act on the ossicula, that degree of tension in this membrane, which is precisely necessary to bring it in unison with the sounds, to which we are inclined to pay particular attention.

It has been conjectured, that the spiral and decreasing lamina which divides the cochlea of quadrupeds into two scalæ, is composed of osseous fibres; and, as these fibres must diminish in length from the base to the point of that organ, that each is fitted to receive concussions from a particular kind of tone. Formerly, the same faculty was ascribed to the osseous rings which compose the semi-circular canals, and which were believed to diminish gradually from the two extremities of each canal to its middle.

The Eustachian tube has been regarded by some

ſome as a ſupplementary paſſage for the ſounds which do not reach the ear by the meatus externus; others have ſuppoſed, that it ſerves as a canal to carry off the ſuperfluous humours from the cavity of the tympanum, &c.

The inveſtigations, to which we are about to proceed, may perhaps throw ſome light upon theſe intereſting queſtions.

Article II.

Of the different Forms of the Membrane which contains the Auditory Pulp, or of the Membranous Labyrinth.

The membrane which incloſes the auditory pulp is tranſparent, fine, and peculiarly elaſtic: with reſpect to its form, it may be regarded as ſelf ſuſtained, as it preſerves its ſhape, independent of the aſſiſtance of the parts which ſurround it. It is, however, finer and weaker in the animals in which it is cloſely encircled by the bones, and particularly in man, and the other mammalia. In young animals it is more thick, more humid, and more eaſily ſeparated from the bones, than in the old.

A. *In Cray-fish.*

The membrane in these animals scarcely merits the name of labyrinth; it resembles a small purse, enclosed in a scaly cylinder, open at both ends. The extremity by which this small cylinder joins the base of the antenna, affords a passage for the nerves into the purse. The opposite extremity is closed by an elastic membrane, which may be named *tympanum*, or, with more propriety, *fenestra ovalis*.

The air, or water, in which the animal lives, acts immediately on this membrane: the external appearance of this part is readily discovered, by looking at the inferior surface of the base of the large antennæ.

Fabricius and Scarpa have described it in detail.

B. *In the Sepiæ,*

The ear is almost as simple as in *cray-fish*; but it is entirely concealed in the body of the annular cartilage, which serves as the base of the great tentacula, or feet of these animals.

The membrane of the labyrinth is also a simple purse, of an oval or roundish form. In the *common cuttle-fish (sepia officinalis)* it has internally several conical eminences, disposed in an irregular manner: these eminences are wanting in the other species. In the pulp which fills the membrane, there is a ſmall body ſuſpended, which is oſſeous in the *cuttle-fiſh*, properly ſo called, and ſimilar to ſtarch in the *octopus*.

In the *ſepia officinalis*, it reſembles a ſmall valve of a concha.

C. *In Fiſhes that have free Branchiæ.*

The membranous labyrinth begins to aſſume a more complicated form. It is uniformly compoſed of three ſemi-circular canals, the dimenſions of which vary, but which all communicate with a ſac, more or leſs divided by contractions. Beſides the common pulp, this ſac contains one, two, or three ſmall bones, according to the ſpecies. In the oſſeous fiſhes theſe bones are as hard as ſtone. They are always ſuſpended in the midſt of the pulp, by a great number of nervous fibrillæ. Each of the three ſemi-circular canals has an enlargement, in the form of a bubble, near the place where it penetrates the ſac, and two are united at one of their extremities: in conſequence of this junction, the canals communicate with the ſac, by five apertures only, inſtead of ſix which would have exiſted had the union not taken place.

All the circumſtances we have pointed out reſpecting theſe three canals, alſo exiſt in the ſuperior claſſes; the whole apparatus is ſituated in the ſides of the cavity of the cranium, and fixed ved there by a cellular tiſſue, conſiſting of ſſels and oſſeous or cartilaginous fræna.

Fiſhes differ from each other in the form and oportion of the parts of the labyrinth, and thoſe of the petrous oſſicula it contains.

One of the three canals is directed obliquely rward and outward, in a plane which is nearly ertical; another is directed backward and outard, alſo in a vertical plane; the third is almoſt horizontal, and external to the other two: e two extremities, which join, and open into e ſac by one aperture, are the poſterior extreity of the firſt, and the anterior of the ſecond anal: their other two extremities, and the two elonging to the third canal, enter ſeparately.

The enlargement of the two firſt canals takes lace near the extremities, which do not unite. n the third, it is at the anterior termination.

There are ſome obvious differences in the proortional length of the canals to the dimenſions f the ſac; but in general they are ſhorter in he oſſeous than in the cartilaginous fiſhes.

The *moon-fiſh*, the *frog-fiſh*, and the *ſturgeon*, ave them very long and ſlender. In the oſſeous iſhes, the *pike* and the *tunny* have them longer han the *carps*, *eels*, *ſalmon*, &c.

The ſac preſents more varieties than the ſemiircular canals.

In the *moon-fiſh* it is a ſimple cone, the point f which is directed towards the brain, and the bafe enlarged, to receive the three canals. In the *fturgeon*, it is a broad, flat, and vertical difk, which is fituated on the lateral and internal parietes of the cranium, and which alfo immediately receives the three canals. In the *frog-fifh*, it is alfo a fimple fac. It appears, therefore, that an undivided fac is a general character of all the cartilaginous fifhes with free branchiæ; but in moft of the other fifhes, the part which receives the canals, and which we fhall name the *finus*, is feparated by a contraction from the other part, which we fhall more particularly call the *fac*.

The finus is ufually flender, and elongated from before backward: the fac is oval, and is fo fituated on the bafe of the cranium as to be frequently found very near that of the other ear; fometimes it lies in a depreffion of the bafe of the cranium.

The *pike* has a fmall hollow appendix, which is connected with the pofterior part of the finus, by a very fmall canal, and fixed, by its other extremity, to the cranium, near the edge of the occipital foramen: this appendix may be regarded as a third divifion of the fac, and has only, as yet, been obferved in this fifh.

In the *moon-fifh*, the fac contains no officula; but, inftead of them, we find fome lumps, the fubftance of which is more of a mucous than of a cretaceous nature. In the *fturgeon* there is only

only a ſingle triangular oſſiculum, the hard nucleus of which is partly ſurrounded by cretaceous matter.

In the oſſeous fiſhes, and even in ſome of the cartilaginous kind, as the *frog-fiſh*, there are always three oſſicula: two of theſe are in the ſac, viz. the largeſt, and a ſmall one behind it; the third is alſo very ſmall, and is ſituated in the common ſinus of the canals.

The form of the bones, and their mode of adheſion to the ſac, deſerve to be noticed, particularly with reſpect to the largeſt.

It is commonly oblong from before backward, ſituated obliquely in the ſac, convex on its internal ſurface, and concave on its external.

The internal ſurface is ſmooth, but marked with a furrow, which varies according to the ſpecies. The external ſurface has ſome aſperities. The ſuperior margin is uſually denticulated in a more conſpicuous manner than the inferior, and the anterior extremity has frequently ſome tubercles or projections; there are two of theſe in the oſſiculum of the *pike*, the *mackrel*, and the *herring*; three on that of the *carp*, which has the middle one in the form of a ſtyle. In the *cod*, and other *gadi*, the *roach*, the *labrus*, &c. the anterior extremity is rounded, and has no points.

The proportional ſize of this bone varies conſiderably; it is ſmall in the *eel*, the *ſtar-gazer*, the *pleuronectes*, the *dory*, and the *pike*. Of a

 middling

middling ſize in the *herring;* and large in the genus *gadus*, (particularly in the *cod*,) in the *carp*, and a number of the thoracici.

Its general form is oval in the *cod*, and moſt of the *gadi;* it is almoſt round, with an inward angle in the genus *cyprinus*, as the *carp*, the *bream*, the *tench*, the *roach*, and alſo in the genus *ſilurus*. In the *pike*, the *ſalmon*, and other *trouts*, and in the *ſturgeon*, &c. it is irregularly triangular.

The furrow on the internal ſurface of the bone appears to form, with an internal production of the membrane of the ſac, a ſmall canal, which paſſes through a part of the interior of the ſame ſac: this furrow is commonly longitudinal; ſometimes it is ſhaped like a horſeſhoe; it is almoſt circular in the *carp*. In the *cod*, its place is ſupplied by an elevated ridge.

Some tranſverſe ſtriæ are almoſt always obſerved to extend from the furrow to the edge; they are intended to lodge the numerous nervous filaments which ſuſpend the bone: theſe ſtriæ are more particularly conſpicuous in the *carps*, which have them radiated.

The denticulations on the edge of the bone are nearly equal all round in the *cod*, and in the *carp*, but the former has them blunt, and the latter pointed; they are found on one ſide only in the *ſalmon*, *trouts*, and *perches*. The *congre eel* has only three, which are on the ſuperior margin, &c.

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The fecond officulum of the internal ear of fifhes is ufually fituated behind the large bone, but a little more outwardly; it is moft commonly of a femi-lunar form, the concave part being turned forward; it is of a particular fhape in the *carp*, fimilar to the head of a fpear; its fize varies, but it is always much fmaller than the firft.

The third officulum, we have already obferved, is within the finus; fometimes it is fo near the largeft of the bones, that it can fcarcely be diftinguifhed at firft fight. In the genera *gadus*, *fcomber*, &c. it is triangular; in the *trigla*, lenticular. The *pike* has it rounded, and unequal. It is proportionally larger in the *carp*, than in the other genera, and its furface is fcabrous, and the edge ferrated.

Cafferius, who firft defcribed the organ of hearing in fifhes, confidered thefe bones as analogous to the *malleus*, *incus*, &c. of quadrupeds.

It has fince been conjectured, and Camper, in particular, has fhewn, that fubftances thus fufpended, in a tremulous gelly, which is calculated to be put in motion by the flighteft external vibrations, may communicate the concuffions to the numerous filaments of the auditory nerve, to which they are connected.

A feptum is formed within the fac, by means of its internal membranes, united with thefe officula, and their nervous fibres: this ftructure induces us to confider the facs as analogous to

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the organ, with two apartments, which is, in man, called, from its form, the cochlea.

D. *In Fiſhes that have fixed Branchiæ,*

We find the ſame parts as in the other ſpecies, but they are differently diſpoſed. The ſituation of the ſac is nearly horizontal, and its figure is triangular. The angle which is neareſt the brain, is prolonged in a canal which penetrates the cranium, and extends to the external ſkin, where it is cloſed by only a thin membrane: this ſmall membrane may be diſtinguiſhed without diſſection, becauſe it forms a ſmall external depreſſion near the nucha; it is, perhaps, analogous to the feneſtra ovalis in animals, of a more elevated order, and performs alſo the functions of the tympanum.

The ſecond angle of the ſac is poſterior; it is round or oval, and contains the largeſt of the cretaceous ſubſtances. The third angle is directed forward and outward, and the two ſmall cretaceous bodies are ſituated near it.

There are three ſemi-circular canals, each of which has a bullular enlargement, or ampulla, as in the other fiſhes: one is anterior, and directed obliquely forward and outward: the ſecond is external, and horizontal: the third is poſterior, and ſituated in a plane, which is almoſt vertical, and directed backward and outward. Thoſe extremities of the three canals, which

which have no ampulla, communicate with the internal angle of the ſac ; the firſt and the third near the feneſtra rotunda, and the ſecond a little lower. As to their other extremities, the firſt and the ſecond unite, and communicate, by a common canal, with the external angle of the ſac ; the ampullaceous extremity of the third enters the ſac ſeparately, very near the place whence its other extremity ariſes.

The whole of this organ is, as uſual, filled with a gelatinous pulp. The ſolid parts contained in the ſac do not reſemble thoſe of the oſſeous fiſhes, with reſpect to their conſiſtence. They are not harder than moiſtened ſtarch, and may be bruiſed by the fingers : the largeſt of theſe ſubſtances is rounded on one ſide, and compreſſed and recti-linear on the other ; the two ſmaller are nearly oval.

All theſe obſervations are common to the *rays* and *ſharks*. The ſpecies of theſe two genera differ from each other only in the proportion of the canals and the ſac ; but the variations thus produced are very unimportant.

E. *In Reptiles.*

The membranous labyrinth in this claſs is, in general, compoſed, as in the fiſhes, of three canals and a ſac : but there are ſome ſpecies which have an additional part.

In the *ſalamanders*, whoſe ear, like that of

 fiſhes,

fiſhes, conſiſts of the labyrinth only. The three canals are ſituated above the ſac; they are depreſſed ſuperiorly, and form together a triangle which is almoſt equilateral; each has its ampulla, and the ſac contains a body of the conſiſtence of ſtarch, as in the *rays* and *ſharks*.

Frogs and *toads* differ very little from *ſalamanders*, with reſpect to the membranous labyrinth; they have the ſame parts in the ſame poſition, and their ſac alſo contains one amylaceous ſubſtance: their three canals form nearly a complete circle, by their junction with the ſac.

Crocodiles and *lizards* have alſo three canals, but they are larger, and each approaches nearer to a perfect circular form: the ſac is ſituated proportionally more within the head; its membranous parietes are furniſhed with ſeveral blood-veſſels, which are particularly conſpicuous in the *crocodile*. The ſolid parts it contains are three in number, and they are ſmaller, and even ſofter than thoſe of the Chondropterygious fiſhes. Laſtly, their labyrinth is rendered remarkable, by having an additional part to thoſe we have already deſcribed: this is the firſt veſtige of the cochlea; it is a production of the ſac, in the form of a cone ſlightly arched; it is directed, under the cranium, towards the middle line, and is divided into two compartments, or rather canals, by a double cartilaginous ſeptum: one apartment communicates with the ſac; the other, which is a continuation of the firſt, reflected on itſelf, terminates at a very ſmall hole, which is cloſed by a membrane that ſeparates it from the cavity of the tympanum.

This organ is preciſely ſimilar to that which is found in all birds. Comparetti was the firſt who deſcribed it in *lizards*. It is very large in the *crocodile*, and may be eaſily prepared from young ſubjects.

It is more difficult to find this part in the *camelion*, and the *marbled-lizard*. A veſtige of it may be obſerved in the *ſerpents*. The production which may be compared to this trumpet, or rudiment of the cochlea in the *tortoiſe*, is very ſimilar to the part we named the ſac, ſtrictly ſo called, in fiſhes; and this reſemblance conſiſts not only in its form, but in the ſmall amylaceous ſubſtances it contains: this ſeems to leave no doubt of the analogy between the ſac and the cochlea in man, or of that between the part we called the ſinus, and the veſtibule. We muſt, therefore, judge of the perfection of the labyrinths of theſe different ears, by the degree in which the cochlea is developed.

Tortoiſes and *ſerpents* have the ſemi-circular canals, like the other reptiles. In the tortoiſe they are proportionally very ſhort.

The *warm-blood animals* have the labyrinth always cloſely enveloped by bones; and in all the ſpecies, it is compoſed of three ſemi-circular canals, each of which has an ampulla; of a ſinus common to theſe canals, called the veſtibule;

bule; and of an organ, with two canals or ſcalæ, called *cochlea*, but which is not really ſpiral, except in the Mammalia.

F. *In Birds.*

The part correſponding to the cochlea in birds, we have already obſerved, reſembles that of the crocodile; it is conical, ſlightly arched, obtuſe at the point, and ſituated obliquely from before backward, and from without inward, under the inferior part of the cranium. The ſeptum, which ſeparates it into two ſcalæ, is compoſed of two narrow cartilaginous laminæ, united by a thin membrane throughout the whole of their length, and ſlightly twiſted on themſelves; they adhere weakly to the parietes of the cochlea. The poſterior ſcala is ſhorter, and communicates with the cavity of the tympanum by the feneſtra rotunda, which is cloſed by a membrane. The anterior and longer ſcala penetrates into the veſtibule, and is not cloſed.

The veſtibule is ſmall, and almoſt round. The ſemi-circular canals are diſpoſed in the following manner: the largeſt is vertical, and directed obliquely from behind forward, and from within outward: the ſecond is horizontal, and directed outward: the third is vertical, croſſes the ſecond, and takes a courſe which is the oppoſite of that of the firſt.

In the Paſſeres the firſt canal is ſmalleſt, and ſituated

ſituated farther back with reſpect to the other two, than in other birds. The other differences are not important : they appear, however, more conſiderable in the birds of prey, particularly the nocturnal kind ; and in the Paſſeres, than in the Gallinæ and the Palmipedes.

In the *caſſowary* and the *oſtrich* the cochlea approaches more to a vertical poſition ; and of all birds, the *oſtrich* has the ſmalleſt cochlea, in proportion to the other parts. The *gooſe* is the ſpecies in which it proceeds moſt directly towards the middle line.

G. *In Mammalia.*

The labyrinth of the mammalia does not differ from that of other animals, except that the cochlea is really formed with ſeveral ſpiral turns round a conical axis, and may, therefore, with propriety, be compared to the ſhell of a ſnail.

The three canals are almoſt equal in *man* ; they do not croſs each other ; the horizontal is rather the ſmalleſt ; the anterior, or vertical canal, and the poſterior, are united at one of their extremities ; each of the three has a ſmall ampulla ; the veſtibule is a little rounded ; the cochlea is ſituated forwards, and a little inward ; the plane of its baſe is almoſt vertical, and directed obliquely from behind forward, and from without inward. The breadth of the baſe does not exceed that of the horizontal canal.

The ſpiral part forms two turns and a half; it diminiſhes rapidly, ſo that the cochlea approaches, upon the whole, to a globular form. As the axis is oblique, one ſcala is anterior and external, and the other internal and poſterior. The internal, which is neareſt the baſe of the cochlea, is a little longer than the other, and turns back, to terminate in the feneſtra rotunda, which communicates with the barrel, or cavity of the tympanum. The external, which is nearer the apex, extends to the veſtibulum, which is itſelf connected with the cavity of the tympanum by the feneſtra ovalis. The relative proportions of the parts of the labyrinth vary conſiderably in the different ſpecies.

In *bats*, properly ſo called, but more particularly in the *horſe-ſhoe bat*, the cochlea greatly exceeds the ſemi-circular canals in magnitude: the breadth of the cochlea in the *horſe-ſhoe bat* is four times greater than the circumference of one of the canals, and the diameter of its cavity is ten times longer than theirs.

This diſproportion is much leſs conſiderable in the *ternate bat*.

In moſt of the Sarcophaga, and in the *hog*, *elephant*, and *horſe*, the cochlea is alſo larger, in proportion to the canals, than in man. But in the *mole* it is ſmaller. The *hare* has it alſo proportionally

portionally ſmaller than man. Its proportion in the Ruminantia is nearly the ſame as in man. In all theſe animals it has the ſhape of thoſe ſhells which cónchyologiſts call turbinated, that is, of a round or globular cone. The number of the turns is as in man, two and a half.

The *guinea-pig*, the *cabiai*, and the *porcupine*, have a turriculated cochlea, with three turns and a half; theſe are the only examples I know of this number. The *common rat* has, like the other quadrupeds, only two and a half.

The cochlea is very large in the Cetacea, and all its parts are well developed; but the ſpiral part remains nearly in the ſame plane, without riſing upon its axis; it makes, beſides, only a turn and a half. The ſemi-circular canals are ſo ſmall, that Camper long denied their exiſtence. They are, however, in other reſpects, ſimilar to thoſe of the reſt of the mammalia, and I have made a very perfect diſſection of them in the fœtus of the *whale*.

The proportion between the two ſcalæ of the cochlea is not the ſame in all mammalia: that which goes to the tympanum is ſomewhat larger than the other in *man*, the *dog*, the *ſloth*, the *elephant*, the *horſe*, the *dolphin*, &c. The difference is very remarkable in the *bat*. The ſcalæ are nearly equal in the *hippopotamus* and the *hog*. That which communicates with the veſtibulum, is the largeſt in the *calf*, the *goat*, the *ſheep*, the

hare,

hare, the *rat*, the *guinea pig*, the *cat*, &c. But even in theſe animals, the part of the ſcala of the tympanum, which is very near the feneſtra rotunda, widens and becomes broader than the other.

In mammiferous animals in general, the labyrinth, conſidered as a whole, is much ſmaller, in proportion to the reſt of the head, than in birds. It contains no ſolid parts in theſe two claſſes; we obſerve only ſome white parts, which proceed from the expanſion of the extremities of the nervous filaments, in the gelatinous pulp which fills it. Of theſe we ſhall ſpeak hereafter.

ARTICLE III.

Of the Manner in which the Membranous Labyrinth is contained in the Bones, or of the Oſſeous Labyrinth.

THE membranous labyrinth of vertebral animals is more completely contained in the bones, and more cloſely embraced by them, in proportion as thoſe animals are more perfect, and poſſeſs ears, with which the external element freely communicates.

A. *In*

A. *In Fishes that have free Branchiæ,*

The labyrinth is contained in the same cavity as the brain: the parietes of the cranium afford only some depressions for receiving it, and it is retained in these hollows by vessels and cellular substance. Only a part of the semi-circular canals is situated in pulleys, or short osseous canals.

In the *moon-fish* the large lateral depression of the cranium, which contains the ear, is divided by only two small cartilaginous columns, one of which is horizontal, and furnishes a pulley to the posterior semi-circular canal: the other is vertical, and affords one to the horizontal canal; but as the interval between these columns and the parietes of the cranium is ten times greater than the diameter of the canals, they are suspended in that space by vessels and cellular substance. The anterior vertical canal has even no column of this kind, and there is no depression for the sac in the base of the cranium.

The cartilaginous columns become broader in the *frog-fish*, and approach more to the parietes of the cranium. In the osseous fishes they are still farther enlarged, and there is constantly a certain portion of all the semi-circular canals contained in others, which are formed of bone. The posterior and horizontal canals are always more enclosed than the anterior; the latter

latter has only a ſmall oſſeous pillar in the *eel*, the *pike*, the *roach*, and the *mackrel*. It has merely a furrow in the *dory*, and ſome of the jugulares. It has an oſſeous canal, which is a little longer, in the *cod* and the *carp*: the other two are almoſt ſunk in the bones. In the *ſalmon* and the *carp* the ſac is commonly ſituated in a depreſſion at the baſe of the cranium. In proportion as the ſac is farther removed from the ſinus or veſtibule, the foſſa, which receives it, becomes deeper. This may be obſerved in the *cod*, but particularly in the *carp* and the *herring*, which have the ſac cloſely enveloped in an oſſeous antrum, that has no outlet, except one for the narrow canal, which joins the ſac to the ſinus.

In all the oſſeous fiſhes, the ſinus, and the extremities of the canals, are at liberty in the cavity of the cranium, and the nerves have not to paſs through bones in order to reach them.

In the *ſturgeon*, the ear begins to ſeparate from the cavity which contains the brain. The three canals are placed in cartilages, throughout the whole of their length: the cartilaginous canals, which receive them, are ſomewhat larger than they are; the ſac, to which they are joined, is cloſely applied to the ſide of the cranium; and between it and the cavity for the brain, there is a very thick membrane, connected by ſeveral ligamentous productions, and perforated by ſeveral holes for the paſſage of the nerves.

B. *In*

B. *In the Chondropterygii,*

Or fiſhes that have fixed branchiæ, as the *rays* and the *ſharks*, the whole of the membranous labyrinth is encloſed in a particular cavity, formed in the ſubſtance of the cranium; this cavity is ſituated on the ſide and poſterior part of that which contains the brain, with which it does not communicate, except by the holes that afford paſſages for the nerves.

This cavity ſeems moulded upon the membranous labyrinth itſelf; it is compoſed, in the ſame manner, of three canals, and of another, with which they join. But all theſe parts are conſiderably larger than thoſe they contain, and the latter do not adhere to the parietes of theſe cavities, but are ſuſpended in them by veſſels, nerves, and cellular ſubſtance. In conſequence of the ſize of the external labyrinth, the termination of the membranous ſemi-circular canals are ſituated within the cavity which contains the ſac of the amylaceous bodies. The holes, through which the nerves paſs, correſpond with this cavity on the internal ſide; externally it communicates with the hole called feneſtra ovalis, which is cloſed only by a membrane, and by the ſkin which paſſes above it.

C. *In Reptiles.*

The offeous labyrinth of reptiles refembles that of the Chondropterygii, that is to fay, it envelopes the whole of the membranous labyrinth, but in a manner more or lefs clofely.

In the *tortoife*, the feptum which feparates the veftibule from the cranium, is not offified; it remains partly membranous.

In the *crocodile*, and other *lizards*, the offeous labyrinth clofely embraces the membranous, or completely covers it by a thin and hard lamina.

D. *In Birds and Mammalia.*

The membranous labyrinth in thefe claffes is fo completely, and fo clofely encafed by the bones, that its nature has long been mifunderftood. It has moft commonly been regarded as the internal periofteum of the cavities in which it is contained. When obferved in a dry ftate, and fhrivelled up into hard filaments in thefe cavities, it has been defcribed under the name of the nervous zones of the femi-circular canals, or the membranous feptum of the veftibulum.

Scarpa and Comparetti have, however, affigned to this part its proper importance. Indeed, when we examine it in young and recent fubjects, we find that it does not differ from the

the analogous membrane in fiſhes : that it is really the eſſential part of the labyrinth, and that the oſſeous cavities ſerve only as its caſe.

The oſſeous labyrinth of birds is formed by a thin and hard boney plate, ſo exactly fitted to the membranous labyrinth, that we can even diſtinguiſh in it the ampulla of the ſemi-circular canals : as it is ſituated in the ſubſtance of the temporal and occipital bones, the two tables of which are ſeparated by only a very open diploe, which is eaſily removed, it may, without much trouble, be laid bare, ſo as to afford a view of all the parts.

Some of theſe parts, particularly two of the ſemi-circular canals, are even viſible within the cranium, without any preparation. The auditory cells, of which we ſhall ſpeak hereafter, and which form vacant ſpaces around and within the intervals of the labyrinth, render its preparation ſtill more eaſy.

In mammalia, the labyrinth is uſually enveloped by the ſubſtance of the pars petroſa of the os temporum, which is ſo denſe in the adult animal, that the two parts cannot be diſtinguiſhed. The cavities which compoſe the labyrinth, appear to be hollowed out in that petrous ſubſtance, in the ſame manner as quarries, or mines, are formed in rocks.

It is only in the fœtus that the oſſeous labyrinth can be diſengaged from the ſubſtance which envelopes it, and which has not then

 acquired

acquired the ſame degree of hardneſs as the laminæ, of which it is formed.

There are, however, ſome ſpecies, and they are of the number of thoſe which hear beſt, that have not the petrous ſubſtance around the thin lamina of their oſſeous labyrinth.

In the *mole*, for example, the three ſemi-circular canals are diſengaged, and viſible on the interior of the cranium, without any preparation. The cochlea is enveloped by cellular ſtructure, almoſt as lax as that of birds.

The enormous cochlea of *bats* is viſible, without any preparation, under the baſe of the cranium, where it forms a conſiderable projection, ſimilar to that made by the cavity of the tympanum, in a number of ſpecies: their ſemicircular canals may be obſerved within the cranium, in the ſame manner as thoſe of the *mole*.

In the *hare-lipped bat* (*veſpertilio Leporinus*,) the cochlea projects within the cranium.

In the *guinea pig* (*cavia cabaya*,) and in the *cabiai* (*cavia capybara*,) it projects into the tympanum, under the two feneſtræ, in the form of a nipple. It has the ſame appearance in the *marmotte* and the *porcupine*; and is more or leſs ſimilar in all the Rodentia. It alſo projects a little within the tympanum in the *elephant*.

The Cetacea are the animals which have the ſubſtance of the pars petroſa hardeſt.

From the deſcription we have given of the mem-

membranous labyrinth, it will be eaſily perceived, that the oſſeous veſtibule muſt have five holes for the extremities of the ſemi-circular canals; one for the ſcala of the cochlea, which communicates with it; and one communicating with the cavity of the tympanum, which is the feneſtra ovalis.

We ſhall not ſtop to deſcribe the differences which occur in the ſize, ſhape, and relative poſition of theſe ſeven holes.

The oſſeous cochlea turns round a conical axis; it may be compared to the fuſee of a watch; the proportions of its height and baſe vary according to the ſpecies. The ſection of each turn of the oſſeous cochlea is not round; there is, on each ſide of the axis, a ſharp ridge, which is the ſection of the oſſeous part of the ſpiral lamina that divides all theſe turns into two ſcalæ.

In man, only that portion of the lamina which touches the axis is oſſeous; the other part is entirely membranous. The ſame ſtructure, however, does not prevail in all mammiferous animals. In the *dolphin* there is only one very narrow fiſſure, which divides the lamina, throughout its whole length, into two parts; that which touches the axis being three times larger than the other. The fiſſure only is completed by a membrane in the freſh ſtate.

In the *dolphin* alſo, the oſſeous part of this ſeptum, which touches the axis, has, under its bafe, and in the fcala that joins the tympanum, a fmall canal, following the fame curvature from one extremity of the cochlea to the other; the tranfverfe fection of this canal is round, and its parietes are very flender; it might be regarded as forming a third fcala in the cochlea, but it is probable that it ferves to envelope a veffel or a nerve; befides, its diameter diminifhes in the oppofite direction of that of the fcalæ, and it is largeft towards the apex of the cochlea. In the Ruminantia we alfo obferve a fimilar canal, but proportionally much fmaller.

We have fufficiently defcribed the external form of the os petrofum of quadrupeds, in Articles III. and IV. of Lecture VIII. That of the Cetacea deferves to be confidered feparately; it is not articulated with the bones of the cranium, but is fufpended by ligaments under a cavity, or vault, which is fituated on each fide of the bafe of the cranium, and principally formed by the os occipitis.

The os petrofum may itfelf be confidered as formed of two portions foldered together, viz. the cavity of the tympanum, which we fhall defcribe at the end of the next Article; and the petrous part, properly fo called, which contains the labyrinth.

The fuperior furface of this fecond portion has, towards its internal edge, a femi-circular eminence, which correfponds to a hole in the bafe of the cranium, and where we obferve a depreſſion, which is the internal meatus auditorius. The cochlea is ſituated in this eminence. The external portion of the os petroſum is conſiderably larger than the eminence we have juſt pointed out; it partly forms an arch above the cavity of the tympanum; it is oblong in the *dolphins*. In the *cachalots* it is coarſely rounded, and prolonged backward into a ſcabrous proceſs. The *lamantin* has it deeply bilobated.

We ſhall now briefly notice the *aquæducts*. Theſe are two canals, which form a communication between the labyrinth and the interior of the cranium, different from that which affords a paſſage for the nerves; one goes to the veſtibulum, near the common orifice of the two united ſemi-circular canals; its orifice, on the ſide of the cranium, is triangular, and ſituated above and behind the meatus auditorius internus: the other ariſes from the cochlea, at the ſcala tympani, very near the feneſtra rotunda, and opens into the cranium, under the inferior edge of the os petroſum, and below the internal meatus: theſe aquæducts are found in all the mammalia. They are very large in the *dolphin*, particularly that of the tympanum.

In ſome other mammiferous animals, as the *elephant* and the *horſe*, the laſt duct forms only a narrow fiſſure on the ſide of the cranium. I have not ſufficiently examined them in the other ſpecies of this claſs.

According to Comparetti, two analogous canals are found in birds, but their ufe appears to us ftill doubtful.

Article IV.

Of the Cavities fituated between the Labyrinth and the external Element, or, Of the Cavity of the Tympanum, and its Appendages.

In the *fifhes with free branchiæ*, whether cartilaginous or boney, the labyrinth has no communication externally: all the parts of the ear are inclofed within the cranium, and covered by the bones.

In the *fifhes with fixed branchiæ*, or the Chondropterygii, the labyrinth communicates by a fmall canal, with an aperture fituated behind the head, and clofed by a membrane and the fkin: there is nothing befides this between the ear and the furrounding element.

Among the reptiles, the *falamander* has the labyrinth completely enclofed within the cranium, and deprived of all external communication, as in the fifhes that have free branchiæ: but the other genera of the fame order have all a feneftra, called *oval*, fupporting an offeous plate, analogous to the bone, called ftapes in man.

man. The *lizard* genus has another aperture, but which is closed only by a membrane, and which receives the name of *fenestra rotunda*. These two apertures exist in all birds, and in all quadrupeds, as has already been shewn.

The cavity, which is situated anteriorly, and which is more or less complicated in different animals, is called the *barrel*, or *cavity of the tympanum*; it communicates with the mouth by a canal, or by a simple wide aperture, called the *Eustachian tube*: another aperture affords a communication with the external element; it is sometimes shut by a thin membrane, at other times covered with a thick, or even scaly skin; these parts are called *membrana tympani*.

The osseous plate, which covers the fenestra ovalis, is connected by a handle-like production of a single piece, or by a chain of ossicula, articulated with each other, and with the membrane of the tympanum, and may therefore communicate the impressions received by the latter, to the interior of the vestibulum.

The cavity of the tympanum forms the subject of description in the present Article.

A. *In Reptiles.*

The barrel, or cavity of the tympanum, cannot be said to exist in *serpents*: the stalk of the plate is surrounded by the flesh, and its extremity touches

touches the ſkin, near the articulation of the lower jaw.

In *toads* and *frogs*, the whole of its poſterior part is membranous; it communicates immediately with the back of the mouth, by a large hole, which may be ſeen on opening the mouth of the animal. It is very ſmall, and almoſt entirely membranous in the *pipa*, in which the labyrinth is connected with the feneſtra ovalis by only a very long canal.

It is alſo membranous poſteriorly and inferiorly in the common *lizards*, and in the *camelion*; it communicates with the bottom of the palate by a ſhort wide canal.

The barrel of the *crocodile* may be divided into two parts: one external, which is very wide, and cloſed on the outſide by the membrane of the tympanum, and the ſkin, but entirely ſurrounded by the bones; and one internal, which is ſeparated from the former by a contraction, and which communicates with the two feneſtra, and with ſome cavities analogous to the maſtoid cells of man, but much larger: one of theſe cavities is placed between the ſemicircular canals, and the other is directed backward and outward; the barrel is ſituated towards the ſuperior part of the cranium.

The cavity of the tympanum in the *tortoiſe* is placed more laterally; it is not ſo wide externally; and the contraction, which ſeparates the

the external part from the internal, is lefs confpicuous, becaufe the projection, which it forms, is rounded, and not acute, as in the *crocodile*. The internal portion is prolonged backward, in the form of a large round cell : in the bottom of the cavity, oppofite to the membrane of the tympanum, there is a narrow canal, in which the offiulum is funk, and which communicates with the feneftra ovalis. The Euftachian tube is a canal of a moderate length, which proceeds downward, and a little backward, and terminates in the palate, behind and within the articulation of the jaw.

B. *In Birds.*

The cavity of the tympanum is alfo very wide on the outer part, in birds : its pofterior and inferior parietes are formed by a projection of the os occipitis : the anterior is, in a great meafure, completed by a bone peculiar to birds, called *os quadratum*. We fhall defcribe this bone when we treat of the articulation of the lower jaw.

It communicates with three large cavities, which are more or lefs prolonged into the fubftance of the bones of the cranium, and which particularly characterize the organ of hearing in birds. Thefe cavities, being inclofed by thin and elaftic offeous lamina, are doubtlefs very fonorous, and confiderably augment the effect

effect of found, with refpect to the labyrinth, which they furround on all fides. In the *owl* genus, particularly in the *white owl (ftrix flammea)*, they are more extenfive than in any other birds; the firft opens into the fuperior part of the tympanum, and extends through the whole breadth of the occiput, as far as the correfponding cavity of the oppofite ear, with which it unites above the foramen magnum; the fecond enters the barrel at its pofterior and inferior part; this cavity extends only between the femicircular canals, and is the fmalleft of the three; the third communicates with the anterior part of the barrel of the tympanum, above the Euftachian tube: it paffes above that tube, and extends through the breadth of the bafe of the cranium; it unites with the cavity of the other fide, under the part which contains the pituitary gland: thus the barrels of the tympana, in the *white owl*, communicate by two different channels: the third cavity furrounds the part analogous to the cochlea.

