

**A short system of comparative anatomy / translated from the German of J.F. Blumenbach by William Lawrence, with numerous additional notes, and an introductory view of the classification of animals. By the translator.**

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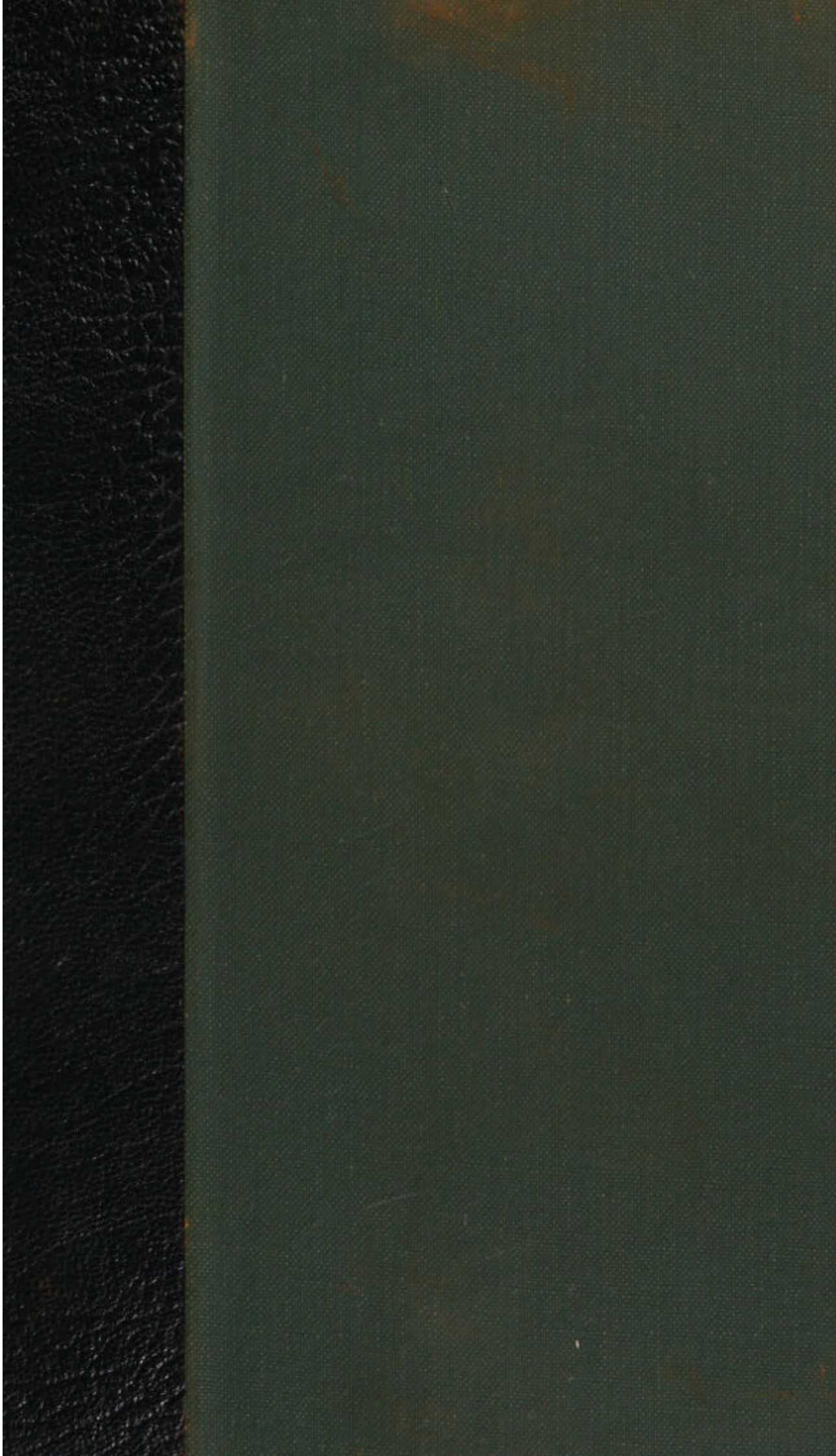
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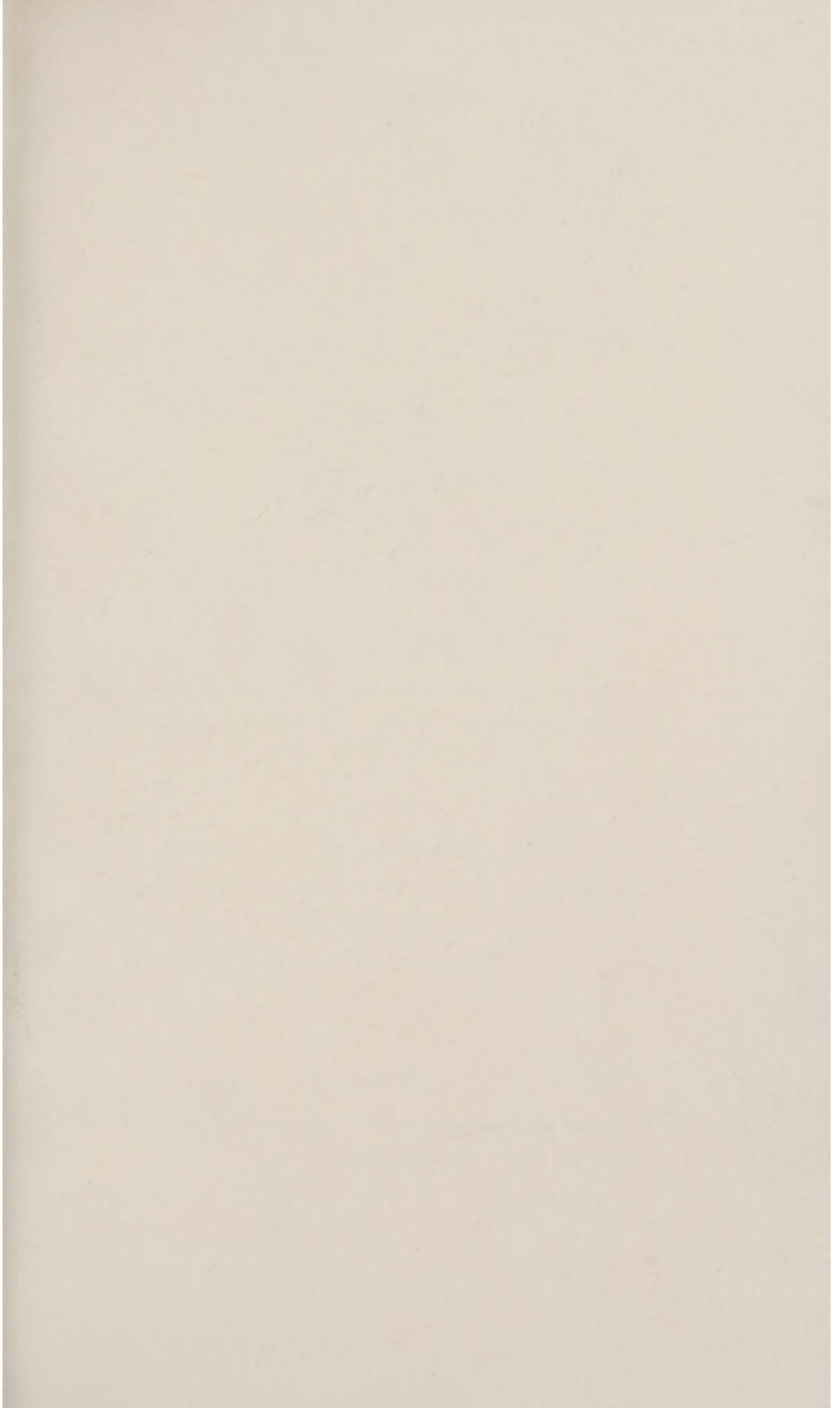


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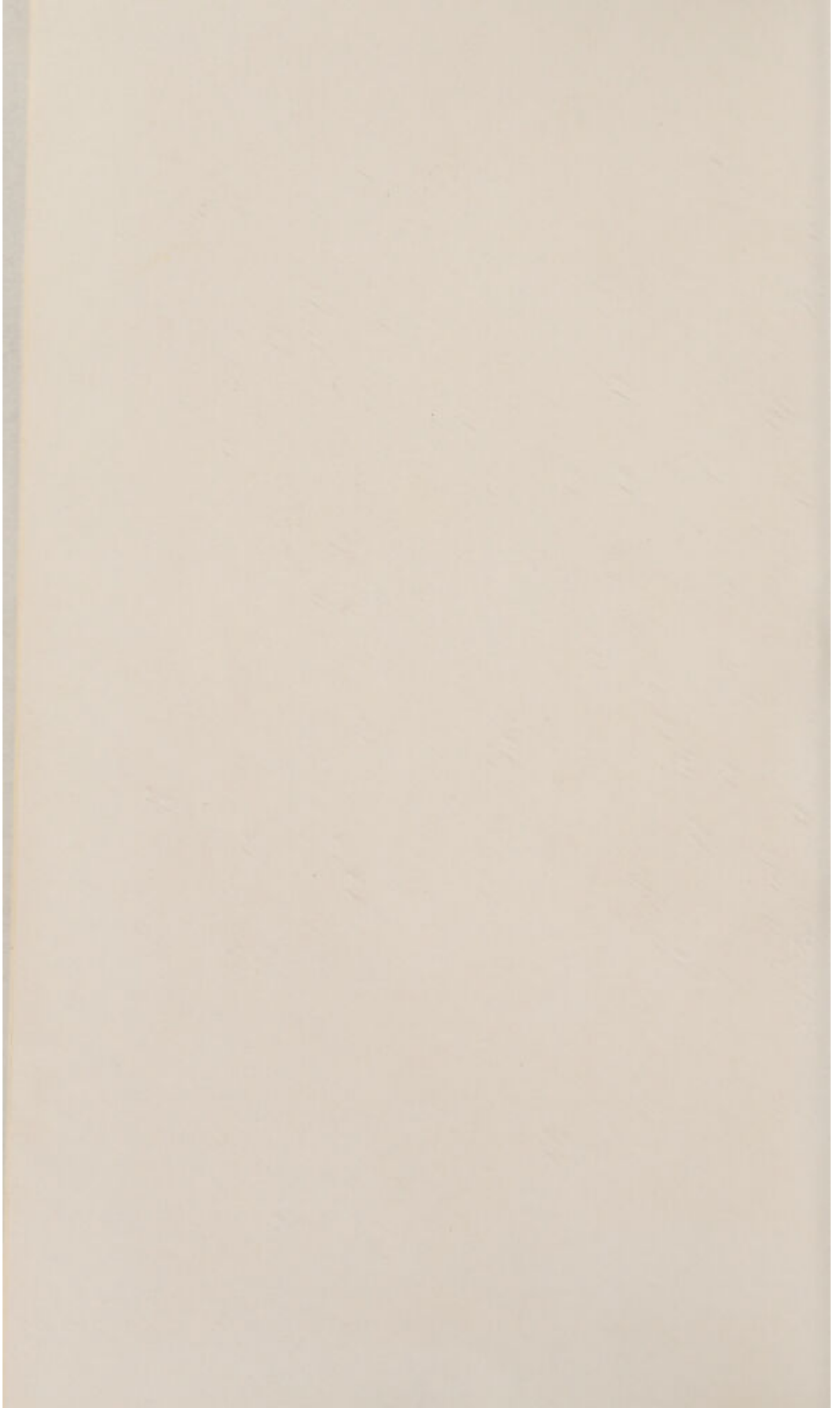












SHORT SYSTEM

COMPARATIVE ANATOMY,

OF THE

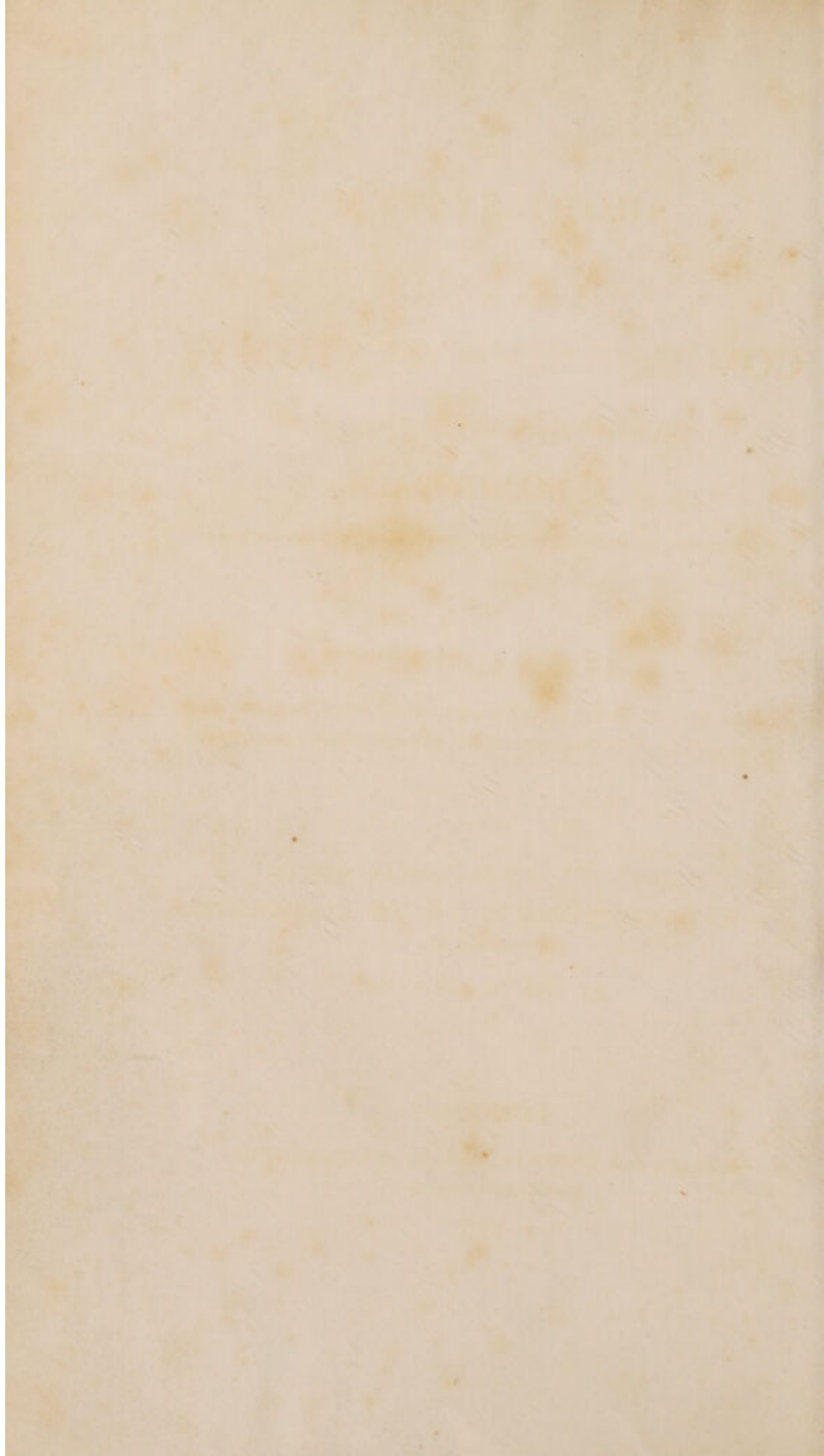
VERTEBRATE CLASS

WITH  
SOME ADDITIONAL NOTES  
ON THE INDEPENDENT VIEW OF THE CLASSIFICATION  
OF ANIMALS,  
BY THE TEMPERATURE

LONDON

PRINTED AND SOLD BY THE AUTHOR, 10, BROADWAY, LONDON.





Edward Jenner 43154  
from his respect & affectionate friend  
A William Lawrence  
SHORT SYSTEM October 1807

OF

# COMPARATIVE ANATOMY,

TRANSLATED FROM THE GERMAN OF

J. F. BLUMENBACH,

PROFESSOR OF MEDICINE IN THE UNIVERSITY OF GOETTINGEN.

BY

WILLIAM LAWRENCE,

FELLOW OF THE ROYAL COLLEGE, OF SURGEONS IN LONDON, AND  
DEMONSTRATOR OF ANATOMY AT ST. BARTHOLOMEW'S HOSPITAL:

WITH

NUMEROUS ADDITIONAL NOTES,  
AND AN INTRODUCTORY VIEW OF THE CLASSIFICATION  
OF ANIMALS,

BY THE TRANSLATOR.

LONDON:

PRINTED FOR LONGMAN, HURST, REES, AND ORME,  
PATERNOSTER-RROW.

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AND AN INTRODUCTION TO THE CLASSIFICATION  
OF ANIMALS,  
BY THE TRANSLATOR.

LONDON:

PRINTED FOR LONGMAN, BROTHERS, AND CO.,  
PATERNOSTER-ROW.

Strahan and Preston,  
Printers-Street, London.

TO  
Sir JOSEPH BANKS, K.B. P.R.S. &c. &c.

WHOSE LABOURS HAVE SO MATERIALLY CONTRIBUTED

TO THE

ADVANCEMENT OF NATURAL HISTORY;

AND WHOSE MUNIFICENT PATRONAGE HAS SO SIGNALLY  
PROMOTED EVERY BRANCH OF SCIENCE;

THIS HUMBLE ATTEMPT

TO FACILITATE THE STUDY OF

COMPARATIVE ANATOMY,

IS MOST RESPECTFULLY INSCRIBED,

AS AN

INDIVIDUAL TRIBUTE OF THAT ESTEEM AND ADMIRATION

WHICH ARE SO UNIVERSALLY FELT AND EXPRESSED

BY THE LOVERS OF SCIENCE,

IN ALL PARTS OF THE WORLD:

BY HIS MOST OBEDIENT SERVANT,

WILLIAM LAWRENCE.