This vaft extent of cells, attached to the barrel of the tympanum, is found in the *white owl* only. In the other *common* and *horned owls*, the cavities are a little contracted, and they diminifh more and more down to the *caffowary* and the *oftrich*, which, of all birds, have them the fmalleft. The *goat-fucker*, a nocturnal bird, to which a quick fenfe of hearing is neceffary, has them very large. Diurnal birds of prey, and the

the Gallinæ, have the firſt cavity, and the third, in the form of a narrow conical tube, without any communication from the one ſide of the head to the other: the ſecond, or that between the ſemi-circular canals, is larger in the diurnal birds of prey than in the owls, becauſe they extend outward, behind the poſterior edge of the barrel; theſe cavities are generally ſmall in the Anſeres and Grallæ. They appear to be entirely wanting in ſeveral ſpecies of *parrots*, in which the internal ſubſtance of the bones of the cranium is uniformly a very looſe diploe: their tympanum, however, has a more conſiderable concavity poſteriorly, than that of other birds.

The Euſtachian tube is completely oſſeous in birds; it is a conical canal, which commences at the anterior and inferior part of the tympanum, by a large aperture, and which paſſes under the third cavity, deſcribed above, from which it is ſeparated by only a thin lamina; it proceeds obliquely inward, contracting gradually, and terminates in a ſmall aperture very near the middle line, and conſequently alſo very near the tube of the other ſide; theſe two apertures open into the palate behind the internal nares.

The two feneſtra, by which the labyrinth of birds communicates with the cavity of the tympanum, are ſituated one above the other, in a depreſſion oppoſite to the membrana tympani; an oſſeous bar ſeparates them. The feneſtra called *ovalis*, or that which communicates with the veftibulum, is above the feneftra named *rotunda*, which communicates with the cochlea; but they are both of an oval fhape; the feneftra rotunda is the largeft, and frequently exceeds the fize of the other confiderably.

C. *In Mammalia.*

The cavity of the tympanum, in mammiferous animals, prefents very remarkable differences, as to dimenfions, form, ftructure, and internal arrangement.

In *man* this cavity forms almoft a hemifphere, and the membrane may be regarded as its great circle; it neither projects without nor below the cranium; its parietes are very unequal; that which is oppofite to the membrane of the tympanum, has an angular elevation, which afcends obliquely from before backward, and which is named the *promontory*. The *feneftra ovalis* is above it: the longeft diameter of this feneftra is tranfverfe, and almoft double the fmaller; it is exactly oppofite to the membrane of the tympanum: the *feneftra rotunda* is below the promontory; it is directed a little downward and backward; they are both a little funk. There are fome flight excavations in the barrel of the tympanum, which might be compared to the cells of birds, but could only be regarded as very minute veftiges of them; they are not fimilar ſimilar in all individuals; there is one above and before the oval feneſtra, and another behind the round; the latter communicates in adults with the cells, which are formed, at a certain age, within the maſtoid proceſs of the temporal bone. The Euſtachian tube begins at the anterior and inferior part of the barrel, by a hole which is nearly round; it firſt forms an oſſeous canal, which is directed downward and inward, towards the point of the os petroſum, where it is narroweſt; it is continued from this place as a cartilaginous canal, which is enlarged, as it advances, and terminates in the back of the mouth, near the internal pterygoid proceſs, and conſequently near the poſterior orifice of the nares of the ſame ſide, by a wide aperture, like the end of a trumpet, the edge of which forms a projecting burr, or roll.

1. *External Form of the Cavity of the Tympanum in Mammalia.*

Amongſt *apes*, the *guenons* and the *maggots* have not the os petroſum more prominent under the cranium than we obſerve it in man, and the barrel, or cavity of the tympanum, remains concealed within it: the maſtoid proceſs becomes very ſmall, or is almoſt obliterated; but the maſtoid cells extend farther into the reſt of the temporal bone.

In the other mammiferous animals, beginning with the *ſapajous*, the barrel increaſes conſiderably

ably in ſize, and forms a large protuberance under the cranium.

This protuberance is oval; and its great axis is longitudinal in the *ſapajous*, *badgers*, *civets*, and *martins*.

It is a little rounded, and its great axis is directed obliquely inward, in *dogs*, *cats*, and *coatis*.

It is almoſt round in *hares* and *beavers*.

It is ſemi-ſpherical in *ternate bats* and *pangolins*.

It is more or leſs angular in the Ruminantia, the *cabiai*, the *ſloth*, the *hippopotamus*, the *elephant*, and the *rhinoceros*.

It is plain in the *mole*, and touches that of the other ſide, which makes the cranium appear ſmooth inferiorly.

In the *ant-eaters*, the floor of the noſtrils being continued between the two barrels, their projection, under the cranium, cannot be obſerved.

In the *bear* there is no protuberance.

In the *hog* there is a long projection, like a ſac or a club, which is moſt contracted at the part joining the cranium.

In moſt of the digitated mammalia there is no maſtoid proceſs, except a ſlight protuberance ariſing from this projecting part of the barrel, or the barrel itſelf ſupplies the place of that proceſs: but in the *cabiai*, the *guinea-pig*, *hogs*, the Ruminantia, and *horſes*; there is, behind the tympanum, a long proceſs, which anſwers

ſwers to the maſtoid. It belongs, however, to the occipital bone.

In moſt of the Sarcophaga and Rodentia, the parietes which form this projection are thin, hard, and leave a large vacancy between them. In *hogs*, on the contrary, the whole of the interior is compact and cellular.

In the Carnivora and the Rodentia, the ſurrounding lamina which encloſes the cavity of the tympanum, is distinguiſhed from the reſt of the os petroſum by a ſuture, and is not united to it until theſe animals reach an advanced age.

In *cats* and *civets* it is itſelf ſubdivided into two parts by another ſuture: the poſterior portion has much reſemblance to a cochlea, and, except the difference in thickneſs, is perfectly repreſented by the barrel of the *whale*.

2. *Internal Diviſion of the Cavity of the Tympanum, and Maſtoid Cells.*

The oval frame which ſupports the membrane of the tympanum, is almoſt parallel to the oppoſite ſide of the cavity; it correſponds nearly to the middle of that ſide in *man*, the *monkey*, the *dog*, the *badger*, *weaſles*, Rodentia, Ruminantia, &c. In all theſe animals, the promontory correſponds to the middle or poſterior part of the tympanum; but a ſpace always remains between it and that membrane; and the parts of the barrel ſituated before and behind the promontory, are not ſeparated in a marked manner.

In the *cat* and *civet* genera, however, there is an offeous procefs, which extends from the pofterior and inferior edge of the frame of the membrana tympani, to the promontory, and which, being prolonged obliquely, divides the barrel into two unequal parts that communicate together only by a hole. The anterior and external cavity is the barrel of the tympanum, properly fo called, and contains the officula and the feneftra ovalis. The other part, which is much larger, contains the feneftra rotunda. In the *lion*, this feneftra correfponds precifely to the line of feparation, and is fituated at the hole by which the two parts communicate. The pofterior part may be regarded as analogous to the large cells of birds, and it appears to be given only to animals that are remarkable for a quick fenfe of hearing.

In a number of Sarcophaga, and even in thofe I have named, there is another offeous ridge, but not fo broad as the former, and tranfverfe: it appears to ferve merely as a fupport to the frame of the membrana tympani. The *horfe* has a number of fimilar pieces.

In the *fapajous* and the *ant-eaters*, the cavity has alfo an additional cell formed by an offeous feparation; but this cell is fituated before the cavity of the tympanum, properly fo called, or that part to which the membrana tympani belongs. The *floth* has a cell at the bafe of the zygomatic arch.

The

The barrel or cavity of the tympanum in the *elephant*, has no ſeptum; but its ſides are furniſhed with a great number of prominent laminæ, which croſs each other in every direction, and produce a multitude of irregular cells and ſinuſes. We find the veſtiges of ſimilar cells in the irregularities and depreſſions of the barrel in ſeveral Rodentia, particularly the *cabiai*, the *guinea pig*, the *marmotte*, and the *porcupine*.

In the *hippopotamus*, the barrel, properly ſo called, is extremely ſmall; but it communicates by a hole with another cavity, divided internally into a great number of irregular cells, analogous to thoſe of the *lion*, *civet*, &c.

In the *ſeal*, and the *morſe*, the cavity of the tympanum is very large, rounded on every ſide, and undivided.

3. *Form and Proportions of the Feneſtra Ovalis, and Feneſtra Rotunda.*

We have already ſhewn, that the feneſtra rotunda, which communicates with one of the ſcalæ of the cochlea, is only cloſed by a membrane. As it is always directed backward, we may ſuppoſe that it is chiefly deſtined to receive the ſounds produced by the reſonnance of the poſterior chamber of the barrel, which we have juſt deſcribed, and which is ſo diſtinct in nocturnal animals, the *cat*, the *lion*, &c. Scarpa

 conſiders

confiders this membrane of the feneftra rotunda as a fecond membrana tympani.

In Man, the fhape of thefe two feneftræ is conformable to the names which are given to them, though they are not perfectly regular. The oval feneftra is a little larger than the round.

In the other animals the variations are fo confiderable, both with refpect to figure and dimenfions, that the terms, oval and round, are no longer applicable: we fhall fubftitute in their ftead, the names *feneftra veftibularis*, and *feneftra cochlearis*.

Monkies have them fimilar to thofe of man.

In *bats*, the feneftra cochlearis is the largeft.

Both feneftræ are oval in the *mole*: a bar extends from one edge of the feneftra veftibularis to the other, and paffes between the legs of the ftapes. This occafioned the miftake of Derham, who believed that the ftapes of the mole had no plate, but that one of its legs refted on the feneftra ovalis, and the other on the feneftra rotunda. The fame ftructure is found in feveral other mammiferous animals. In the *marmotte*, the offeous bar, which paffes between the legs of the ftapes, is fo thick, that when the latter bone is removed, there appears to be two feneftræ veftibulares: this bar is always hollow, and affords a paffage for fome veffels.

In the Sarcophaga, the feneftra cochlearis is commonly the largeft; it is nearly double the fize ſize of the other in *cats* and *civets*. The *ermine* has them almoſt equal. In the *opoſſum*, the feneſtra veſtibularis is round; the cochlearis is irregular and ſmaller.

In the *beaver* and the *marmotte*, the latter is triangular. In the *hare* it has the form of a ſmall, and almoſt perpendicular fiſſure. The veſtibularis is round, and much larger.

The *guinea pig* has them nearly equal, both directed upward, and ſeparated only by a thin bar.

They are both oval, and nearly equal in the Edentata.

In the Ruminantia the cochlearis is the largeſt. The *calf* has it nearly double the ſize of the other. It is alſo twice as large, and ſituated very near the other in the *hog*. It is three times larger than the veſtibular hole in the *hippopotamus*. In the *elephant*, on the contrary, it is very ſmall, irregular, and concealed behind an elevation of the promontory.

The cochlear feneſtra is largeſt in the Solipeda and the Cetacea.

4. *Euſtachian Tube.*

The oſſeous part of this tube preſents few differences that are remarkable in quadrupeds. That part is ſhorter in the Sarcophaga than in man. In *cats* and *civets* it is rather a narrow fiſſure, than a canal: it might be repreſented as a vacant ſpace in the ſuture, which unites the

the bone of the barrel to what ſhould be ſtrictly called the pars petroſa.

The *otter*, the *badger*, and the *weazle*, &c. have a ſimple hole, ſeparated from the reſt of the cavity of the tympanum by a projecting longitudinal ridge. In the *hare*, the origin of the tube within the barrel is a triangular foramen. In the *cabiai* it commences by a half-formed canal, which becomes complete in piercing the point of the os petroſum.

In the *elephant* it is a long and wide canal, which begins under the membrana tympani, and terminates at the point of the os petroſum; its parietes are ſmooth, and have no cells.

We have not yet ſufficiently examined the cartilaginous part of the tube in quadrupeds to enable us to deſcribe it.

In the *horſe*, the lower end of the cartilaginous tube opens into a large membranous ſac, ſituated at one ſide of the back of the mouth; this ſac, on ſome occaſions, is filled with pus, and then produces a dangerous preſſure on the pharynx.

D. *Particular Deſcription of the Barrel, or Cavity of the Tympanum, in Cetacea.*

The cavity of the tympanum in the Cetacea deſerves to be deſcribed ſeparately; it is formed by an oſſeous lamina, which has the appearance of being rolled upon itſelf, and which, with

reſpect

refpect to its figure, may be compared to the fhell, called *bulla*, except that the thick fide, inftead of containing a fpiral cavity, is entirely folid: this thick part is internal; it is more than two inches thick in the *cachalot*; its edge is blunt and rounded; the oppofite fide is thinner, and its edge is irregular: the membrane of the tympanum is fituated between two of its proceffes: this barrel adheres to the os petrofum by its pofterior extremity, and by a procefs of the anterior part of its thin edge. In the *dolphins*, the anterior procefs of the barrel alfo afcends to the os petrofum; but in the *cachalots* it does not reach that part. The anterior extremity of the cavity is entirely open, and there the membranous tube commences; this tube afcends along the pterygoid procefs, and perforating the os maxillare, terminates at the fuperior part of the nofe. This pofition of the orifice, as well as the fize of the tube, muft render it more ufeful than the meatus externus to the Cetacea, in diftinguifhing founds. In treating of the fenfe of fmelling, we fhall fhew that, by a ftructure not lefs fingular, the Euftachian tube alfo conveys the odoriferous emanations to the place where that fenfe refides.

The aperture by which this tube communicates with the nofe, is furnifhed with a valve, which does not permit the water to enter when the animal ejects it by the blow holes.

ARTICLE V.

Of the Membrane of the Tympanum, and its Offeous Frame.

THE membrane, which clofes the external aperture of the barrel, and which immediately receives the vibrations of the air, and tranfmits the impreffions to the internal ear, is called *membrana tympani*, or fometimes fimply *tympanum.*

1. *Subftance of the Membrana Tympani.*

Animals which want the barrel of the tympanum, as fifhes, falamanders, &c. have no membrana tympani. That membrane is alfo wanting in feveral reptiles that have a barrel, as the *camelion:* the fkin paffes over the external aperture of their ear, without undergoing any change, either in its thicknefs or its ftructure, and the exiftence of the organ of hearing can only be afcertained by diffection. On removing the fkin, and fome portions of the mufcles, we find, in fome fpecies, and particularly in the *flow worm (anguis fragilis)* a kind of membranous expanfion.

In the *tortoife*, the large external aperture of the barrel is clofed by a very thick cartilaginous plate, which is itfelf covered by a fcaly fkin, perfectly fimilar to that of the reft of the head.

In *frogs* and *toads*, the membrana tympani is on a level with the head, and the ſkin that covers it becoming finer, it is rendered perceptible by an oval ſpot, which is ſmoother than the reſt of the head, and uſually of a particular colour.

In *common lizards*, the membrana tympani is alſo level with the head, but very thin, ſmooth, and tranſparent, for at that part the ſkin becomes as ſmooth and fine as on the cornea of the eye.

In the *crocodile*, it is of the ſame nature, but more ſunk into the head, and covered by two fleſhy lips, which ſupply the place of the external ear.

All warm-blooded animals, *birds*, *Cetacea*, and *quadrupeds*, have, like *man*, the membrana tympani thin, tranſparent, dry, elaſtic, more or leſs ſunk into the head, and preceded by a canal, to which, in ſome of theſe animals, is ſuperadded the concha, or external ear.

Notwithſtanding its fine texture, the membrana tympani is at leaſt divided into three lamina: one, which is proper to it; one internal, which is the continuation of the internal membrane of the barrel, and which is itſelf derived from that of the mouth; and one external, which is a production of the ſkin.

2. *Surface and Direction of the Membrana Tympani.*

The membrane of *man*, and all other mammiferous

miferous animals, has a conical ſurface, the point of which is directed inward, and the concavity outward; this cone is very wide, and its apex does not correſpond to the middle of its baſe. The *mole*, however, forms an exception to this rule, as its membrana tympani is plane.

In all birds, the diſpoſition is the contrary of that of the mammalia: the apex is on the outer part.

In *lizards*, though the point projects leſs than in birds, it is alſo directed outward. It is nearly plane in *frogs* and *tortoiſes*.

The membrana tympani is on a level with the adjacent parts of the head, and conſequently is nearly vertical in all animals in which its ſituation is ſuperficial; but in thoſe which have it ſunk, its inclination, whether conſidered with relation to the head itſelf, or to the external meatus, varies conſiderably. We ſhall conſider it with reſpect to the head, which muſt be ſuppoſed upright, and the plane of the palate horizontal.

The membrane of the tympanum inclines obliquely upward, and to one ſide in the *crocodile*: obliquely downward, backward, and laterally in moſt birds; and even more downward, in proportion as the bird hears weak ſounds more diſtinctly. In the *owl* it is, therefore, very oblique. It is more vertical in the *gooſe* and the *parrot*.

In quadrupeds, the membrana tympani is alſo

alſo more oblique, with reſpect to the external canal, and inclined more downward, in proportion as the animal hears better. The *mole*, which has the ſenſe of hearing very delicate, notwithſtanding the want of the concha, has the membrane almoſt parallel to the baſe of the cranium, and anſwering as a floor to the barrel of the tympanum: this diſpoſition doubtleſs takes place, in order that the membrane may be rendered more extenſive. Another rule may, therefore, be deduced from obſervation, namely, that the larger the membrana tympani, all other circumſtances being equal, the more acute is the ſenſe of hearing.

In *otters*, *weazels*, and *badgers*, the membrane of the tympanum is almoſt as oblique as in the *mole*. It is alſo very oblique in the *pangolin*.

It is nearly vertical, and directed forward, in *man*, *apes*, *dogs*, *cats*, *civets*, and *coatis*.

It is almoſt vertical, and turned directly towards the ſide, in *hares*, *cabiais*, *marmottes*, and the greater number of Ruminantia.

3. *Frame of the Membrane of the Tympanum.*

The membrana tympani is attached to an oſſeous circle, which is called its *frame*. This frame forms the extremity of the meatus auditorius externus, next the barrel, and is that portion of it which firſt oſſifies; it is nearly round, and makes only a ſlight projection inward, before which there is a furrow in man. In a great number

number of mammalia, it forms a projection within the barrel, which reprefents a narrow plate, circularly or elliptically twifted, one of the edges of which is attached to the external part of the barrel, and the other is unconnected. This free edge is more or lefs fharp and wide, according to the fpecies; it is frequently fuftained by fome prominent fpines, which proceed from different parts of the barrel, and join it perpendicularly. We have already noticed them in the laft article.

This projecting frame is not perfectly complete. A fegment, which, according to the fpecies, is a greater or lefs portion of its circumference, is almoft conftantly wanting towards the upper part. The *guinea-pig*, the *paca*, the *feal*, and the *ant-eater*, are the only animals in which I have obferved it entire. In the latter, however, it projects fo little, that it is difficult to diftinguifh where it terminates.

It wants almoft the whole of its upper quarter, in the *cat*, the *dog*, the *rabbit*, and the *rat*. The part wanting is rather proportionally fmaller in the Ruminantia and the Solipeda. The *elephant* wants all the upper half.

The figure of the frame is commonly an oval, with the great axis defcending obliquely forward, and the anterior arch lefs convex than the pofterior. This oval is more oblong in the Sarcophaga than in herbivorous quadrupeds. It approaches a circular form, and has its fides almoft almoſt equal in the *guinea-pig* and the *paca:* next to them the *rabbit* has it moſt regular.

Man and the *ant-eater* have it almoſt circular. It is perfectly round in the *mole.*

In the Cetacea, the membrane of the tympanum, properly ſo called, has no frame; but the barrel has three proceſſes, which produce irregular notches in the aperture, and give it the figure of three unequal lobes.

In birds the frame of the membrana tympani is not ſo well defined as in quadrupeds, and does not project within the barrel. In ſome ſpecies, as the *white owl,* it is complete: others, and frequently very nearly allied ſpecies, as the *great-horned owl,* have it interrupted at its anterior part, and the membrane is attached to the ſquare bone for the articulation of the lower mandible, a proceſs of which, as we have already obſerved, always forms a part of the anterior parietes of the barrel, or cavity of the tympanum.

The figure of the frame of birds is alſo an oblique oval, the great axis of which deſcends obliquely forward; but it uſually approaches more to the round form than in quadrupeds.

The direction of the great axis is leſs forward in ſeveral paſſeres; but all theſe differences are of little importance.

In reptiles, the frame is not marked by any prominent edge; it is interrupted poſteriorly. Its great axis is vertical in the *tortoiſe* and the

common

common lizards, and its anterior arch is more convex. In the *crocodile* it is a regular oval, the great axis of which is directed obliquely backward.

ARTICLE VI.

Of the Officula which eftablifh a Communication between the Membrana Tympani and the Feneftra Ovalis, and of their Mufcles.

I. *Of the* BONES.

ALL the animals which have a real feneftra veftibularis, have it clofed by an offeous plate of the fame fhape. This plate communicates by a pedicle or ftalk with the membrana tympani, or, when that membrane does not exift, with the fkin, or parts near it. The ftalk is fometimes fimple, and forms, with the plate, only one and the fame officulum; fometimes the communication is maintained by two or four little bones of very different figures. This chain of officula is moft complicated in the Mammalia, and with them we fhall commence our defcription.

A. *In Mammiferous Animals.*

All the Mammalia have four officula, which are named *Malleus, Incus, Os Lenticulare,* and *Stapes.*

The

The *malleus* is always formed of an elongated handle, which is thin and pointed, and which adheres to the membrana tympani, in the direction of a line extending from the fuperior edge of that membrane to the apex of its cone; and of a head which makes an angle with the handle, and extends backwards and a little upwards within the cavity of the tympanum.

The *incus* joins the head of the malleus by an articular furface. Its oppofite part is divided into two points; one proceeds directly backward; the other defcends in a direction nearly parallel to the handle of the malleus, but a little more backward and inward. The extremity of this fecond procefs articulates with the *officulum lenticulare*, which is the fmalleft bone in the body of mammiferous animals, and by it with the *ftapes*. The latter takes its name from its figure, which is that of a ftirrup. It forms almoft a right angle with the branch of the incus which fupports it, and proceeding directly inward, applies its oval plate or bafe to the feneftra ovalis. Each of thefe bones varies in its fize, figure, and pofition in the different fpecies. We fhall examine fome of thefe varieties.

1. *The Malleus.*

In *man*, the handle of the malleus, or hammer, is flightly compreffed, and bent a little, in fuch a manner that its point is directed obliquely forward; the head is a little fhorter than the handle,

handle, and forms with it an angle of 120 degrees; it is terminated by an oval mafs, rounded at the end, the pofterior fide of which prefents to the incus an articular furface, compofed of four fmall planes. At the angle, formed by the head and the handle, there is a fmall fpine directed upward, which is called the *fhort procefs of the malleus*. The neck, or portion of the head, which is a little contracted, has anteriorly a flender procefs, which is prolonged like a ftile, and which is named *proceffus gracilis:* behind and above the neck there is alfo a fmall lamina projecting obliquely.

The malleus of the *orang outang* does not differ from that of man, except in having the head a little more pointed.

In the *fapajou* the head is one half fhorter than the handle. The articular furface occupies the whole of the pofterior part. The proceffus gracilis is continued in a plate, which extends along the whole of the anterior edge. It is very confpicuous in the *guenons;* but in them the head is alfo in a right line with the handle, and forms a projection forward. It is not diftinguifhed from the handle in the *fimia beelzebul,* except by its fudden enlargement.

In *dogs* and *cats,* the handle has the figure of a long pyramid with three fides, the narroweft of which adheres to the membrana tympani. The angle, which the head forms with it, is as large as in man; the neck is flender, and turns forward;

forward ; but the proceſſus gracilis, or anterior apophyſis, which is very long, is extended into a thin plate, and occupies the whole of the angle included between the head and the handle. The ſhort proceſs is very prominent : there is another apophyſis at the internal ſurface of the neck, which ſupplies the place of the ſmall ſpine in man.

The other Sarcophaga preſent no differences, except in the length of the proceſſes. The anterior, for example, is longeſt and narroweſt in the *badger*, and ſhorteſt and broadeſt in the *otter*.

It is very broad in the *mole*, and gives to the malleus a figure nearly rhomboidal.

In the Rodentia, the handle is compreſſed like the blade of a knife, and adheres to the membrane of the tympanum by one of its edges. The neck makes an obtuſe angle with the handle, which bears, as uſual, the ſhort proceſs. The head, after receiving the incus on its poſterior ſurface, has its thick portion ſituated in the oppoſite direction, that is to ſay, forward. This maſſy portion is oval in the *cabiai* and the *guinea pig*, and pointed in the *rabbit* and the *rat*. The handle of the *ſloths* reſembles that of the Rodentia; the head is like that of the human malleus. In the *ant-eater* it differs from the form it has in the *ſloths*, in the neck only, which is thinner; and in the *pangolin*, in having the ſame part very ſhort.

In all theſe animals, reckoning from the Rodentia, the ſmall internal apophyſis, or poſterior procefs of the neck, is almoft obliterated. It is, however, found very diftinct in the *hog* and the Ruminantia, which have the malleus very fimilar to that of the Sarcophaga.

The *feal* has the handle compreffed; and the neck fhort, with fcarce any anterior procefs; the head is flightly flattened, and circular from before backward.

There is no handle in the *dolphin*; but the membrana tympani has the form of an elongated tunnel, and its point is fixed at the bafe of the neck, which feems obliquely truncated. The anterior procefs is long and arched. The articular furfaces for the incus are not directed entirely backward, but partly upward, on account of the pofition of the labyrinth above the barrel. The malleus of the *whale* is, in every refpect, fimilar to that of the *dolphin*, but double its fize.

2. *The Incus*,

Or anvil, exhibits fewer differences than the malleus. In all the mammalia thefe two bones are articulated by a very clofe ginglymus, compofed at leaft of two furfaces, and moft commonly of four, in fuch a manner that each bone has a convexity croffed by a concavity. The principal variation in the incus of different fpecies, occurs in the relative length and thicknefs of the two proceffes.

In *man*, the fuperior procefs, which is attached to the bone of the barrel by a ligament, is fhorter and thicker than the inferior, which is articulated

lated to the ſtapes, through the medium of the os lenticulare; the latter is arched in ſuch a manner that its convexity is directed outward; they form nearly a right angle at their junction. The ſame diſpoſition takes place in the *orang outang*.

In the *guenons*, the ſuperior proceſs becomes nore ſlender. It is almoſt as long as the other n the *ſapajous*. In *monkies*, in general, the ar-icular depreſſion becomes deeper.

The two proceſſes are ſlender, and nearly qual, in the *cat*. The *dog* has them like thoſe f man. *Weaſels*, *otters*, and *ſeals*, have the ſu-erior very ſhort. The incus of the *mole* is ingular; its inferior, or ſtapedian proceſs, is ery ſhort and ſmall; the other is very large, blong, and hollowed poſteriorly like a ſpoon. 'erhaps it ſerves to lodge a muſcle.

Hares and *rats* have the ſtapedian proceſs very ng, and the other ſcarce viſible. They are iore equal in the *cabiais*.

They are nearly equal, and make an obtuſe igle, in the *ſloths*.

The ſuperior is moſt ſlender in the *ſheep*.

They are both directed upward in the *dolphin*.

3. *The Oſſiculum Lenticulare,*

Or *orbiculare*, notwithſtanding its ſmallneſs, ries as to form in different ſpecies, but the erations it undergoes are too minute to be 'elt on here.

4. *The Stapes.*

This oſſiculum differs, in ſeveral ſpecies, in the ſeparation and curvature of its branches, in the extent of the vacancy between them, and in the figure of its baſis or plate.

In *man*, for example, the branches are arched, and the baſis or plate is ſemi-oval.

In the *ſapajou*, the branches are nearly ſtraight, and the baſis forms a narrow ellipſis.

No animal has the branches more arched, and proportionally more ſeparate than the *mole*, in which the baſis has the figure of an elongated and narrow ellipſis.

In all animals, the poſterior branch is thicker than the anterior. Inſtead of the two branches, the Cetacea have a ſolid body, compreſſed conically, and perforated by only a very ſmall foramen. In the *lamantin*, this part of the ſtapes repreſents a twiſted cylinder; on one ſide there is an oblique groove, and the foramen has the appearance of the puncture of a pin. The ſurface, attached to the feneſtra ovalis, is exceedingly convex.

B. *In Birds.*

Birds have only one oſſiculum, compoſed of two branches, which form an elbow: the firſt is attached to the membrana tympani, from its inferior and poſterior edge, to the apex of the projecting cone, which that membrane forms externally; its direction is, therefore, almoſt the

the contrary of that of the malleus, to which this branch correſponds. At its union with the ſecond part of the bone, there are two cartilaginous proceſſes, the poſterior of which joins a third branch, which runs back to the firſt part of the bone. In this manner, a triangle, nearly right angled, is formed, the three ſides of which are attached to the membrane of the tympanum. The other part of the oſſiculum makes an acute angle with this firſt branch, and then paſſes directly into the barrel, in the form of a ſlender oſſeous ſtalk; it there expands a little, and ſometimes is divided into two or more ſmall oſſeous filaments, after which it terminates in an oval or triangular plate, which, like the baſis of the ſtapes in mammalia, cloſes the veſtibular feneſtra. There is no difference among birds with reſpect to this oſſiculum, except in its ſize, and the ſhape of the plate. The ſmall branches, which adhere to the membrana tympani, vary, it is true, in their relative inclination and magnitude, but in a manner too unimportant to merit notice.

C. *In Reptiles.*

The *frog* and the *toad* have two oſſicula in the ear; one ſupplies the place of the malleus, and the incus: it is attached to the membrana tympani by a ſlender branch which forms an acute angle with the part that paſſes into the barrel; that part has the ſhape of a club; its internal extremity is the thickeſt, and articulates by a double ſurface to the ſecond oſſiculum, which correfponds to the ftapes: the latter has a femi-elliptic form, and is applied to the feneftra ovalis by its plane furface; both thefe bodies, which are offeous in other animals, are cartilaginous in the *frog* and *toad*.

Lizards and *tortoifes* refemble birds, in having a fingle officulum with a thin hard ftalk, and an oval or triangular plate. It is attached to the membrane of the tympanum in the *lizards*, and particularly in the *crocodile*, by a cartilaginous branch; but in the *tortoife*, its outward extremity is directly implanted in the cartilaginous mafs, which correfponds to the membrana tympani itfelf.

In the *crocodile*, the plate is an elongated ellipfis, the great axis of which is fituated longitudinally.

In the *tortoife*, the bone is enlarged in the form of a trumpet, and is applied to the feneftra by a regularly oval and concave furface.

Serpents have an officulum, but no membrana tympani; its external extremity touches the bone that fupports the lower jaw; it is furrounded by the flefh, and is applied to the feneftra by a concave plate, the edges of which are irregular.

In the *camelion*, the plate alfo refembles the wide end of a trumpet; its ftalk becomes cartilaginous, and is loft in the flefh.

The feneftra veftibularis of *falamanders* is clofed only by a fmall cartilaginous operculum, which has no ftalk, and is concealed by the flefh.

II. *Of*

II. *Of the* Muscles.

In man and other mammiferous animals the officula have four mufcles; three to the malleus, and one to the ftapes.

The incus has no mufcle: its head is attached to the pofterior furface of the head of the malleus, and the extremity of its fuperior procefs is fixed to the temporal bone in the upper and pofterior part of the bottom of the barrel of the tympanum. It fhares in all the motions of the malleus, which makes it act like a balance upon its fixed point.

The mufcles of the malleus are,

1. *The Tenfor Tympani, or Internus Mallei.*

This mufcle arifes from the cartilaginous part of the Euftachian tube, and runs in a half formed canal fituated in the os petrofum, upon the offeous part of that tube. Soon after it enters the barrel, it reaches an eminence fituated before the feneftra ovalis, which has been likened to the fpout of an ewer. Its tendon turns upon this eminence. It is then directed outward, and inferted into the internal furface of the manubrium mallei under the proceffus gracilis. It pulls the malleus completely inward, and ftretches the membrane of the tympanum: by the motion which the malleus communicates to the incus, the fuperior leg of which remains fixed, its inferior leg muft defcribe an arch from without

 inward,

inward, and preſs the ſtapes into the feneſtra ovalis.

2. *The Externus Mallei,*

Proceeds parallel to the preceding muſcle, but more outwardly. It is inſerted into the ſlender proceſs of the malleus, which is itſelf lodged in a ſmall canal formed above the ſuperior edge of the frame of the membrana tympani. This muſcle is ſo delicate that its real nature can ſcarcely be aſcertained. When it acts, it muſt draw the malleus forward, and thereby ſtretch the poſterior half of the membrana tympani, and communicate a balance-like motion to the incus. In this movement the head of the incus is lowered, the extremity of its inferior proceſs is directed backward, and a tremulous ſhock is given to the ſtapes in the feneſtra ovalis.

3. *The Laxator Tympani.*

This muſcle ariſes from the arch of the meatus externus, near the membrana tympani, paſſes through the notch of the frame of that membrane, and is inſerted into the ſmall oblique proceſs, on the neck of the malleus: it pulls that bone outward, and thereby relaxes the tympanum. In conſequence of the motion communicated to the incus, it muſt, at the ſame time, draw the ſtapes a little from the feneſtra ovalis.

The ſingle muſcle of the ſtapes, or—

The Stapedius,

Lies within the cavity of a projection ſituated behind

behind the feneſtra ovalis, near the poſterior edge of the barrel, which is called the *pyramidal eminence*. Its tendon comes forth from the cavity, and proceeds directly to the poſterior part of the ſtapes, which it pulls backward, raiſing at the ſame time its anterior part a little.

We have not examined theſe muſcles in a great number of mammalia; but we have ſeen moſt of them, and particularly the ſtapedius, and tenſor tympani, in ſeveral ſpecies, in which they have preſented few varieties.

The malleus of the *dolphin* appears to have no muſcle, but there is evidently one to the ſtapes, which is attached very far up, and not in the middle of one of the branches, as in man.

The preſſure of the ſtapes on the feneſtra ovalis muſt have a double effect: it firſt agitates the whole interior of the labyrinth:—ſecondly, it compreſſes the gelatinous ſubſtance which the labyrinth contains, and forces it through the cochlea, on the membrane of the feneſtra rotunda, which will thereby be rendered more tenſe.

The ſecond effect muſt, in particular, depend upon a fixed preſſure produced by the action of the muſcles: theſe are doubtleſs contracted, when we wiſh to liſten with great attention.

As to the ſimple concuſſion, or ſhock, it may be cauſed merely by the agitation communicated to the membrana tympani by the vibrations

tions of the air: this is, probably, one of the immediate caufes of hearing. Animals that have no mufcles to their officula, are only fufceptible of this kind of impreffion: it would be interefting to difcover whether they are capable of paying more or lefs attention to founds.

Birds have a fmall mufcle behind the ear, on the occiput; it penetrates into the barrel by a hole, and is inferted into the hypotheneufe of the fmall right-angled triangle, formed on the membrana tympani by the three branches of the officulum: this mufcle ftretches the membrane, by drawing its conical apex more outward. Two filaments, which appear to be tendinous, oppofe the action of this mufcle, and prevent it from becoming too great: one filament, which is very long, arifes from the anterior procefs of the cartilage attached to the tympanum, and is fixed in the cell fituated above the Euftachian tube; the other afcends, and is inferted into the column which feparates the entrance of that cell from the one above the labyrinth.

We are not fufficiently acquainted with the mufcles of the internal ear of reptiles; and the defcriptions of Comparetti do not poffefs that clearnefs which might enable us to fupply the want of our own obfervations.

It appears that *ferpents*, *camelions*, and *falamanders*, are entirely deftitute of thofe mufcles, and that they are very indiftinct in *tortoifes*.

Article VII.

Of the Meatus Auditorius Externus, of the Concha, and of the Mufcles of the External Ear.