*John-Street, Adelphi,  
April, 1807.*

TO

SIR JOSEPH BANKS, K. B. R. S. &c.

WHOSE LABORS HAVE SO MATERIALLY CONTRIBUTED

TO THE

ADVANCEMENT OF NATURAL HISTORY,

AND WHOSE SPONTANEOUS PATRONAGE HAS SO GENERALLY

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YOUR HUMBLE ATTITUDE

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# COMPARATIVE ANATOMY,

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BY HIS MOST OBLIGED SERVANT,

WILLIAM LAWRENCE

Printed by J. G. & J. S. Nichols, 10, St. Paul's Church-yard, London.



## PREFACE.

**T**HE object of the present publication is to exhibit a concise, but at the same time general and systematic view, of the structure of the body throughout all classes of the animal kingdom. This science, which is very aptly denominated, *Comparative Anatomy*, affords the most essential aid in elucidating the structure of the human body, and in explaining the doctrines of physiology.

The want of any organ in certain classes of animals, or its existence under different modifications of form, structure, &c. cannot fail to suggest most interesting conclusions concerning the office of the same part in the human subject. Thus our physiological reasonings, which must necessarily be partial and incomplete, when deduced from the structure of a single animal or class, are extended and cor-



rected by this general comparative survey, and may, therefore, be relied on with the greater confidence. We are indebted to such investigations for the discovery of the circulation and of the lymphatic system; for the elucidation of the functions of digestion and generation; indeed, there is no branch of anatomy or physiology which has not received most material benefit from the same source. Hence HALLER has very justly observed, that "physiology has been more illustrated by Comparative Anatomy, than by the dissection of the human body."

The study of Comparative Anatomy is moreover of the greatest importance in its connection with veterinary science, and with that highly interesting pursuit, natural history. It would be an affront to my readers to enlarge upon its utility in the former point of view; but I may be allowed to observe on the latter subject, that anatomical structure forms the only sure basis of a natural Classification of the animal kingdom; and that any arrangement not founded on this ground-work will lead us into the most gross and palpable errors.



Lastly, this study opens to the mind a great source of interest and satisfaction, in exhibiting such numerous and undeniable proofs of the exertion of contrivance and design in the animal structure: in displaying those modifications of particular parts and organs, by which they are adapted to the peculiar circumstances of the animal, and become subservient to its wants, its necessities, or its enjoyments.

The importance of the subject from the above mentioned circumstances is now so fully recognized, that it begins with justice to be considered as an essential part of a regular medical education. Public lectures have been delivered on it for some years in Germany and France; and lately the example has been followed in this metropolis. Yet a short elementary treatise on the subject still remains a desideratum\*; and I have undertaken the

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\* BLASIUS has given a collection of the writings of several authors on the anatomy of particular animals, in one volume 4to, entitled "*Anatomia Animalium Figuris variis illustrata*, Amstel. 1681, which may still be consulted with



translation of the present work, in order to supply this defect. The author is well-known throughout Europe for his successful labours in Physiology and Natural History; and has a particular claim on the public gratitude, for the excellent elementary treatises, which he has published, on different branches of the profession. The present work will not, I trust, detract from his well-earned reputation.

If any reader should think that the author has treated the subject with too much brevity; the defect is compensated by the numerous references to sources of more detailed information, in the works of the best and most approved preceding writers; parti-

---

advantage; particularly on account of the plates. CUVIER'S *Léçons d'Anatomie comparée*, in five large octavo volumes, form a very valuable and useful repository of facts in Comparative Anatomy; but the subject is treated at such length, and with so many uninteresting details, that the book is by no means adapted for the use of students. There is a most admirable description of the anatomy of the class BIRDS in the fourth volume of Dr. REES'S *New Cyclopædia*, from the pen of Mr. MACARTNEY: and it were much to be wished, that we had an account of the whole animal kingdom from the same able hand.

cularly



cularly to such as have given good plates of the parts, which they describe. These quotations may afford assistance even to those, who have made some progress in the study.

I have taken the liberty of adding notes to such parts as appeared defective either from omission, or too great conciseness; and I have placed these at the end of each chapter. Many of these are derived from CUVIER'S work, which I acknowledge in this general manner, to save the trouble of numerous references.

A short view of the Classification of Animals is prefixed, for the accommodation of such readers as may not understand enough of natural history. BLUMENBACH has published a most excellent "*Manual of Natural History*," in German; and there is a similar work in French, by CUVIER, entitled "*Tableau Elementaire de l'Histoire Naturelle*;" either of which will be found very useful to beginners.

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W. LARRANCE



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# INTRODUCTION,

CONTAINING

A SHORT ACCOUNT OF THE CLASSIFICATION OF ANIMALS,  
IN WHICH THE TECHNICAL TERMS ARE EXPLAINED:

BY THE TRANSLATOR.

**I**T is necessary for me to make a few remarks on the classification of this animal kingdom; as the terms employed in the work differ occasionally from those of the Linnean system, which has been hitherto chiefly followed in this country. And, independently of this circumstance, such of my readers as have not particularly attended to the study of natural history, may derive assistance and information from a short sketch and explanation of the arrangement of animals according to their anatomical structure, with an enumeration of the chief genera in each order.

That the Linnean system is exposed to numerous and well-grounded objections, and that in many instances it disregards anatomical structure, which should form the basis of a natural classification, will be readily allowed by the most sanguine admirers of its illustrious author. Yet it must be remembered, that the general adoption of this method renders it desirable to deviate from it in as few instances as possible; since the introduction of new orders and names must necessarily create difficulty and confusion in the study of the science. The French zoologists, whose successful labours in the advancement of  
natural



natural history must be acknowledged with every due tribute of respect, have carried the rage of innovation too far, in the universal rejection of the Linnean method, and the unnecessary multiplication of new orders and genera. The defects or errors of any system could not cause so much perplexity and inconvenience as the want of a generally received standard, and the unlimited licence, in which every individual indulges, of fabricating new classifications and arrangements. To judge by some recent works, we should be led to suppose, that the merit of a systematic arrangement of animals does not consist in the simplicity or intelligibility of the system; but is in proportion to the number of newly-created terms.

The *Zoologie Analytique* of DUMERIL, (Paris, 8vo. 1806) appears to have been constructed on this principle; and recalls to our mind the just and forcible observations of BLUMENBACH, as expressed in his admirable work on *The Varieties of the Human Species*. “Alienissimus quidem  
 “sum a nostrericorum multorum novandi pruritu, qui  
 “rebus naturalibus, quæ pridem nominibus suis vel in  
 “vulgus notissimis, insignes sunt, nova imponendo, miri-  
 “ficé sibi placent: qui quidem onomatopoietarum lusus  
 “ingentem studio historiæ naturalis calamitatem attu-  
 “lit.” Edit. 3rd, p. 16.

Animals may be distributed into two grand divisions: those which have a vertebral column, and red-blood: and those which have no vertebræ, and are white-blooded.

In the former division there is always an interior skeleton; a spinal marrow contained in the vertebral canal; never more than four members, of which one, or both pairs are wanting in some instances. The brain is contained in a cranium: there is a great sympathetic nerve; five senses; two moveable eyes; and three semicircular  
 canals



canals in the ear. The circulation is performed by one muscular ventricle at least. There are lymphatic, as well as blood-vessels. The jaws being placed horizontally, the mouth is opened by their moving from above downwards, or from before backwards. There is a continuous alimentary canal: peritoneum; liver, spleen, and pancreas, two kidneys, and renal capsules; and two testicles.

The *vertebral* animals are subdivided into the warm and cold-blooded.

*Warm blooded vertebral animals* have been ventricles, and a double circulation; and breathe by means of lungs. The cranium is completely filled by the brain. The eyes are closed by eyelids. The tympanum of the ear is hollowed out of the cranium, and the labyrinth is excavated in the bone. Besides the semi-circular canals, there is a cochlea. The nostrils communicate with the fauces, and allow the passage of air into the lungs. The trunk is constantly furnished with ribs.

In *cold-blooded vertebral animals* the brain never entirely fills the cranium. The eyes seldom possess moveable eyelids. When the tympanum exists, it is on a level with the surface of the head. There is no cochlea. The different parts of the ear are connected but loosely to the cranium.

The division of warm-blooded animals contains two classes; MAMMALIA and BIRDS.

The *mammalia* are viviparous, and suckle their young (from which circumstance the name is derived). They

<sup>1</sup> The *ornithorhynchus* is an exception to this rule; as it possesses only two ossicula; and according to our author, other animals only possess three; as the *os lenticulare* is represented by him as an apophysis of the *incus*.



have an uterus with two cornua; and the male has a penis.