The reptiles have no external meatus auditorius. In the *crocodile* only we find fome appearance of that part, becaufe the fkin forms a kind of lip, or operculum, above the membrana tympani; and the latter is entirely concealed, except when this covering is removed. This is, doubtlefs, the part which Herodotus regarded as the external ear of the *crocodile*, and to which, he fays, the Egyptians attached rings.

The external meatus of birds is very fhort; the orifice is commonly only a fimple hole, level with the head, and furrounded with feathers of a particular ftructure; they are fine and elaftic, and their radii, or beards, are fimple, fmall, elaftic, feparate from each other, and allow the air to pafs between them. Thefe feathers are placed with much regularity about the aperture which they cover. In fome birds they are elongated, and affume various forms, as in the *buftard*, the *tufted-necked humming bird (Trochilus ornatus)*, a fpecies of *bird of Paradife*, *(Paradifea aurea,)* &c.

In the *owls*, the external orifice of the ear is fituated in the bottom of a large cavity, hol-
lowed

lowed out on each ſide of the head, and lined by a naked ſkin, the folds of which form ſepta, which divide it like the human concha; this cavity would, indeed, reſemble the external ear of man, were it projecting, and capable of motion.

The fine feathers which cover the cavity, form the circles that give to the phyſiognomy of thoſe birds its ſingular character. The *white owl* has a membranous operculum, of a ſquare form, at the anterior edge of the cavity.

We ſhall now examine the external ear in man, and other mammiferous animals.

1. *The external Oſſeous Meatus.*

The external meatus is oſſeous at its inner part, or that next the tympanum. The tubular portion of the cartilage of the external ear is attached by membranes and ligaments to this bony part; it ſometimes forms only a ſingle piece with the concha, and ſometimes is ſeparate from it.

The Cetacea are the only mammalia that have no oſſeous meatus: their external meatus is a very ſlender cartilaginous canal, which commences at the ſurface of the ſkin, where, in the *dolphin*, it would ſcarcely admit a pin; it takes a ſerpentine direction, as it paſſes through the lard, under the ſkin, to reach the membrana tympani.

In all the other families there is an oſſeous canal,

canal, of greater or lefs length; at leaft in adults, for it is longer in offifying than moft of the other bony parts of the ear. The frame of the membrana tympani only is offified in infancy, and preferves its fize, while the reft of the temporal bone continues to increafe.

In man, the external offeous meatus is fhort, ftraight, and directed almoft horizontally inward, and a little forward; its fection is an oval, the great axis of which defcends from before backward; its diameter remains nearly the fame throughout its whole length.

It is, proportionally, a little longer and narrower in the *guenons*, and ftill more fo in the *Barbary ape*; it defcends a little in thefe fpecies, but is not directed fo far forward as in man; it is very fhort and circular in the *fapajous* and the *bats*.

The Sarcophaga, in general, have it like man, nearly horizontal. In *dogs*, *cats*, and the *badger*, it proceeds directly inward, and does not incline either forward or backward.

It is directed a little forward in the *coati*.

In the *otter*, the *pole-cat*, and, in general, in the genus *muftela*, it is directed backward.

The external canal of the *mole* is very fingular; it is flat in the vertical direction, but enlarges in the horizontal; and the great circular membrana tympani ferves for its roof, in the fame manner as it forms the floor of the barrel.

This canal is directed very much downward in in the Rodentia, particularly in the *hares*. It alſo proceeds forward in this genus, and in the *marmotte*.

Its direction is inward and downward in the *beaver*.

The *porcupine* has it turned backward.

In the *cabiais*, and the *agoutis*, it is ſhort, and runs ſtraight inward; under its inferior edge there is a hole, which penetrates into the cavity of the tympanum, and, in ſome ſpecies, unites with the meatus by a fiſſure.

The *ſloths*, *pangolins*, and *ant-eaters*, have the external meatus very ſhort, wide, and circular.

In the *elephant* it is large and long, and is directed a very little downward and backward.

It deſcends at an angle of 45 degrees in the *rhinoceros* and the *hippopotamus*, but is neither directed forward nor backward. In the *babirouſſa* it has the ſame inclination, but is directed a little forward. In the *common hog* it deſcends ſtill more, and alſo inclines forward. All theſe animals have it very long and very narrow.

It is ſhorter in the *horſe*, in which it deſcends leſs abruptly, and is inclined a little backward.

Laſtly, in the Ruminantia it proceeds directly inward, with a ſlight inclination upward.

II. *The external Cartilaginous Meatus, and the Concha.*

The Cetacea excepted, there are very few mammi-

mammiferous animals which have not, at the orifice of the external meatus, that kind of cartilaginous expanſion, like the end of a trumpet, which is called the *concha*.

Thoſe which want it are, in the Sarcophaga, the *mole*, and ſome *ſhrews*. In the Rodentia, the *zemni*, and ſome *mole rats*. In the Edentata, the *pangolins*. And in the amphibious mammalia, the *morſe*, and ſeveral ſpecies of *ſeals*.

We obſerve great varieties in the concha, or external ear of different animals: theſe variations relate to its ſize, poſition, figure, and internal eminences, to the compoſition of its tube, and, finally, to its muſcles.

a. *Size.*

The animals which are remarkable for the ſize of the ear, are almoſt all timid or nocturnal, and therefore require a delicate ſenſe of hearing, as the feeble Ruminantia, the *gazelles* and *deer*, the *aſs*, *hares*, and ſome ſmall Rodentia, but particularly the *bats*.

In the laſt genus, there are ſeveral ſpecies which have the ear as large as the whole of the head; and one ſpecies, the *eared bat (veſpertilio auritus,)* has it as large as the body.

The *African elephant* is diſtinguiſhed by a large, flat, open ear, ſituated cloſe to the body, and therefore not well calculated to anſwer the purpoſe purpofe of an acouftic trumpet. The ear of the *Indian elephant* is fimilar, but much fmaller.

b. *Direction.*

Naturalifts have remarked, that the aperture of the concha is moft frequently directed forward in the animals that hunt for their food, and backward in thofe that are their prey; but this pofition depends upon the neceffity of the moment, and not upon any peculiar ftructure of he organ. All animals which have ears of a certain length, may vary their direction at pleafure, except, perhaps, the *vefpertilio fpafma*, which has the two great ears united by their internal edges, and confequently very little moveable.

Ears with the fuperior part of the concha pendent, are a mark of flavery. *Dogs, fheep, goats*, and *hogs*, have them always thus in fome of their domeftic varieties. The *elephant* has alfo a pendulous ear, but unlike the preceding animals, it is the pofterior and inferior part of the ear that hangs down.

c. *Figure.*

The concha of the human ear has the fhape of half an oval, more contracted inferiorly, and terminated by a lobe which is filled with fat. The anterior edge adheres to the reft of the fkin, and is almoft rectilinear, with the exception of the

he eminences, of which we ſhall ſpeak pre-
ently: the ſuperior and poſterior edges are free,
nd directed outward.

In the *orangs* and *ſapajous*, the lobe dimi-
iſhes, and the free part becomes more conſider-
ble, but remains round. In the *guenons* and
acaques, it is pointed a little ſuperiorly. In
he *ſtriated monkey (Simia jacchus)*, it is even
rooved poſteriorly by a ſinuoſity. The form
f the ear varies in the other genera, without
ny direct relation to the orders to which they
elong. In general it becomes more elliptical
s it increaſes in ſize; it belongs to ordinary Na-
ural Hiſtory to deſcribe thoſe ſmall variations
f ſhape, which are entirely external. It is ſuf-
cient, therefore, to refer our readers to plates
hich repreſent quadrupeds.

d. *Eminences.*

The eminences of the human ear are, 1. The
ld of its ſuperior and poſterior edge, called
lix; it turns inward, below its anterior part,
d is terminated above and behind the external
eatus. 2. The ſharp elevation, which is al-
oſt parallel to the helix poſteriorly, and which
terwards croſſes the ear obliquely, named
tihelix. 3. The eminence, ſituated before the
eatus, and denominated *tragus*. 4. That which
ſituated behind the meatus, which terminates
e antihelix inferiorly, and which is called
titragus.

The fold which forms the *helix* diminiſhes in *apes*, diſappears in the *ſapajous*, the *ſtriated monkey*, and in all other animals; they have all a ſharp edge to the ear. The *antihelix* becomes flat, and is replaced by a tranſverſe eminence ſituated very low down.

The *tragus*, which ſtill exiſts in the *dog*, is reduced in the *hares*, *horſes*, &c. to a ſlight projection of the ſuperior edge of the concha on the inferior.

In the *bats*, the tragus is particularly developed, and aſſumes very remarkable forms.

In the *eared bat*, it is ſo large that a double concha has been aſcribed to that animal: it is forked in the *veſp. ſpaſma;* notched in the *v. leporinus*, and the *v. crenatus;* oval, round, pointed, &c. in the other ſpecies. It may ſerve to prevent the too violent irruption of air into the ear while the animal flies. The *antitragus* of bats is generally round; it is ſometimes prolonged forward, beyond the tragus, to the angle of the mouth. It is found of that form in the *v. moloſſus*.

In ſome *ſhrews* the antitragus ſerves as an operculum to the ear. It cloſes it exactly in the *aquatic ſhrew* of Daubenton.

e. *Compoſition.*

The external ear of man conſiſts of a ſingle piece: the concha becomes tubular, and preſerves that form until it reaches the oſſeous meatus,

meatus, to which it is intimately united: we obſerve only one fiſſure or irregular inciſion.

In animals which have the ears rather long, and very moveable, the tube of the ear is divided into two parts, one of which is connected with the concha; the other forms a particular tubular cartilage, attached to the oſſeous meatus by a ligament, and has, like the portion united to the concha, a longitudinal fiſſure. In conſequence of this diviſion, the tube may be ſhortened and elongated, as well as dilated and narrowed.

Theſe animals have, beſides, a third cartilage, ſituated above the tube of the ear; it is flat, and forms no part of the concavity, but merely ſerves as a point of attachment for ſome muſcles. This cartilage is triangular in the *horſe*; lunated in the *ſheep*; pointed poſteriorly, and bifurbed anteriorly, in the *rabbit*; and rhomboidal in the *dog*. We ſhall call it the *ſcutum*.

III. *The* Muscles.

A. *In Man.*

The number and ſize of the muſcles of the external ear, depend upon its degree of mobility; their ſhapes and proportions on the poſition of that organ, which, in its turn, is influenced by that of the exterior orifice of the oſſeous meatus. This orifice is always ſituated cloſe behind the articulation of the lower jaw; it is, therefore,

 farther

farther back, and nearer the occiput, in proportion to the length of the jaws, compared with that of the cranium. It is alſo more elevated with reſpect to the whole head, in proportion as the aſcending branches of the lower jaw are higher, and the cranium more flat. Thus deſcending from man, we find that its ſituation becomes progreſſively more upward and backward, and that the two ears approach more and more towards each other, until we come to the Solipeda, in which the approximation is greateſt.

The muſcles which act on the human ear are reducible to three which ariſe from different parts of the head, and five which proceed from one point of the concha to another.

The three firſt are—

1. *The Superior Auris.*

This is a thin radiated muſcle; it covers a part of the temple, and is inſerted into the ſuperior portion of the convexity of the concha.

2. *The Anterior Auris,*

Which is ſmall, and not very diſtinct from the preceding; it ariſes near the zygomatic arch, and terminates in the anterior part of the convex ſide of the concha.

3. *The Poſterior Auris.*

This is a ſmall muſcle, divided into ſome flips which arife from the occiput, and are inferted behind the concha.

The five mufcles of the concha are—

1. *The Major Helicis.*

It arifes above the tragus, and is loft on the anterior edge of the helix.

2. *The Minor Helicis,*

Which is extended over that part of the helix which runs acrofs the concha.

3. *The Tragicus.*

The fibres of this mufcle are extended tranfverfely over the tragus.

4. *The Antitragicus.*

It arifes from the antitragus, and is loft cn the internal edge of the antihelix.

5. *The Tranfverfus Auris.*

This mufcle extends acrofs that hollow fold, on the back of the ear, which correfponds to the projection made by the antihelix upon the concave furface.

Thefe mufcles have no apparent ufe in moft men. Some of them have, however, been obferved to produce a flight motion of the ear.

B. *In Quadrupeds.*

The mufcles of the ears of quadrupeds are,

 in

in general, very numerous: they may be divided into four claſſes: 1. Thoſe which ariſe from the head, and are inſerted in the ſcutum: 2. Thoſe which have alſo their origin in the head, and are inſerted in the concha, or its tube: 3. Thoſe which proceed from the ſcutum to the concha: 4. Thoſe which extend from one part of the concha to another.

Theſe muſcles move the ear in every direction, or turn it on its axis in ſuch a manner that the ſuperior ſurface is ſometimes placed forward, ſometimes backward, and the inferior in the oppoſite directions. We ſhall deſcribe theſe muſcles in the *horſe*, the *ſheep*, the *rabbit*, and the *dog*.

a. *Muſcles which proceed from the Head to the Scutum.*

1. *The Vertico-Scutalis,*

Ariſes in the *dog*, from the middle line, along the whole of the upper ſurface of the head; and in the *horſe*, from the ſuperior edge of the temporal foſſa: it is inſerted into the ſuperior edge of the ſcutum. In the *ſheep* it is reduced to a band, which comes from above and behind the orbit; and in the *hare*, to a ſtill narrower ſlip, ariſing from the occipital creſt merely: this is the *communis* of Lafoſſe, and the *fronto-auricularis* of Girard; it raiſes both ears, and draws their convex ſurfaces towards each other.

2. *The Jugo-Scutalis.*

This muſcle ariſes in the *horſe* from the zygoma, aſcends backward, and is inſerted into the anterior edge of the ſcutum. In the *dog*, it comes from the ſkin of the cheeks, and expands conſiderably, as it proceeds upward, where it is inſerted, not only into the ſcutum, but alſo in the anterior edge of the preceding muſcle. It is wanting in the *hare* and the *ſheep*. It draws the ear forward, and a little upward.

3. *The Cervico-Scutalis.*

It comes from the cervical ligament, and is inſerted in the poſterior edge of the ſcutum; it is peculiar to the *dog* and the *rabbit*, and approximates the ears poſteriorly.

b. *Muſcles which proceed from the Head to the Concha, or to its Tube.*

4. *The Vertici-Auricularis,*

Ariſes from the crown of the head, paſſes under the vertico-ſcutalis, and expands on the concha towards its anterior edge; it is proper to the *horſe* and the *ſheep*, and approximates the conchæ very conſiderably while it elevates them.

5. *The Supercili-Auricularis,*

Supplies the place of the preceding muſcle

in

in the *hare* and the *dog*; it comes from the ſuperciliary-arch, paſſes before the margin of the ſcutum, and is attached to the concha. In the *hare* it is inſerted by a ſlender tendon. In the *dog* it is united throughout almoſt its whole length, to the anterior edge of the vertico-Scutalis, and is inſerted by an expanſion very near the anterior edge of the concha.

6. *The Cervici-Auricularis.*

It ariſes from the cervical ligament, paſſes behind the edge of the ſcutum, and expands on the concha, which it moves backward, and draws towards that of the other ſide.

7. *The Occipiti-Auricularis,*

Comes from the parts near the occipital creſt, and paſſes below the ſcutum and the laſt muſcle; it is attached to the concha, which it elevates, but does not move it backward. It is not found in the *hare*.

8. *The Cervici-Tubalis Profundus.*

It ariſes from the cervical ligament below the cervici-auricularis; it is inſerted at the origin of the tube of the ear, which it draws backward. It is double in the *horſe*, and wanting in the *hare*.

9. *The Occipiti-Auricularis Rotator,*

Ariſes from the poſterior part of the occiput, and

and is inſerted in the form of a band into the concha, near its tube: this muſcle is found in all long-eared animals; it turns the ear on its axis, by directing its concavity outward and backward when it is erect, and downward when it is horizontal.

10. *The Parotido-Auricularis,*

Which comes from the parotid gland, and the parts next the ſkin, is inſerted under the concha, near the tragus; it lowers the ear, and is always found. The *hare* has it longer than others.

11. *The Jugo-Auricularis.*

In the *ſheep* this muſcle is very conſpicuous; it ariſes from the anterior part of the zygomatic arch, and runs backward to its inſertion in the edge of the concha, next the meatus auditorius. In the *dog* it is double; one portion comes from the ſkin of the cheek; the other from the poſterior edge of the jugo-ſcutalis. In the *horſe*, one portion ariſes from the middle of the zygoma, and another from the poſterior edge of the jugo-ſcutalis; it draws the ear horizontally forward. It does not exiſt in the *hare*.

12. *The Jugo-Auricularis Profundus.*

This is a ſmall ſlender muſcle, found in all the before-mentioned animals; it is attached to the poſterior part of the zygomatic arch, near the articula-

articulation of the lower jaw, and extends to the part of the concha next the tube, a little ſuperiorly: it ſerves chiefly to ſhorten the tube of the ear.

The *horſe* has two muſcles belonging to this claſs, which are not found in the other ſpecies, viz.

13. *The Vertici-Auricularis Rotator.*

This muſcle comes from the top of the head near the occipital eminence; paſſes under the poſterior angle of the ſcutum, and over the occipiti-auricularis; proceeds obliquely forward, and is expanded, like a ſcarf, on the anterior part of the concha, near its tube: it turns the ear on its axis, directing the concavity forward and inward when it is erect, and upward when it is horizontal.

14. *The Vertici-Auricularis Profundus,*

Has a common origin with the preceding; it ſeparates from it under the ſcutum, and deſcends between the head and the concha; it is inſerted in that part of the latter, which is inward, when its concavity is directed outward, and which is neareſt the tube; its uſe appears to be to lengthen the tube of the ear.

c. *Muſcles which unite the Scutum to the Concha, or to the Tube of the Ear.*

α. The *ſuperficial,* which are attached to the ſcutum.

15. *The*

15. *The Scutalis Anterior,*

Extends from the inferior edge, and anterior angle of the ſcutum, to the front of the concha, which it turns on its axis, and directs upward and forward when horizontal. It is wanting in the *dogs* that have hanging ears.

16. *The Scutalis Poſterior,*

Proceeds from the ſame edge, and ſometimes from the ſame angle, and extends backward behind the concha, which it elevates. It is wanting in the *hare.*

β. The *deep-ſeated,* which are inſerted under the ſcutum.

17. *The Scutalis Rotator.*

This muſcle ariſes under the ſcutum, and proceeds in the form of a ſcarf, behind the part of the concha which is next the tube. It turns the concavity of that part towards the earth, and backward when it is horizontal. It is double in the *hare.*

d. *Muſcles which extend from one Part of the Concha of the Ear to another.*

There are no muſcles of this kind in the *ſheep,* and only one in the *horſe,* viz.

18. *The Tragicus.*

It is ſituated on the fiſſure of the concha, and produces

produces the croſſing of the edges of that part; it conſequently contracts the aperture of the external meatus; it alſo exiſts in the *dog* and the *hare*. In the latter it is accompanied by

19. *The Tubo-Helicus,*

Which comes from the cartilaginous tube of the concha, and which ſhortens the tube of the ear.

We find in the *dog*,

20. *The Plicator Auris.*

This muſcle is analogous to thoſe of the helix in man; it extends along the anterior edge of the concha, near its baſe; it folds, and depreſſes the ſuperior part of the ear.

Laſtly, the *dog* and the *horſe* have, on the back of their concha,

21. Some ſcattered fleſhy fibres which are analogous to the tranſverſus auris of man.

ARTICLE VIII.

Of the Diſtribution of the Nerves within the Ear.

WE have deſcribed the *meatus auditorius internus*, in pages 46 and 56 of this volume. Its bottom is ſituated nearly oppoſite to the middle of of the cochlea. It is divided into two foſſæ by an oſſeous ridge. The ſuperior contains a hole for the facial nerve, and a number of ſmall foramina for a branch of the auditory nerve. The ſecond alſo contains ſeveral foramina for the other branches of the auditory nerve.

We have deſcribed the origin of this nerve pages 151 & 177; and its courſe to the ear, pages 233 and 234. The inferior foſſa through which the chief part of the nerve paſſes is oval. Its great diameter is tranſverſe. Anteriorly there is a particular depreſſion which correſponds to the baſis of the conical axis of the cochlea. It is perforated by a vaſt number of ſmall foramina, ranged in a ſpiral manner, and which extend into the holes of that cavity. In the poſterior part of the foſſa there are other cluſters of ſimilar ſmall holes, but diſpoſed in a circular order. One of theſe cluſters leads into the veſtibulum, and two others into the ſemi-circular canals. There is a fourth group, ſituated, as we have already obſerved, in the ſuperior foſſa. Theſe ſmall foramina lead alſo into the canals.

The nerves are greatly ſubdivided in perforating the oſſeous parietes, ſo that they arrive in the labyrinth divided to an incredible degree of minuteneſs. Thoſe which enter into the cochlea, after having followed the parietes of its axis, penetrate, according to Scarpa, into the ſubſtance of its bony ſeptum, and come out on the unconnected ſide of that ſeptum.

The

The nerve, when enclofed in the internal auditory canal, appears twifted on itfelf; and its filaments, when beginning to be apparent, affume an oblique fpiral direction.

They foon divide into four fafciculi, one of which correfponds to the beginning of the fuperior femi-circular and external canal; one to that of the pofterior, and the third to the middle of the veftibulum. The fourth, which is the continuation of the trunk, is twifted fpirally to purfue the feries of fmall foramina which enter into the cochlea. Its filaments fill all the tubes of which thefe fmall holes are the orifices, and it is thus diftributed in this part of the labyrinth to terminate in the membranous part of the feptum. Numerous anaftomofes take place among thofe filaments along the pyramidal axis.

As to the three other fafciculi, the firft, which is the largeft, having penetrated into the offeous veftibulum by one of the fmall fieves of which we have fpoken, is divided into two fmall portions, which extend to the ampulæ of the two neareft femi-circular canals.

The fecond proceeds without dividing into the ampula of the pofterior canal. The filaments of thefe two fafciculi terminate in thefe ampulæ, where they fpread out like a fan, and form a kind of feptum. The canals receive no nerve in any other part.

The third fafciculus is fituated between the two preceding. It extends into the membranous

branous veſtibulum, and is diſtributed on its internal ſurface in a net-work as ſoft as it is complicated.

We ſhall in this place deſcribe the courſe of the *facial nerve* through the ear. We pointed out the origin of this nerve, page 152. The hole into which it enters at the bottom of the internal meatus, is the orifice of a long canal bent in different directions, and called *aquæductus Falopii*. This canal perforates, in the firſt place, the pars petroſa, as it aſcends outwardly. It ſoon receives another ſmall canal, which extends from before backward, and which conveys a branch of the Vidian nerve of the fifth pair, to its union with the facial. (See page 211.) The aqueduct afterwards proceeds ſuddenly backward, and croſſes the upper part of the barrel, where it is partly membranous. It then becomes oſſeous, is bent, and deſcends vertically parallel to the poſterior part of the barrel, as far as the ſtylo-maſtoid-foramen.

In page 228 and the following pages, we have deſcribed the diſtribution of the facial nerve after it comes out of the laſt foramen; but while it is paſſing through the aqueduct, it detaches, 1ſt, a nerve to the tenſor tympani; 2d, one to the muſcle of the ſtapes; and 3d, a long filament which paſſes through the cavity of the tympanum, as we have ſhewn in page 227, to unite with a branch of the inferior maxillary nerve of the fifth pair. This filament has been named

named the *chorda tympani*, becaufe it is fituated behind that membrane in a manner fimilar to the cord which croffes the under head of a drum. It feparates at an acute angle, and afcends in a fmall canal which opens into the cavity of the tympanum, under the pyramidal eminence. It leaves the barrel by the *fiffura Glazeri*. We have already defcribed it in page 227.

The external meatus receives nerves from the inferior maxillary branch of the fifth pair, and from its fuperficial temporal branch (fee p. 217.) The back of the concha, and its mufcles, derives their nerves from the occipital branch of the facial (fee p. 228,) and from the fecond cervical pair (fee p. 248,) which alfo fends filaments to the concave part of the concha; but this part receives, befide, another branch of the facial nerve (fee p. 228.)

The nerves of the internal ear of mammiferous animals do not differ effentially from thofe of man. The nerves of the external ear are larger, and more numerous, in proportion to the fize of the concha and its mufcles; but they all have the fame origin.

In birds, the depreffion which occupies the place of the internal meatus, is oval, and its greateft diameter almoft horizontal; it contains five holes for the paffage of the nerves, one of which receives the facial, and four the auditory; three of the latter penetrate into the offeous veftibulum, and one into the cochlea. The three

ramifi-

ramifications of the auditory nerve, which go to the ſemi-circular canals, are diſtributed to the ampullæ, as in man, and the mammalia. The ramification which goes to the cochlea extends to the uppermoſt of the two cartilages which form the ſeptum of that organ; when it has reached one half of its length, it penetrates it, and is expanded, like a gooſe's foot, on the apex of the cone of the cochlea. Several filaments aſcend in the contrary direction of the trunk, to proceed to the baſe of the ſame cone.

The facial nerve of birds receives a filament from the par vagum, ſimilar to that which we have deſcribed in the *calf*, page 230; it croſſes the ear in an oſſeous canal, and, having left the cavity of the tympanum, is diſtributed principally to the palate.

In reptiles and fiſhes, but particularly in the latter, we have the opportunity of obſerving, ſtill better than in warm-blooded animals, the conſtancy with which the branches of the auditory nerve proceed to the ampullæ of the ſemi-circular canals: in the reptiles, it divides before it paſſes into the oſſeous labyrinth, which it enters by ſeveral holes. In the chondropterygious fiſhes, it penetrates by a ſingle hole, and is not divided until it is in the labyrinth. In the other fiſhes it has no ſeptum to perforate, the ear being ſituated within the cavity of the cranium; but it is detached by ſeveral branches from the nerve of the fifth pair, of which it forms a part.

In the *rays* and the *ſharks* there are always two branches; the ſmaller one detaches filaments to the ſac, near the ſmall amylaceous ſubſtances, and is afterwards divided in the two ampullæ of the anterior and horizontal canals. The other forms an expanſion, like a gooſe's foot, in that part of the ſac which contains the largeſt amylaceous ſubſtance. Theſe numerous branches frequently anaſtomoſe.

The facial nerve enters the ear by a particular foramen; it joins a branch of the auditory, which extends into the ampulla of the poſterior canal; it then ſeparates, to come out by a ſecond foramen, and is diſtributed to the teguments of the head and the adjacent muſcles.

The auditory nerves of fiſhes are frequently three or four in number, and are detached ſeparately from the nerve of the fifth pair; they extend to the ampullæ, and to the ſac which contains the ſtones: they expand, in particular, on thoſe ſtones, in numerous filaments; when they are large, the net-work formed by the filaments is exceedingly beautiful, as may be obſerved in the *cod*. The ſize of the nets decreaſe with that of the calcareous bodies.

LEC-

LECTURE FOURTEENTH.

Of the Sense of Touch, and its Organs.

Article I.

Of the Senſations produced by Touch or Feeling.

The ſenſe of touch ſeems to afford us a more intimate communication with external bodies than thoſe of ſight and hearing, becauſe there is no intermediate ſubſtance between them and us when theſe bodies act upon that ſenſe: though, therefore, not entirely free from error, it is leſs capable of deceiving us than the other ſenſes, the impreſſions of which it ſerves to verify and to perfect, particularly thoſe of ſight. By touch alone we obtain the idea of the three dimenſions of bodies, and conſequently of their figures as ſolids. The preſſure, more or leſs forcible, more or leſs direct, made by the different parts of an external body, when applied to our ſkin, enables us to recognize whether that body be flat or round, or formed with various angles. By the equality or inequality of this preſſure, and the degree of friction which takes

takes place when we move any part of our ſkin along the ſurface of another body, we aſcertain whether that ſurface is ſmooth or rough. The degrees of reſiſtance which bodies oppoſe to the preſſure of ours, in whole or in part, afford us the means of determining whether they are moveable or immoveable, hard or ſoft, fluid or ſolid; and the preſſure or percuſſion of theſe bodies on us, while in motion, or tending to move, makes us acquainted with the force with which they act, and the direction of that force.

All theſe actions of external bodies on our own are purely mechanical. The ſenſations they communicate may be the effects of a chemical change in our nervous ſyſtem; but that change can only be produced in conſequence of ſimple preſſure being capable of forming or deſtroying ſome of the combinations which enter into this ſyſtem. This ſuppoſition is not inconſiſtent with analogy: we know, for example, that the combination of fire with water, which produces vapour, may be deſtroyed by the ſame means.

But the ſenſe of touch alſo procures us ſenſations of another kind, which appear to be produced by one of the ſurrounding elements penetrating more intimately our bodies; I mean the ſenſations of heat and cold. Theſe ſenſations depend on the proportion which exiſts between the quantity of caloric we acquire or loſe in a given moment, and that which we acquire

quire or loſe in the preceding moment; but they are not in direct relation with the abſolute heat of bodies, nor even with the proportion between their heat and ours.

All things in other reſpects equal, bodies which have an higher degree of temperature than our own appear to us to be warm; thoſe which are of a lower temperature ſeem cold. When, however, we have touched a very cold body, if we come in contact with another which is leſs cold, the latter will appear to us warm, though it may ſtill be of a temperature much inferior to that of our own body. Thus cellars and ſpring water appear warm in winter, becauſe they preſerve their ordinary temperature, while other bodies change theirs.

When we touch in ſucceſſion two ſubſtances of different denſity, or, to ſpeak more properly, of different capacities for caloric, that which has the greater capacity appears to us colder, though both may be of the ſame temperature, becauſe it abſtracts more caloric from us in a given time than the other. For this reaſon marble and metals appear always cold. Water is colder than the air, and the air, which ſeems cold before we enter into cold water, appears warm when we leave the water, &c.

Bodies which are good conductors of caloric, or which tranſmit it rapidly, for the ſame reaſon appear cold. Thus we find that ſilk or wool are warmer than linen of equal thickneſs.

This part of the ſenſe of touch is liable to many more errors than that by which we obtain a knowledge of the figure and conſiſtence of bodies, becauſe our judgment poſſeſſes more influence in the latter caſe.

The general organ of touch reſides in the ſkin which covers the whole body, or rather in the extremities of the nerves which terminate in that ſkin.

That organ poſſeſſes greater or leſs ſenſibility, in proportion as the nerves diſtributed upon it are more numerous, more expoſed, and leſs intercepted or covered by callous parts. The heat of bodies, their general reſiſtance, and their motion, are more perfectly felt when this general ſenſibility is moſt delicate.

With reſpect to the motion, the reſiſtance and the heat of a liquid or fluid, particularly if the animal experiencing its action is immerſed in it, the degree of the ſenſation alſo depends on the extent of the ſurface which the ſenſible body preſents to the fluid; but ſomething more is neceſſary for recognizing the forms of ſolids, particularly thoſe that are ſmall. In this caſe a very ſenſible ſkin muſt be extended over ſeveral ſmall, divided, and moveable parts, capable of embracing the ſolid, by their different ſurfaces feeling its ſlighteſt inequalities, and tracing its moſt minute parts.

Thus the total perfection of the ſenſe of touch depends on the quality of the ſkin, the number

of

of its nerves, the extent of its furface, its freedom from infenfible parts, and the number, flexibility, and delicacy of the appendices by which the animal can examine bodies.

As touch is the moft important of all the fenfes, its degrees of perfection have a prodigious influence on the nature of different animals. From the inveftigation we are about to make, it will be found, that, of all vertebral animals, man has this fenfe moft perfect. But among the invertebral animals the fenfe of touch improves in proportion as the others degenerate; and thofe which have no other fenfe, poffefs it fo exquifitely that fome of them feem even to feel the light.

Independently of the fenfations of which we have fpoken, and which have a direct relation to the qualities of external bodies, we experience others in the fkin, particularly in the places where it is thinneft, and abounds moft in nerves. Thefe feelings are occafioned by the irritation which the motions, rather than the qualities or nature of bodies, produce upon the nerves, and belong more to the order of internal than external fenfations: thefe are ticklings, prickings, and itchings.

Laftly, the fkin performs a different function from that of touch, which confifts in tranfpiration and abforption; that is to fay, in the exhalation of a part of the elements of our fluids, and in the inhalation of a part of the fluids which ſurround us.

This ſecond kind of function does not belong to ſenſation. We ſhall therefore conſider it in another place.

ARTICLE II.

Of the Skin and its Organization.

THE whole ſurface of the animal body is covered by an organ of a particular nature, named *ſkin*. It is a membrane applied to all the ſuperficies which terminates the body, and its thickneſs varies according to the ſpecies of animals, and the different parts which it covers.

The organization of the ſkin appears to be eſſentially the ſame in all the claſſes of vertebral animals. The external differences which it preſents are more or leſs connected with the developement of certain ſuperadded parts, as we ſhall explain in the ſequel. The ſtructure of the ſkin cannot, however, be eſtabliſhed in ſo general a manner in the animals that have no vertebræ, though it will be ſeen that its parts have ſome analogy to thoſe found in red-blooded animals.

The ſkin of all the animals that have vertebræ

bræ is compoſed of four layers, more or leſs diſtinct, but which the anatomiſt ſeparates, and may eaſily demonſtrate. The loweſt is called *dermis*, *cutis*, *corium*, or the *true ſkin*. The next is called *corpus papillare*, *tela mammillaris*, or the *villous ſurface*. The third, *corpus reticulare*, or *rete mucoſum*. Laſtly, the fourth, or moſt external, has been denominated *epidermis*, or *cuticle*.

We do not eaſily diſtinguiſh all theſe parts in animals that have no vertebræ. Some of the ſtrata are more diſtinct, others leſs ſo. There are alſo ſome ſpecies in which we do not find the whole of them. Theſe differences we ſhall point out more clearly in treating ſucceſſively of each of the layers.

1. *The Cuticle.*

This layer, as we have already obſerved, is the moſt ſuperficial. It is a tranſparent and inſenſible pellicle, which prevents the immediate contact of the nerves of animals with the medium in which they live. It is alſo continued into all the apertures of the body, and lines them internally to preſerve them from the contact of air or water. Thus we find it on the eye, in the ears, the noſtrils, the mouth, the anus, the vulva, &c.; but it is then deſcribed under different names, as has already appeared when we treated of the *conjunctiva* and the *membrane* of the *tympanum*, and as we ſhall ſhew hereafter in treating of the other organs.

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The confiftence of the epidermis varies with the medium in which the animal is immerfed and obliged to exift. It is dry, and as it were horny in thofe that live in air; mucous, and more or lefs vifcous in thofe that inhabit the water.

In the animals which are conftantly fubject to the drying action of the air, the cuticle appears varioufly folded, according to the parts of the fkin to which it adheres. Thefe folds form wrinkles, papillæ, circles, and fpiral lines, which correfpond to the elevations and depreffions of the fkin, but chiefly to thofe of the rete mucofum, and the fcales when thefe laft exift.

In general the epidermis is confiderably the thickeft on the parts which are moft expofed to friction; as the fole of the foot, the palm of the hand, and all the other parts frequently ufed by animals, either in walking or in grafping other bodies.

In the furrows of the cuticle we obferve the holes through which the hairs pafs. Thefe appear as conical elongations, or infundibula, which feem to have been forced outwardly by the hairs, to which they ferve as fheaths.

In the animals which have fcales, inftead of hairs, the epidermis envelopes thefe parts in every direction, and is intimately attached to them.

In man the cuticle is generally very thin, with the exception of the parts which cover the

fole

fole of the foot and the palm of the hand. Friction, or deficcation, either by heat or certain chemical agents, harden it confiderably. They change it into a kind of horn, which blunts, and even totally deftroys the fenfe of touch. We have very remarkable examples of this change in blackfmiths and dyers, and in men who walk bare-footed on burning fands.

The furrows of the epidermis form figures, with feveral angles, on the back of the hand; parallel and elongated lines on the palm and on the fole of the foot; arches, curves, and very fingular, clofe and fymmetrical fpirals under the extremities of the toes.

The cuticle of the other mammalia is nearly fimilar to that of man. It is thin in proportion as the hairs that cover it are compact. That which covers the wings of the *bat* is alfo very thin, and has furrows which form many angles, like thofe we obferve on the back of the human hand.

In the *porcupine* it is thin, and little diftinct from the other ftrata of the fkin, which is gelatinous.

We find the epidermis deficcated, and as it were fcaly on the prehenfile tails of the *beaver*, *rats*, *ondatra*, &c. and on the fcales which cover the bodies of the *pangolins* and *armadillos*.

In the *elephant*, the *rhinoceros*, and the *hippopotamus*, which have the fkin very thick and deeply furrowed, the epidermis, which is alfo thick,

thick, and covered with fmall plates that feparate from it like fcales, finks into the different furrows. The cuticle of the fole of the foot prefents a very fingular ftructure. It is divided externally by deep depreffions, nearly circular, with fix or eight furfaces more or lefs regular, each of which contain an infinite number of fmall polygons much more irregular. This gives to the whole furface of the fkin the appearance of fhagreen. The epidermis detached from the animal, and examined by its internal furface, exhibits elevated lines correfponding to the furrows of the great polygons. It alfo prefents others which are fmaller, and correfpond to the little polygons. The refult of this difpofition is a kind of net-work, in relief, of a pretty regular defign, and refembling lace with large points.

The Cetacea have a very fmooth epidermis, without any remarkable fold, and always covered with a mucous oily humour, which oppofes the maceration of the animal during its refidence in the water.

In birds the epidermis of the body is very thin, and formed of folds which correfpond to the quincunces in which the feathers are arranged. That of the feet is fmooth, fhining, and formed of horny fcales. It covers the different plates which we obferve on the feet of the gallinæ and grallæ, of which we fhall fpeak in the article on Scales. It is detached at certain

certain periods of the year, chiefly in the moulting ſeaſon.

In all the animals we have mentioned, the Cetacea excepted, the epidermis comes off in ſmall pellucid ſcales, which give to the ſurface of their ſkin a meally appearance. In ſome mammalia the cuticle is renewed at certain periods of the year, at the ſame time that they change their hair. In others it takes place more inſenſibly, and at all times as in man.

The epidermis of *tortoiſes* is not very diſtinct, except on the neck and limbs. It is analogous to that of the *ſalamanders*, which we ſhall deſcribe preſently. That which covers the ſcales of the back-ſhell and of the breaſt-plate is extremely thin. It is detached in tranſparent laminæ, the figure of which is exactly the ſame as of the horny plates.

In the *ſalamanders* and *frogs*, the epidermis is a mucous membrane, which covers the whole body, and which falls off in large pieces at ſeveral periods of the year.

The cuticle of *lizards* and *ſerpents* covers and entirely envelopes the ſcales. It is detached in a ſingle piece like a ſheath, at a certain period of the year: we obſerve, in theſe kind of exuviæ, even the portion of a ſphere, which covered the tranſparent cornea.

In fiſhes, the epidermis, which covers all the body, the fins, and other appendices, appears always in a ſoft ſtate; it ſometimes ſeems a ſimple

ple mucous fubftance enveloping every part of the animal's body. It is this mucous epidermis which renders it in general fo difficult to feize the body of a fifh. It is alfo detached in large pieces at certain periods of the year.

We fhall fee, in the fequel, when we treat of the internal tunics of the organs, into which the air, the water, or the aliments penetrate, that the prolongation of the cuticle which lines their internal furface, alfo becomes mucous, and that it has a confiderable refemblance to the external epidermis of fifhes.

We alfo find an epidermis in animals that have no vertebræ. Thofe which live in water have it commonly mucous, and of a very different thicknefs in the feveral fpecies.

In the Cephalapoda it is nearly the fame as in fifhes.

In the naked Gafteropoda it very much refembles that of the falamanders and frogs.

In the Teftacea in general we find an epidermis on the furface of the fhells. In the land kind, as the *fnails*, it is a dry pellicle, very eafily detached, when the fhell is, after the death of the animal, expofed to the action of the atmofphere, or plunged into boiling water. In the *anodontites*, the *mufcles*, and other bivalves, we obferve a fimilar epidermis, which envelopes the fhell externally. This epidermis is always wanting on the furface of the projecting parts, on which the animal draws its fhell along the

fand,

ſand, becauſe it is there worn off. In ſome ſpecies of ſhells, the epidermis is thick and villous, and on this account it has been named *ſea-cloth*. This is very remarkable in ſeveral ſpecies of the genus *arca* of Linnæus; and to expreſs this peculiarity he has called one of them *piloſa*.

In all the Teſtacea, the epidermis which envelopes the ſhell is continued to produce the pellicle which covers the animal; and it experiences the ſame change as that which is prolonged within the body of vertebral animals. It is thin and mucous on all the parts which are not expoſed to the action of the ambient fluid. In the ſpecies of Gaſteropoda, however, whoſe ſhell is concealed under the ſkin, and does not ſerve for a defence, the epidermis does not change its nature. We have examples of this in ſome ſpecies of *aplyſia* and *ſcyllea*, as well as in the animal which produces the ſhell, called by Linnæus, *helix halyotoidea*. (Lam. *ſigaret*.)

In the Cruſtacea and the inſects, whether in the larva, nympha, or perfect ſtate, there is a real epidermis. This ſkin, however, when once dry and indurated, is not ſuſceptible of extenſion, ſo as to accommodate itſelf to the growth of the animal. In proportion therefore as the inſect increaſes in ſize, and at fixed periods in each ſpecies, but with reſpect to which the atmoſphere appears to have conſiderable influence, the animal quits its epidermis, by drawing itſelf as it were out of a caſe. This is called the *moulting* period,

period, in effecting which the infect frequently employs feveral days, and which is fometimes mortal to it. The greater part of the caterpillars, of butterflies, and of bombices, change the fkin feven times before they pafs into the chryfalis ftate. The *bombyx-caja* quits in this manner the fkin ten times. We intend to dwell more particularly on the fubject of moulting in the Article on Metamorphofis, in the Lecture on Generation.

There is a very diftinct cuticle in worms. It is eafily feparated from the fkin in the *earth-worms*, which have been immerfed for a few hours in fpirits of wine, or macerated fome days in water; it is a pretty folid pellicle, which may be removed in a fingle piece. In the worm called *fipunculus faccatus*, this epidermis is even entirely feparated from the body, which is unconnected and floating within it, as if it were enclofed in a fack. The *leeches*, and fome other worms, have the cuticle mucous, like that of the gafteropodous mollufca.

It is very difficult to afcertain the nature of the epidermis in Zoophites, or even to difcover whether it exifts in fome of them. The *fea-ftars*, the *urchins*, and the *actiniæ* appear to poffefs it.

The *medufæ* are covered with a pellicle, but fo thin and tranfparent that it cannot be fuppofed to confift of ftrata. The other Zoophites, as the *polyps*, &c. have a mucous furface, the foftnefs ſoftneſs of which prevents us from diſtinguiſh-ing any membrane.

2. The Rete mucoſum,

Is ſituated, as we have already ſtated, imme-diately between the epidermis and the villous ſurface of the ſkin. It is not membranous, but forms rather a mucous layer, the colour of which varies in different kinds of animals, and ſometimes even in different parts of their ſur-face. The colour of an animal's ſkin depends on that of this mucous ſubſtance, for in all thoſe which have the ſkin coloured, if we remove the epidermis, it is found almoſt pellucid, and the cutis is alſo free from colour.

It appears that the influence of the ſolar rays determines, to a certain degree, the colour of the human ſkin; it is white in temperate countries, becomes more and more dark in warm regions, and, finally, becomes black in the burning cli-mates of Africa and Aſia. May not the cauſe of theſe varieties be referred to the different degrees of light which colours living bodies, by removing their oxygen, and developing the carbon and hydrogen which they contain? We find, indeed, that men who are expoſed to the rays of the ſun grow tawny, while thoſe who inhabit ſubterraneous places undergo a change ſimilar to the etiolation of plants, and become exceedingly white.

The colour of the mucous fubftance varies greatly in mammiferous animals. It appears to determine, as will be feen hereafter, that of the nails and hairs. It is even frequently found coloured in the cavities of organs, into which it is prolonged, as on the palate, the tongue, the ear, the conjunctive and nafal membranes of *apes*, *dogs*, Ruminantia, and Cetacea.

The rete mucofum of the mammalia is not often of a very vivid colour. It is however white on the cheeks of fome *mandrills*; red, violet, and carmine on their hips and nofe. It is of a fine filvery white colour on the belly of the Cetacea.

The rete mucofum is thickeft in the laft family of mammalia. In the *dolphin* and *porpoife* it is nearly half a millimeter thick on the back parts of the body and the head, which are of a black colour. We cannot compare it better, with refpect to confiftence and colour, than to the black produced by greafe between the nave of a wheel and the axle-tree.

The mucous fubftance is little diftinct in birds, and almoft always white in all the parts covered by the feathers; but its colour on the feet, ceræ, and carunculæ of the head, is fubject to variations.

On the tarfi and the toes, it is frequently black, as in the *ravens*, the *turkies*, fome *ducks*, *fwans*, &c.; grey, as in *hens* and *peacocks*; blue, as s in the *titmouſe*; green, as in the *water-hen*; ellow, as in the *eagle*; orange, as in the *ſtork*; ed, as in the *ſcolopax calidris*, &c.

The rete mucoſum is black in the caruncle f *ſwans*, grey in the ceræ of the bill in a numer of *parrots*, white in the chops of the *blue ra*, green in the ceræ of the bill of the *ſparw-hawk*, yellow in that of moſt diurnal birds prey, red on the neck and cheeks of the *king the vultures*, &c. In general, it adheres to the in; it is even difficult to ſeparate it by macetion.

The colours of reptiles alſo depend on the eſence of the mucous ſubſtance.

In the *tortoiſes*, for inſtance, the ſkin which vers the feet and the neck, is not only difently coloured by the rete mucoſum, but the nmetrical ſpots which we remark on the ſcales produced by the ſame ſubſtance. This we cover by diſſection. The thickneſs of the n greatly diminiſhes as it approaches the eaſt-plate and the back-ſhell. It paſſes below ſcales which cover thoſe parts, and which themſelves covered by the epidermis and e mucoſum, the variegated colours of which m the ſpots which we obſerve through the nſparent parts.

t is the ſame with reſpect to *ſalamanders* and *s*. Their mucous ſubſtance varies ſtill more o colour; it is black, brown, grey, white, en, and yellow, red-orange, carmine, &c.

We alſo find a mucous ſubſtance under the ſcales of *lizards* and *ſerpents*, and its colours are exceedingly various.

Of all vertebral animals, however, fiſhes are the moſt remarkable for the brilliant and metallic colours which their rete mucoſum exhibits. We find in them gold, ſilver, and copper, tin, lead, and even all the tints which theſe metals aſſume in different degrees of oxydation. But as the deſcription of theſe colours is the province of Natural Hiſtory properly ſo called, we wiſh merely to point out in this place that they are produced by the mucous ſubſtance which adheres cloſely to the internal ſurface of the ſcales, and with which it is frequently removed.

Moſt molluſca have a rete mucoſum below their epidermis.

In the Cephalopoda it is moſt commonly of a blue or red colour, but it forms a very thin layer.

That of the Gaſteropoda varies conſiderably, as we may obſerve particularly in the *ſlugs*. It is thick and viſcous, but diſſolves completely in water.

May not the ſubſtance of the ſhell itſelf be really analogous to the rete mucoſum, though the term *mucous* cannot be applied to it? I am very much inclined to believe that this is the caſe.

The calcareous ſhell is in fact found immediately under the epidermis; and when ſome of its

its parts are removed, it is a kind of cruft without any apparent organization, and not a membrane. It is produced by fucceffive ftrata. Finally, it is coloured, and its fhades are infinitely various.

In the Cruftacea, the mucous fubftance is alfo reprefented by the calcareous cruft fituated below the epidermis. Its colour is ufually a dark-green, but fometimes red, white, or black. Alcohol, acids, and particularly the action of fire, change the green colour to a red, which is frequently very brilliant. This we obferve every day at our tables in *cray-fifh*, *lobfters*, &c.

In infects, in the larva ftate, we obferve between the epidermis and the mufcles, a layer of mucous matter, the colours of which vary infinitely in the different fpecies. In *caterpillars*, and in the larva of fome Hymenoptera, this fubftance is moft remarkable for its colour. It gives to their bodies the moft beautiful aud lively tints, the fhades and fymmetry of which are truly admirable. White, purple, violet, blue, green, yellow, aurora, black, &c. &c. are diftributed in the moft regular and ftriking manner.

We are alfo of opinion that the mucous matter dried or mixed with the horny fubftance, produces the colours exhibited by perfect infects, for when the Lepidoptera are in their chryfalid ftate, the fmall coloured fcales which afterwards ornament the wings of the perfect

 infect,

infect, are then found in a mucous ftate, fimilar to that which we obferve in the fkin of *caterpillars*. The colours of *fpiders* are alfo the effect of the rete mucofum; we find it under the fkin; it has the appearance of fmall glandular points, the fhades of which vary confiderably. But in the Coleoptera, and feveral other orders, the colours of the fkin are diffufed through the horny cruft, nearly in the fame manner as thofe of the Cruftacea, through their calcareous fhells.

The rete mucofum cannot be diftinguifhed, except in a fmall number of fpecies of Zoophyta; and it is even fo thin, that we cannot feparate it from the fkin, as may be obferved in fome *fea-ftars* and *actiniæ*. It appears to be confounded with the calcareous fhell which forms the habitation of feveral other genera. This may be obferved in fome fpecies of *urchins* and *corallines*; and in the Ceratophites, and a number of Lithophites.

3. *Corpus Papillare, or the Villous Surface of the Skin.*

Anatomifts have given this name to that part of the fkin which is fituated between the cutis and the rete mucofum. It is not membranous like the epidermis, but is a furface produced by the aggregation and approximation of a multitude of fmall tubercles of different fhapes, which are fuppofed to be formed by the laft extremities

tremities of the cutaneous nerves; they are, therefore, named *nervous papillæ*.

Though the figures of theſe tubercles are very different, their ſtructure is nearly the ſame: it is eaſily exhibited, by macerating them for ſome days in water; we then obſerve that each tubercle conſiſts of a collection of fibrils, united at their baſe, nearly in the manner of hairs in a pencil. Sometimes the fibrils of the center are longer than thoſe of the circumference, and then the papilla is of a conical figure. Sometimes they are nearly of the ſame length, and in that caſe it is flat.

The ſenſe of touch reſides particularly in theſe papillæ: we find them, therefore, in the greateſt number, and moſt conſpicuous, on the tongue, the lips, and the extremities of the fingers.

In man, the papillæ are particularly remarkable on the ſoles of the feet, and on the palms of the hands; they are ſituated cloſe together in a very compact manner, and diſtributed in lines correſponding to thoſe we obſerve externally, and of which we have already ſpoken in treating of the epidermis. Thoſe under the nails produce a villous ſurface, the compact fibrils of which are all directed obliquely towards the extremity of the fingers. The fibrils of the lips are diſpoſed in the ſame manner, but they are ſtill more delicate, longer, and cloſer to each other.

It is nearly the ſame in all other mammiferous

rous animals; but the papillæ are more developed, in proportion as the parts to which they belong are employed in touch. In the *mole*, the *ſhrew*, and the *hog*, the nervous papillæ are very viſible on the ſnout; they form tufts, conſiſting of very cloſe fibres. We find them alſo on the proboſcis of the *elephant*, and we have obſerved them very diſtinctly on the tail of the *Cayenne opoſſum*; it is probable that they exiſt in the ſame manner in all prehenſile-tailed mammalia. We have not obſerved them on the ſkin of the *dolphin* and *porpoiſe*.

Birds have no diſtinct papillæ, except under the ſole of the foot, and the toes; they are very cloſe ſet tubercles, arranged in parallel lines. We eaſily demonſtrate them on the feet of poultry, when the epidermis is removed by the action of fire. We alſo obſerve them on the membrane which unites the toes of the Palmipedes.

Reptiles reſemble birds with reſpect to the papillæ; we find none, except under their feet; they are very thick, and projecting in ſeveral ſpecies of *lizards*, and particularly in the *cameleon*. We cannot diſtinguiſh them in the *ſea-tortoiſes*, which have the feet in the form of fins. They do not exiſt in *ſerpents*, or at leaſt have not the form of papillæ.

We have obſerved nothing under the ſkin of white-blooded animals, which can be regarded as nervous papillæ. In the cephalapodous molluſca, however, we have ſeen ſome nervous filaments

filaments in the fmall globules, which appeared to us glandular, and with which the fkin is covered. In the other mollufca we can trace fome nervous filaments into the fubftance of the fkin, but we have never obferved them to form papillæ.

4. *The Cutis.*

This is the name given to that part of the fkin which is fituated moft internally. Anatomifts have developed its ftructure in a very diftinct manner, by the means of certain preparations, and particularly by maceration in water. They have demonftrated, that it is compofed of a tiffue of gelatinous fibres, which crofs each other in every direction, and which are fo interwoven that the whole may be compared to felt: among thefe fibres we difcover a great number of fine ramifications of nerves, and arterial, veinous, and lymphatic veffels, to which we fhall return in a particular article.

The organization of the cutis is fuch, that the fibres, which compofe it, are capable of elongation and extenfion in every direction; its extenfibility was neceffary to give to the furfaces of animals the power of refifting the phyfical action of other bodies.

Manufacturers have profited by this property of the fkin, to prepare it in certain ways, which fit it for different purpofes, in which ftrength and flexibility are neceffary, and in which a great friction is fuftained; this conftitutes the art

art of the currier. The fibres are likewife approximated, or feparated, in order that the leather may be applied to various ufes; and this is the foundation of the arts of the tanner, fkinner, parchment-maker, morocco-maker, &c.

In man, the cutis is from two to three millimeters thick in certain parts of the body, as in the dorfal and lumber regions; but it is only half a millimeter on the arms and the body. By maceration, and the proceffes ufed by fkinners, we obferve that the fibres, which enter into its compofition, are long, fine, and very folid; but united in a lax manner.

In mammiferous animals, in general, the cutis is thickeft on the dorfal, and thinneft on the ventral region.

It is much thinner in birds, than in the mammalia. In fome families, however, it has a confiderable confiftence, particularly in birds of prey, and in the anferes. It is exceedingly thin, even proportionally confidered, in fome fpecies of *titmoufe*, and the genus *motacilla*.

Reptiles, which have the body unfurnifhed with fcales, or only partly covered by them, have a very compact and denfe fkin. We have an example of this in the *tortoifes*, *falamanders*, *frogs* and *toads*. In the two laft genera, in particular, the cutis is rendered remarkable, by not adhering to the body in all its points, as in the other animals, in which it is intimately united with the cellular fubftance. In thofe genera,

genera, however, it adheres only at the edges of the mouth, in the middle line of the body, the arm-pits, and the groins. In all the other parts, the body is free within the cutis, which encloſes it like a ſac.

The cutis of *lizards* and *ſerpents* reſembles that of fiſhes.

In this claſs of animals, we find a very tenacious cutis below the ſcales; but it is intimately attached to the muſcles, even much more cloſely than in the other claſſes, and is very thick in the *ſturgeon*, the *ſharks*, the *rays*, the *eel*, &c. on the contrary, it is thin in fiſhes which have large ſcales, as the *carps*, *breams*, &c.

We have not obſerved a real cutis among the invertebral animals, except in the *cuttle-fiſh*, and the other Cephalapoda; it is applied almoſt immediately to the muſcles, by the means of a very denſe cellular ſubſtance; it is itſelf of a very coriaceous nature, and not eaſily lacerated; its fibres are very ſlender.

In the other invertebral animals, we find no part that can be compared to the cutis. There is, indeed, a pellicle below the ſhell of the cruſtacea, but it is fine, tranſparent, and has very little conſiſtence. In inſects in the larva ſtate, the ſkin, which they caſt off in moulting, is of the ſame nature and the ſame thickneſs as that below it, and which is deſtined to ſucceed it. Even the envelope of *chryſalides coarctatæ*, as thoſe of the Lepidoptera and Diptera, cannot

cannot be regarded as cutis: it is rather a kind of horny epidermis. Finally, in the perfect ſtate, we find no part of the teguments of inſects that can be compared to the cutis. The ſame obſervation applies to the worms and the Zoophites.

ARTICLE III.

Of the Muſcles of the Skin, or the Panniculus Carnoſus.

IN the preceding Article, we have explained the nature and the organization of the different ſtrata of the teguments. We ſhall now proceed to conſider the motions of which the ſkin is ſuſceptible, and the organs by which they are produced.

In man, the ſkin has very little motion; the muſcles inſerted into it have, therefore, very little force: they form three pairs; two of theſe muſcles are particularly deſtined to move the ſkin of the forehead and the head; the third acts on the teguments of the neck and the cheeks.

All the ſpace compriſed between the occiput and the ſuperior part of the orbits, is occupied immediately below the cutis, by a digaſtric muſcle, principally aponeurotic, and which is named

named *occipito-frontalis*. The fleſhy fibres are very ſhort, and ſituated at the two extremities of the large aponeuroſis, which forms a kind of cap to the cranium. The anterior fibres are attached to the ſkin below the eye-brows: the poſterior are inſerted into a tranſverſe line above the occipital bone: their other extremity paſſes under the aponeurotic cap, to which they are fixed. Theſe muſcles are more diſtinct in ſome ſubjects, than in others; they raiſe the eye-brows, corrugate the ſkin of the forehead, and produce thoſe tranſverſe wrinkles, more or leſs parallel, which we obſerve above the brow.

Immediately below the anterior fleſhy fibres of the occipito-frontalis, and in the line which correſponds to the eye-brow, we find ſome other fleſhy fibres, which ariſe from the naſal eminence of the os frontis, and are inſerted partly into the ſkin of the eye-brow, and partly into the fibres of the occipito-frontalis, with which they are covered: this ſmall muſcle is called the *corrugator ſupercilii (fronto-ſupercilius;)* it oppoſes the effect of the occipito-frontalis, and approximates the eye-brows, and thus corrugates the ſkin above the root of the noſe.

Finally, the third pair of cutaneous muſcles, *(thoraco-facialis)* in man, occupies all the anterior part of the neck; they form a kind of fleſhy membrane, ſituated immediately below the ſkin; it originates, upon the anterior part of the breaſt, by ſlender and very diſtant fleſhy fibres in the cellular fubftance, which covers the great pectoral and deltoid mufcles, and extends to the lateral parts of the cheeks; it is there partly attached to the lower jaw, and partly to the zygoma; thefe mufcles are exceedingly thin, and loofely connected in the inferior part of the neck. They become thicker, in proportion as they contract.

It is difficult to determine the action of thefe cutaneous mufcles; they act on the mouth by their union with the mufcles of the lips; they have alfo great influence on the expreffion of the countenance. They produce very remarkable wrinkles in the teguments of the neck and the chin.

There are alfo fome mufcular fibres under the fkin of the fcrotum in man, which are denominated the *dartos;* but thefe fibres are very flender. They vary confiderably, and, ftrictly fpeaking, do not conftitute a mufcle: they are deftined to corrugate the fkin of the fcrotum.

In all the other mammalia, we find thefe cutaneous mufcles; thofe of the head are commonly lefs confpicuous, but that of the neck is moft ftrongly marked: there is, befides, a particular mufcle, which extends under all the fkin of the belly, and even under the thighs, and is inferted into the humerus.

Apes and *dogs* have an occipito-frontalis; it is alfo very thin, but its flefhy fibres are proportionally longer than the human. We find, befides, beſides, under the ſkin of the face, ſome fleſhy fibres, which perform the action by which theſe animals wrinkle the lateral parts of the cheeks and the noſe.

The cutaneous muſcle of the neck in *apes* is connected to the ſkin by a very compact cellular ſubſtance: it is prolonged over the face, and unites with the fibres we have already mentioned.

In *dogs*, we obſerve only ſome very ſlender fleſhy fibres on the neck.

The cutaneus of the belly alſo adheres very cloſely to the ſkin in theſe animals; its fibres cover the thorax and abdomen, and all unite below the arm-pit, where they are inſerted by one or two tendons, along with that of the great pectoral muſcle, under the head of the humerus. This muſcle has the ſame inſertion in all the mammalia; it aſſiſts in the motions of the arms, and may be named *dermo-humeralis*.

In the Quadrumana, Cherioptera, and male Sarcophaga, we alſo find muſcular fibres in the ſkin of the ſcrotum. They are even proportionally more conſpicuous in the *bat*, than in man.

In the *racoon*, the dermo-humeralis is likewiſe a very powerful retractor of the prepuce; it forms a bundle of fibres, of the breadth of two fingers, attached to the prepuce, and deſcribing an oval, with the bundle of the oppoſite ſide: the remainder of the muſcle, which covers the belly, is very thin. Anteriorly, the

6 muſcle

mufcle is attached to the humerus by two diftinct flips.

The cutaneus colli in the *marmotte* very much refembles that of man: below it, however, we find another thicker mufcle, which forms, as it were, a lining to the firft, but proceeds farther up; it extends to the lateral parts of the head, and even to the face and the muzzle.

The dermo-humeralis occupies the whole of the back, from the origin of the tail, to the pofterior point of the trapezius. The part on the belly arifes from the pubis, the groin, and the thighs: all the fibres unite below the armpit, where they form two tendons, one of which is inferted with thofe of the latiffimus dorfi and teres major, and the other with that of the pectoralis major.

There are very few variations in the other fpecies of mammalia. In almoft all of them there are fome mufcular fibres under the fkin of the male genital parts, particularly in thofe that eject their urine by fquirts.

We find a cutaneous mufcle even in the *dolphin*; it arifes from the lateral parts of the body, and terminates in the os humeri.

As the *European hedge-hog* prefents a very complicated and curious organization in the mufcles of the fkin, we fhall here give an abridged defcription of them.

It is neceffary, in the firft place, to obferve, that thofe mufcles, being attached to the fkin, change

change their ſituation with it, and that they are therefore fixed with reſpect to their points of attachment only. We muſt then ſuppoſe the animal placed in certain poſitions, in order that the parts deſcribed may be more readily found.

Let us ſuppoſe the hedge-hog rolled up as in the poſition the animal aſſumes for defence. All the body is then enveloped under the ſkin, by an oval-ſhaped ſac, compoſed of fleſhy and concentric fibres.

Theſe fibres adhere cloſely to the ſkin, and even to the root of the ſpines which cover it, and it is difficult to detach them with inſtruments. The fleſhy purſe they form is thickeſt at the margin of its aperture, which correſponds to the belly, at which place they form a kind of ſphincter or muſcle with orbicular fibres.

When the body of the hedge-hog is elongated, as in ſtanding or running, the figure of this muſcle is completely changed. It is ſituated on the animal's back, where it forms an oval, the middle part of which is very thin, but the circular margin conſiderably thicker, and more elevated. Several acceſſory muſcles ariſe from different points of the margin.

Towards the head, or at the anterior extremity of the oval, we obſerve two pairs of acceſſory muſcles; one has its origin in the middle line, and is inſerted into the bones of the noſe; the other, which ariſes more externally, appears to be confounded with the exterior or-

 bicular

bicular fibres, and is inſerted anteriorly into the lateral parts of the noſe and intermaxillary bones.

Another pair of muſcles ariſe from the poſterior extremity of the oval. They are of a broad pyramidal form, and are likewiſe continued with the external orbicular fibres. The tendinous point of each is inſerted laterally near the end of the tail.

There are alſo ſome other ſub-cutaneous muſcles, ſituated towards the belly, or below the great orbicular muſcle.

When the ſkin of the belly is removed, we readily perceive three diſtinct portions of fleſhy fibres.

The firſt is ſituated under the throat, and correſponds to the cutaneus colli. It comes from the top of the breaſt under the ſkin, and is inſerted on the lateral parts of the head, near the ears. The portion of one ſide unites to its correſpondent by a middle line, which is made of fat.

The ſecond comes from the middle line of the ſternum; it takes an oblique direction, becoming thicker and narrower above the ſhoulders, as it proceeds to join the edge of the great orbicular muſcle.

The third ventral portion, which is ſtill more ſlender than the two former, extends over the whole ſurface of the abdomen; it ariſes from the circumference of the arms, from the lateral parts

parts of the tail, and from the tops of the thighs: upon reaching the ribs, it divides. The internal portion, which is the broader of the two, paſſes under the arm-pit, and is inſerted into the internal ſide of the upper end of the os humeri. The external is prolonged laterally, and unites with the great orbicular cutaneus, towards the neck.

Theſe are the muſcles of the ſuperficial layer: there are ſtill ſome others, which are appendices of the former, and are ſituated under the muſcles of the back.

One ariſes from the head, where it is attached, on both ſides, to the poſterior edge of the external meatus auditorius. It is loſt poſteriorly in the anterior point of the orbicular muſcle.

Another ſmall bundle of fleſhy fibres ariſes from the laſt cervical proceſſes, and is loſt in the cutaneus of the back.

Laſtly, below the great orbicular muſcle, we obſerve ſome tranſverſe fibres, which form a very thin layer. The anterior are attached to the internal and upper part of the humerus: the poſterior, to the external bundle of the third ventral portion.

Let us now conſider the uſe of theſe muſcles. The animal, when rolled up like a ball, is enveloped by the orbicular muſcle. To preſerve this poſition, it is ſufficient to contract the marginal fibres, which are very ſtrong; and

 which,

which, in closing the purse so as to cover the belly, have the effect of a sphincter.

When the animal wishes to return to its ordinary posture, it unrolls itself thus: the middle fibres of the oval contract; the external fibres at first relax, and leave the belly and the feet free; all the circular fibres then contract together, and gather up towards the back.

By this general contraction, the accessory muscles are rendered fixed, and capable of contracting. The anterior move the head upward, and extend it towards the back. The posterior raise the tail.

Those of the deep-seated layer elevate the head and the neck; the animal is then enabled to walk.

If the approach of danger induce the hedgehog to roll itself up, the animal accomplishes this purpose in the following manner:

The orbicular cutaneus relaxes, and the muscles of the head and the neck elongate the oval; the deep transverse fibres attached to the external portion of the ventral cutaneus, render it broader.

Every thing now yields to the impulse: the flexors, and the cutaneus of the neck and breast, draw the head towards the belly; the cutaneus, and muscles of the abdomen, bring the tail and the thighs towards the head; the flexors of the limbs contract; the great orbicular muscle then

descends

descends on the ribs, contracts obliquely, and thus, assuming the shape of a purse, retains the animal in a globular form.

The cutaneous muscles of *armadillos (dasypus)* are not so strong, nor so complicated as those of the hedge-hog, though these animals have also the faculty of rolling themselves up.

The great dorsal cutaneus is thickest at its ventral margins, by which it strongly adheres to the fold that unites the skin of the abdomen with that of the back; it is fixed to the skin of the groins and arm-pits: it also detaches some slips, which are inserted into the head and the tail; but its fleshy fibres are very slender. A certain number of fibres are sent off at different spaces, and inserted into the anterior edge of each of the osseous bands which cover the animal.

The cutaneous muscles of the belly are also very slender; they furnish some fleshy fibres to the penis: and the bundle which these fibres form, very much resembles that which we have observed in the *racoon*; but it is less thick.

The cutaneus colli exists, but it is exceedingly small; it is prolonged under the scales of the face.

Among birds, these muscles are more conspicuous in certain species, particularly when the bird has the power of moving at pleasure, the feathers of the crest, neck, or tail, as the *hoopoes*, *cockatoos*, *herons*, &c. They are

 very

very eaſily diſſected in the *gooſe*, and from that bird we ſhall deſcribe them.

The ventral cutaneus ariſes from the ſeventh and eighth ribs, by two fleſhy digitations, like the ſerratus magnus; it is broad and flat; it proceeds obliquely forward and upward towards the ſcapular articulation of the humerus, and is inſerted into the ſkin, above the ſhoulder joint.

There are alſo ſome fleſhy fibres on the external lateral part of each of the great pectoral muſcles. In the ſubſtance of the ſkin, immediately above the arm-pit, theſe fibres are confounded with the tendon of the pectoralis major.

Immediately above the broad flat part of the bone of the pelvis, between the two ilei, we obſerve two ſmall fleſhy layers below the ſkin: the ſhort, and apparently papillated fibres of theſe layers, act on the feathers of that part of the pelvis, and erect them.

We alſo remark along the ſkin of the neck, ſome longitudinal muſcular fibres, which move that part; they form two diſtinct layers, particularly on the ſides.

There is no cutaneous muſcle on the trunk of *frogs*, becauſe the ſkin does not adhere to that part of their body. Under the throat, however, we find ſome fibres, which are attached to the margin of the jaw, and inſerted into the cellular ſubſtance that unites the ſkin to the origin of the breaſt.

In *tortoiſes*, the cutaneus colli is very viſible, and

and ſeems to be formed of two parts; it is extended from within the concavity of the lower jaw, to the bottom of the neck, at the anterior part of the breaſt-plate. A middle cellular line unites it with the muſcle of the other ſide; it takes its origin from the tranſverſe proceſſes of the cervical vertebræ. Being ſpread over all the muſcles of the neck, it ſerves as a girdle to them; in its lower part it is perforated by the ſterno-maſtoideus, which, as we have already obſerved, ariſes from the lateral parts of the breaſt-plate.

On removing the ſkin of ſpinous fiſhes, ſuch as the *carp*, we find ſome muſcular fibres adhering intimately to it: they are divided into two portions, by a longitudinal line, which correſponds to the ſituation of the vertebral column. We here obſerve impreſſions made by the tendons, inſerted in the ſkin; they deſcribe curves, the convexity of which is towards the tail. Theſe are the only parts that can be regarded as cutaneous muſcles in fiſhes.

In the animals without vertebræ, that have ſoft bodies, almoſt all the muſcles may be conſidered as cutaneous; for the greater number are attached to that integument. But as they are alſo employed in progreſſion, we have deſcribed them among the Organs of Motion.

Article IV.

Of the Glands of the Skin, and the Subcutaneous Fat.

1. *The Glands.*

The furface of the fkin is fpontaneoufly bedewed with fubftances, which appear deftined to preferve it from the action of the furrounding elements, and which vary according to the nature and habitation of different animals.

This humour is unctuous in man, and other warm-blooded animals; it is a kind of fat, which would gradually accumulate on the fkin, if we did not take care to remove it.

In the cold-blooded animals it is of a vifcous or gelatinous nature, and does not diffolve in cold water: thefe animals have it in the greater abundance, in proportion as they refide more conftantly in the water, and have their bodies lefs completely covered with fcales. It appears to be a fupplement to this laft kind of armour. Fifhes that are deftitute of fcales, therefore, as *rays* and *fharks*, have a great quantity of this fluid, compared with thofe that are covered with large fcales.

Among reptiles, thofe that have fcales, as *fnakes* and *lizards*, have the fkin almoft dry: but thofe with naked fkins, as *falamanders* and *frogs*,

frogs, have the ſurface of the body always copiouſly lubricated with viſcous matter.

Toads and *ſalamanders* have even the power of augmenting the ſecretion of this liquor, and of making it exude like a dew through the pores of the ſkin.

Among the animals that have white blood, we find that moſt of the molluſca produce a glutinous liquor, which lubricates the whole of their ſkin; they even throw out a conſiderable quantity of it, when they are in the leaſt danger. This is particularly remarkable in *ſnails*, &c. In thoſe that have a hard and ſcaly ſkin, however, nothing ſimilar is exuded, and their excretions take place only at particular parts of the body.

The ſame animal does not produce the ſame kind of ſubſtance in all the parts of the ſkin. In man, for example, there are three of theſe excretions, beſides perſpiration.

A very ſubtile oily matter tranſudes through the pores of the whole ſkin, and prevents, for ſome time, pure water from ſpreading upon it. This matter alſo appears upon the hair of the head, and other parts of the body, and at laſt gives them a greaſy appearance, if they are not frequently cleaned.