There are two occipital condyles: a very complicated brain; four ossicula auditus, and a spiral cochlea. The skin covered with hair. A muscular diaphragm separates the chest and abdomen. There is an epiglottis. The lower jaw only moves. The fluid in the lacteals is white, and passes through several conglobate glands. There is an omentum.

BLUMENBACH establishes the following orders in this class:

I. BIMANUM. Two handed.

Genus 1. *Homo*.

II. QUADRUMANA, four handed animals: having a separate thumb, capable of being opposed to the other fingers, both in their upper and lower extremities. Teeth like those of man, except that the *cuspidati* are generally longer.

1. *Simie*, apes, monkeys, baboons.
2. *Lemur*, macauro.

III. BRADYPODA, slow-moving animals.

1. *Bradypus*, sloth.
2. *Myrmecophaga*, ant-eater.
3. *Manis*, scaly-lizard, or pangolin.
4. *Dasyurus* or *Tatu*, armadillo.

This order forms two in the arrangement of CUVIER. 1st, TARDIGRADA; which includes the sloths. There are no incisors in either jaw. There is a complicated stomach, but no rumination. 2ndly, EDENTATA, toothless animals. Some of these have no teeth; others want the incisores and cuspidati. The tongue is long, slender, and projectile, for seizing the insects on which the animals



mals feed; body covered with hard substances. The armadillo, manis, ant-eater, and *ornithorhyncus*, or duck-billed animal belong to this order.

IV. CHEIROPTERA, having the fingers elongated for the expansion of a membrane, which acts as a wing.

*Vespertilio*, bat.

V. GLIRES. *Rodentia* of CUVIER—gnawing animals. Have two long and very large incisor teeth in each jaw, by which they cut and gnaw hard bodies, chiefly vegetables. There is a large interval behind these teeth, unoccupied by cuspidati.

1. *Sciurus*, squirrel.
2. *Glis*, dormouse (*Myoxus* Linn).
3. *Mus*, mouse and rat.
4. *Marmota*, marmot.
5. *Cavia*, guinea-pig.
6. *Lepus*, hare and rabbit.
7. *Jaculus*, jerboa.
8. *Castor*, beaver.
9. *Hystrix*, porcupine.

VI. FERÆ, predaceous and carnivorous animals. Very strong and large pointed canine teeth: molares forming pointed prominences. Short and simple alimentary canal, and consequently slender belly.

1. *Erinaceus*, hedge-hog.
2. *Sorex*, shrew.
3. *Talpa*, mole.
4. *Meles*, badger.
5. *Ursus*, bear.
6. *Didelphis*, opossum, kangaroo.
7. *Viverra*, weasels, ferret, polecat, civet.
8. *Mustela*, skunk, stoat, &c.
9. *Canis*, dog, wolf, jackal, fox, hyena.
10. *Felis*,



10. *Felis*, cat, lion, tiger, leopard, lynx, panther, &c.
11. *Lutra*, otter.
12. *Phoca*, seal or sea-calf.

The five first genera of this order, form the *plantigrada* of CUVIER; animals which rest the whole of the foot on the ground. They are less carnivorous than the others; have a longer intestinal canal, and no cæcum.

The sixth genus forms the PEDIMANA of the same zoologist: as they possess a separate thumb on the hind extremities only. They have a pouch in the abdomen containing the mammæ, and holding the young in their early state. One species, the kangaroo, (*didelphis gigantea*), must however be excepted. That is placed among the *rodentia*; and does not possess the separate thumb.

The order *carnivora* of CUVIER, will include from the 7th to the 11th genus: both inclusive. The seal belongs to his *amphibia*.

VII. SOLIDUNGULA (*solipeda*, CUVIER), a single toe on each foot, with an undivided hoof. Large intestines, and particularly an enormous cæcum. Incisors in both jaws.

1. *Equus*, horse and ass.

VIII. PECORA or BISULCA (*Ruminantia* of CUVIER), a divided hoof. No incisors in the upper jaw. Stomach consisting of four cavities. Rumination of the food. Long intestines.

1. *Camelus*, camel, dromedary, lama.
2. *Capra*, sheep, goat.
3. *Antilope*, antelope, chamois.
4. *Bos*, ox, buffalo.
5. *Giraffa*, giraffe or camelopard.
6. *Cervus*, elk, deer-kind.
7. *Moschus*, musk.



IX. BELLUA, animals of an unshapely form, and a tough and thick hide; whence they have been called by CUVIER, *pachydermata* (from *παχυσ* thick, and *δέρμα* skin). They have more than two toes: incisors in both jaws; and in some cases enormous tusks.

1. *Sus*, pig kind, pecari, babirouffa.
2. *Tapir*,
3. *Elephas*,
4. *Rhinoceros*,
5. *Hippopotamus*,
6. *Trichecus*, morse or walrus, manati or sea-cow.

The last genus of this order, together with the *phoca* (seals) constitutes the *Amphibia* of CUVIER. These animals have short members adapted for swimming.

X. CETACEA, whales, living entirely in the sea; and formed like fishes; breathe by an opening at the top of the head, called the *blowing-hole*; through which they throw out the water, which enters their mouth with the food. Smooth skin covering a thick layer of oily fat. No external ear. A complicated stomach. Multilobular kidneys, larynx of a pyramidal shape, opening towards the blowing-hole. Testes within the abdomen. Mammæ at the sides of the vulva. Bones of the anterior extremity concealed and united by the skin, so as to form a kind of fin.

1. *Monodon*, narwhal, sea-unicorn.
2. *Balæna*, proper whales.
3. *Phyfeter*,
4. *Delphinus*, dolphin, porpoise.

CUVIER distributes the class *mammalia* into three grand divisions:

1. Those which have claws or nails (*mammifères à ongles*); including the following orders:

a 3

bimana,



bimana, quadrumana, cheiroptera, plantigrada, carnivora, pedimana, rodentia, edentata, tardigrada.

2. Those which have hoofs (*mammif. a ongles*) including the pachydermata, ruminantia and folipeda.
3. Those which have extremities adapted for swimming (*mammif. a pieds en nageoire*). Amphibia and cetacea.

BIRDS are oviparous; have a single ovary and oviduct; a single occipital condyle; a very large sternum; and anterior extremities adapted for flying.

They have three eyelids; no external ear; a cochlea conical, but not spiral; a single ossiculum auditus; body covered with feathers. The lungs are attached to the surface of the chest; and penetrated by the air, which goes all over the body: there is a larynx at each end of the trachea; no epiglottis. The jaws are covered with a horny substance. The chyle is transparent; no mesenteric glands; nor omentum. No bladder of urine; the ureters terminating in a bag through which the eggs and fæces come, viz. the cloaca.

This class cannot be distributed into orders so clearly distinguished by anatomical characters as the preceding one. BLUMENBACH divides them into two leading divisions.

#### (A) TERRESTRIAL BIRDS.

Order I. ACCIPITRES. Birds of prey; with strong hooked-bills, and large curved talons, a membranous stomach, and short cæca.

1. *Vultur*, vultures.
2. *Falco*, falcon, eagle, hawk, kite.
3. *Strix*, owl.
4. *Lanius*, shrike or butcher bird.

II. LEVIROSTRES, light billed birds, having a large hollow bill.

1. *Pfittacus*, parrot kind.
2. *Ramphastos*, toucan.
3. *Buceros*, rhinoceros bird.

III. PICÆ, this and the two following orders are not clearly characterised.

1. *Picus*, woodpecker.
2. *Jynx*, wryneck.
3. *Sitta*, nuthatch.
4. *Alcedo*, kingfisher.
5. *Trochilus*, humming birds,  
&c. &c.

IV. CORACES.

1. *Corvus*, crow, raven, jackdaw, magpie, jay,  
&c.
2. *Coracias*, roller.
3. *Paradisæa*, birds of paradise,
4. *Cuculus*, cuckoo,  
&c. &c.

V. PASSERES, small singing-birds.

1. *Alauda*, lark.
2. *Sturnus*, starling.
3. *Turdus*, thrush, blackbird.
4. *Emberiza*, bunting.
5. *Fringilla*, finches, canary-bird, linnet, sparrow.
6. *Motacilla*, nightingale, redbreast, wren.
7. *Hirundo*, swallows, martins, &c.
8. *Caprimulgus*, goatfucker.  
&c.



VI. GALLINÆ, gallinaceous birds, mostly domesticated. They possess a large crop, strong muscular g

1. *Columba*, pigeons.
2. *Tetrao*, grouse, quail, partridge
3. *Numida*, guinea-fowl.
4. *Meleagris*, turkey.
5. *Pavo*, peacock.
6. *Otis*, bustard.

VII. STRUTHIONES, struthious birds. The largest of the class: possess extremely small wings, and are therefore incapable of flight; but run very swiftly.

1. *Struthio*, ostrich.
2. *Casuarus*, cassowary or emu.

#### (B) AQUATIC BIRDS.

Order I. GRALLÆ, waders, frequenting marshes and streams; long naked legs; long neck; cylindrical bill of different lengths.