A kind of ointment is produced in certain parts, and particularly at the roots of the hairs in the arm-pits and the hams, &c. from ſmall follicles, which are viſible to the eye: this matter,

matter, in hardening, attaches itſelf to the ſkin, and produces a ſort of ſcales, which are removed by water and friction.

Laſtly, there are glands, the apertures of which are very viſible in certain places, that furniſh a concrete ceruminous matter. This ſubſtance may be compreſſed in the form of ſmall worms: theſe glands are found on the ſides of the noſe, behind the ears, under the eye-lids, around the nipple, on the perinæum, and in the groin: they may alſo be obſerved ſcattered almoſt every where, except, perhaps, on the palm of the hand, and the ſole of the foot.

We may include, in the laſt kind, that thick fetid matter, which accumulates in lumps between the glans of the penis and the prepuce, and beneath the nymphæ, and alſo that which covers the edge of the anus.

We are unacquainted with the organs which produce the firſt kind of humour; it is, perhaps, a ſimple exhalation of the fat, which always exiſts in a certain quantity under the ſkin.

The follicles, which produce the ſecond kind of ointment, are very ſmall, and round, or oblong. Their excretory canals are ſmall and twiſted.

The third kind of ointment is produced by glands which are named *ſebaceous*, and which are ſometimes compound.

The ſubſtances which anoint the ſkin of quadrupeds, are ſimilar to thoſe which we find on on our own : ſome have them collected in large cluſters, on certain parts of the body, as for example in the groin. The glands, or particular follicles, do not appear conſpicuous in the ſkin of the Cetacea ; an oily fluid exudes from the whole of its ſurface, in ſuch abundance as to render it every-where ſmooth and ſlippery.

In birds, the ſebaceous glands are difficultly ſeen, and ſituated more deeply under the ſkin. On the rump there is a conglomerate gland of a particular ſtructure, from which they expreſs an oil, which ſerves to imbue their feathers. We ſhall deſcribe this gland when we treat of Excremental Secretions. At the ſame time, we ſhall notice ſeveral other glands peculiar to certain kinds of quadrupeds, as thoſe which produce *muſk*, *civet*, *caſtor*, &c.

The cutaneous glands are more viſible in cold blooded animals, than in the preceding.

The *ſalamanders* have ſeveral glands ranged along the back, which form elevations, or lumps on the ſkin.

The *toads* have them ſcattered irregularly, on the whole ſurface of the body ; we obſerve, in particular, two which are very large, behind their ears ; theſe glands produce an acrid humour, which is a poiſon to very ſmall animals.

In *lizards*, we obſerve a very regular row of ſmall pores, which alſo yield a viſcous humour.

But the pores which tranſmit the viſcous matter to the ſkin, and the ſources which produce

duce it, are no where ſo eaſily obſerved as in the *rays* and the *ſharks*.

On the ſuperior and inferior ſurface of the body, in thoſe fiſhes, we find a great number of very large pores, which are the orifices of an equal number of tranſparent excretory veſſels. In the *ſharks*, theſe veſſels are as thick as the tube of a quill; they proceed from certain centers, in faſciculi, which are not divided into branches; theſe centers are more or leſs numerous according to the ſpecies, and the gelatinous humour they contain appears to be formed within them: the centers, however, do not reſemble glands; we obſerve in them only a cellular texture, filled itſelf with the ſame humour, and to which a great number of nerves are in particular diſtributed. In the *ray*, there are two principal centers, ſituated towards the ſides of the mouth. The *tope (ſqualus galeus)* has only one in the ſnout. We ſhall return to this ſubject in the Article on Secretion.

In oſſeous fiſhes, the viſcous liquor chiefly exudes through pores ſituated along the furrow, which extends longitudinally on each ſide of the body, and is called the *lateral line:* theſe foramina are the orifices of an equal number of ſmall tubes, which communicate with one large tube ſituated behind this line, throughout the whole of its length. This great veſſel reaches to the head, and is there divided into ſeveral branches, which ſpread over both jaws, and two of of which unite towards the upper part of he ſnout. The *rays* and *ſharks* have alſo theſe large viſcous veſſels on the head, independent of the numerous ſmall veſſels which we have juſt deſcribed, and which are peculiar to them.

We obſerve theſe veſſels, and the pores, which are the orifices of their ſmall branches on the head, more diſtinctly in the *chimæra monſtroſa*, than in any other fiſh. The pores are alſo very viſible in the *common pike (eſox lucius)*, and the *ſea pike (eſox bellone)*.

2. *The Adipoſe Subſtance.*

A cellular web more or leſs firmly unites the ſkin to the fleſh; this membrane exiſts in almoſt all animals, except *frogs* and *toads*, in the greater part of which the ſkin adheres cloſely only in ſome parts of the body, and is connected with the fleſh of the other parts merely by veſſels and nerves.

We alſo find in birds, and principally under their axillæ, large portions of ſkin, which adhere only in a very looſe manner to the fleſh. In conſequence of this ſtructure, the air is admitted into the vacant ſpace.

If we may believe Sparman, the *ratel*, or *honey-eating badger of the Cape*, (*viverra mellivora*, Lin.) preſents a ſimilar diſpoſition.

The ſubcutaneous cellular membrane is uſually filled with fat, the quantity and conſiſtence of which

which varies according to the ſpecies, and the ſtate of each individual. Every one knows, that the *hog* has the fat thicker, and more uniform, than other quadrupeds, in which it is, therefore, called lard.

The Cetacea have ſtill a thicker coat of lard than the *hog*, but their fat is ſo liquid, that it runs off in the form of oil, without being expreſſed.

Animals, in which the ſubcutaneous fat is very abundant, have the ſenſibility of the ſkin greatly diminiſhed.

In the cold-blooded animals, there is, ſtrictly ſpeaking, no ſubcutaneous fat. Sometimes only we find the inner ſurface of the ſkin moiſtened like the reſt of the body by an oleaceous fluid. This we obſerve, for example, in the *ſalmon* and *trouts*. At other times we find ſubſtances of a very different nature. The *moon-fiſh*, for example, has, under the ſkin, a layer two or three fingers breadth thick, of a fat ſubſtance, apparently like lard, but which preſents all the chemical characters of albumen.

The uſe of theſe different ſubſtances placed under the ſkin, appears to be to weaken the impreſſions of blows, or other external ſhocks, and to diminiſh their effect upon the fleſh. But the fat, in general, has ſeveral other uſes; it ſerves to preſerve the flexibility of all the parts between which it is interpoſed, and, in particular, forms a kind of magazine of nutritive ſubſtance, fubftance, which may be abforbed, and conveyed again into the blood.

This is chiefly remarkable in animals which exift for a certain period, annually, without food: as thofe that fleep during winter, caterpillars, when they pafs to the chryfalid ftate, &c. Such animals do not fall into thefe lethargies, until after they have accumulated a great quantity of fat, which is found to be exhaufted when they awake.

There are particular refervoirs for this fubftance, which we fhall defcribe in the *bears*, *dormice*, *marmottes*, *caterpillars*, &c. when we come to the Article on Nutrition.

ARTICLE V.

Of the Fingers and Toes, and of their Structure relative to the Senfe of Touch.

IN Lectures IV. and V. we defcribed the number, form, and ufe of the bones and mufcles of the members, and of their extremities, with refpect to their ufe in motion; we are now about to confider thefe parts in another point of view, namely, with relation to the organ of touch.

The fingers are particularly intended to procure us a knowledge of the forms of bodies.

Two circumftances tend to perfect or diminiſh the faculty of touch: 1. The diviſion of the hand and foot into fingers or toes, more or leſs numerous, more or leſs long, diſtinct and moveable. 2nd, The form of theſe fingers or toes, and the nature of the teguments which cover, arm, or protect them. Theſe conſiderations form the ſubject of the preſent article.

The organ of touch is more perfect, in proportion as the hand is divided into diſtinct and moveable fingers: man, therefore, poſſeſſes this ſenſe in a very eminent degree. *Monkies*, indeed, have the hand organized like that of a man; but, as we obſerved in treating of the muſcles, Vol. I. p. 335, &c. they cannot move the fingers ſeparately, as they have no proper extenſor or flexor muſcles: beſides, their thumb is ſhorter, and cannot be ſo eaſily oppoſed to the other fingers. It is, however, on this oppoſition of the fingers that the faculty of ſeizing the moſt minute objects, and of diſtinguiſhing their ſlighteſt eminences, depends. But if the hand of *monkies* be leſs perfect than that of man in this reſpect, they have a more advantageous organization of the foot, the toes of which are longer and more moveable.

In man, and in the greater number of Quadrumana, the fingers are ſlender, rounded, and covered by a compact ſkin, on which numerous nervous papillæ are diſpoſed in a very regular manner: their extremity is covered by a nail, on the ſuperior part only: this nail is flat, or ſemifemi-cylindrical : only the *fagouins (fimia rofalia, jacchus, &c.* Lin.) have the extremity of the toe inclofed in a horny and pointed nail, refembling that of the Sarcophaga.

In the Cherioptera, the fingers are not capable of grafping folid bodies, becaufe they are all inclofed between two fine membranes. They therefore do not poffefs, in a high degree, that part of the fenfe of touch which ferves to afcertain the forms of bodies ; but the extenfive furface which the membranes prefent to the air, fit them for receiving fuch delicate impreffions of refiftance, motion, and temperature, that fome authors have been induced to afcribe a fixth fenfe to thefe animals.

Spallanzani had obferved that *bats* blinded, and afterwards fet at liberty, could, notwithftanding their total deprivation of fight, conduct their flight through fubterraneous paffages without ftriking againft the walls ; that they even turned exactly as the moft complicated windings required ; that they difcerned the holes in which their nefts were placed ; and that they avoided cords, lines, and other obftacles which had been placed in their way.

Spallanzani then endeavoured to afcertain by what fenfe thefe animals directed their motion.

It was not fight, fince that organ was entirely deftroyed ; it was not hearing, for the ears of feveral individuals had been completely ftopped ; it was not fmell, for in others he had taken the

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precaution to ſhut up the aperture of their noſtrils.

He concluded therefore, that *bats* poſſeſs a ſixth ſenſe, of which we have no idea. Citizen Jurine has made other experiments, which tend to prove that it is by the ear they guide their flight; but it appears to us, that the operations to which he ſubjected the individuals he deprived of the power of directing their motions were of too ſevere a nature, and that ſomething more was done than merely preventing the animals from hearing. It appears to us alſo, that the nature of their organ of touch is ſufficient to explain all the phænomena *bats* preſent.

The bones of their metacarpus, and the phalanges of the four fingers which ſucceed the thumb, are exceſſively elongated. The membrane which unites them, preſents an enormous ſurface to the air: the nerves which are diſtributed to it, are numerous, and minutely divided; they form a net-work very remarkable for its fineneſs, and the number of its anaſtomoſes. It is probable that, in the action of flight, the air, when ſtruck by this wing or very ſenſible hand, impreſſes a ſenſation of heat, cold, mobility, and reſiſtance on that organ, which indicates to the animal the exiſtence or abſence of obſtacles which would interrupt its progreſs. In this manner blind men diſcern, by their hands, and even by the ſkin of their faces, the proximity of a wall, door of a houſe, or ſide of a ſtreet, even

without

without the aſſiſtance of touch, and merely by the ſenſation which the difference in the reſiſtance of the air occaſions.

The toes of the poſterior feet in *bats*, are ſimilar in their ſtructure to thoſe of the other Sarcophaga.

Notwithſtanding the Plantigrada have the fingers very ſhort and little moveable, and generally five in number, the ſenſation of touch ought to be ſomewhat more perfect than in the Carnivora, becauſe the whole ſole of their foot is free from hairs; and as the contact with the bodies which they touch is more immediate, the ſenſation muſt be ſtronger and better perceived.

The *mole* has the hand greatly enlarged, and ll the fingers united as far as the nail.

The Pedimana come naturally after the Plangrada with reſpect to the preſumed perfection f touch, as their great toe is ſeparate from the her toes. This renders their poſterior foot a nd of hand; the toe is proportionally very ick, elongated, moveable, entirely deprived the nail, and enlarged at its free extremity.

The *cheſnut coloured*, or true *orang outang*, is e only animal, beſides the Pedimana, that has eparate great toe without the nail.

The Carnivora walk on the extremity of their s, which are ſhort, and all placed in the ſame ection, and are therefore much leſs favoured to the ſenſe of touch, but they are in general mpenſated by that of ſmell. The greater number have the laſt phalanx incloſed in a cutting nail. In the *cat* and *civet genera*, this phalanx bends back, and cannot be employed as an organ of touch whilſt the animal walks.

Among the Rodentia, the *hares*, *ſquirrels*, and *rats*, which walk on the four feet, but on the extremities of the toes, and which have the laſt phalanges only ſeparate from each other, have an elongated conical nail which envelopes all the free part of the toe. Some *cavies*, and the *porcupine*, have almoſt all the toes incloſed in hoofs like thoſe of hogs. The *aye-aye*, (*ſciurus Madagaſcarienſis* Lin.) is particularly remarkable for the diviſion of the toes of the fore feet. All the phalanges are greatly elongated, particularly thoſe of the middle toe, by means of which the animal picks inſects from under the bark of the trees. This is alſo the only animal among the Rodentia which has the great toe ſeparate, and oppoſeable to the others.

Laſtly, the *kangaroos* and *jerboas*, which uſe chiefly the hind feet in progreſſion, have the fore feet divided like thoſe of rats, and armed with pointed nails; but the poſterior feet have the toes enveloped in hoofs.

The Edentata in general have the toes united by the ſkin as far as the nails, ſome of them even, as the *ſloths*, walk only on the convexity of the nails, which bend under the ſole of the foot. The *Cape ant-eater* has flat and very broad nails. Several *armadillos* have them almoſt in the

the form of hoofs. In all thefe animals the toes vary from four to two, and are capable of no motion except extenfion and flexion. This difpofition arifes from the deep pullies in the articulations of the phalanges.

The *elephant* and the *rhinoceros* have all the toes united by a thick and callous fkin. They are only diftinct externally by the number of hoofs which are placed on the edges of the foot.

The *hippopotamus*, the *tapir*, and the *hogs*, have the toes more feparated; but they walk on their extremities only, which are enveloped in hoofs.

All the Ruminantia, without exception, have only two toes, covered with hoofs of a triangular form, on which they walk. The inferior furface, which touches the ground, is the moft foft, and appears tuberculated. The external is convex and fmooth. The third furface, or that which is next the other toe, is a vertical plane. The *camel* only differs a little in the form of the hoof, which is fmall, more regularly triangular, and prolonged inferiorly by a piece of horn which invefts all the fole of the foot.

Finally, in the Solipeda there is only a fingle toe, terminated by a femi-circular hoof, on which the animal walks.

Before we conclude this article on the divifion of the members in Mammalia, we fhall notice fome difpofitions relative to motion, but which have an influence on the fenfe of touch.

We have already pointed out one of thefe peculiarities in the Cherioptera. Among the Sarcophaga, the *otters*, the *feals*, the *didelphis memina*, and one fpecies of *fhrew*; and among the Rodentia, the *beaver*, the *ondatra*, &c. which fwim and dive frequently, have all the feet palmated, that is to fay, their toes are united by a membrane.

Laftly, in the *morfe*, and in the Cetacea, we do not diftinguifh the toes which form the feet; they become real fins, on the edges of which we however remark, in the *morfes* and *lamantin*, rudiments or veftiges of nails indicating the five toes, which we indeed find, but concealed under the coriaceous fkin that clofely envelopes them.

In birds, the thoracic member is not intended to exercife the fenfe of touch; it therefore is not divided at the extremity into fingers or appendices, and is alfo almoft entirely covered by long and clofe feathers. The feet are the only parts which poffefs the faculty of touch, and in them it is very much blunted by the horny laminæ or fcales which cover the tarfi and the toes. Sometimes it is rendered ftill more obtufe by feathers, and always by the callofities in the form of excrefcences and tumors which cover the feet inferiorly.

We have already defcribed, in Vol. I, page 411, the number and direction of the toes in different birds. They are not in any fpecies covered with hoofs, but are merely furnifhed with nails, which

which ſtrengthen them, without injuring the ſenſe of touch.

In the ſwimming or web-footed birds, as the *ducks*, the anterior toes are united by a membrane which extends to their extremity. Sometimes the pollex is alſo united to the other toes by this membrane. The birds however in which this takes place, are of all the anſeres thoſe which employ their feet moſt frequently in touching and ſeizing ſubſtances. A ſhort membrane unites merely the baſe of the anterior toes in gallinaceous birds. The two external toes are alſo united at their baſe in a number of the Grallæ and the rapacious birds.

The Paſſerine birds have in general the two external toes intimately united by their firſt phalanges; and in ſome genera, as the *king's-fiſhers*, and the *bee-eaters*, they are united nearly to the extremity.

The ſcaly membranes which border the toes in ſome wading birds, and their exceſſive length, as well as that of the nails in others, are alſo obſtacles to touch.

From what we have ſtated, this ſenſe appears to be very obtuſe in birds; the ſcanſores, however, particularly the *parrots*, are, with the *owls*, thoſe which poſſeſs it in the greateſt perfection, and exerciſe it moſt frequently.

The number of the fingers, and their flexibility, vary more in reptiles than in all the other claſſes.

Common *lizards* have in general five fingers, of different lengths, well calculated to embrace objects in every direction. Some, as the *crocodiles*, have them palmated, at leaft in the pofterior feet. Others, as the *gecko*, have them invefted inferiorly with imbricated fcales.

The *camelion* has them united by the fkin, as far as the nails in two parts which form the forceps. The fkin of their inferior furface is furnifhed with very fenfible papillæ. The long lizards, called *feps* and *chalcides*, have only three very fmall toes. The *falamanders* and *frogs* have them naked, and deftitute of nails; they therefore enjoy a very delicate touch. It ought to be ftill more exquifite in the *tree-frogs*, which have the extremity of the toes enlarged into a fpongy difk, capable of adhering with force to bodies; but in the *tortoifes*, which have the toes palmated, this fenfe muft be lefs perfect. Laftly, the ferpents are completely deprived of feet and toes.

This is alfo the cafe with fifhes. Their fins are intended for motion only, and are of no ufe in afcertaining the forms of bodies.

What we have ftated in Lecture Sixth, refpecting the number and divifion of the feet in animals that have no vertebræ, appears to us fufficient to enable the reader to form an idea of the different degrees of perfection thefe parts poffefs as to the fenfe of touch.

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Article VI.

Of the Appendices which ſupply the Place of the Fingers in exerciſing the Senſe of Touch.

Besides the fingers, ſeveral animals have received different parts, which are ſufficiently moveable and ſenſible to enable them to exerciſe the faculty of touch. In the ſpecies which want fingers, or which have them enveloped in inſenſible ſubſtances, theſe appendices ſupply their place.

The tails of ſeveral mammiferous animals, as the *ſapajous*, the *opoſſums*, one ſpecies of *porcupine*, ſeveral ſpecies of *ant-eaters*, &c. are ſo organized, that they are capable of embracing bodies, and ſeizing them in the manner of a hand. In Lecture III. we have deſcribed the form of the bones, and the diſpoſition of the muſcles which are employed in this prehenſile motion: the nerves are diſtributed to them in numerous ramifications; they ariſe from the termination of the medulla ſpinalis, and come out through the intercaudal foramina. Tails of this kind are uſually deſtitute of hair on that part of their inferior ſurface which is applied to the bodies they ſeize.

We find ſimilar tails in ſome reptiles, as the *camelion*, and the whole body of ſerpents, perform

form the ſame function, when they twiſt themſelves round the objects they wiſh to feel or compreſs: this faculty is the more uſeful to them, as they are deprived of fingers, and every other appendix fitted to procure them the ſenſation of touch.

In the ſpecies of mammalia, which have a ſmall number of fingers covered with horny hoofs on all the parts that ſupport the weight of the body, the ſenſe of touch ſeems to reſide in the lips, which are the moſt moveable parts. We have an example of this in the Ruminantia and the Solipeda: we ſhall not here deſcribe the muſcles of theſe parts, as that may be done with more propriety in the Lecture on Maſtication. The lips themſelves have a very peculiar organization: the facial nerve, and that of the fifth pair, terminate in them by an infinite number of branches. Theſe ramifications anaſtomoſe, and form various plexuſes, which give to theſe parts a moſt exquiſite ſenſibility. We know that they procure us the moſt delicious of all the ſenſations of touch.

In ſeveral animals, we find numerous and compact glands forming a layer below the ſkin, which is thin and covered with fine ſoft hairs; amongſt them are placed ſome long ſtiff hairs, called *whiſkers*, each of which is implanted into a papillated tubercle.

The whiſkers, in conſequence of their rigidity, eaſily communicate, to the nerves of the

 lips,

lips, the flighteft concuffions they receive from furrounding bodies: on this account, though infenfible themfelves, they may be ranked among the appendices which affift the fenfe of touch.

The fuperior lip of the *rhinoceros* is prolonged into a fmall procefs, which that animal employs in feeling, grafping, tearing, &c. We are not acquainted with its mufcles.

Hogs, *moles*, and *fhrews* have a long pointed and moveable muzzle, to which the term *fnout* is in particular applied, and which they alfo appear to employ as an organ of touch. In the fubftance of this part, there is frequently a peculiar bone, the form of which differs according to the fpecies; it is fituated between the intermaxillary and the nafal bones, and named the *bone of the fnout*: the mufcles of the fnout fhall be defcribed when we treat of the fenfe of Smell, in order that we may give, in one view, every thing relative to the nofe of animals.

The probofcis of the *elephant*, that of the *tapir*, which is lefs elongated, and the fnout of the *mufk fhrew*, or *defman*, fhall alfo be defcribed in the fame Lecture; but as they are employed by thefe animals in the manner of real hands, we notice them here as appendices of the organ of touch.

The crefts, or flefhy parts on the heads of feveral birds, particularly in the Gallinaceous family, as *cocks*, *turkies*, &c. are perhaps alfo ufed as an organ of touch: thefe parts are def-

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titute of feathers; they are foft and flaccid; and the nerves they receive, though few in number, muft convey to the animal the impreffions of external bodies.

In animals which have no members with moveable fingers calculated to feel bodies, as fifhes, the appendices are more numerous, larger, and more varied. Different names have been given to thefe prolongations of the fkin: thofe which are placed about the mouth, or on the lip, are called *cirri*: thofe which proceed from the upper part, or fides of the head, are named *tentacula*. When they proceed from lateral parts of the body, they retain the name of *fingers*.

The *cirri* are ufually foft; they receive filaments from the fifth pair of nerves. There is only one in the *cod*, and other fpecies of the genus *gadus*; two in the *furmulets*, &c.; four, which are very fhort, in the *carp*; four in the *barbel*; fix or eight in the genus *cobitis*, and in feveral fpecies of *filurus*, in which the cirri of the upper jaw are frequently very long. The *frog-fifh*, the *gadus tau*, and others, have a great number round the lips.

The *tentacula* are organized like the cirri. In feveral fpecies of the genus *lophius*, thefe appendices are fufceptible of motion, and can be bent in different directions at the will of the animal. It is even pretended that they are ufed as a bait for catching fmall fifh. In the fpecies called *hiftrio*, the anterior tentacula divides like

a Y,

a Y, the branches of which terminate in a flefhy mafs. The others are very long and conical. Several fpecies of *Blennius* and *Scorpæna* have them above the eyes.

The lateral appendices of the body, which ichthyologifts name fingers, have an offeous jointed ftalk, which is fimilar to that of the radii of the pectoral fin, from which thefe fingers do not differ except in being free and moveable. They are chiefly remarked in the *trigla*, and in the *polynemus*.

There are ftill more varieties in the appendices of white-blooded animals.

We fhall omit here the arms of the Cephalapoda, which we have already defcribed among the organs of motion.

We fhall alfo pafs over the flefhy horns of the Gafteropoda, as we have defcribed thofe of the fnail in the Lecture on the Eye. Thofe of the other genera do not differ, except that they are incapable of that kind of motion by which they are retracted, and protruded like the finger of a glove. Their mufcular fibres only become rigid or relaxed.

Several fpecies have fimilar appendices around the cloak. Such are the *limpets*, the genus *halyotis*, &c. Among the Acephala, the greater part are provided with thefe appendices, and fome have them in great numbers. In the fpecies which have the cloak completely open, they are placed around it, and particularly towards

wards the anus: this may be obferved in *oyfters, mufcles, anodontites*, &c. In thofe in which the cloak opens by a tube only, the appendices are attached to the circumference of its orifice. Such are the genus *venus, cardium*, &c. The tube itfelf furnifhes thefe animals with an excellent inftrument of touch. The flefhy and ciliated arms of the genera *lingula* and *terebratula* are equally proper for this employment; but thofe of the *anatifa* are very inferior, in confequence of their horny fubftance.

We alfo find cirri in feveral fpecies of worms; they fometimes appear to be formed of different articulations, like the antennæ of infects. We have obferved nerves proceeding into thofe of the *aphrodita* and *nereis*. There are none in the *lumbricus* and the *leech*, but they are fupplied in the latter by the two difks which terminate their bodies.

The antennæ of infects appear to be principally employed in the fenfe of touch; we have defcribed the nerves that proceed to them. Entomologifts have defcribed their forms, which are very numerous, and have even made them the foundation of characters for the genera. It would, therefore, be fuperfluous to defcribe them here.

Some larvæ have retractile tentacula, refembling thofe of fnails.

In thofe of feveral fpecies of *butterflies*, as the *podalirius, machaon*, and *apollo*, a fingle branch is is protruded between the occiput and the body, which is bifurcated at its extremity like the letter Y: this appendix appears rather an inftrument of defence againft the puncture of the *ichneumons*, than an organ of touch: it is moiftened by a bitter and odorous liquor.

In the *fork-tailed bombyx (vinula)*, the retractile appendices, refembling thofe of fnails, are fituated above the anus, at the extremity of two flefhy proceffes.

The arms, the tufts, and the flowers of feveral zoophytes; the innumerable tentacula of the *fea ftars*, *urchins*, and *actiniæ*, and the complicated branches of the *medufæ*, are alfo excellent organs of touch; but thefe are fufficiently defcribed by Naturalifts.

ARTICLE VII.

Of the Infenfible Parts which cover the Organs of Touch, and protect them againft too ftrong Impreffions.

THE epidermis defends the fkin, and prevents the contact of external bodies from becoming painful; but it would not, under all circumftances, be fufficient for this purpofe. Nature has, therefore, armed it with various parts, com-

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posed of the same materials as itself, but differing as to form and thickness, which serve to reinforce it; these are *hairs*, *feathers*, *scales*, *nails*, and *horns*.

1. *Of Hairs.*

Hairs are filaments of a horny substance, which are particularly intended to cover the skin of mammiferous animals; one of their extremities is implanted in the cutis, and is even frequently rooted in the *panniculus carnosus*; this extremity is enlarged into a bulb, more or less thick, which is inclosed in a membranous sheath, and which contains sometimes a small drop of blood. This cell is larger in proportion as the hair is young; if it be punctured at this time, the blood flows from it, and it becomes soft and flaccid.

All the part of each hair which is without the skin, is called the *shaft*; it is a very elongated cone, the free extremity of which forms the apex; the hairs grow from their base, and are therefore finer in young animals than in old: for the same reason, they seem to augment in number when cut, though, in fact, they increase only in diameter.

When the hairs rise out of the skin, they carry with them a small portion of the epidermis, which forms a kind of sheath at their base; this is gradually detached under the appearance of transparent and farinaceous scales.

Some

Some animals have, at their birth, the hair of ſome parts of their bodies more or leſs developed. In other parts no hair appears until a certain period of life.

As the hairs of the human body are very ſlender, it is difficult to examine their ſtructure; but the briſtles of *hogs*, and the whiſkers of *cats*, and other Sarcophaga, may be very well employed in this kind of inquiry.

When we examine with the microſcope the briſtle of a *wild boar*, we obſerve that it is canulated throughout the whole of its length, by about twenty furrows, formed by an equal number of filaments, the union of which conſtitutes the ſurface of the hair: in the middle of the briſtle there are two canals, which contain an humour called the *medulla*. The filaments of the hair ſeparate by deſiccation, the ſeparation commencing at the point, as may be obſerved in the briſtles of bruſhes: the cavities are then empty, and we obſerve in them only ſome laminæ which croſs each other in different directions.

The hairs of the *elk*, the *muſk*, the *hedge-hog*, the *tenrec*, *porcupine*, &c. are not altogether ſimilar; their ſurface is covered with a horny lamina, the thickneſs of which varies, and on which we obſerve ſome furrows: internally they contain a white ſpongy ſubſtance, which appears at firſt ſight ſimilar to the pith of the elder tree (*ſambucus*).

The colour of the hair ſeems partly to depend on that of the rete mucoſum; for, as we have obſerved in animals which have the fur of different colours, the various ſpots ſeen upon the hair indicate others below them in the ſkin.

Even in the human ſpecies there are very ſtriking relations of this kind. Negroes, in general, have the hair black. Perſons who have red hair have almoſt always the ſkin freckled, or covered with reddiſh ſpots: thoſe whoſe hairs are black have commonly a dark complexion.

The colour of the hairs exiſts in their horny ſubſtance, and not in their medulla, which is commonly white. This is particularly evident in the quills of the porcupine: the colours are infinitely various, and ſome hairs are coloured differently in ſeveral parts of their length: the works of Naturaliſts may be conſulted on this ſubject.

The ſhape of the hairs is moſt frequently round, as thoſe of the head, the mane, &c. They are flat on the tail of the *hippopotamus*, and on the body of the *great ant-eater*. They are, as it were, crimped in ſeveral ſpecies of the Ruminantia, and more particularly in the *muſk (moſchus moſchiferus)*.

Their ſurface preſents ſpiral channels in the *mules*. They are fine, long, and ſilky in ſome varieties of *goats*, *cats*, &c. They appear criſped and frizzled in the *rams*. They are ſtiff and elevated in the *hogs*, the *hedge hogs*, the *porcupines*,

pines, &c. From their great thicknefs in the two laft animals, they have obtained the name of *fpines*.

The climate has great influence on the nature of the hair, in domeftic animals: in cold regions they become long and rigid, as we obferve in the *Siberian dog*, the *Iceland ram*, &c. In the climate of Spain and Syria, they become tufted, fine and filky, as we find them in the *Spanifh fheep*, in the *Maltefe dogs*, and in the *goats*, *cats*, and *rabbits* of Angora. In very warm countries they become thin, or are altogether wanting, as in the *dogs of Guinea*, vulgarly called *Turkifh dogs*, and in the *African and Indian fheep*.

Different names are given to all the varieties which the hairs prefent on different parts of the body. Hence the appellations—*hair*, *eye-lafhes*, *whifkers*, *beard*, &c.

All mammiferous animals, the Cetacea excepted, have a certain quantity of hair. We fhall briefly indicate its difpofition in the different families.

Man has the whole body covered with fcattered hairs, though, in fome parts, they are fo fine that they cannot eafily be perceived: thofe of the head and the beard are the longeft; thofe of the axillæ and the pubis are next in length; thofe of the interior of the nofe and the ears, the eye-lafhes, and the hair of the eye-brows, are ftill fhorter; thofe of the other parts of the

 body

body rank laſt in point of length ; there are more on the breaſt and on the belly, than on the back, which is contrary to the diſpoſition in other animals. The palm of the hand and the ſole of the foot never have any.

In *apes*, properly ſo called, the hair of the head is not, in general, longer than that on the other parts of the body : the hairs which cover the fore-arm point upwards to the elbow, inſtead of being directed towards the hand, as may be ſeen in the *orang outang*, and ſome other ſpecies. This is one of the circumſtances in which theſe animals reſemble man. In a great number of Quadrumana the buttocks are callous, and entirely deſtitute of hairs.

Among the Cheiroptera, which have the hair ſhort, fine and villous, we obſerve that the *flying lemurs* have ſome on the lateral membrane of the tail, and on the ears. The *veſpertilio laſiurus* Lin. has alſo ſome on the membrane of the tail. The other ſpecies have only a few ſcattered hairs on the membranes of the wings, on the noſe, and on the ears.

The *hedge-hogs* have the ſpines, of which we have ſpoken, placed only upon the back and the head : the members, and inferior ſurface of the body, are covered with ſtiff briſtles. In this reſpect the *tenrecs* reſemble the *hedge-hogs*. Some ſpecies have the briſtles and the ſpines intermixed.

In *moles* and *ſhrews* the hair is ſo ſhort, fine and

and cloſe, that their ſkin is as ſoft to the touch as velvet.

In the Carnivora the hair varies conſiderably. In the ſpecies which are covered with a fine fur, as the *weaſels, ſables, ermines, martins,* &c. there are two kinds of hair; one cloſe to the ſkin, which is very fine, thick-ſet, and intermixed; the other, which is longer and ſtiffer, and which alone appears on the ſurface; theſe are the two kinds of hair which conſtitute fine furs.

Nearly the ſame thing takes place in the fine haired Rodentia. In the *porcupines,* the ſpines on the head, neck and belly, are more ſlender, ſhort and flexible, than thoſe of the back: on the tail there are about a dozen, which reſemble tubes of quills, truncated at their free extremity; they are fiſtular; their other extremity is filled up, and is ſlender and very flexible; theſe tubes reſound when the animal moves its ſkin; and it even appears that the urine can be conveyed into them in order to be thrown to a diſtance.

No family preſents more variety with reſpect to the hairs than the Edentata.

In the *great ant-eater (myrmecophaga jubata)* the hair is broad and flat, and has a longitudinal furrow on both ſurfaces, ſo that each hair reſembles a dried blade of graſs. The *two-toed ant-eaters* are, on the contrary, covered with very fine wool: ſeveral have hard and cutting ſcales, placed one above the other like the tiles

 of

of a roof, in the manner of the *pangolins (manis* Lin.); others are covered with prickles, as the *ſpinois ant-eater (echudna).* The *armadillo* genus *(daſypus,)* have, beſides the ſcales or oſſeous bands which cover their back and head in regular compartments, ſome ſcattered hairs, which are ſhort and rigid like thoſe of the *elephant:* theſe hairs, however, fall off as the animal advances in age.

Of all the Pachydermata, the *hogs* have the greateſt quantity of hairs, which, in them, are called *briſtles;* they are ſcattered, and frequently bifid at their free extremity. There are very few in the other genera.

We have already noticed the nature of the hair of the *elk* and the *muſk.* The *ox, ſtags, antelopes,* and *girafe* have, in general, ſhort hair. *Camels* have it very fine and very ſoft, particularly the *camelus vicunna:* all have calloſities, which are deſtitute of hairs on the knees and on the breaſt. The hair of *goats* is long and fine, and they have the chin furniſhed with a pointed beard. *Sheep* have the hair long, and diſtinguiſhed by a criſped or frizzled appearance, and to it the term *wool* is applied.

Solipeda have the hair in general ſhort, like the Ruminantia; that of the neck and tail, which is much the longeſt, is more particularly called *crines.*

The amphibious mammalia have ſhort, rigid, and very cloſe hair.

We

We have already obſerved that the Cetacea have no hair.

The chemical analyſis of the hair of all theſe animals, whatever form it aſſumes, whether that of *wool*, *briſtles*, *ſpines*, *quills*, *ſcales*, &c. affords nearly the ſame reſults: when ſubjected to the action of fire, and in open veſſels, it fuſes or liquifies at firſt by ſwelling up; it afterwards emits a white flame, and reſolves into a black carbon, the incineration of which is very difficult.

Hair, on diſtillation, yields a reddiſh liquor, which contains pruſſiat of ammoniac, and another ſalt of an ammoniacal baſis, combined with a particular animal acid, which Berthollet has named zoonate of ammoniac: the charcoal, which remains at the bottom of the ſtill, is light: it contains carbon and the phoſphat of lime.

The hair does not completely diſſolve in boiling water, but there is ſeparated from it a mucilaginous matter, which is its medulla; it is completely ſoluble in cauſtic alkalis, and in ſome acids.

2. *Of Feathers.*

Feathers are proper to birds, as hairs are to mammalia, and ſcales to reptiles and fiſhes.

Before we deſcribe the forms and numerous varieties which feathers preſent, it is right to notice their ſtructure. To give a diſtinct idea of this part of the ſubject, we ſhall point out the manner in which they grow.

At the time the young bird leaves the egg, and for ſome days after, it is covered more or leſs with hairs, except on the region of the belly. Theſe hairs, which vary in colour and thickneſs, come out of the ſkin in faſciculi, each compoſed of ten or twelve hairs; they are implanted in a bulb or follicle, which appears to contain the rudiment or ſheath of the feather: after a few days the feather appears externally, in the form of a blackiſh tube: we then obſerve that the common faſciculus of the hairs is attached to the end of this tube, and that it even penetrates into the interior of the ſheath.

In proportion as the feather grows, and is developed, the hair falls off. In ſome families, as the birds of prey, it adheres for a long time to the extremity of the feather, in the form of a kind of down.

It is only at this period that we obſerve hairs on the bodies of birds; for when the feathers are renewed in the moulting ſeaſon, there is then no appearance of them.

We have already obſerved, that the ſheath of the feather becomes apparent ſome days after the bird is hatched: the quills, or great feathers of the wings and the tail, appear firſt; the down manifeſts itſelf next, and laſtly, the ſmall feathers of the body.

The ſheath is a tube, cloſed on all parts, except

cept at the extremity, which is fixed in the ſkin; we observe there a ſmall hole, or umbilicus, by which the blood veſſels paſs into the cavity of the tube; when the feather is plucked out, therefore, a ſlight hemorrage takes place.

On leaving the ſkin, the ſheath ſplits, in conſequence of being dried in the air, and the expanſive force of the contained parts. A longitudinal laceration takes place, and the extremity of the *ſhaft* of the feather comes out: in proportion as the ſhaft grows, the ſheath becomes more torn, and its deſiccated tunics are detached in the form of thin pellucid ſcales.

If about this period the tube be opened longitudinally, it will be found that it is formed of numerous and cylindrical ſtrata of a horny and tranſparent ſubſtance, and that it contains a cylinder of gelatinous matter, into which the blood-veſſels penetrate.

The external extremity of this gelatinous cylinder is conical, and harder than the other parts; it is covered by a layer of black matter, which is the firſt rudiment of the barbs of the feather.

The growth of this gelatinous cylinder takes place longitudinally; the conical part, which forms its apex, comes out of the ſheath, and brings with it the ſtratum of black matter, which ſplits in drying, and forms the firſt barbs. The ſhaft of the feather elongates and hardens; the firſt cone has ſcarcely made its exit from the ſheath

ſheath when a ſecond is formed, which comes out in its turn, developing new barbs, and making an addition to the length of the ſhaft, which grows always at its baſe: at laſt the ſhaft, with the whole of its vane, is protruded from the ſheath, which becomes deſiccated internally: we then obſerve only membranous cones inſerted into each other, ſimilar to thoſe which, by their development, protrude the barbs externally, and which form what is called the heart of the feather.

When the growth of the feather is completed, the tubular portion becomes ſolid, and is continued with the ſhaft, the germ of which it formerly contained; it is a cylinder which joins force and elaſticity to ſpecific levity. The dry and veſicular matter we obſerve within it, is the reſiduum, or veſtige of the large fleſhy canal which exiſted in a leſs advanced age; it is a ſort of cavernous body, formed of ſeveral ſmall cups or cells ſucceeding each other; theſe cells are more elongated, in proportion as they approach the ſhaft; they then become ſimilar to ſmall tunnels, which are of different lengths according to the ſpecies, and are incaſed into each other. The laſt of the cells is divided into two; one paſſes without the line in the longitudinal furrow which appears at that part; the other penetrates even into the interior of the ſhaft.

The ſhaft of the feather is the continuation of the

the tube. It is a cone more or lefs elongated, convex on one furface, and flat and furrowed on the other. The barbs are attached to its fides. All the fuperficies of the fhaft is covered by horny matter, which feems to proceed from the tube. Internally, it is filled up by a white and very light fpongy fubftance, fimilar to that which we find in the quills of the porcupine.

The barbs are fmall laminæ of a horny nature, planted into the fides of the fhaft. They are applied to each other throughout their whole length, like the leaves of a book. Sometimes they are applied very clofely, as in the feathers of the *goofe*, or the *fwan*; fometimes in a more loofe manner, as in the rump feathers of the *peacock*.

The beards are themfelves fhafts, from the edges of which an infinite number of hairs proceed. Thefe hairs are fometimes loofe, and detached from each other, fometimes compound and fub-divided, but moft frequently fo fine and fo compact that they can only be perceived with a magnifying glafs. By means of thefe hairs or *barbulæ*, the barbs of the feather are fo intimately attached to each other as to prevent the paffage of the air.

Such is the general organization of the feathers. We fhall now confider the varieties which they prefent.

All birds change their feathers, at leaft once a year. The old feather is pufhed off by a new

one.

one, which obſtructs the veſſels deſtined to the nouriſhment of the former. All the feathers do not fall off at once. The moulting in general takes place about the period of laying.

Different names are given to the feathers, according to the regions which they occupy. They are diſpoſed in quincunces on the body. There are never any on the lateral lines of the neck and of the breaſt, nor on the umbilical region. The term *quills* has been given to the feathers of the wings and tail. Thoſe which are implanted in the humerus have been called *ſecondary*. Their number varies conſiderably; but there are conſtantly ten attached to the metacarpus, and the fingers, which are called *primary quills*.

We ſhall ſtate ſome examples of the principal varieties of the feathers, independent of their colours, which are ſo brilliant and ſo numerous that we could not find language to deſcribe them.

All the feathers of the *caſſawary* may be called *barbleſs*. The wing quills of that bird are only five in number, and reſemble the prickles of the porcupine. The other feathers of the body have two ſhafts from one tube, and their barbs are detached, long, and deſtitute of barbules. They reſemble *crines*.

The feathers that form the creſt of the *peacock* have no barbules in their middle and inferior part. Thoſe which form the creſt of the

balcaric

balearic crane (ardea pavonina,) are twifted fpirally on themfelves, and their barbs are only fine hairs. The creft of the *little egret (ardea garzetta,)* is alfo compofed of fimilar feathers. In the *male turkey* there is a tuft of hairs at the bafe of the neck, which may be regarded as barblefs feathers, &c.

We fhall give the name of *loofe feathers* to thofe which, though they have the barbules very confpicuous, and frequently very long, are fo far feparate that they cannot be attached to each other. Such are the hypochondriac feathers of the *bird of paradife*, thofe of the rump of the *peacock*, of the thighs of the *jabiru*, and the *balearic crane*; thofe of the body in *toucans*, and thofe which furround the ears in *owls*, &c.

The term *floating feathers* may be very well applied to thofe of which the barbs, though provided with barbules, are fet wide, and are flexible, as in the feathers of the tail of the *oftrich*.

The nocturnal birds of prey have foft feathers, the barbs of which are covered with a long and filky down. On this account we fcarcely hear the flapping of their wings when they fly. Feathers of this kind may be called *downy*.

Other birds have the feathers of the body furnifhed with barbs, which are fo fine and gloffy that we may term them *filken*. Such are thofe of the *bullfinch*, of the *purple-throated flycatcher (mufcicapa rubricollis,)* of the *tanagra fepticolor*; thofe thoſe of the head of the *red-headed manakin*, and of the *momot* (*ramphaſtos momota*).

We ſhall name thoſe *ſatin feathers* which have cloſe-ſet barbs, bearing long, fine, and ſilky barbules, diſpoſed on the ſurface in ſuch a manner as to imitate ſatin. Such are the rump feathers of the *golden thruſh*, thoſe of the tail of the *jay*, and thoſe of the neck of the *common duck*.

We ſhall apply the term *metallic* to the feathers which have barbs of brilliant colours, reſembling the luſtre of poliſhed metals. We have examples of this kind in the feathers of the *humming-bird*, of the *jacamar*, of the *curucui*, of the *peacock*, of the *paradiſea aurea*, &c. This brilliancy is occaſioned by the breadth of the barbs, and the ſmooth ſurface they preſent to the eye.

We ſhall deſignate by the word *gemmaceous*, all the little feathers which have the barbs that terminate the ſhaft, coloured by imbricated ſemicircles like the ſcales of a fiſh. Of this kind are the head and throat feathers of the *ruby-necked humming-bird* (*trochilus moſchitus*), and thoſe of the head and belly of the *amethyſtine humming-bird*. They exceed in luſtre the preceding kind of feathers, and reſemble precious ſtones. The effect is produced by the extreme denſity of their barbs, and the poliſh of their ſurfaces.

Laſtly, we ſhall make but one order of the *common feathers*, ſuch as belong to *cocks*, *pigeons*, *rollers*, *ravens*, &c.

All birds have feathers on ſome parts of their body. Several ſpecies have them even upon their toes, as *owls*, and ſome varieties of *cocks* and *pigeons*. Others are deprived of them in certain parts of the body, as *vultures* and *turkies* on the head, the *oſtrich* and the wading birds on the thighs. Some even want them on the wings, as the *manchots*.

Chemical experiments on the compoſition of the feathers, prove that they have a very great analogy to hair: The ſame reſults are obtained from both by the ſame proceſſes. Feathers however contain leſs mucilaginous matter.

3. *Of Horns.*

There are prolongations of horny ſubſtance which grow upon the head of certain ſpecies of mammalia, eſpecially the Ruminantia. They alſo appear on ſeveral other parts of animals.

We have already deſcribed the development of the antlers or deciduous horns, in Lect. II. Art. 2, when we treated of Oſteogeny. We ſhall now notice the horns which are formed upon proceſſes of bone, and which grow at their root or baſe, and have a great reſemblance to the integuments.

In the third month of conception, while the fœtus of the cow is ſtill encloſed in the membrane, the cartilaginous os frontis preſents no mark of the horns which it is afterwards to bear.

Towards

Towards the ſeventh month, it is in part oſſified, and preſents in its two portions the ſmall tubercle which appears to be produced by the elevation of the oſſeous lamina. Theſe bony tumours ſoon after appear externally. They raiſe the ſkin, which becomes callous at that part, in proportion as the tumour grows. It becomes at laſt horny as it elongates, and it forms a kind of ſheath which covers externally the proceſs of the frontal bone. Between this ſheath there are numerous branches of blood veſſels which ſerve to nouriſh the oſſeous part.

The horns therefore are only ſolid, hard, elaſtic, and inſenſible ſheaths, which protect the oſſeous prolongation of the frontal bone. Theſe ſheaths are generally of a conical figure, and broadeſt at the baſe, the extremity from which they grow. Their curvatures vary with the ſpecies, and have been deſcribed by naturaliſts. They alſo preſent different channels or tranſverſe furrows, which depend on the age of the animal, and which denote the number of years it has lived in a very certain manner according to the ſpecies.

The texture of the horns appears to be much the ſame in the *goat*, *ſheep*, *antelope*, and *ox*. They conſiſt of fibres of a ſubſtance analogous to hair, which appear agglutinated in a very ſolid manner. In the two firſt genera theſe fibres are ſhort, and covered by ſuperincumbent layers like

like tiles. In the two laſt they are longer, more compact, and form elongated horns incaſed in each other.

The horns of the *Rhinoceros* appear to differ ſomewhat from thoſe of the Ruminantia. They have no oſſeous part, and are not ſituated on the os frontis, but on the lines of the noſe. They are formed however of the ſame ſubſtance, and we even obſerve more diſtinctly in the horn of this animal the fibres analogous to hairs. The baſe of the horn, indeed, preſents externally an infinite number of rigid hairs, which ſeem to ſeparate from the maſs, and which render that part rough to the touch, like a bruſh. When ſawed tranſverſely, and examined with a glaſs, we perceive a multitude of pores that ſeem to indicate the intervals reſulting from the union of the agglutinated hairs. When divided length-ways, numerous longitudinal and parallel furrows alſo demonſtrate the ſame ſtructure. This kind of horn is attached by the ſkin only. Thoſe of the *Rhinoceros bicornis* appear always in a degree moveable. When fixed, as in the *unicornis*, there is a thick mucus interpoſed between its baſe and the bone on which it is ſituated.

The colour of the horns depends, like that of the hairs, on the mucous ſubſtance. Their chemical analyſis affords ſimilar reſults. Heat ſoftens, and even fuſes them. It is the agent employed in manufacturing them into different articles.

From this examination of the horns, it appears that they differ effentially from the offeous prolongations called *antlers* of deer. The latter increafe at the extremity. They are covered with fkin during their growth. They fall off, and are reproduced at a certain period of the year. The others grow at the bafe, are not covered by the fkin, and are permanent.

We find feveral other horny parts in animals. Such are the protuberances of the head in *horn-bills*, the *guinea-fowl*, the *Caffowary*, &c. Thefe are laminæ of horny fubftance which inveft the offeous finufes, of which we have already fpoken, and which we fhall defcribe hereafter, in treating of the organs to which they belong. In the fame manner we fhall poftpone our account of the horn which covers the jaws of birds and feveral reptiles, the fpines of the wings, and the fpurs. The external defcription of thefe parts is indeed more the province of the natural hiftorian, than of the anatomift.

4. *Of Nails.*

This name is given to the horny prolongations which arm and protect the extremities of the fingers or toes in mammalia, birds, and reptiles. Their number is in general equal to that of the fingers and toes. Their form, as we have already

already obſerved in the article on the diviſion of the extremities, appears to depend on that of the laſt phalanx. They are to theſe phalanges what the hollow horns are to the proceſſes of the os frontis which they cover.

The nails ſeem incaſed in a duplicature of the ſkin. The part covered by the ſkin is called the *root*. They grow by that part preciſely in the manner of hairs, but the oppoſite extremity wears by the friction of the ground, and by other uſes to which animals apply their nails. We obſerve, therefore, that they grow exceedingly long in animals that are confined, and have few opportunities of motion.

No part of the nail is ſenſible, except that which adheres to the ſkin. The free extremity may be cut, or broken, without occaſioning any pain.

The colour depends upon that of the rete mucoſum, as we have already remarked.

The human nails appear in the third month of conception; the development takes place nearly in the ſame manner as in the common horns, which we have already deſcribed. At firſt they appear like a kind of cartilage, which gradually acquires a proper conſiſtency. Almoſt all animals have at their birth the nails in ſome degree formed.

The nails of man, and the greater part of unguiculated animals, appear to be formed of extremely thin ſtrata placed one upon another. The anterior laminæ are larger than thoſe of the inferior ſurface; therefore we do not perceive externally the kind of imbrication which takes place: but in diſeaſes, or upon a tranſverſe ſection of the nail, after it has been completely dried, this ſtructure becomes manifeſt. Frequently we obſerve on the ſuperficies of the nail, ſome ſtriæ, or very fine longitudinal and parallel lines, which appear to reſult from the manner in which this part is moulded upon the laminæ it covers.

The nails ſeem intended to protect the extremities of the fingers and toes. They are, in general, wanting in thoſe animals which do not employ theſe parts either in walking or graſping. We have examples of this circumſtance in *bats*, in the wings of birds, with the exception of ſome ſpecies of the *palamedea*, *tringa*, *charadrius*, and *parra*; in the fins of ſeveral *tortoiſes*; and in the claws of ſome other aquatic reptiles, as *frogs*, *ſalamanders*, &c.; laſtly, in the members or fins of fiſhes.

Birds have commonly nails on the toes only. They are ſtrong, and reſemble thoſe of the Sarcophaga and birds of prey. They are flat in the web-footed, ſlender pointed, and very much elongated on the poſterior toe of *larks* and *jacanas* (*parra* Lin.)

The nail is ſerrated on one of its ſides in the middle toe of the *goat-ſuckers* (*caprimulgus* Lin.) and of the *herons*.

There

There is a fupernumerary nail, or offeous procefs, which forms a kind of horn on the tarfus of the greater number of gallinæ. It is called the *fpur*. The *Iris peacock* (*Pavo bicalcaratus*) has two. They become very long in the *cock*. A curious experiment has been performed when pullets are made capons, by cutting off this fpur, and fixing it in the place of the comb. It takes root there, and grows to a confiderable fize.

The nails prefent no particularity in reptiles.

The chemical analyfis of the nails affords nearly the fame refult as that of the hairs and feathers, parts with which they have much relation, both in their mode of growth, and in their ftructure.

Hoofs differ from nails in the following circumftances. They envelope the phalanx inferiorly as well as fuperiorly. They are neither pointed nor cutting at the extremity, and both furfaces meet to form a round and blunt edge.

Their interior is rendered remarkable by deep and regular furrows, which receive projecting laminæ, and which are not obfervable in nails. Thefe furrows are particularly remarkable in the *elephant* and *rhinoceros*. They are alfo very ftrongly marked in the *horfe*, but lefs confpicuous in the Ruminantia.

Between the nails and the foft parts of the phalanx, there is always a layer of mucous matter; and in the inferior part of the hoof, there is a ſoft ſubſtance abounding in nerves, which give a degree of ſenſibility to that part.

5. *Of Scales.*

Theſe are laminæ, or ſmall plates, of a ſubſtance which is either horny or oſſeous, and which cover certain parts of the body of vertebral animals.

Scales have a great reſemblance to hairs, feathers, horns, and nails, in the manner of their development, in their uſe, and in their chemical analyſis.

They might generally be conſidered as very flat horns, as hairs are very ſlender horns.

Almoſt all reptiles, and the greater number of fiſhes, are entirely covered with ſcales: we obſerve them only on ſome parts of the body in a very few ſpecies of mammalia; and in birds, they are moſt commonly found on the feet alone.

The term *ſcales* is here applied to very different ſubſtances; it being uſual to include, under this denomination, all the parts we are about to deſcribe in a general manner, in the four claſſes of red-blooded animals.

The ſcales of the *pangolin*, and *long-tailed manis*, are a kind of flat nails, of a horny ſubſtance; they are thick; their anterior third, which is bevelled and ſharp-edged, is free, but they adhere to the ſkin by their other portion. Their external ſurface is channelled longitudinally,

nally, particularly in the *long-tailed manis*, in which they ufually terminate in three points; they are furrowed tranfverfely on the fide next the fkin, and appear to be formed of imbricated laminæ.

In the *armadillos*, the fcales are fmall compartments of a calcareous fubftance, covered with thick, fmooth, varnifh-like epidermis.

The fcales which cover the tail of the *beaver*, are fimilar to thofe of the feet of birds.

Thofe on the tails of *rats* and *opoffums*, and feveral other prehenfile tailed animals, are of the fame kind.

The fcales of the feet of birds confift of thin laminæ, of a horny fubftance.

The fcales which cover the wings of *manchots*, are only very fhort feathers, the barbs of which are united to the epidermis.

Among the reptiles the fcales vary greatly, according to the genera. In *tortoifes* they are plates of a horny fubftance, which are very hard and denfe in the greater number. But in the *teftudo coriacea*, and feveral others, they are foft and flexible: fometimes thefe fcales are imbricated, as in the *hawkes-bill turtle*; and then they are fmooth, or channelled longitudinally: at other times they form compartments of different figures; in the latter cafe they are more or lefs convex, and furrounded with furrows, or concentric channels, in the midft of which are points, which are either fcabrous, elevated, or blunt, as in the fpecies named *geometrica, græca*, &c.

In the *crocodile* the fcales are offeous, and difpofed in bands, as in the *armadillos*; they are imbricated like thofe of fifhes, and are marked by a longitudinal ridge, or elevated line.

In the greater number of *lizards* and *ferpents*, the fcales are only fmall plates, or compartments of the fkin, between which the epidermis is continued and moulded. The *fcinks* and *flow-worm* have real fcales, which lie upon each other like tiles, in the manner of the fcales of fifhes.

In the clafs of fifhes, all the folid parts with which the body is covered are called fcales; but the ftructure and ufe of thefe infenfible parts render it neceffary that we fhould confider them more in detail.

We name *fcales* thofe thin horny plates which are imbricated like ancient coats of mail, and ufually crefcent-fhaped at their unconnected edge, as in *carp, pike*, &c. Thefe plates moft commonly prefent longitudinal lines, which are rough to the touch: their external third is coloured by the rete mucofum. Thofe above the lateral line have ufually a furrow on the furface next the body; fometimes they are perforated by an oblique hole, through which a membranous canal paffes; thefe fcales are covered with fcabrous points in the *baliftes*. They are finely ferrated on their edges in the *fole (pleuronectes*

folea),

solea). They are very small in *eels*, in which we cannot perceive them until the skin is dried. But they grow to the length of seven centimeters in the *great scaled bream*; in this fish, in particular, the structure of the scales may be easily observed. Besides the longitudinal, or rather radiated lines of which we have spoken, we perceive concentric striæ, which seem to indicate that the scales grow in every direction, by the addition of new layers in the manner of horns and nails.

We may name the plates of calcareous matter which are contained in the skin, *osseous escutcheons*. In the *trunk-fish (ostracion)*, &c. they are small compartments of a regular figure, and disposed like mosaic work. In the *sturgeon*, these plates are of different forms, hollowed externally by numerous holes, and bear a longitudinal ridge. In the *turbot (pleuronectes maximus)*, the scutcheons are small, and in the form of lozenges. In the *essox osseus* the plates are rhomboidal, and covered with a compact and glossy epidermis.

In the *thornback* the spines are curvated points, of a transparent osseous substance; the base of the spine is white, opaque, and hollow internally; it exhibits the print of the muscular fibres, into which it is implanted.

These spines are nearly similar in several species of *diodon*, and other genera; but they have not a round and hollow base, as in the *ray*.

In

In the *piked dog-fiſh* (*ſqualus acanthias* Lin.) the ſcales or prolongations which ſupply their place are ſmall briſtly laminæ; they are flat, bent, figured like myrtle-leaves, and have a longitudinal ridge in their middle.

In other ſpecies of the ſame genus, as the great *dog-fiſh*; in the genus *theuthis*, the *remora*, &c. the ſkin is covered with ſmall tubercles, which are extremely hard, very cloſe, rough to the touch, and which cannot properly be called ſcales.

The ſcales are covered in fiſhes, as well as in all the other claſſes, by the epidermis, which varies in thickneſs and ſoftneſs according to the ſpecies. It is the epidermis only which is caſt by *ſerpents*: the ſcales below it continue to adhere to the ſkin; it appears that the hairs, horns and nails are alſo formed under the epidermis, which is always found on theſe parts, unleſs it has been deſiccated, and worn off by friction.

All the inſenſible parts are deſtitute of nerves and veſſels, except when they include cavities that contain them, as is the caſe with feathers, the ſpines of the *ray*, &c.

They grow like the epidermis, by the addition of new layers, which tranſude from the ſkin, and become united to the laminæ that have been already formed.

6. *Of*

6. *Of the Infenfible Parts in the Animals without Vertebræ.*

Little remains to be faid on thefe parts, fince the fkin of the greater number of invertebral animals is hard and infenfible, as has been already defcribed.

In Lecture II. Article 2. we have explained the manner in which the fhell is developed. We have alfo, in the Article on the Skin, in the prefent Lecture, made fome obfervations on the colour of the calcareous fhell of the Mollufca and the Cruftacea.

The horny fubftance which ferves both for bone and fkin to the greater number of perfect infects, has alfo been defcribed.

The hairs or fpines appear to be a continuation of the epidermis, for they are caft off with it in moulting; and others are reproduced, which are longer than the preceding.

The fcales of the wings and of the body in the Lepidoptera, and fome other orders of infects, are fmall horny plates, differently coloured, implanted in the fkin, and covering it like tiles upon a houfe.

The plumes of the *pterophorus*, of fome butterflies, and of the tailed *hefperia*, are only prolongations or fhreds of the wings furnifhed with long hairs on the fides.

A number of animals of the clafs *vermes* have the body furnifhed with bundles of hairs, which are

are ſometimes ſtiff and retractile, and ſerve for feet, as we have pointed out in the genera *nereis, terebilla, lumbricus*, &c. In the *aphrodita* there are, beſides theſe briſtles employed in progreſſion, an infinite number of other hairs, which are long, flexible, and of a changeable ſea-green colour; there is alſo a tomentous felt-like ſubſtance covering the branchiæ, through which the water is ſtrained.

We refer to Lecture VI. Article 8. for the inſenſible parts of Zoophytes.

LEC-

LECTURE FIFTEENTH.

Of the Organs of Smell and Taste.

Taste and Smell have a more immediate relation to Touch, than Seeing and Hearing; they ſeem indeed only more exalted modifications of the ſenſe of Feeling, by which we are enabled to perceive the differences of the more minute particles of bodies when they are diſſolved in liquids, or in the atmoſphere; their organs are eſſentially the ſame as that employed in ordinary touch, and differ from it only by a greater development of the nerves, and a finer and ſofter texture in the other parts. The organs of which we have to treat are, indeed, real prolongations of the ſkin, formed of all its different layers: we therefore find the epidermis, the rete mucoſum, the villous ſurface, the true ſkin, and the cellular ſubſtance. The tongue of certain animals is even furniſhed with inſenſible teguments, as ſcales, ſpines, teeth, &c.

We ſhall now deſcribe the Organs of Smell and Taſte, in the manner we have examined the other ſenſes; that is, both as to their eſſential parts, and with reſpect to thoſe that ſerve only to augment or diminiſh the force and extent of the ſenſations.

SEC-

SECTION FIRST.

Of the Organs of Smell.

Article I.

Of the Senſe, and its Organs in general.

Of all the ſubſtances which act on our ſenſes, thoſe which produce the ſenſation of Smell are leaſt underſtood, though their impreſſions on the animal body are, perhaps, of the moſt powerful and extenſive kind.

We know, in general, that this ſenſation is cauſed by volatile particles diſſolved or floating in the atmoſphere, and conveyed by the air into the noſe, where they are diffuſed.

Some bodies are always odorous, becauſe, the whole or a part of their ſubſtance being volatile, it conſtantly exhales. Others become odorous under certain circumſtances: for example, when a volatile principle, which has been retained by its affinity with other ſubſtances, is extricated by the addition of ſome new body; as the ſalts which contain *ammoniac*, after a more powerful alkali has diſengaged it: or when there is united to them an external body, capable of forming a volatile compofition, as *muriatic acid* is changed into *oxygenated muriatic acid*, by the acceffion of new oxygen: or, laftly, when a fubftance, which deprived the body into which it had entered, of its volatility, is diflodged; as *nitric acid*, when it is changed into *nitrous*, by the lofs of a part of its oxygen. It is, doubtlefs, in one or other of thefe ways that the prefence or abfence of heat, light, or humidity, may render certain bodies odorous: thus fome flowers poffefs that quality only during the night, clay acquires it when it is moiftened, &c.

Odours appear, therefore, to be propagated in the air, in the fame manner as one fluid diffufes itfelf, and mixes with another: their motion is not direct like that of light; it is not rapid, and is neither fufceptible of refraction nor reflection; it refembles that of the matter of heat, with this difference only, that the fubftances through which the air cannot pafs, are alfo impermeable to odours.

Odours may combine with different bodies by affinity, and are frequently deftroyed by the fame means; they alfo adhere in preference to certain bodies, according to the nature of each. Some are moft eafily retained in fpirits, others in oils, &c.

Thefe phænomena, it will be perceived, feem to prove that each fmell is occafioned by a particular fubftance floating in the atmofphere. There

There are others, however, which appear to indicate that odour is not always produced in this manner.

Several bodies yield a ſtrong ſmell for a great length of time, without ſuſtaining any ſenſible loſs of ſubſtance. Such, for example, is muſk. Some odours are experienced when no evaporation can be obſerved, as the ſmell which ariſes from the friction of copper, that produced by the fuſion of a great number of bodies, and even by the melting of common ice. In other caſes, real evaporations produce no ſenſible odour; this may be remarked on the diſengagement of ſeveral gazes, and even on the ordinary evaporation of water. Perhaps theſe phænomena only prove that the force of the ſenſation is not proportional to the quantity of the ſubſtance by which it is excited, but that it depends on the nature and degree of the affinity of that ſubſtance with the nervous fluid. The action of the greater part of odorous ſubſtances on the nervous ſyſtem, is rendered manifeſt by a number of other effects beſides the ſenſation of ſmell; ſome produce faintings, others giddineſs, or even convulſions. Some, on the contrary, ſerve to remove theſe diſorders: indeed the greater part of medicaments act in general rather by their volatile and odorous parts, than by their other principles; and afford new proofs of the influence exerciſed in the animal economy by the gazeous and impalpable ſubſtances, the

the greater part of which are doubtlefs ftill unknown to us.

We know not whether odours have a peculiar vehicle, befides the matter of heat which is common to them all in their quality of vapours or elaftic fluids.

We are ignorant of the circumftances which render them agreeable or difagreeable to us; and we can as little explain why fmells, which are difgufting to us, feem to be pleafing to certain animals, which teftify alfo an indifference for thofe that are delicious to man. Though the human fpecies, and other animals, are in general fond of the odour of thofe fubftances which ferve for their particular food, that odour is difpleafing when they are fed: on the contrary, they fometimes are fond, to a degree of madnefs, of the odour of fubftances which are of no ufe to them, as *cats* are of *nepeta*, &c. Odours that are conftantly difagreeable, proceed in general from fubftances which may prove injurious. Venomous plants, corrupt flefh, and poifonous metals, have almoft always a difagreeable fmell.

Whatever may be the anfwers given to thefe queftions, the organ of Smell, in all the animals in which it has been obferved to exift, is a very fine expanfion of the fkin, abounding in veffels and nerves moiftened by a quantity of mucous matter, and acted on by air or water impregnated with odorous fubftances; for it appears, that

that a fiſh ſmells in water in the ſame manner as other animals in air: thus odorous ſubſtances, thrown into water to ſerve as bait, attract fiſhes from a very conſiderable diſtance, in the ſame manner as they would attract quadrupeds or birds through the medium of the atmoſphere. We know not whether ſubſtances, which are inſoluble, indiffuſible, and inodorous in the air, but which diſſolve in water, as for example ſalt, act in the latter medium on the organ of ſmell of fiſhes.

In all the red-blooded animals, which reſpire by lungs, the organs of ſmell are ſo ſituated, in the paſſage of the air, as to be impreſſed by it at the moment of inſpiration. In fiſhes, they are ſimply at the end of the muzzle, and muſt receive impreſſions from the water when the fiſh ſwims forward.

We are not ſufficiently acquainted with the nature of the olfactory membrane, nor with that of the nerves diſtributed to it, to enable us to form an opinion reſpecting the degree and the kind of ſenſations they procure to different animals. It may, however, be at firſt ſight preſumed, that, all things in other reſpects being equal, the animals in which the olfactory membrane is moſt extenſive, enjoy the ſenſation of ſmell moſt exquiſitely, and experience confirms this conjecture. It would be curious to learn, why the animals which poſſeſs the ſenſe of ſmell in the higheſt degree, are preciſely thoſe which feed

feed on the moſt fetid ſubſtances, as we obſerve in *dogs* which eat carrion. Perhaps the Sarcophaga have, of all animals, the fineſt ſmell, as it is neceſſary they ſhould be able to trace their prey from a great diſtance.

In treating of the organs of Smell, we ſhall have to examine the ſtructure and extent of the pituitary or olfact ory membrane, the ſize and number of the nerves diſtributed to it, and the means by which it receives the odorous exhalations. Theſe ſhall form the ſubjects of the following articles.

ARTICLE II.

Of the Form and Magnitude of the Naſal Cavity.

THIS ſubject is included in ſeveral of the Articles of Lecture VIII: we ſhall therefore content ourſelves by referring—

For the compoſition of the naſal foſſæ, to pages 60, &c. of this volume.

The external aperture, pages 82, &c.

Their ſize and their vertical ſection, pages 10, &c.

Their tranſverſe ſection, and their direction, pages 82, &c.

We ſhall merely add here, that, in ſome fiſhes, the naſal foſſæ are not formed in the muzzle, but, on the contrary, ſuſtained upon pedicles, and elevated like drinking-glaſſes. Of this number is the *frog-fiſh*.

Article III.

Of the Sinuſes which increaſe the Extent of the Naſal Cavity.

It is not proved that the ſenſe of Smell reſides in theſe ſinuſes: the membrane which covers them is thinner than that of the reſt of the noſe; and it does not appear to receive any ramifications of the olfactory nerve; no uſe is attributed to them, except that of ſecreting an aqueous humour calculated for lubricating the interior of the noſe. It is certain, however, that the animals which have the moſt perfect ſmell, have theſe ſinuſes the longeſt; perhaps they are intended as reſervoirs for a great quantity of air impregnated with odorous particles, in order that it may act more forcibly on the olfactory membrane.

Theſe ſinuſes hardly exiſt in young animals, and are not fully developed until puberty.

They are found only in man and quadrupeds; they

they communicate with the cavity of the nofe by contracted apertures.

There are three finufes, which are named, from the parts they occupy, the *frontal*, the *fphenoidal*, and the *maxillary*.

A. *In Man.*

The *frontal finufes* open into the upper part of the vault of the nofe; they extend about an inch in height, and a little more in breadth on each fide above the eye-brows; they are feparated from each other by a vertical feptum.

The *fphenoidal finufes* open into the pofterior and inferior part of the nafal vault; they occupy all the interior of the os fphenoides, under the anterior and middle part of the fella turcica; they are alfo feparated by a vertical feptum.

The *maxillary finufes*, or *antra Highmoriana*, fill the whole body of the fuperior maxillary bones; they open into the fides of the nafal cavity, near its bottom.

B. *In other Mammiferous Animals.*

1. *The Frontal Sinufes.*

Thefe are very fmall in *monkies*. They are even entirely wanting in the greater number of *baggois* and *guenons*. But they are confiderably extenfive in fome of the *fapajous*.

Among the Sarcophaga, *dogs*, *wolfs*, *foxes*,

 &c.

&c. have them moſt conſiderable; they occupy the whole extent of the os frontis, fill the interior of the two poſt-orbitar proceſſes, and deſcend on each ſide in the poſterior wall of the orbit. They are ſomewhat leſs extenſive in the *bear* towards the ſides, and in the *cat* poſteriorly. The ſinuſes of the *coati* reſemble thoſe of the *cat*. Thoſe of the *civet* occupy only the poſterior part of the frontal bone. There are none in the *badger*, in *bats*, nor in the greater number of *weaſels*. The excavations of the poſt-orbitar proceſſes, it is true, exiſt in thoſe animals, but they are only prolongations of the naſal cavity, communicating freely with it, and not by a narrow aperture.

With reſpect to the Rodentia, theſe ſinuſes are wanting in *rats*, the *marmot*, the *agouti*, the *ſquirrel*, the *beaver*, and the *hare*. But they are very large in the *porcupine*, and penetrate even into the ſubſtance of the naſal bones.

The ſame difference occurs among the Edentata. The *ant-eater* and the *pangolin* have no frontal ſinuſes. The *armadillo* has them of a moderate ſize. But in the *ſloth* they are very large, and in the adult animal extend nearly to the occiput.

The Ruminantia exhibit varieties equally ſtriking. The *ſtag* appears to have no frontal ſinuſes. The *ox*, the *goat*, and the *ſheep*, have them of an enormous ſize, and extending into the ſubſtance of the oſſeous proceſſes which fill the

the horns. Thofe of *antelopes* occupy the thicknefs of the os frontis, but the offeous part of the horns is folid. The *camel* has alfo numerous finufes, which are very much divided, but they do not extend further back than the frontal bone.

Of all animals, the *elephant* has the largeft frontal finufes. It is their magnitude which gives to his cranium the extraordinary thicknefs which diftinguifhes it from all others. They extend through the whole fubftance of the parietal and temporal bones, and even the articular condyles of the os occipitis. Numerous and fingular laminæ divide them into cells, all of which communicate with each other.