1. *Ardea*, crane, stork, heron, bittern.
2. *Scolopax*, woodcock, snipe, curlew.
3. *Tringa*, lapwing, ruffs and reeves.
4. *Charadrius*, plover.
5. *Fulica*, coot.
6. *Rallus*, rail.
7. *Phenicopterus*, flamingo.
8. *Tantalus*, ibis, &c.

II. ANSERES, swimming birds; web-footed; bill, broad and flat, covered by a somewhat soft substance, on which large nerves are distributed.

1. *Colymbus*, diver.
2. *Larus*, gull.
3. *Procellaria*, petrel,

4. *Dia*

4. *Diomedea*, albatross.
5. *Pelecanus*, pelican, cormorant.
6. *Anas*, swan, duck, goose.
7. *Mergus*, goosander.
8. *Alca*, auk, puffin.
9. *Aptenodytes*, penguin.

The two classes of *cold-blooded vertebral animals* are the **AMPHIBIA** and **FISHES**.

The former, differing considerably from each other, have very few common characters; for in different instances they walk, fly, swim, and crawl. There is no external ear, nor cochlea; the brain is always very small. The lungs are in the same cavity with the other viscera; no epiglottis, omentum, nor mesenteric glands. Two ovaries and oviducts. Cloaca, through which the fæces and urine are expelled; and in which the organs of generation terminate. Neither hair, feathers, nor mammæ.

Order I. **REPTILIA**, having four feet, (*quadrupeda ovipara*).

1. *Testudo*, tortoise, turtle.
2. *Rana*, frog, toad.
3. *Lacerta*, lizards, crocodile, chameleon, newt, salamander, iguana, &c.

II. **SERPENTIA**. No external members; body of an elongated form, and viscera of a similar shape. They are oviparous; but the egg is sometimes hatched in the oviduct. Both jaws moveable.

1. *Crotalus*, rattlesnake.
2. *Boa*. Immense serpents of India and Africa.
3. *Coluber*, viper.
4. *Anguis*, blindworm,

5. *Am-*



5. *Amphibæna*.

6. *Cæcilia*.

FISHES. Breathe by means of branchiæ or gills; and have no trachea, nor larynx. Organs of motion consisting of fins. Nose unconnected with the organs of respiration. Ear entirely inclosed in the head; the tympanum, &c. being absent. Both jaws moveable. The place of the pancreas supplied by the pyloric cæca. An urinary bladder. Two ovaries. Heart consisting of a single auricle and ventricle. They may be distributed into two leading divisions; the *cartilaginous*; whose skeleton consists of cartilage: the *bony*; where it is formed of a more firm substance.

(A) CARTILAGINOUS FISHES.

Order I. CHONDROPTERYGII; having no gill-cover; an uterus, with two oviducts.

1. *Petromyzon*, lamprey.
2. *Gastrobranchus*.
3. *Raia*, skate, torpedo, stingray.
4. *Squalus*, shark, saw-fish.
5. *Lophius*, sea-devil, frog-fish.
6. *Balistes*, file-fish.
7. *Chimera*.

II. BRANCHIOSTEGI; having a gill-cover.

1. *Accipenser*, sturgeon, beluga.
2. *Ostracion*, trunk-fish.
3. *Tetrodon*.
4. *Diadon*, porcupine-fish.
5. *Cyclopterus*, lump-sucker.
6. *Centriscus*.
7. *Syngnathus*, pipe-fish.
8. *Pegasus*.

(B) BONY

## (B) BONY FISHES, divided according to the situation of their fins.

## Order I. APODES ; no ventral fins.

1. *Murana*, eel-kind.
2. *Gymnotus*, electrical eel.
3. *Anarrhichas*, sea-wolf.
4. *Xiphias*, sword-fish.
5. *Ammodites*, lance.
6. *Ophidium*.
7. *Stromateus*.
8. *Trichiurus*.

## II. THORACICI ; ventral fins directly under the thoracic.

1. *Echeneis*, sucking fish,
  2. *Coryphæna*, dorado.
  3. *Zeus*, dory.
  4. *Pleuronectes*, flounder, plaice, dab, holibut, sole, turbot.
  5. *Cheladon*.
  6. *Sparus*.
  7. *Perca*, perch.
  8. *Scomber*, mackarel, bonito, tunny.
  9. *Mullus*, mullet.
- &c. &c.

## III. ABDOMINALES ; ventral fins behind the thoracic ; chiefly inhabit fresh water.

1. *Cobitis*, loach.
  2. *Silurus*.
  3. *Salmo*, salmon, trout, smelt.
  4. *Esox*, pike.
  5. *Clupea*, herring, sprat, shad.
  6. *Cyprinus*, carp, tench, gold-fish, minnow, &c.
- &c.

## IV. JUGU-



## IV. JUGULARES; ventral fins in front of the thoracic.

1. *Gadus*, hadock, cod, whiting, ling.
2. *Uranoscopus*, stargazer.
3. *Blennius*, blenny.
4. *Callionymus*, dragonet.
5. *Trachinus*, weaver.

The animals which have no vertebral column, do not possess so many common characters as the vertebral classes. Their hard parts, when they have any, are generally placed on the surface of the body. The centre of the nervous system, instead of being inclosed in a bony case, lies in the same cavity with the viscera. The oesophagus is generally surrounded by a nervous chord coming from the brain. Their respiration is not carried on by lungs; and they have no voice. Their jaws move in various directions. They have no urinary secretion.

The *invertebral animals* were distributed by LINNEUS into two classes; *insects* and *worms* (*vermes*). The anatomical structure of these animals was very imperfectly known, when the Swedish naturalist first promulgated his arrangement. But the labours of subsequent zoologists, and particularly those of CUVIER, have succeeded in establishing such striking and important differences in their formation, that a subdivision of the Linnean classes became indispensibly necessary. The insects of LINNEUS are divided into *crustacea* and *insecta*: and the *vermes* of the same author form three classes; viz. *mollusca*, *vermes*, and *zoophyta*.

The *mollusca* derive their name from the soft fleshy nature of their body. This class includes those pulpy animals, which may either be destitute of an external covering; when they are called *mollusca nuda*; as the lug: or may be enclosed in one or more shells, as the snail, oyster, &c. when they are termed *testacea*.

The



The animals of this class have no articulated members: they have blood-vessels, and a true circulation. They respire by means of gills. They have a distinct brain, giving origin to nerves; and a spinal marrow.

1. *Sepia*, cuttlefish.
  2. *Argonauta*.
  3. *Nautilus*.
  4. *Limax*, slug.
  5. *Aplysia*.
  6. *Doris*.
  7. *Clio*.
  8. *Patella*, limpet.
  9. *Helix*, snail.
  10. *Haliotis*, Venus's ear.
  11. *Murex*, caltrop, or rockshell.
  12. *Strombus*, screw.
  13. *Buccinum*, whelk.
  14. *Ascidia*.
  15. *Thalia*.
  16. *Ostrea*, oyster.
  17. *Solen*, razorshell.
  18. *Cardium*, cockle.
  19. *Mytilus*, muscle.
- &c. &c.

CUVIER classes the numerous genera of this order under the three following divisions; 1st, *cephalopoda*, (from κεφαλη the head, and πος the foot) which have their organs of motion placed round the head: 2dly, *gasteropoda*, (from γαστηρ the belly, and πος), such as crawl on the belly: and 3dly, *acephala*, (from α privative, and κεφαλη), which have no head. The three first genera belong to the first division; the ten succeeding ones come under the second; and the remainder exemplify the last order.

According

According as the shell of the *testaceous mollusca* consists of a single convoluted tube; or of two or more separate pieces, they are called *cochleæ bivalves, multivalves, &c.*

CRUSTACEA possess a hard external covering, and numerous articulated members. A long nervous chord, beset with ganglia. Compound eyes. Antennæ and palpi like those of insects. A heart and circulating vessels; and gills. Teeth in the cavity of the stomach.

1. *Cancer*, crab, lobster, crayfish, shrimp.
2. *Monoculus*.

INSECTS have articulated members and antennæ. Those which fly are subject to what is called a *metamorphosis*: they pass through certain intermediate states of existence, before they assume the last, or perfect form. From the egg proceeds the *larva*, or caterpillar: this changes to the *chrysalis, nympba, or auvelia*; from which the perfect insect is produced. Nervous system consisting of a chord beset with ganglia. No heart nor blood-vessels. Respiration carried on by means of tracheæ.

Order I. COLEOPTERA; having a hollow horny case, under which the wings are folded.

1. *Scarabæus*, beetles.
2. *Lucanus*, stag-beetle.
3. *Dermestes*.
4. *Coccinella*, ladybird.
5. *Curculio*, weevil.
6. *Lampyris*, glow-worm.
7. *Meloe*, Spanish-fly.
8. *Staphylinus*.
9. *Forficula*, earwig.