The frontal finufes of *hogs* are equally extenfive, though lefs elevated. They proceed to the occiput, and are only feparated from each other by fome offeous laminæ, which are placed in a longitudinal or flightly oblique direction, and which do not entirely intercept communication. There are four rows in the *babiroüffa*, and feven or eight in the *common hog*. The *hippopotamus*, and the *rhinoceros*, want the frontal finufes.

The frontal finufes of the *horfe* occupy a great part of the os frontis. They do not open immediately into the nofe, but communicate, by a very large aperture on each fide, with the pofterior maxillary finus; for this animal has two.

 2. *The*

2. *The Maxillary Sinuses.*

The relations of thefe finufes do not correfpond to thofe we have pointed out in the frontal. They are rather proportionally fmaller in the Quadrumana than in man. They are reduced almoft to nothing in the Sarcophaga, the greater part of the Rodentia and Edentata, and, in general, in all animals in which the maxillary bone does not form a floor under the orbits. Thefe finufes exift however, and are even very confiderable in the *porcupine*; but in the greater part of the other unguiculated mammalia, even when the maxillary bone is hollow, the cavity forms a part of that of the nofe, and cannot be called a finus, as it has no contracted aperture.

Hogs have no finus that can properly be called maxillary, but they have one in the bafe of the os malæ, which is particularly extenfive in the *Ethiopian hog*. The *hippopotamus* has a fmall one in the fame place.

The maxillary finufes of the Ruminantia are very large, and open into the nofe by a narrow fiffure behind the inferior fpongy bones.

The *horfe* has two, the pofterior is the largeft. It opens laterally towards the back and upper part of the nofe by a triangular hole. Its parietes form a large projection within the nofe, which feparates the portion of the nares, occupied by the ethmoidal foramina, from that in which

which the two great turbinated bones are ſituated. The anterior maxillary ſinus opens into the bottom of this laſt part.

The interior of the oſſa maxillaria of the *elephant* is, like that of the bones of his ſkull, divided into a multitude of very large cells, all of which communicate together, and one opens by a hole into the ſide of the noſe.

3. *The Sphenoidal Sinuſes.*

Theſe ſinuſes are ſmall in proportion as the ſella turcica is flat.

Monkeys and *makis* have them ſmaller than man. The Sarcophaga have them alſo ſmaller, and of a more elongated form. The *otter*, the *ſeal*, and the *pole-cat*, want them entirely. It alſo appears, that there are none in the other unguiculated Mammalia, nor in the Ruminantia. The *hog* and the *hippopotamus* have them, but they are very ſmall. In the *elephant* they are enormous, and occupy even a part of the pterygoid proceſſes. They are not divided into ſmall cells, like the other ſinuſes of that animal.

In the *horſe*, each opens into the poſterior maxillary ſinus of the ſame ſide.

I have not found ſinuſes of any kind in the bones of the Cetacea.

The cavities of the bones of the cranium in birds, communicate with their ears, and not with their noſe. The large vacuities in the beaks

beaks of the *hornbills* and *toucans*, communicate indeed with their nares, which in theſe birds are very ſmall; but it appears, in the freſh ſtate, that the pituitary membrane cloſes this communication, and that it does not penetrate into theſe vacancies which are every-where traverſed by oſſeous filaments.

Reptiles and fiſhes have nothing that can be compared to ſinuſes.

Article IV.

Of the Projecting Laminæ which increaſe the Internal Surfaces of the Naſal Cavity.

Besides the uſe of theſe laminæ in multiplying the internal ſurfaces of the noſe, and thereby augmenting the extent of the pituitary membrane, and the intenſity of the ſenſation of ſmell, they alſo form conduits which are joined to the apertures of the different ſinuſes.

A. *In Man,*

Theſe laminæ are of three kinds, viz. the *oſſa turbinata inferiora*, formed by particular bones; the *turbinata ſuperiora*, which are productions of the os ethmoides; and its *anfractuoſities*.

The

The *inferior turbinated bones* have the form of a thin lamina, which adheres by one of its edges to a ridge of the maxillary bone, and is ſlightly twiſted in ſuch a manner that the free edge points downward. Its convex ſurface is ſuperior and internal. We obſerve that it is marked by ſome oblique furrows. The aperture of the maxillary ſinus is above it poſteriorly. The conduit formed by its concavity, proceeds directly from the anterior to the poſterior nares.

The *os ethmoides* is formed of three laminæ perpendicular to each other, and of ſeveral intermediate laminæ. The *cribriform lamella*, which completes the cranium between the roofs of the two orbits, and the two *oſſa plana*, each of which forms a conſiderable part of the internal parietes of the orbits, are the three external laminæ. We have already deſcribed them. See pages 20, 36, 48, and 61, of this volume.

Between the two *oſſa plana* there is a ſingle vertical lamina, which, continued with the *vomer*, divides the cavity of the noſe into two parts. In the interval which it leaves on each ſide, there are ſome irregular lamellæ which adhere to the os cribriforme, and the os planum of the ſame ſide only, but not to the middle ſeptum. Theſe irregular lamellæ form communicating cells which we have named *anfractuoſities*, and which may alſo be called *ethmoidal ſinuſes*. This collection of cells is cloſed, on the ſide of the ſeptum, by a vertical and ſulcated lamina. The interval

interval which remains between these two laminæ, leads directly to the sphenoidal sinus of that side.

The inferior part of the lamina, which is opposed to the septum, is prolonged obliquely, and extends a little posteriorly, where it forms a fold, the concavity of which is directed downward; and the anterior part is continued with a short canal, which ascending obliquely, and penetrating the ethmoidal anfractuosities, leads into the frontal sinus of the same side. This reflected lamina is the *superior os turbinatum*.

The two turbinated bones have a more spongy structure than the other osseous laminæ; and we observe, particularly in the superior pair, that they contain a multitude of small holes.

B. *In other Mammiferous Animals.*

1. *Of the Ossa Turbinata Inferiora.*

We have shewn that these bones form only a simple lamina in man. We shall now describe their different degrees of complication in other animals.

They are similar to those of man in the *monkies* of the old continent, but in *sapajous* they begin to resemble in structure those of the Pachydermata and Ruminantia; in all which animals the lamina is only simple at its base, and is bifurcated at a small distance. The two laminæ which arise from it, are twisted spirally

on

on themſelves. They incline from the ſide of the maxillary bone, and make two turns, or two and a half, according to the ſpecies.

The kind of horn or concha produced by this ſpiral turning, is cloſed poſteriorly in a point. We know that it contains two canals, one above, the other below the principal lamina. The inferior leads, as in man, into the poſterior nares. In the Ruminantia, the fiſſure which leads to the maxillary ſinus, is found in the hollow of the ſuperior canal. In the *hogs*, this canal is continued poſteriorly by a long furrow, at the extremity of which there is a conduit which goes into the ſinus in the baſe of the os malæ.

In *hogs*, the laminæ of the oſſa turbinata are ſolid, but in the Ruminantia they are perforated by numerous foramina, more or leſs large. Theſe foramina are ſmall in *ſheep*. They become very large and numerous in *deer*; and in the great Ruminantia, as *cows*, large *antelopes*, &c. their ſize is ſo conſiderable that they leave between them only oſſeous filaments, and the bone reſembles lace.

The interior of theſe bones is divided by ſeveral vertical partitions, which are perforated like the reſt of the ſepta.

In the *hippopotamus*, the two turbinated bones are flattened horizontally, but in other animals vertically. This is occaſioned by the form of the

the head. The foramina are very fine, and innumerable.

The inferior ſpongy bones are leſs regular in the Solipeda. The horizontal lamina, inſtead of bifurcating folds at firſt downward, then bends upward, and is attached behind to the maxillary bone. It aſcends poſteriorly to cover the foramen of the inferior maxillary ſinus, and even to penetrate into it. Laſtly, it produces, towards its middle, two or three oblique laminæ, which are attached to the anterior edge of this hole.

In the *ant-eaters*, the *pangolins*, the *oryćteropus*, the *armadillos*, and even in the *three-toed ſloth*, the inferior turbinated bones nearly reſemble thoſe of the Ruminantia. But in the *two-toed ant-eater*, they repreſent two priſmatic boxes cloſed on all parts, the interior of which is divided by ſome vertical laminæ. We find two ſimilar boxes in the *makis*, but no internal diviſions.

Among the Rodentia, the *rat* has the turbinated bones ſimilar to thoſe of the Ruminantia; but the oſſa turbinata of the other genera of that order, may be divided into two kinds: the firſt are formed like thoſe of the Sarcophaga; the others, which are met with only in the *porcupines*, the *marmottes*, and a few other ſpecies, conſiſt of a double lamina attached longitudinally, the two parts of which, ſeparate from each other,

other, aſcend by a ſpiral convolution, and repreſent a portion of the ſhell called *turbo*.

The other Rodentia, as the *hares*, *rabbits*, *ſquirrels*, *beavers*, *rats*, and the greater number of the Sarcophaga, as *dogs*, *bears*, *badgers*, *ſeals*, the *domeſtic cat*, &c. have a very complicated ſtructure in the inferior turbinated bones. The lamina by which they are fixed is bifurcated. Each branch is again divided; the laſt lamina form, by their parallel ſituation, a number of ſmall canals through which the air paſſes, and which are covered by the pituitary membrane.

The number of theſe laminæ is very variable. The *ſeals* and the *otters* are the ſpecies that have moſt of them. The *dogs* and *bears* rank next. Of all the Rodentia, the *beavers* have them moſt numerous, and the *hares* the leaſt ſo.

The direction of the canals is moſt ſtraight in the Sarcophaga, and moſt curved in the Rodentia.

When there are few laminæ, the laſt are ſpirally rolled as in the animals which have only two.

Some Sarcophaga have the inferior turbinated bones as ſimple as the animals firſt mentioned. The *lion*, for example, has only a bifurcation and a double roll, almoſt like the Ruminantia. The oſſeous lamina is pierced with many holes; the *civets* and *genettes* have a ſimple rolled bone without holes.

2. Of

2. *Of the Offa Turbinata Superiora, and of the Ethmoidal Cells.*

The ethmoidal cells, in a number of animals, are very diftinct from the fuperior turbinated bone. The part of the nafal cavity which contains them, is fometimes feparated from the reft by a particular feptum. In *hogs*, this feptum is formed inferiorly by a lamina which belongs to the palatine bones, and anteriorly by a projection of the offa maxillaria, which goes to the feptum of the nares, and only permits the air to pafs by a narrow paffage above it.

In the *horfe*, this projection does not extend to the feptum. It produces, however, a very evident feparation, and leaves behind it a lateral depreffion, which is occupied by the ethmoidal cells. The fame difpofition prevails in the Carnivora, but neither in the Ruminantia nor the Rodentia, in which the depreffion is inconfiderable.

To form an idea of the ethmoidal cells in the greater number of animals, it is neceffary to imagine a great number of hollow pedicles, all connected to the os cribriforme. They extend forward and outward, and, in proportion as they advance, thofe which are neareft unite. Vefîcles arife from them, which increafe in fize in proportion as they become lefs numerous. They are all hollow, and there are an infinite number of conduits or ways between them, all of which commu-

communicate with each other. Such is their ſtructure in the Edentata, the Ruminantia, the Solipeda, the Pachydermata, and the Sarcophaga. The latter of theſe orders have them the moſt numerous. The Rodentia have very few. The *porcupine*, for example, has only three or four on each ſide. Some genera, as the *hare*, have irregular cells, like thoſe of man. Thoſe of the quadrumana are ſimilar.

The *ſuperior turbinated bone* is repreſented in the Ruminantia, the Pachydermata, and the Solipeda, by one of the cells, which is larger, and in particular much longer than the others, and which extends to the inferior turbinated bone, which it covers in the manner of a roof. In the *hog*, it diminiſhes towards the lower part, and ends in a lamina, which is joined to the os naſi under its external edge. This edge, therefore, appears to be bent inwards to cover the inferior turbinated bone. The ſuperior turbinatum becomes thin much higher up in the Sarcophaga, ſo that the hollow part of the cell, of which we ſpeak, is not longer than in the other animals.

C. *In Birds*,

The external ſide of each noſtril is occupied by three kinds of laminæ. The inferior turbinated bone is only a fold connected on one part to the alæ of the noſe, and on the other to the ſeptum. The middle or largeſt lamina, the fiſ-

 ſure

ſure of which Scarpa compares to that of a cucurbite, adheres by its bottom to the oſſeous part of the ſeptum. It folds two and a half times on itſelf. The ſuperior lamina, which has ſome reſemblance to a bell, adheres to the frontal bone and to the os unguis. It contains two apartments, each of which is prolonged into a hollow tube. The moſt internal tube extends to the orbit, and the external terminates in a blind cavity behind the middle lamina. Theſe three laminæ divide the naſal cavity into three paſſages. They vary in their magnitude and inflexions, according to the ſpecies. Scarpa, from whom we borrow this deſcription, aſſures us that the middle makes only one turn and a half in the Gallinæ and the Paſſeres, and that the ſuperior is in the ſame birds very ſmall. It increaſes a little in the *pies*, is more conſiderable in birds of prey, and is ſtill larger in the Anſeres. Finally, in the Grallæ it alone occupies two thirds of the cavity, while the middle lamina is very ſlender, making only a turn and a half, and the inferior is only an indiſtinct fold.

Theſe turbinata are in general cartilaginous. Harwood ſays, they are membranous in the *caſſowary* and the *albatroſs*. To me they appear oſſeous in the *hornbill* and the *toucan*.

D. *In Reptiles.*

Reptiles have alſo different projecting laminæ within

within their nofe; but they are produced by the folds of the internal membrane, and are not fuftained by offeous parts. The *tortoife* has three laminæ, which divide the nafal cavity into feveral foffæ. The middle one correfponds to the external aperture of the noftrils; between it and the next, there is an oblique canal which leads to the pofterior nares. We find only fome tubercles in *frogs* and other fmall fpecies. It does not appear that any refearches have been made refpecting thefe parts in the *crocodile*.

E. *In Fifhes.*

The internal laminæ of the nares in fifhes are alfo entirely membranous; but they are more numerous and more regularly difpofed than in the other claffes. In the Chondropterygii, the *rays* and *fharks* have them placed parallel to each other on both fides of a large lamina, which extends from one end of the foffa to the other. Each confift of a femi-lunar fold of the pituitary membrane, and has other fmaller laminæ fituated on both its fides, in the fame manner as it is placed with refpect to the great middle lamina.

In the other fifhes, whether cartilaginous or offeous, the laminæ proceed like radii from an elevated and round tubercle. They have a very elegant appearance in the *fturgeon*, where each is divided into more flender laminæ, as the branch of a tree into ſmaller ramifications. In ſome ſpecies, and particularly in the *carp*, the middle tubercle is ſomewhat oval, and this renders the diſpoſition of the laminæ more like that which prevails in the Chondropterygii.

ARTICLE V.

Of the Pituitary Membrane.

THIS membrane is a continuation of the external ſkin; it unites in the back of the mouth with that production of the ſame tegument, which, after inveſting the lips and all the interior of the mouth, covers the œſophagus and the reſt of the inteſtines.

It takes the name of pituitary membrane in all the interior of the noſe, on its ſeptum, its parietes, its laminæ, and even in its ſinuſes. It is attached to the perioſteum of all theſe parts by a compact cellular ſubſtance, and is itſelf every-where covered by the epidermis.

In the ſinuſes it is exceedingly thin, ſimilar to a common membrane, and its veſſels can ſcarcely be obſerved; but in the reſt of the noſe it is more thick and ſoft, particularly at the inferior and poſterior part of the ſeptum. Its ſubſtance is pulpy or fungous. We obſerve in it a ſpongy texture, rendered leſs compact in ſmall fmall fpots, which reprefent the mefhes of a net. Its fuperficies is of a beautiful red colour, and it is only by examining it very clofely that we perceive that colour to refult from innumerable ramifications of fmall blood-veffels. We diftinguifh them better, however, near their trunks, particularly at the pofterior part of the feptum, or when they are diftended by inflammation or injections.

The furface of this membrane has a great quantity of fmall pores, from which a mucous humour perpetually exudes. It is fuppofed that thefe are the orifices of an equal number of minute follicles concealed in the fubftance of the membrane. Many of thefe follicles have even been obferved to exift in fome parts, and to have common excretory canals. They were difcovered by Stenon in the nares of the fheep. Ruifch, and after him Haller, perceived feveral to communicate with one common finus, particularly towards the anterior part of the feptum.

There have been obferved in feveral quadrupeds, as the *cow* and the *fheep*, fome parallel white lines between them. I have feen fome of them tranfverfe or oblique on the feptum, and longitudinal on the inferior turbinated bones of the *fheep*.

A vifcous humour conftantly exudes from all parts of the pituitary membrane. In inflammations produced by colds, this at firft becomes more abundant and fluid, and at laft turns thick, yellow, and diſagreeable to the ſmell. The ſinuſes produce a more limpid fluid, which ſeems intended to dilute the other.

Except the Cetacea, of which we ſhall ſpeak ſeparately, the mammalia exhibit little difference in the ſtructure of the pituitary membrane.

In birds, it is, according to Scarpa, very thin on the ſuperior turbinatum. The veſſels form a beautiful net-work on its ſurface, and a multitude of pores produce mucous matter in great abundance, particularly on the middle turbinatum, where the membrane is alſo more thick and villous.

In reptiles it is every where furniſhed with reticular ramifications of blackiſh veſſels. We alſo find theſe black veſſels in ſome fiſhes, and particularly in the *pike*; but in the greater number of ſpecies they are red. We obſerve between them ſome ſmall papillæ, that ſecrete a thick mucilage, which appears to be more abundant in fiſhes, particularly in the *rays* and the *ſharks*, than in the other claſſes.

Article VI.

Of the Nerves which are diſtributed to the Internal Parts of the Noſe.

These nerves come from the firſt and the fifth pairs.

4 I. *The*

I. *The Olfactory Nerve.*

We have already defcribed the origin of the firft pair in man, page 148; in quadrupeds, page 164; in birds, page 168; in reptiles, page 170; and in fifhes, pages 172 and 176 of this volume.

We have defcribed all the portion of the nerve between its origin and its entry into the nafal cavity, by one or feveral foramina, in Lecture X. Article 1.; it remains for us now to treat of its paffage through the cranium, and its diftribution in the interior of the nofe.

A. *In Mammiferous Animals.*

1. *The Cribriform Lamella.*

The mammalia are the only animals that have a cribriform lamella to the ethmoid bone, and we muft, even in them, except the Cetacea, which have neither an olfactory nerve, nor holes for its paffage. All the other animals have only a fimple hole, or a fimple canal.

The pofition, and the concavity of the cribriform lamella, have been defcribed in Lecture VIII. Article 3. § B: it now remains for us to fpeak of its fize, its figure, and its foramina.

In man it has the form of an elongated rectangle,

angle, and we reckon in it about 40 ſimple foramina. In *monkies* it is proportionally much narrower, and its foramina are leſs numerous.

In the other quadrupeds, the cribriform lamella is ſhaped like a heart, or it is oval; it is placed at the bottom of a foſſa, which a contraction, more or leſs conſpicuous, ſeparates from the reſt of the cranium, and is perforated by a great number of holes of different ſizes, collected in groups; theſe groups leave between them vacant ſpaces, diſpoſed like the ſmall and great branches of a tree, ſo that the whole lamella exhibits the appearance of very fine lace.

The number and figure of theſe cluſters of foramina are not ſubject to conſtant laws; but, judging by the animals in which the ſenſe of ſmell is known to exiſt, that ſenſation ſeems to be in proportion to the number of the holes.

They are large and numerous in the *elephant*, the *hippopotamus*, the *hog*, and ſtill more ſo in the *hind*, or *female ſtag*. The Sarcophaga have them more numerous than all other animals. The *hog*, the *ſheep*, and the *ant-eater* have, on each ſide of the criſta galli, a range of holes which are larger than the others. We alſo find theſe holes, but leſs conſpicuous, in ſome other ſpecies. The Rodentia appear, in general, to have fewer holes than the other orders. The *camel* has the lamella ſmall, and the perforated ſpaces

larger

larger than in the other Ruminantia. The Edentata have the lamella large, and furnifhed with many holes.

2. *The Olfactory Nerve.*

This nerve—whether it arife from the hemifphere, as in man, and in *monkies*—or whether the pia-mater unites it in fuch a manner to the caruncula mammillaris as to appear to form but one body with it, which takes place in the other quadrupeds,—always dilates, by its extremity, to cover the cribriform lamella, and to penetrate through it by as many filaments as that lamella has holes.

Thefe filaments are diftributed to the part of the pituitary membrane which covers the anfractuofities and turbinata of the os ethmoides, and to the intermediate feptum of the nares: they are fo very foft that it is difficult to trace them. We obferve, however, fome principal branches fpreading over the feptum. There are, in particular, two in the *fheep*, which are very beautiful. Several authors believe that this nerve does not extend to the inferior turbinated bones. Though we have not made particular refearches on this f bject, the complication of thefe bones in the animals which have the moft acute fenfe of fmell, would prevent us from adopting the fame opinion.

B. *In Birds.*

The olfactory nerve in birds arifes only from the anterior extremity of the hemifphere, which has been compared to the caruncula mammillaris of quadrupeds; it paffes through a canal, the length and diameter of which varies according to the fpecies, but which is not fubdivided. On reaching the root of the nofe, the nerve divides like a hair pencil into a multitude of fibrillæ, which expand in the pituitary membrane of the feptum, and the fuperior turbinata. Scarpa is of opinion that they extend no farther, and fuppofes that the middle and inferior turbinata receive nerves only from the fifth pair, and are not organs of fmell. The only ufe he attributes to them is that of breaking the force of the air, which thefe animals refpire in a greater quantity than others, and thus preventing its fhock from injuring the fuperior turbinata.

He ftates, that his experiments on living birds have convinced him, that fmell is ftrongeft in the fpecies which have the fuperior turbinata and olfactory nerves the largeft. The following is the order in which he places birds with relation to the faculty of fmell, commencing by thofe in which that fenfe is moft delicate— the *Grallæ*, the *Palmipedes*, the *Accipitres*, the *Picæ*, the *Pafferes*, the *Gallinæ*.

C. *In*

C. *In Reptiles.*

The olfactory nerve in this clafs differs little from that of birds, as to its origin and its courfe; it differs ftill lefs in its diftribution, fince it alfo divides, according to Scarpa, upon the feptum, and the fuperior turbinatum, without proceeding farther.

D. *In Fifhes.*

When the olfactory nerve arrives behind the folded membrane which forms the naris, it is dilated to be applied to the whole of its internal and convex furface. Sometimes, before it expands, it fwells into a real ganglion. This may be feen in the *carp*; at other times, its expanfion takes place without any previous enlargement: it is thin, and may be compared to the retina, but we obferve more diftinctly the nervous fibres, of which it is compofed. In *rays* and *fharks* there is a trunk under the principal fold of the pituitary membrane, and branches in the lateral folds; thefe branches produce fmall filaments, which penetrate into the fubftance of the membrane, where they are regularly diftributed.

II. *The Nerve of the Fifth Pair.*

In all vertebral animals, the interior of the nofe

nofe receives a ramification of the ophthalmic branch of the fifth pair, as we have fhewn, page 206 of this volume, in man; page 209, in the other mammalia; page 220, in birds; page 222, in reptiles; and page 223, in fifhes. This ramification is called the *nafal nerve.*

The *fpheno-palatine* ganglion of the fuperior maxillary nerve furnifhes, befides, in man and the other mammalia, feveral filaments to the pofterior nares. See pages 210 and 211.

The maxillary finus receives fome ramifications from the fame branch; and the frontal finus, fome from the frontal branch of the ophthalmic nerve.

In birds, the firft nafal branch of the ophthalmic arifes at the place where the nerve enters the bill; it is flender, and extends the whole length of the fuperior edge of the feptum; the ophthalmic afterwards produces a fecond and larger branch, which divides into three or four ramifications, that extend to the middle and inferior turbinata. A third branch is diftributed to the external parts of the margin of the nares.

The diftribution of the fifth pair in the nofe of reptiles, is not correctly known to us.

In fifhes, the nafal branch of the ophthalmic is fometimes as large as the olfactory nerve itfelf. As thefe two nerves proceed a confiderable way in a parallel fituation in *carps*, the genus *gadus*, the *pike*, &c. fome old anatomifts (Collins among

among others) believed that thefe animals had two olfactory nerves on each fide: this error has been copied by feveral more recent writers.

The nafal nerve appears to us, to be principally diftributed towards the external edges of the pituitary membrane.

Article VII.

Of the Cartilages which cover the Aperture of the Noftrils, and their Mufcles.

We have defcribed, in page 82 of this volume, the aperture of the nafal foffa, as it exifts in the fkeleton, when the foft parts have been removed. In the frefh ftate that aperture is furnifhed with feveral cartilages, which more or lefs prolong the nafal cavity anteriorly, and which can enlarge or contract its entrance by their motions.

A. *In Man.*

I. *The Cartilages.*

The intermediate feptum of the noftrils becomes cartilaginous at its anterior and inferior part, and is prolonged to the point of the nofe; its anterior edge is reflected upon the part which is immediately under the offa nafi, in two triangular

angular laminæ, which extend to the ſide of the noſe, and increaſe the planes formed by its proper bones.

The interval which remains on each ſide between theſe triangular laminæ and the ſeptum, is occupied by an oblong tranſverſe cartilage, reflected in two plates, between which is the vacant ſpace that leads into each noſtril; one of theſe folds is placed againſt the ſuperior edge of the ſeptum, the other occupies the ſubſtance of the *ala*, for ſuch is the name given to the inferior part of each of the ſides of the noſe. The ala alſo contains, towards its root, one, two, or even three ſmall irregular cartilages, which are ſometimes membranous: all theſe parts are connected by a fat cellular ſubſtance, and covered by the ſkin.

II. *The Muſcles.*

Several muſcles act on theſe cartilages, and contribute, with the two lips, to give to the human countenance thoſe various expreſſions which characterize it:

1. *The Pyramidalis Naſi.*

This muſcle is a production of the occipito-frontalis, which deſcends between the eye-brows, and covers the ſides of the noſe; it is terminated by an aponeuroſis, which is common to it with the muſcle we have next to notice.

2. *The Tranfverfalis, or Compreffor Naris,*

Arifes below the internal angle of the orbit, and extends along the fide of the nofe, to unite with its correfpondent on the back of that part.

3. *The Levator Labii Superioris Alæque Nafi.*

This mufcle defcends from the internal angle of the orbit towards the lip, and, in paffing, furnifhes feveral fibres to the ala of the nofe.

4. *The Depreffor Alæ Nafi,*

Comes from the part of the maxillary bone which contains the dentes incifores, and extends directly upward to the inferior edge of the alæ nafi.

5. *The Nafalis.*

This mufcle has its origin in the inferior part of the feptum, and proceeds downward and laterally, to be confounded with the orbicularis of the lips.

The action of each of thefe mufcles may be very eafily comprehended.

B. *In other Mammiferous Animals.*

The cartilages of the nofe and their mufcles vary confiderably in the mammalia, as well as the greater number of other external parts.

The cartilages of the nofe of *monkies* do not differ from thofe of man, but in their extreme fmallnefs;

ſmallneſs; they appear to have no muſcles, except an expanſion of longitudinal fibres, which uniformly covers the whole face, and which ſeems to be a continuation of the Panniculus Carnoſus; this at leaſt we have obſerved to be the caſe in the *macaques*.

In the Sarcophaga, in which the noſe is not prolonged beyond the mouth, as, for example, the *dog*, the cartilages are alſo ſimilar to thoſe of man. The cartilage of the ſeptum produces two alæ which prolong the bones of the noſe, and the edges of the noſtrils are furniſhed with two inflected cartilages: there are no diſtinct muſcles, except the *levator communis alæ naſi, labique ſuperioris*, which covers the whole cheek, almoſt in the ſame manner as the expanſion we have deſcribed in the monkey; and the *depreſſor alæ naſi*, which is very ſmall.

In the Sarcophaga, which have projecting and moveable ſnouts, as the *bears*, and particularly the *coatis* and the *moles*, the cartilages form a complete tube, which is articulated to the oſſeous nares.

In the *bear*, the cartilaginous ſeptum is reflected inferiorly, as well as ſuperiorly; the ſuperior alæ bend downwards, the inferior upwards; they meet on the ſides, where they are united by cellular ſubſtances, and complete the external parietes of each noſtril. The edge of each ala continues afterwards to bend inward, and forms a kind of concha, which makes an addition

addition to the inferior os turbinatum, and which is covered, like it, by a prolongation of the pituitary membrane.

This cartilaginous tube is moveable, in every direction, on the end of the offeous fnout: its mufcles are particularly remarkable in the *mole*; there are four on each fide, all attached above the ear, and extending between the temporal and the mafteter mufcles; they terminate by an equal number of tendons, which are placed round the nafal tube, like ropes round a maft: the moft deep-feated of thefe mufcles produces the fuperior tendon, which unites with its correfpondent, and a large aponeurofis, which covers all the upper part of the nofe. The two next mufcles proceed to the fide of the nofe, the one a little higher, the other a little lower: the fourth, which is the moft external, unites with the correfponding mufcle under the nofe, as the firft does above it; thefe tendons are inferted into the fungous plate which terminates the fnout, and cover the extremity of the cartilages: a fmall mufcle alfo arifes from the alveolar edge of the inter-maxillary bone, and depreffes the fnout. The end of the feptum is offified.

The fnout of the *hog* is, in a great meafure, fimilar to that of the mole; its cartilages are only proportionally fhorter; their extremity is alfo offified on the end of the feptum: this animal has likewife four mufcles to the nofe, but they

they are ſhorter, and differently ſituated; the ſuperior ariſes from the os lachrymale before the eye; its tendon extends to the ſnout, but does not come near enough to the correſpondent muſcles to unite with it: two other muſcles are ſituated under the preceding; they ariſe from the os maxillare before the zygoma, and partly unite, but their tendons proceed ſeparately, the one to the ſide, the other towards the lower part of the ſnout: the fourth, which is very ſmall, proceeds obliquely from the naſal bone, towards the inſertion of the preceding muſcle, and paſſes under the tendons of the two firſt.

The ſnout and its longitudinal muſcles are enveloped in the hog, as in the mole, by annular fibres, which are a continuation of the orbicularis of the lips.

In the Solipeda and the Ruminantia, which have the oſſeous nares very open, directed obliquely upward, and formed by a large notch on each ſide of the point of the proper bones of the noſe; a great portion of the ſoft part of the nares is membranous, and, in particular, bears the name of *noſtrils*; the edge of their aperture only encloſes a cartilage in the *horſe*: this cartilage, called *ſemi-lunar* by Hippotomiſts, is analogous to the inferior cartilage of man, and is alſo formed of two branches; one almoſt parallel to the ſeptum, which is long and narrow; the other, which is ſituated in the external

ternal ala of the nofe, is fhort, and almoft of a fquare form: all the reft of the external ala is only a fold of the fkin, which forms at firft a blind cavity, the convexity of which is vifible externally, and which is named the *falfe naris.* A long and narrow fiffure of the internal parietes leads into the *true naris:* a principal mufcle dilates the falfe naris. It is the *pyramidalis* of Hippotomifts, and arifes from the maxillary bone, near the origin of the zygomatic arch, by a narrow tendon; its flefhy part dilates, and is loft on the convexity of the falfe naris, and in the orbicularis labiorum: another mufcle placed above the former, and arifing from the os maxillare, near the notch of the offeous nares, penetrates into the fold fituated between the bone and the falfe naris, and is inferted into a cartilaginous production of the inferior os turbinatum.

The femi-lunar cartilage is approximated to the feptum, and the noftril is dilated by a mufcle common to both nares, which is named *tranfverfalis* by Bourgelot; its fibres are parallel to the orbicularis of the lips, from which no feparation diftinguifhes them. Superiorly there are fome fibres which arife from the nafal bone, and are inferted on the fuperior convexity of the falfe naris; they form the *mufculus brevis* of Bourgelot.

The *mufculus maxillaris* of the fame author arifes from all the anterior part of the forehead,

 proceeds

proceeds obliquely to one ſide, and downward, and is bifurcated; the external branch paſſes over the pyramidalis, and extends to the commiſſure of the lips; the internal paſſes under the pyramidalis, and intermixes with it, to be inſerted in the external convexity of the falſe naris. Finally, the *levator labii ſuperioris* may alſo be conſidered as a muſcle of the noſtril, on which it acts powerfully; it is a long muſcle, which ariſes from the lachrymal bone; it produces a ſtrong tendon, which unites with that of the correſpondent muſcle on the extremity of the oſſa naſi, and forms with it an aponeuroſis, which is inſerted into the ſuperior lip.

The muſcles of the noſe of the Ruminantia are much leſs complicated; their cartilages conſiſt only of a duplicature of the ſeptum, which is continued into the external ala of the noſe by a pointed and arched production: the noſtrils are not ſo far ſeparate, and are directed more forward than in the horſe.

There are two muſcles on each ſide, which ariſe from the inferior part of the os maxillare, above the anterior molares; the ſuperior divides into two tendons, one of which proceeds to the ſuperior edge, and the other to the poſterior angle of the noſtril; the inferior divides into three other portions, which all go to its inferior edge: there is alſo a depreſſor; it is ſituated anteriorly.

We ſhall terminate this deſcription of the cartilages

tilages of the nofe, and their mufcles, in mammalia, by that of the probofcis of the elephant.

The following defcription is the fubftance of that which was given by the Academicians of Paris :

The probofcis of the elephant is a very elongated cone, broadeft at the root. Its interior is hollow, and divided into a double tube, covered with a ftrong tendinous membrane, and perforated by a number of fmall holes, which are the orifices of an equal number of mucous cryptæ, and from which a liquid flows in great abundance. Thefe tubes afcend to the offeous nares; but a little before they arrive there, they are twice inflected, and their communication with the nares is clofed by a cartilaginous and elaftic valve, which the animal can open at pleafure, and which falls down by its own elafticity when the mufcles ceafe to act upon it.

All the interval between the membranous tubes which are in the axis of the probofcis, and the external fkin, is occupied by a very thick flefhy layer, compofed of two kinds of fibres. Thofe of the firft kind extend from the membrane of the tubes, to a tendinous membrane fituated under the external fkin, in fuch a manner that they appear tranfverfe upon a longitudinal fection of the probofcis, and that in a tranfverfe fection they reprefent the radii of a circle. They approximate the external fkin and the membrane of the tubes, and, by compreffing

 the

the intermediate layer, produce the elongation of the probofcis, without narrowing the tubes, in the manner of annular fibres; a mode of action which is very remarkable. The other fibres of the probofcis are longitudinal: they form a number of fhort and arched fafciculi; the two extremities of which are attached to the membrane of the tubes, and the middle or convexity of which adheres to the external membrane. There are fome of thefe fafciculi all along and around the probofcis. The effect they produce is to fhorten it wholly, or in any particular part, as the animal pleafes.

It will be eafily conceived, that thefe partial elongations and contractions, on either fide, enable the elephant to give to his probofcis any imaginable flexure; but that which is moft difficult of explanation, is the manner in which he conveys to his mouth the water which he has taken into his trunk. As there are no annular fibres, he cannot comprefs the tubes, and he has no other means of impelling it forward but by refpiration; but how can this be done at the moment of fwallowing? Perhaps the end of the probofcis is conveyed beyond the opening of the larynx.

We have diffected only the fœtus of an elephant, which has however enabled us to add fome facts to the preceding defcription. All the fmall longitudinal fafciculi belong to four large mufcles, which are almoft confounded in the

the probofcis, but are fufficiently diftinct at their fuperior attachment. The two anterior are connected, by the whole of their breadth, to the frontal bone above the offa nafi; the two lateral adhere to the maxillary bones, under and before the eye. The pofterior, or inferior furface of the probofcis, is furnifhed with fibres which feem to be continued with thofe of the orbicularis of the lips. They are directed from above downward, and from within outward; fo that thofe on one fide form a figure like an Λ, with thofe of the other.

All thefe mufcles are fupplied by a very large branch of the fub-orbitar nerve, which penetrates, on each fide, between the lateral and inferior mufcles, and ramifies through the whole probofcis.