II. HEMIPTERA



II. HEMIPTERA ; four wings, either stretched straight out, or resting across each other.

1. *Blatta*, cockroach.
  2. *Gryllus*, locust, grasshopper.
  3. *Fulgora*, lantern-fly.
  4. *Cimex*, bug.
- &c. &c.

III. LEPIDOPTERA ; soft hairy body, and four expanded wings.

1. *Papilio*, butterfly.
  2. *Sphinx*,
  3. *Phalena*,
- } moths.

IV. NEUROPTERA ; four reticulated wings.

1. *Libellula*, dragon-fly.
  2. *Ephemera*.
- &c.

V. HYMENOPTERA ; generally possessing a sting.

1. *Vespa*, wasp, hornet.
  2. *Apis*, bee.
  3. *Formica*, ant.
  4. *Termes*, white ant.
  5. *Ichneumon*.
- &c.

VI. DIPTERA ; two wings.

1. *Æstrus*, gad-fly.
  2. *Musca*, common flies.
  3. *Culex*, gnat, mosquito.
  4. *Hippobosca*, horse-leech.
- &c.

VII. AP-

## VII. APTERA ; no wings.

1. *Podura*, springtail.
  2. *Pediculus*, louse.
  3. *Pulex*, flea, chigger.
  4. *Acarus*, tick, mite.
  5. *Aranes*, spiders.
  6. *Scorpio*, scorpion.
- &c.

The VERMES may be divided into two orders ; the *intestinal*, which inhabit the bodies of other animals ; and the *external*.

The former are not of such a complicated organisation as the latter ; so that they are sometimes arranged among the zoophytes. The external worms have a nervous chord possessing ganglia, an elongated body composed of rings ; and having no distinct head. There are no members. Circulating vessels, but no heart. No nerves have been discovered in the intestinal worms.

## Order I. INTESTINI.

1. *Gordius*, guinea-worm.
2. *Ascaris*, thread-worm, round-worm.
3. *Tricocephalus*.
4. *Fasciola*, fluke.
5. *Tania*, tape-worm.
6. *Hydatid*, hydatid.

## II. EXTERNI.

1. *Aphrodite*, sea-mouse.
  2. *Sipinculus*.
  3. *Hirudo*, leech.
  4. *Nereis*.
  5. *Nais*.
  6. *Planaria*.
  7. *Lumbricus*, earthworm.
- &c.



The ZOOPHYTES have neither brain nor nerves; no heart, nor, perhaps, blood-veffels; no articulated members.

Order I. ECHINODERMATA; covered by a hard and tough coriaceous skin.

1. *Echinus*, sea hedgehog.
2. *Asterias*, star-fish.
- &c.

II. SOFT or GELATINOUS ZOOPHYTES.

1. *Medusa*, sea-blubber, sea-nettles.
2. *Actinia*, sea-anemone.
3. *Hydra*, fresh water polype.

III. INFUSORIA, the animalcules of infusions.

1. *Vorticella*, wheel-animal.
2. *Brachionus*.
3. *Vibrio*, eel of vinegar.
4. *Volvox*.
6. *Monas*.

IV. Inhabitants of corals, corallines, sponges, &c.

The Nerves have tender brain nerves; to heart, not, perhaps, blood-vessels; no articulated mem- bers.

Other I. Hominidematia; covered by a hard and tough cutaneous skin.

- 1. Fishes, for hydrology.
- 2. Mammals, for lib.

II. SORT OF ORGANS OF NERVES.

- 1. Nerves, for hydrology, for anatomy.
- 2. Nerves, for anatomy.
- 3. Nerves, with their organs.

*Lately published, by the same Author,*

**A Description of the Arteries, arranged in the Form of Tables, for the Use of Students; translated from the Latin of A. MURRAY, Professor of Anatomy at Upsal.**

IV. Description of the Veins, for anatomy, for hydrology, for lib.



COMPARATIVE OSTEOLOGY.

COMPARATIVE OSTEOLOGY



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## CHAPTER I.

### ON THE BONES OF ANIMALS IN GENERAL.

§ 1. **RED-BLOODED**<sup>1</sup> animals only possess a true *skeleton*; to which all their bones<sup>2</sup> are connected, and on which the general form<sup>3</sup>, as well

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<sup>1</sup> Parts of a really bony structure are found only in a few insects and worms: viz. in the stomach of the lobster, and other species of the genus *cancer*; in the mouth of the sea hedgehog (*echinus*), &c. These parts at least resemble true bones more than that body, which is commonly called *cuttle-fish bone*; for the description of which see note (A) at the end of the chapter.

<sup>2</sup> There are a few exceptions to the general rule, that "*all the bones of an animal enter into the formation of its skeleton*:" viz. the bone of the tongue, commonly called *os hyoides*; the bone of the penis, of several mammalia; the bony ring in the sclerotica of birds; the *clavicular bones* of some mammalia, &c.

(To these instances we must add two others, which, though not enumerated by the author, are sufficiently remarkable to deserve notice: viz. the whole anterior extremity in such mammalia, as possess no clavicles; and the abdominal fins of fishes, which correspond to the posterior extremities of other animals.) T.

<sup>3</sup> See Galen's remarks on this subject, when speaking of the resemblance between the ape and the human subject; in the 1st book of his *Chef-d'œuvre de Anatomieis Administrationibus*, tom. 4. p. 26. Chartier's edition.



as the greater or less flexibility of the body depend.

§ 2. The ordinary white <sup>4</sup> colour of the bones has several gradations, which are sometimes observable in the different parts of the same bone; as in the grinding teeth of the elephant \*, And, in some few genera the whole bony structure is of a different colour <sup>5</sup>. Thus, in the garpike, (*esox belone*) the bones are green; and in some varie-

<sup>4</sup> The red tint, which the bones of animals receive in consequence of madder being mixed with the food, is observed by ANT. MISAUD, in his *Centuria Memorabilium seu Arcanorum omnis generis*, p. 161. Cologne, 1572. 12mo.

It is remarkable, that this well known experiment meets with very imperfect success in cold blooded animals.

\* A section of a grinding tooth of the elephant, or of any other herbivorous animal, as the horse, ox, &c. shews that its substance contains parts differing considerably in appearance. Besides the processes of enamel, which are intermingled throughout with the bone, there are two kinds of osseous structure of different colours. In the above remark, the author probably alludes to this circumstance, although he has not particularly described this formation in that part of his work, which treats on the teeth. See the additional observations on that subject at the end of the Chapter. T.

<sup>5</sup> This has however been asserted without foundation of some animals: thus NICHOLLS, in his *Compend. Anat.* p. 7, says that the *amedabad finch* (*fringilla amandava*) has yellow bones; and others have stated the same circumstance respecting the *golden pheasant*, (*phasianus pictus*). I have dissected both these animals, and found the assertions to be incorrect.



ties of the common fowl they approach to a black colour <sup>6</sup>.

§ 3. The structure of the bones is subject to still greater variations; which occur in the different bones of the same skeleton, as well as in the whole skeleton of particular classes and orders. Instances may be observed in the dry and brittle texture of the air bones of birds; in the long fibres, which appear on splitting the bones of the larger amphibia and fishes; in the peculiar tenacity and solidity of individual parts in some cartilaginous fishes \*.

§ 4. Excepting the crown of the teeth, bones are universally covered with periosteum; and for the most part they contain marrow <sup>7</sup> internally;

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<sup>6</sup> ABULFAZEL, the vizier of AKBER the Great, has remarked this of the fowls at Indore, and Neermul in Berar; in his classical work *Ayeen Akbery*, vol. 2. p. 72. and Niebuhr has stated it of those at Persepolis. *Travels*, vol. 2.

(Mr. Hunter is said to have discovered that the blackness resides in the periosteum. *Rees's Cyclopædia*, Art. BIRDS.) T.

\* For a further account of the differences in the structure of bones see note (A) at the end of the chapter.

<sup>7</sup> The erroneous opinion, which ARISTOTLE held, of the want of marrow in the bones of the lion, does not require an express refutation. On that subject, as well as on some other mistaken assertions, see R. HENER *apolog. pro VESALIO adversus SYLVIVM*. Venet. 1555. 8vo. p. 27.



which varies much in consistence, being fluid in the whales.

§ 5. Bones are formed by the ossification of original cartilages; the teeth being again for the most part excepted. Ossification commences earlier and proceeds more rapidly in viviparous, than in oviparous animals<sup>9</sup>. This fact appears at least from comparing the incubated bird with the foetus of mammalia. Again, in the latter class, many points in the formation of the bones are completed sooner in quadrupeds than in man \*<sup>9</sup>.

*Additional*

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\* It is well known that the incubation of the chick occupies twenty-one days. The commencement of ossification is not perceptible before the beginning of the ninth day; which corresponds with the seventeenth week of human pregnancy. In the human embryo the first points of ossification may be discerned in the seventh or eight week after conception, (certainly not in the third or fourth week, as some great anatomists have lately supposed). These facts shew how little confidence can be placed in that remark of HALLER's, which concludes his excellent observations on the formation of the bones in the incubated chick. "The facts, which we have shewn in the bones of the chick, will hold good of those of the other classes of animals, and of man."

\* In note (B) at the end of the chapter, there is a short account of the composition of the different bony substances, which belong to the various classes of animals. T.

<sup>9</sup> An example occurs in the closure of the fontanells. I have found these openings of considerable size in young fetuses of the *fera* and *pecora*, but could hardly discern any trace



*Additional Notes on the First Chapter.*

(A) Ossification does not go on with equal rapidity in all animals, nor in all the bones of the same animal. Thus the ossification of the internal ear of man, and the mammalia, is completed before any other parts; and it surpasses all other bone in its density, and in the proportional quantity of phosphate of lime, which it contains. In the *cetacea*, particularly the *balæna* and *physeter* (the black and white whales,) this part acquires a density and hardness equal to that of marble. Its section presents an homogeneous appearance, without the least vestige of fibres, cellular texture, or vessels.

Bones are slow in acquiring their complete formation, in proportion to the remoteness of the period, at which the growth of the animal is finished. The skeleton remains constantly in a cartilaginous state in some animals; such are the *shark*, *skate*, *sturgeon*, and all those fishes, which,

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trace of them at the time of birth; nothing at least which could be compared to their magnitude in a human fœtus of nine months. When we compare the pelvis, and the whole mechanism of parturition in the woman, with those of the female quadruped, the cause of this difference appears. We then discover, why the yielding and overlapping of the large bones of the cranium, which is chiefly effected by the fontanells, is only required to facilitate the birth of the human fœtus.



from this circumstance, have been denominated cartilaginous, or *chondropterygii*. Although the bones of other fishes, of reptiles, and serpents acquire a greater hardness, they constantly remain more flexible, and retain a larger proportion of gelatine in their structure, than those of warm-blooded animals.

The bony texture of the mammalia is not so fine and delicate as that of man: it is particularly loose and coarse in the *cetacea*, where the distinction of the fibres is very manifest, even on the external surface. In the jaw and the ribs particularly, they may be loosened by maceration, and become very obvious.

The bones of reptiles and fishes have a very homogeneous appearance, the earthy matter and the gelatine appearing to be uniformly mingled; this is more strikingly marked, as we approach to the cartilaginous fishes, where the gelatine predominates, and conceals the earth.

Several animals have no medullary cavities even in their long bones. This is the case with the *cetacea*, the *seal*, and *turtle*.

The structure of the bones of birds should be noticed in this place. They are almost universally hollow; but their cavities, which never contain marrow, are filled with air. This organization unites the advantages of lightness and strength. For a further account of it see the chapter on the organs of respiration.

The



The *horn* of the stag is a real bone, as appears both from its texture, and its component elements. Its outer part is hard, compact, and fibrous: the internal substance is reticulated, but very firm; and possesses no cavities nor marrow. See the chapter on the *skeleton of the mammalia*, for the mode of its formation, &c.

The shells of the testaceous animals are formed of a calcareous substance, which is sometimes laminated; sometimes as hard and dense as marble. This is mingled, as in other bones, with a gelatinous matter, from which it may be separated by means of acids. The earth is not disposed in fibres or laminæ, as in other bones; but is uniformly expanded through the animal substance.

The layers of the shell are formed successively, as the animal increases in size. The exterior or smallest are formed first: others are successively deposited on the inner surface of these; each new layer extending beyond the margin of the former one, so that the shell, by every addition increases in thickness and circumference. Are these new layers formed by vessels existing in the shell itself, or are they produced by exudation from the surface of the animal? REAUMEUR broke the shell of snails, and found that no reproduction took place, when he covered the exposed part of the animal's body; while the injury was quickly repaired, when no artificial obstacle impeded the effusion of fluids from the surface. This experi-



ment seems to prove that the shell is formed by deposition from the body of the animal: but there is an argument equally strong in favour of the existence of vessels in the shell itself. Between the two last formed layers of the convex shell of the oyster, a considerable cavity is found, filled with a fluid, and communicating by a particular opening with the internal parts of the body. This must be destroyed and reproduced whenever a new lamina is added; and we cannot understand how such processes can be effected without arterial and absorbing vessels.

*Crustaceous animals*, (crab, lobster, &c.) have a skeleton which surrounds and contains their soft parts, and which serves at the same time the purposes of a skin. When it has attained its perfect consistence, it grows no more: but as the soft parts still increase, the shell separates, and is detached, being succeeded by a larger one. This new covering is partly formed before the other separates: it is at first soft, sensible, and vascular; but it speedily acquires a hard consistence by the increased deposition of calcareous matter.

Some of the *mollusca* have hard parts in the interior of their body. The common cuttlefish (*Sepia officinalis*) has a white, firm, and calcareous mass of an oval form, and slightly convex on its two surfaces, commonly known by the name of the *cuttlefish-bone*, contained in the substance of its body. It has no connection with any soft part,  
whence



whence it appears completely as a foreign body: no vessel nor nerve can be perceived to enter it; nor does it receive the attachment of any tendon. In the calmar (*Sepia loligo*), this body resembles horn in its appearance; it is transparent, hard, and brittle. Its form resembles that of a leaf, except that it is larger; and sometimes that of a sword-blade. These parts must grow like shells, by the simple addition of successive layers.

(B). As chemical analysis has discovered some interesting differences in the constituent ingredients of the hard parts of various animals; it seems right to give a short account of them in the present place.

The bones and teeth of red-blooded animals, consist chiefly of phosphate of lime, deposited in the interstices of an animal substance; which, when freed from the earthy matter by the immersion of the bone in an acid, approaches in its consistence to cartilage. This is completely dissolved by boiling in a close vessel, and is thereby proved to consist of gelatine. A small quantity of carbonate of lime is mixed with the phosphate; and hence effervescence arises when a bone or tooth is subjected to the action of acids.

The relative proportions of these ingredients in the general structure of bone have not hitherto been determined with much accuracy; but the obvious differences of structure and appearance



not only in the different classes, orders, and genera, but even in the several bones of the same individual, and in parts of the same bone, leave no doubt that much variation must exist in these points.

The horn of the stag is bone, containing a large proportion of gelatine.

The bones of fishes contain phosphate of lime; but the animal substance exists in very large proportion, particularly in those which are called cartilaginous, where it completely obscures the earthy matter.

Carbonate and phosphate of lime, deposited on a cartilaginous basis, which retains the form of the part, after the earthy matter has been separated, constitute the external covering of the crustaceous animals (crab, lobster, &c.). The carbonate is in greatest quantity.

Carbonate of lime, with a small quantity of phosphate, forms the earthy principle of the shell of the echinus.

The shells of the testacea, are entirely composed of carbonate of lime, united to a gelatinous substance. When immersed in acid, a rapid effervescence ensues. Some of them, which are very hard in their texture, and have an enamelled surface, contain so little animal matter, that it does not retain the form of the shell, which is completely dissolved by acids, like the enamel of the teeth. But others, which consist of what is called mother of pearl, and are formed by successive strata, (e. g. the



the oyster, muscle, &c.) contain a much larger proportion. When these have been macerated in acid, a gelatinous substance remains, consisting of several layers of membrane, arranged stratum super stratum.

It appears therefore, that *phosphate of lime* is the peculiar earth of *bone*, and *carbonate* that of *shell*; although no bone has been hitherto discovered, without a small admixture of the latter ingredient. Hence that singular production from the body of the cuttle-fish is improperly called bone; as it consists, like shells, of various membranes, hardened by carbonate of lime, without any phosphate. See "*Experiments and Observations on Shell and Bone*," by C. HATCHETT, Esq. *Philos. Trans.* 1799.

The same excellent chymist has also found, that the *zoophytes*, consist of carbonate of lime joined in different instances to various proportions of animal substance. *Philos. Trans.* 1800, part 2.

## CHAPTER II.

## ON THE SKELETON OF MAMMALIA.

§ 6. **T**HE form of the different mammalia, particularly the fourfooted ones, varies considerably; and their skeletons must be marked by corresponding differences. Yet these varieties may be included, at least for the greatest part, under the following peculiarities; which serve to distinguish their skeletons from those of birds.

The skeletons of mammalia possess;

1. A skull with genuine sutures, (at least with very few exceptions; as perhaps the *elephant*, and the duck-billed animal<sup>1</sup>, *ornithorhynchus*).

2. Jaws furnished with teeth.

Those of birds are distinguished by;

1. \* A skull which has not real sutures<sup>2</sup>.

2. A bill without teeth.

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<sup>1</sup> This is the case, at least, with my specimen: the cranium, destitute of sutures, considerably resembles that of a bird in this point.

\* See note (A) at the end of the chapter.

<sup>2</sup> This is meant to apply to adult birds; for young individuals have at least separate bones in their crania, if they are not connected by real denticulated sutures.

Except



Except the *ant-eaters*, the *manis*, the duck-billed animal \*, the *balæna* (whale).