The probofcis of the *tapir*, which we have alfo diffected in a fœtus, refembles in fome refpects that of the elephant, though it is much fhorter. It is alfo compofed of two membranous tubes, furnifhed with a number of mucous lacunæ, and enclofed in a flefhy mafs enveloped by the fkin. The longitudinal fibres are divided only into two fafciculi, which arife below the eye. The tranfverfe fibres extend, as in the elephant, from the membrane of the tubes, to that which is under the fkin; but the tapir has, befides, a mufcle fimilar to the *levator labii fuperioris* of the horfe. It arifes in the fame manner from the parts adjacent to the eye, and unites in a common tendon with its correfpondent mufcle above the noftrils. The occipito-frontalis alfo furnifhes a tendon which is inferted at the bafe of the probofcis, and elevates it.

C. *In Birds.*

The external nares of birds have neither moveable cartilages nor mufcles. Their aperture is merely contracted by productions more or lefs confiderable, of the fkin which covers the bill. The forms and pofitions of that aperture have been defcribed by naturalifts. It is fituated laterally in the greater number of birds. Some have it at, or even on, the bafe of the bill. The *toucans* afford an example of the latter cafe. It is fometimes broad, fometimes narrow. In the *herons*, for example, it is a fiffure into which a pin could with difficulty penetrate. In the *fea-fwallows*, the two nares correfpond to an aperture of the feptum, fo that we can fee through them acrofs the bill. The Gallinæ have the nares partly covered by a flefhy plate. The *ravens* have them clofed by a fafciculus of ftiff feathers directed forward, &c.

D. *In Reptiles.*

The external nares of reptiles are ufually furnifhed with only fome flefhy ftrata, which dilate or contract their entrance. This is obfervable

fervable in the greater number of *lizards*, which differ from each other only as to the pofition of their external nares. They are clofeft to each other in the *crocodiles*. The *tupinambis*, the *ftellions*, and the *camelions*, have them more removed, and fituated more laterally. In the *falamanders* they are exceedingly fmall. In *frogs*, we obferve a fmall tube, the motion of which is very apparent, becaufe it is extremely ufeful in refpiration, as will hereafter be fhewn. The *tortoifes* have alfo two very fmall approximated noftrils. In the *matamata*, and one or two other fpecies, they are fituated at the end of a fhort cartilaginous probofcis.

Serpents have fmall lateral nares, which are capable of only a flight extenfion. The *rattle-fnake* has below and behind each naris a blind hole, pretty deep, the ufe of which is not known, but it gives the animal the appearance of having four noftrils.

E. *In Fifhes.*

In fifhes the entry of the foffa, which forms each naris, is narrower than the foffa itfelf. The membrane which furrounds it, is, in a number of offeous fifhes, and particularly in the *carp*, capable of forming a fhort tube, at the will of the animal; but when the fifh is drawn from the water, this tube difappears.

The greater number of offeous fifhes have the nafal aperture divided into two parts by a mem-

branous

branous bar, and this gives them the appearance of having four nares. The two holes on each ſide are ſometimes equal and ſometimes unequal. They are infinitely various in ſize and in poſition, but theſe external differences have been deſcribed by Ichthyologiſts.

In the Chondropterygii, the nares communicate by a groove with the angles of the mouth. A part of their aperture is commonly covered by a lobe of the ſkin, and the muſcular fibres which open them, are attached to the bones of the jaws. They appear to be contracted by a ſphincter. It is difficult to obſerve either diſtinctly.

ARTICLE VIII.

Of the Nares and the Spiracles of Cetacea.

THE nares of the Cetacea merit a particular deſcription, on account of their great difference from thoſe of the other Mammalia.

The Cetacea can reſpire only in air; but they cannot receive it by the mouth, which is more or leſs ſunk in the water, and could not have taken it in by the nares, if their aperture had been ſituated at the end of the muzzle; for this reaſon their noſtrils open on the ſummit of the head, which theſe animals can eaſily elevate above

above the furface of the water. They form, therefore, their only means of refpiration. They ferve befides to difcharge the water, which they would be obliged to fwallow every time that they open their mouth, if they had not the means of ejecting it through their nares, by a mechanifm which we fhall prefently defcribe.

The common pituitary membrane would doubtlefs have been irritated by this conftant and violent paffage of falt water, as we may eafily conceive, from the difagreeable fenfation we feel when a few drops of the liquor we drink enters our nofe. On this account the nares of the Cetacea are lined by a thin dry fkin, which has neither cryptæ nor mucous follicles, and which does not appear fitted to exercife the fenfe of fmell. There are no finufes in the furrounding bones, nor any internal projecting laminæ. The os ethmoides is not even perforated by any hole, which indeed is not neceffary, as the olfactory nerve does not exift. (See pages 165 and 199.) It is not, however, certain that thefe animals have no fmell; but if that fenfe exift, it muft refide in a cavity we are about to defcribe.

We have fhewn in page 503, that the Euftachian tube afcends towards the nares. The part of this canal which is next the ear, has, at its internal furface, a pretty large hole, which leads into a large vacant fpace fituated deeply between the ear, the eye, and the cranium, main-

 tained

tained by a very compact cellular ſubſtance, and prolonged in different membranous ſinuſes which are attached to the bones. This ſac, and theſe ſinuſes, are lined internally by a blackiſh, mucous, and very tender membrane. It communicates with the frontal ſinuſes, by a canal which aſcends before the orbit. Thoſe ſinuſes have no immediate communication with the nares, properly ſo called. We find in this ſac, as well as in the nares, nerves proceeding only from the fifth pair. Hunter ſtates, that he had obſerved ſomething ſimilar in two ſpecies of whale, but he did not ſuppoſe that the organ of ſmell was to be ſeen in the *dolphin* and the *porpoiſe*, from which we have taken this deſcription.

The following is the mechaniſm by which the Cetacea eject the water in thoſe ſpouts by which they are recogniſed from a diſtance at ſea, and which have procured to ſeveral ſpecies the name of *blowers*.

If we trace the œſophagus upwards, we find that, when oppoſite to the larynx, it ſeems to divide into two conduits, one of which is continued into the mouth, and the other aſcends into the noſe. The latter is ſurrounded with glands and fleſhy fibres, which form ſeveral muſcles; ſome, which are longitudinal, are attached to the margin of the poſterior orifice of the oſſeous nares, and deſcend along that conduit to the pharynx and to its ſides: the others are annular, and ſeem to be a continuation of the

proper

proper mufcle of the pharynx. As the larynx rifes in this conduit in the manner of an obelifk or pyramid, its annular fibres may clofe it by their contractions.

All this part is provided with mucous follicles, which pour out their liquor by very confpicuous foramina. When arrived at the vomer, the internal membrane of the conduit, which becomes that of the offeous nares, acquires the even and dry texture which we have already defcribed. The two offeous nares are clofed at their fuperior or external orifice, by a flefhy valve in the form of two femi-circles. This valve is attached to the anterior edge of the orifice, and clofes it by the means of a very ftrong mufcle fituated upon the intermaxillary bones. In order to open it, an extraneous force muft be applied from below. When this valve is clofed, it intercepts all communication between the nares and the cavities fituated above it.

Thefe cavities are two large membranous facs, formed by a black and mucous fkin; they are full of rugæ when empty, but when full affume an oval form. In the *porpoife*, each is of the fize of a drinking-glafs. Thefe two facs are fituated under the fkin, before the nares. They are both continued into an intermediate cavity placed upon the nares, which opens externally by a narrow fiffure, in the form of an arch. Some very ftrong flefhy fibres form an an expanſion which covers all the upper part of this apparatus. They ariſe in radii from the circumference of the cranium, and unite upon two ſacs, which they appear capable of compreſſing very powerfully.

Let us now ſuppoſe, that one of the Cetacea contains in its mouth a quantity of water which it wiſhes to eject: the animal moves the tongue and the jaws, as in the action of ſwallowing, and cloſing the pharynx, forces the fluid to aſcend in the conduit and the nares, where its motion is ſo much accelerated by the annular fibres, that the valve is raiſed, and the two ſacs above it diſtended. When the water is in the ſacs, it may remain there until the animal is inclined to eject it. For this purpoſe, the valve is cloſed, to prevent the water from deſcending into the nares, and the ſacs are ſtrongly compreſſed by the muſcular expanſions which cover them. The fluid is then thrown out through the narrow creſcent-ſhaped aperture, and riſes to a height correſponding to the force of the preſſure.

It is ſaid that *whales* eject water to the height of 40 feet.

Arti-

Article IX.

Of the Organs of Smell in Animals that have no Vertebræ.

We do not find the nofe, properly fo called, nor even any organ which appears evidently appropriated to fmell in invertebral animals, and yet almoft all of them afford very ftriking proofs that they poffefs this fenfe.

Infects difcover their food at a diftance. Butterflies feek their females, even when inclofed in boxes, and as they are liable to be deceived by refemblances of odour, it is evident that thefe infects are guided in many circumftances by the fenfe of fmell. Thus the *flefh-fly (mufca vomitoria)* lays its eggs on plants that have a fœtid fmell, imagining that it places them on corrupted flefh, and the larvæ which are thus produced perifh for want of their neceffary food.

As the organ of fmell, in all animals which refpire air, is fituated at the entrance of the organs of refpiration, the moft probable conjecture that has been propofed refpecting its feat in infects, is that of Bafter, fince revived by feveral naturalifts, who placed it in the mouths of the tracheæ or air tubes. In addition to the reafons hitherto ftated in fupport of this opinion, we may obferve, that the internal membrane of the tracheæ appears very well calculated

lated to perform this office, being ſoft and moiſtened, and that the inſects in which the tracheæ enlarge, and form numerous or conſiderable veſicles, are thoſe which ſeem to poſſeſs the moſt perfect ſenſe of ſmell. Such are all the *ſcarabæi*, the *flies*, the *bees*, &c.

The antennæ, which other anatomiſts have ſuppoſed to be the ſeat of ſmell in inſects, do not appear to us to poſſeſs any of the conditions requiſite for that organ.

The molluſca, which reſpire air, may alſo poſſeſs the ſenſation of ſmell at the entrance of their pulmonary veſſels; but it is not neceſſary to ſearch for a particular organ of this ſenſe in them, as their whole ſkin appears to reſemble a pituitary membrane. It is every where ſoft, fungous, and is always moiſtened by a great quantity of mucous matter. Finally, it is ſupplied with numerous nerves, which animate every point of its ſurface.

The worms and ſoft zoophites, and all the polyps, are probably in the ſame ſituation. It cannot be doubted but that theſe animals enjoy the ſenſe of ſmell. It is chiefly by it that they diſcover their food, particularly the ſpecies that have no eyes. Ariſtotle remarked, that certain herbs, which have a ſtrong odour, were avoided by *cuttle-fiſhes* and the *octopus*.

SEC-

SECTION SECOND.

Of the Organs of Taste.

Article I.

Of the Senſation of Taſte.

Having treated ſo fully of the four preceding Senſes, little remains to be ſaid reſpecting that of Taſte, which is the leaſt removed from the ordinary ſenſe of Touch.

The organs of theſe two ſenſes are, indeed, ſo much alike, that they may ſerve for the mutual explanation of each other. Recourſe may be had to the organ of Taſte, in order to obtain an idea of parts which are not ſufficiently developed for our obſervation in that of Touch.

The organ of Taſte is particularly characterized by its ſpongy texture, which enables it to imbibe liquids. The tongue can only taſte ſubſtances which are liquid, or are ſuſceptible of fluidity when diſſolved in the ſaliva. Inſoluble bodies are taſteleſs. The moſt ſapid even make no impreſſion on the tongue, when it is dry in conſequence of ſickneſs, or when the

 ſaliva,

ſaliva, conſumed by previous maſtication, has not had time to be renewed.

Nature has provided plentifully againſt this want, by a conſtant moiſture.

In all animals which do not live in water, numerous glands pour an abundance of fluids into the mouth, as we ſhall ſee when we treat of Maſtication. The total abſence of ſaliva, and perfect dryneſs of the tongue, is one of the moſt painful ſenſations that can be experienced.

The taſte of bodies ſeems to be greater in proportion as they are more ſoluble: ſalts poſſeſs it in the higheſt degree; but it will be eaſily conceived, that it is impoſſible to account for the different kinds of ſavours attached to each body, and that the explications, founded on the figures attributed to their elementary particles, cannot now be admitted. The change which takes place on the nerve, is doubtleſs the effect of the reciprocal action exerciſed between the principle of each taſte, and the nervous fluid; but the nature of that action is ſtill unknown to us, and of its connection with the image which reſults from it, we muſt neceſſarily be always ignorant.

The ſenſe of taſte in any animal is more perfect—1ſt, in proportion as the nerves, which proceed to the tongue, are more conſiderable: 2d, as the teguments of that part are more capable of being penetrated by ſapid ſubſtances: 3d, as the tongue itſelf is more flexible, and can be applied to a greater ſuperficies, and embrace more cloſely the ſubſtance which the animal wiſhes to taſte.

In the following Articles we ſhall conſider the Organs of this Senſe, under theſe three points of view.

ARTICLE II.

Of the Subſtance of the Tongue, of its Form, and of its Mobility.

THE tongue is at the ſame time an organ of taſte, of deglutition, and of ſpeech; but as the parts which ſerve to move it, contribute more to the two laſt functions than to the firſt, we ſhall not notice them at preſent. In the Article on Deglutition, we ſhall deſcribe the os hyoides, its ligaments, and its muſcles, as well as the muſcles of the tongue, and the motions of which that organ is ſuſceptible. We ſhall, in this place, only explain the nature of its ſubſtance, and the degree of its general mobility, in ſo far as it poſſeſſes an influence on the perfection of taſte.

In all mammiferous animals without exception, the tongue is fleſhy and flexible in all its parts, attached by its root only to the os hyoides,

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and by a portion of its baſe to the lower jaw ; it differs only as to the length and extenſibility of its free part or point. The extremes in this reſpect are the *ant-eater*, which can elongate the tongue exceedingly, and the Cetacea, which have it attached by almoſt the whole of its inferior ſurface.

The other ſpecies preſent no material difference from man, with regard to theſe circumſtances.

In *birds*, the tongue is always ſupported by a bone, which paſſes through its axis, and is articulated to the os hyoides ; it is conſequently very little flexible : the point only of the bone, which becomes in a degree cartilaginous, is capable of flexion. The ſhape of this bone correſponds to the external figure of the tongue, being covered only by ſome muſcles, and by the teguments which are thin. In the *wood-peckers*, and the *wry-necks*, it is conſiderably ſhorter than the ſkin of the tongue. When their tongue is elongated, therefore, the os hyoides, and its cornua, extend forward, and penetrate into this ſurplus of the ſkin, which is thereby extended, and the tongue puſhed forward, as we ſhall ſhew hereafter.

Reptiles vary greatly with reſpect to the tongue, as well as in many other circumſtances. The tongue of *toads* and *frogs* is entirely fleſhy, attached to the lower jaw, and, in a ſtate of repoſe, inflected in the mouth.

In

In *ſalamanders*, it is attached as far as the point, which is not moveable, and the whole tongue is only free on its lateral parts. *Crocodiles* have it attached as cloſe to the edges as its point, and authors long ſuppoſed that this animal had no tongue. It is entirely fleſhy in both theſe genera.

The *ſtellions* and the *iguanas* have a fleſhy tongue, which poſſeſſes nearly the ſame mobility as that of the mammalia. The *ſcinks* and *geckos* differ only in having the tongue notched at the extremity, and in that reſpect it reſembles the tongue of *ſlow-worms*, to which, in general, the *ſcinks* are very much allied.

In *common lizards*, the *tupinambis*, or *monitor*, &c. the tongue is ſingularly extenſile; it terminates in two long flexible points, though ſemi-cartilaginous; it completely reſembles that of ſerpents, if we except the *ſlow-worms* and the *amphiſbena*, which cannot elongate their tongue, but which have it flat, and only forked at the extremity.

The *camelion* has a cylindrical tongue, which may be conſiderably elongated by a mechaniſm analogous to that which takes place in woodpeckers.

In ſome *fiſhes*, as the Chondropterygii, there is no tongue at all; the lower part of the gullet is ſmooth, and has no elevation.

In *other fiſhes*, as the greater number of thoſe that have *free branchiæ*, the tongue is formed

 only

only by the protuberance of the middle bone, to which thofe that fupport the branchiæ are articulated; that bone has no mufcles, except thofe which elevate or deprefs it in deglutition and refpiration; none of its parts are capable of flexion; it is covered only by a more or lefs thick fkin, and is frequently furnifhed with teeth, which are either fharp, or in the manner of a pavement, and which render the furface almoft infenfible.

The *fyren* refembles, in this refpect, the fifhes that have free branchiæ.

The *fepiæ*, the *fnails*, and the greater part of the *gafteropodous mollufca*, have a cartilaginous tongue, the very fingular ftructure of which we fhall explain hereafter; it has no motions, except fuch as are connected with deglutition; its anterior part is fixed below the mouth, and it is incapable of embracing fapid bodies.

The *acephalous mollufca* do not appear to have any tongue; perhaps they exercife the fenfe of tafte by thofe tentacula, fo fimilar to papillæ, with which their cloaks are furnifhed, at the parts where the water, which is the vehicle of their aliments, enters.

There is no tongue, properly fpeaking, in *worms*, though fome have given that name to the probofcis of the *thalaffema*, the *echinorhincus*, &c. The *zoophites* have alfo no tongue; but the tentacula, which furround their mouth, are frequently fo fine, and of fo delicate a fubftance, as as to be very well calculated for the feat of tafte. Befides, why may not the whole fkin of the *polype* be fufficiently fenfible to difcern faline fubftances diffolved in water, fince it is capable of feeling the light which paffes through it?

The numerous clafs of *infects* prefents great varieties with regard to the organs of tafte.

The *coleoptera*, and the *orthoptera*, have the part which has been named, perhaps without much analogy, the inferior lip horny at its bafe, and terminated at its point by a membranous expanfion, which is, in particular, named the *tongue:* the form of this tongue is infinitely various in the different genera, as may be feen by confulting the works of late Entomologifts. The pharynx opens at the bafe of the tongue.

The *hymenoptera*, and fome *neuroptera*, have the tongue fituated at the fame place; but it is concave, and perforated for the pharynx inferiorly, and is frequently prolonged into a probofcis, which fometimes furpaffes the length of the whole body; this probofcis alfo preferves the name of tongue; it is membranous, but we obferve that its fubftance is foft and fungous, and that it is very well fitted for receiving the impreffions of tafte. Accordingly we remark that the infects, in which it is moft developed, are the moft diftinguifhed for the choice of their aliments. The *bees* afford an example of the truth of this obfervation.

All the *diptera* with a flefhy probofcis, as the *flies*, the *tabanus*, &c. feem alfo to have an excellent organ of tafte: the two lips of their probofcis, independent of their foft fubftance, and the delicacy of their teguments, have the faculty of embracing feveral points of fapid bodies.

The *lepidoptera*, or *butterflies*, have a tubular tongue; it confifts of two pieces, exactly joined, and very often of a confiderable length, and may be capable of diftinguifhing very accurately the nature of the liquor it fucks up, if the whole of the canal be fenfible to that fort of impreffion. The fame obfervation may be applied to the fucker of the *ryngota*, or *hemiptera*, and that of the *diptera*, which have not a flefhy tongue, as the *afilus*, the *ftomaxys*, the *culex*, &c. We cannot, however, judge of the perfection of each of thefe inftruments, merely by their proportional extent. It would be neceffary to take into the account the degree of their particular fenfibility, which cannot be eftimated in organs fo minute.

The *cirri*, the *palpi*, or *antennulæ*, are filaments more frequently articulated, and attached to certain parts of the mouths of infects, and which thefe animals conftantly move, for the purpofe of touching their food while they eat. Some authors have fuppofed them to be appropriated to the fenfe of tafte, fome to that of fmell, and, finally, others believe them to be fimple ſimple organs of touch.: different as theſe opinions may be, it is not impoſſible that theſe organs may not perform at once two or ſeveral functions. It is obvious, however, that this is a ſubject upon which we never can arrive at certainty. We ſhall deſcribe theſe Palpi along with the reſt of the organs of Manducation in inſects.

Article III.

Of the Teguments of the Tongue.

A. *In Man.*

The muſcles which form the internal fabric of the tongue, are ſurrounded by a conſiderable quantity of cellular ſubſtance, and covered by a thick membrane, which is the continuation of that which lines the interior of the mouth, and conſequently of the external ſkin of the body.

The particular characters of this membrane on the tongue, are the thickneſs and ſoftneſs of the part analogous to the epidermis, but, above all, the extraordinary development of the papillæ, which, though eſſentially of the ſame nature as thoſe of the external ſkin, are much larger, more cloſe, and afford a more complete view of their intimate ſtructure.

All

All the ſuperior ſurface of the tongue, from the point to nearly its root, is covered with papillæ, called, on account of their figure, *conical*; they are cloſe, like the briſtles of a bruſh; on the middle of the tongue, and towards its point, they are ſharp and elevated, and their extremity is divided into ſeveral filaments; towards the ſides they become gradually ſhorter, and are reduced to ſimple blunt tubercles.

Among theſe papillæ others are diſtributed, which are larger, but much leſs numerous; theſe are called *fungiform* papillæ; they are placed on a ſmall pedicle, and terminate in a large round head; there are more of them towards the end of the tongue, than in any other part.

Laſtly, towards the baſe of the tongue there are about ten ſemi-ſpherical tubercles, each ſurrounded with a circular fold or burr, and on that account called *papillæ in a calyx*, or *incupped papillæ*; they are diſpoſed in two lines, which repreſent a V with the point turned towards the throat.

The ſpace ſituated between the point of this V and the epiglottis, has no papillæ, but the membrane is rendered unequal by glands which are below it; and we obſerve that the greater part of its eminences are perforated by holes, through which fluids, prepared by theſe glands, paſs into the mouth; the inferior ſurface of the tongue has alſo no papillæ, and its ſkin does not differ from that of the reſt of the mouth.

The

The part analogous to the rete mucofum is fo thin on the human tongue, that we can fcarcely recognize its exiftence; but it is very thick on that of quadrupeds, where the papillæ, which pafs through it, render it completely reticular.

B. *In other Mammiferous Animals.*

The tongue of the other mammalia prefents the fame kind of papillæ as that of man: the difference confifts merely in the form of the conical papillæ, and of the fubftance with which they are fometimes armed, in the fize and abundance of the fungiform papillæ, in the number of the incupped papillæ, and the figure which their arrangement reprefents.

In the *guenons*, we obferve no difference from the human tongue, except that the papillæ with a calyx are lefs numerous. The *Chinefe monkey* has feven difpofed in this manner · · · · · · · The *macaque* has four fituated thus · . . ·; the *cynocephalus* and the *mandrill* have only three, which are ranged triangularly · . · We alfo find only three in the *fapajous*, which are farther diftinguifhed by the little prominence of their conical papillæ.

Several *bats* have the conical papillæ elongated, and almoft refembling hairs; thefe are particularly obfervable towards the pofterior part of the tongue: fome of them are alfo found on the

the ſides of the mouth. Theſe papillæ are as hard as horn in ſome ſpecies, as the *ternate bat*, in which the papillæ of the extremity of the tongue have each ſeveral points; there are only three papillæ with cups on the tongue of theſe animals, and they are very cloſe together.

The *cat* genus has the teguments of the tongue of a very particular nature: all the edges of that organ are furniſhed with ſmall ſoft conical and with fungiform papillæ, ſimilar to thoſe of the greater number of animals; but all the middle part is covered by other papillæ, which may be divided into two kinds; ſome are rounded, and, when a little macerated, repreſent faſciculi of filaments, which ſeem to be the laſt extremities of the guſtatory nerves: the others are conical, pointed, and each covered with a horny caſe, terminating in a point, which is inflected backward; theſe caſes render this tongue ſo extremely rough, that it tears off the ſkin by licking; they may be eaſily plucked out, and have then the appearance of ſo many ſmall claws. The filamentous papillæ and the horny points are placed alternately in quincunces, ſo that there are as many of one kind as of the other. There are no fungiform papillæ in all this ſpace: I believe they are replaced by the faſcicular, as the conical are by thoſe with the horny caſes. The poſterior part of the tongue aſſumes the nature of the ordinary teguments: the papillæ with cups are proportionally

tionally ſmaller than thoſe of the other genera, and diſpoſed in two lines, which approach poſteriorly. In the *common cat* we ſometimes obſerve on the back part of the ſides of the tongue, ſome fungiform papillæ dependent from very long pedicles. *Civets* have a tongue ſimilar to that of cats.

The *opoſſums* have alſo, at the middle and anterior part, horny caſes, or ſcales inflected backward, but they terminate in wedges, or in rounded edges; the point of their tongue is denticulated like a fringe; there are only three incupped papillæ. The *phalangers* have the tongue ſoft, like the other Sarcophaga. *Dogs*, *bears*, *weaſels*, *ſeals*, &c. all of which ſcarcely differ from man in this organ, and differ from each other only as to the number of the papillæ with cups.

There are five of theſe papillæ in the *martin*, ten in the *racoon*, two large and ſome very ſmall ones in the *badger*. I have only been able to reckon four very ſmall ones in a large *dog*; there are only three, which are very large, in the *hyæna*. All the ſpace ſituated between the incupped papillæ and the epiglottis is furniſhed with large conical papillæ, which are very acute, and more cloſe together

One of the moſt ſingular tongues among the Rodentia, is that of the *porcupine*: on its ſides, and towards the extremity, it has ſome large ſcales, with two or three points terminated like

wedges.

wedges. The reſt of the ſurface reſembles that of the tongues of the other mammalia; there are only two large papillæ with cups. The other Rodentia do not differ from man, except in having fewer of thoſe papillæ.

The long-noſed Edentata, as the *ant-eaters*, *armadillos*, *oryƈteropus*, all have the tongue long, narrow pointed, and ſingularly ſmooth: in the two latter, the conic papillæ are not diſtinctly ſeen; except with a magnifying glaſs; and in the *ant-eaters*, *properly ſo called*, none are perceptible. There are but three papillæ with cups in the *oryƈteropus*, and only two in the *armadillos*.

The *ſlòths* have the tongue round at the point. The conic and fungiform papillæ little developed, and only two incupped papillæ.

The tongues of the Pachydermata have the papillæ little evident.

In the Ruminantia, the conic papillæ, which cover the anterior half of the tongue, are numerous, cloſe and fine; each terminated by a horny but flexible filament, which is bent backward. Theſe filaments can only be diſtinguiſhed by a glaſs in *ſheep*, *gazelles*, &c. But in the *camel* genus they are long, and render the tongue ſoft to the touch like velvet. The poſterior part of the tongue of theſe Ruminantia is covered with thick tubercles, which ſometimes reſemble ſhort cones, and ſometimes are ſemi-ſpherical, and which become ſmaller towards

wards the ſides. The papillæ with cups are ranged on the ſides of this poſterior part; they are pretty numerous, and cannot be eaſily diſtinguiſhed from the fungiform, which are equally large in this part. The *camel*, however, muſt be excepted, which has the incupped papillæ very large, and concave on their ſurface.

In the *horſe*, the conical papillæ are very ſmall and compact; the fungiform are only found on the ſides of the tongue; there are only three incupped papillæ, the ſurface of which preſents a multitude of irregular tubercles. The ſpace ſituated poſteriorly reſembles the correſponding part of the human tongue.

There is no diſtinct conical papillæ obſerved, even with a glaſs, either on the tongue of the *dolphin* or *porpoiſe*: that organ is, in theſe animals, covered, as it were, with ſmall pimples, which are moſt numerous at its poſterior half: we obſerve at its baſe four fiſſures, diſpoſed nearly as the papillæ with cups uſually are; the edges of its point are divided into ſmall, narrow, and obtuſe ſhreds.

C. *In Birds.*

The tongue of birds has papillæ of different forms: ſome are fleſhy, blunt and rounded; others are covered by horny caſes, which are ſometimes conical, ſometimes cylindrical; others again are oſſeous and cartilaginous. The latter

latter kind is almoſt always found at the poſterior part of the tongue. They are directed backward, and ſeem rather intended to aſſiſt deglutition, by preventing the return of the food, than to exerciſe the ſenſe of taſte.

Vultures have the tongue rounded anteriorly, and horny at its external third. All its ſurface is ſmooth, except the edges, which are ſerrated, and raiſed as if it were to form a canal. Each denticulation is inveſted by a cartilaginous caſe directed backward.

The tongue of *falcons* is thicker, entirely ſmooth on the edge, and notched on both its extremities.

The nocturnal birds of prey have the tongue fleſhy, and furniſhed poſteriorly with ſoft conic papillæ directed towards the throat.

In *parrots* the tongue is very thick, fleſhy, and rounded anteriorly. We obſerve on it ſome papillæ, which are really fungiform, particularly at the poſterior part.

That of *toucans* is narrow, and furniſhed on each ſide with long and cloſe horny briſtles, which give it the appearance of a feather.

The *woodpeckers* and *wrynecks* have the tongue formed of two parts; one is anterior, protractile, and ſmooth. It is pointed anteriorly, and covered with a horny ſheath, and furniſhed on its edges with four or five ſtiff ſpines directed backward, which renders it a kind of harpoon or barbed arrow. The other part of the tongue is is loofe, and ferves as a fheath to the os hyoides and its cornua, when the tongue is elongated. Its furface is covered with fmall fpines directed backward. Each of thefe fpines appears to be implanted in the centre of a flefhy tubercle. The aperture of the glottis is contained in the loofe part of the tongue.

The Gallinæ have the tongue pointed, cartilaginous, and in the form of the head of an arrow. Its furface is fmooth and without any kind of papillæ, except upon the pofterior part.

There are alfo no papillæ on the tongue of the *oftrich*, which is crefcent-fhaped, broad, and fo fhort that feveral authors have fuppofed it did not exift. Its bafe is a fold of the fkin, which fupplies the place of the points in other birds.

The *jays*, the *ftares*, and a great number of pafferine birds, have the tongue fimilar to that of the gallinaceous family; but in feveral genera the point is more or lefs cleft, divided into feveral fmall briftles, or appears lacerated. Naturalifts have founded the characters of fome of their genera of birds on the differences of the tongue, and may be confulted as to its forms. We alfo obferve a flight furrow, which extends throughout the whole length of its middle part.

The *duck* genus, in which the tongue is flefhy, flat, and broad, prefents a number of varieties as to the difpofition of the papillæ.

In the *fwan* there is a deep furrow formed in the middle of the tongue. The furface of the anterior part is covered by a thick layer of ftiff and compact hairs directed towards the fides. Farther back, and towards the middle part along the furrow, there are three rows of plates or offeous laminæ, the bafe of which is thick, and the fharp edge free and turned backward. More pofteriorly, there are fome conic papillæ in the form of fhort ftiff hairs, which are alfo directed backward. Two other lateral furrows feparate the hairs from another range of offeous laminæ, fimilar to thofe of the middle part, but augmenting in breadth in proportion as they approach the bafe of the tongue.

The edges of the tongue are befides furnifhed with long ftiff parallel briftles, fituated very clofe to each other, and refembling the teeth of a comb.

Towards the pofterior third the tongue feems divided by a confiderable tubercle, the furface of which is rugous, but has no papillæ. Behind this tubercle the furface is covered with thick, long, and flefhy papillæ, directed backward. Deep furrows, in the form of an italic *x*, feparate them from each other.

The furface of the tongue of the other fpecies of ducks varies confiderably. The *Brent goofe* has alfo two ranges of offeous laminæ. In the wigeon (*anas penelope*) there are none, except on the edges of the pofterior third. Almoft all the fpecies have the villi ftiff, and directed towards

wards the ſides. In the *velvet duck, (anas fuſca,)* they extend conſiderably beyond the edges of the tongue.

In the *eider duck, (anas molliſſima,)* the point of the tongue has a ſmall, round, flat, and horny appendix. The anterior villi are ſhorter, and the poſterior ſurface is almoſt ſmooth.

In the *grallæ,* the tongue, which is a more or leſs elongated triangle, or in the form of an arrow, is generally ſmooth and flat.

In the *buſtard,* the ſhape of the tongue approaches that of the grallæ. It differs, however, in having its edges furniſhed with long horny ſtiff papillæ, the two laſt of which are very broad, ſharp, and as it were oſſeous.

D. *In Reptiles.*

The tongue of the *tortoiſe* is furniſhed ſuperiorly with long, ſoft, cloſe, conic papillæ, which give it the appearance of velvet.

In the *crocodile* they are very ſhort, and repreſent rather ſlight rugæ than papillæ. They form, on the contrary, a very diſtinctly villous ſurface in the *iguanas* and the *ſtellions.* The tongue of the *camelion* is furniſhed with deep, cloſe, and very regular tranſverſe rugæ; in the *lizards,* with extenſile and forked tongues; and in the *ſerpents,* that organ is ſingularly ſmooth, and, as it were, horny towards its points.

The *ſalamanders* have, like the *iguanas,* a fine

 villous

villous ſurface to the tongue; but in the *frogs* and *toads*, the ſurface is perfectly ſmooth to the eye, and always mucous.

No reptile has two kinds of papillæ, nor glands with a calyx.

E. *In Fiſhes.*

The ſkin which is applied to the bones that ſuſtain the tongue of fiſhes, reſembles that of the reſt of the mouth, and does not preſent to the eye more developed papillæ. The only differences that can be remarked, belong to the teeth, with which the tongue is armed in certain ſpecies, and which we ſhall deſcribe when treating of Maſtication.

We alſo reſerve the deſcription of the Tongue, or the organs which replace it, in white-blooded animals, until we come to the ſame Article.

Article IV.

Of the Diſtribution of the Nerves in the Tongue.

The ſenſe of taſte differs from thoſe of ſight, hearing, and ſmell, and reſembles that of touch, in having no one pair of nerves entirely appropriated to its functions. The tongue receives branches

branches from three different pairs in warm-blooded animals, and two only ſo far as we have obſerved in fiſhes, but they are not all employed in this ſenſation. Thoſe which come from the *hypogloſſus major*, and from the *gloſſo pharyngeus*; appear to be diſtributed only to the muſcles and the glands, as we have ſhewn in pages 243 and 246: at leaſt we are not certain that the filaments of the gloſſo-pharyngeus, which go to the incupped papillæ, are appropriated to the ſenſe of taſte, as we are ſtill ignorant whether theſe papillæ enjoy that ſenſation; and the filaments of the ſame nerve, which ſome ſuppoſe they have traced to other papillæ, appear very inconſiderable.

The *tri-facial nerve*, or the fifth pair, which is diſtributed to all the organs of ſenſe, appears alone to receive the impreſſions of taſte, by the *lingual branch* of the maxillaris inferior, deſcribed in page 217; for this is the only nerve which is diſtributed to the teguments, in which it is evident the ſenſation reſides; and it is alſo the only nerve, the ligature ſection or compreſſion of which annihilates taſte.

Such at leaſt is the opinion now adopted by phyſiologiſts. It ſeems to us, however, that the anaſtomoſes of the fifth and ninth pairs are ſo numerous throughout the whole extent of the tongue, that it is difficult to ſay which has the greater ſhare in the filaments which go to the papillæ. The fungiform papillæ receive all of theſe filaments, which are ſufficiently large to be traced by the naked eye; and this circumſtance, joined to the hardneſs of the conical papillæ in certain animals, induces us to believe that the principal ſeat of taſte is in the fungiform papillæ.

The filaments which proceed to the papillæ below the point of the tongue, are more eaſily followed than thoſe diſtributed to the ſuperior ſurface, becauſe the principal branches paſs along the inferior part. The filaments which go to the upper ſurface ſoon diſappear, by their tenuity in the ſubſtance of the fleſh through which they are forced to paſs. They aſcend, in a parallel and perpendicular direction, to the ſurface, where they terminate.

The diſtribution of the nerves of the tongue preſent no eſſential difference in the three other claſſes of vertebral animals.

END OF THE SECOND VOLUME.

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