3. An upper jaw, which does not move.

3. An upper jaw, which does move.

There are some exceptions, viz. the *rhinoceros bird*.

4. An *os intermaxillare*.

4. No *os intermaxillare*.

(For the probable exceptions, see § 14.)

5. Two occipital condyles.

5. A single occipital condyle.

6. Seven cervical vertebræ.

6. More than seven cervical vertebræ.

Except the *three-toed sloth*, and some *cetacea*.

7. Moveable dorsal vertebræ.

7. Motionless dorsal vertebræ.

8. A pelvis closed in front.

8. A pelvis open anteriorly.

Except the *ant-eaters*; which have it open: and the *cetacea*, which have none.

Except the *ostrich*.

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\* This exception is not strictly correct; as the duck-billed animal has been found to possess a peculiar kind of horny teeth. See the additional note to § 30. T.

9. True clavicles in a few genera only.

9. Clavicles constantly: and almost as universally the *fork-like bone*.

§ 7. We shall first describe the cranium of mammalia; since its structure most materially influences the whole animal economy, from serving as a receptacle for the brain, the organs of sense, and those of mastication.

§ 8. The well known division of the bones of the head, into those of the cranium, and of the face, is convenient for pointing out the remarkable proportions of relative magnitude in the two divisions<sup>3</sup>. Compare, for instance, the skull of the *orang-outang* (*simia satyrus*) with that of the *mandril* (*papio maimon*); or that of the porpoise, with the *white whale*.

§ 9. The number of proper bones of the cranium is, on the whole, the same as in the human subject. The *os frontis* in most of the *horned animals*, is composed of two equal portions: the two parietal bones are consolidated into one in many of these, and in others they are united to the occiput. Some of

<sup>3</sup> A profile view answers as well for this purpose as a view from above. I have explained the use of the latter, (which I call *norma verticalis*) in comparing the national forms of human crania, in the 3d edition of my work, *De Generis humani Varietate Nativa*, p. 203. and in the 4th, *Decas. Cran. divers. Gent.* p. 12.



the *glires* have a separate piece between the parietal and occipital bones<sup>4</sup> \*.

§ 10. A principal variation in the form of the cranium, arises from the size and direction of the *crista occipitalis* †, which bears a determinate proportion to the strength of the jaws. It is wanting in the *orang-outang*; but is very large in the *baboon of Borneo*.<sup>5</sup> The *longitudinal* crista is very strongly expressed in the *badger*; and the *transverse* ridge is remarkable in the *beaver*. Between the arched sides of the upper part of the cranium in the *elephant*, lies a broad and deep impression, with a longitudinal crista at its bottom.

There is considerable difference in this respect, between the different races of dogs: viz. between the pug-dog, and that of Newfoundland.

§ 11. The situation and direction of the *great occipital foramen* are attended with remarkable va-

<sup>4</sup> See MERREM'S *Anatomy of the Domestic Mouse*; in his *Miscellaneous Observations on Natural History*: and MEYER'S *Prodromus Anat. Murium*; who calls it *os transversum*.

\* See note (B), at the end of the chapter.

† See note (C), at the end of the chapter.

<sup>5</sup> This completely untailed baboon, was first described by WURMB, (who very wrongly called it the great *orang-outang*, or *pongo*) in the 2d vol. of the *Transactions of the Batav. Society*. I saw a drawing of its monstrous skeleton, which is four feet two inches high, at the cabinet of the Hague, in December 1791.



riations in some instances. Instead of lying horizontally, as in the human subject, (where indeed the anterior margin is sometimes higher than the posterior) it is placed in most quadrupeds at the extremity of the cranium, and obliquely, with the posterior border turned upwards. In some, indeed, its direction is completely vertical; and in the *marmot of the Alps*, its upper margin is turned more forwards than the lower<sup>6</sup> \*.

§ 12. The futures, which connect the individual bones of the cranium, are generally less intricate, at least to outward appearance, in quadrupeds

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<sup>6</sup> See DAUBENTON, on the different Situation of the great Occipital Foramen in Man and Animals, in the *Mem. de l'Acad. des Sc. de Paris*, 1764. On the difference, which we are now considering, this excellent zootomist founded his *occipital line*, which has been employed in the comparison of different crania with each other. He draws two lines, which intersect each other in the profile of the skull: One passes from the posterior margin of the *great foramen*, (which, in almost all mammalia, is also the superior one,) through the lower edge of the orbit; the other takes the direction of the opening itself, beginning at its posterior edge, and touching the articular surface of the condyles. He determines, according to the angle formed by the junction of these two lines, the similarity or diversity of the form of crania.

This angle is, however, but an imperfect criterion; for its variations are included between 80° and 90° in almost all quadrupeds, which differ very essentially in other points. And small variations occur in the individuals of one and the same genus.

\* See note (D), at the end of the chapter.

than



than in man. Their teeth are however strong and sharp in the *horned pecora*, for obvious reasons; and the frontal bones are thick in the same animals<sup>7</sup>. *Offa triquetra* are seldom seen in the crania of animals. Yet I have specimens of these, in the *hare* and *orang-outang*; the futures of the latter are remarkably elegant<sup>8</sup>.

§ 13. The general form<sup>9</sup> of the cranium, is most materially influenced by the direction, and the

<sup>7</sup> In sheep affected with the staggers, where the hydatid is large, and situated at the surface of the brain, I have found this part of the bone almost completely absorbed; so that it yielded to pressure, and appeared like a thin cartilaginous membrane.

<sup>8</sup> That observation, which EUSTACHIUS makes, concerning the futures of apes, must therefore be understood with some limitation; "they are always so obscure, as scarcely ever to deserve the name of futures." *Offium examen*, p. 173.

<sup>9</sup> To determine this with greater precision, CAMPER instituted the *facial line*; the application of which is most minutely explained in his posthumous work, "*On the natural Differences of the Features, &c.*" Like DAUBENTON, he draws on the profile of the cranium two straight lines, which intersect each other; but in different directions from those of the French anatomist. An *horizontal* line passes through the external auditory passage, and the bottom of the cavity of the nose; this is intersected by a more *perpendicular* one, proceeding from the convexity of the forehead, to the most prominent point of the upper jaw, or of the intermaxillary bone. The latter is the proper *facial line*; and the angle, which it forms with the horizontal line, determines, according to Camper, the differences of the crania of animals, as well as the national physiognomy of the various races of mankind.



the various degrees of prominence of the facial bones. The projection is generally formed by a prolongation of the upper jaw ; partly also, and in many instances chiefly by the intermaxillary bone, which is inclosed between the two upper jaw bones \*.

§ 14. The upper jaw-bones of other mammalia, do not, as in man, touch each other under the nose, and contain all the upper teeth ; but they are separated by a peculiar, single, or double *intermaxillary bone*<sup>10</sup>, which is in a manner locked between the former, and holds the incisor teeth<sup>11</sup> of such animals, as are provided with these teeth. It exists also in the *pecora*, which have no incisor teeth in the upper jaw ; as well as in such genera

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I have mentioned my objections to its application, in the latter point of view, in my work, *De Generis Humani Variet. Nativ.* 3d edit. p. 200. Concerning its use, as applied to the crania of animals, the same observations which were made on the line of DAUBENTON will hold good, mutatis mutandis. About three-fourths of all the species of quadrupeds, which we are hitherto acquainted with, whose crania differ extremely in other respects, have one and the same facial line.

\* For a more particular account of the relative proportions of the cranium and face, together with the measure of these, according to the rules of Camper, see note (E), at the end of the chapter.

<sup>10</sup> GOTTH. FISCHER *on the different forms of the intermaxillary bone in different animals*, with plates, in German. Leipzig, 1800, 8vo.

<sup>11</sup> VESALIUS *de c. h. fabrica*, p. 46, fig. 1.



as have no incisor teeth at all; viz. the *duck-billed animal*, and the *armadillo*. It is even found in those mammalia, which are wholly destitute of teeth; as the *anteater*, and the proper *whales*<sup>12</sup>. It is joined to the neighbouring bones by futures, which run exteriorly by the side of the nose and snout, and which pass, towards the palate, close to the foramina incisiva<sup>13</sup>. Its form and magnitude vary surprisngly in several orders and genera of mammalia. It is small in many feræ; as also in

<sup>12</sup> On this account I prefer the term intermaxillary bone, to that of *os incisivum*, which is employed by HALLER.—BLAIR, in his excellent account of the anatomy of the elephant, calls it *os palati*; and VITET *os maxillaire intérieur*.

<sup>13</sup> In human crania, at least those of the fœtus, and young children, there is at the same part a small transverse slit near the foramen incisivum, of which FALLOPIUS gave the following accurate account in the year 1561: "I find this division to be rather a slit than a future, since it does not separate one bone from the other, nor does it appear exteriorly, nor join two bones; which is the office of futures." *Obs. Anat.*

Hence I was much surpris'd to find VICQ D'AZYR in 1780 discover in this point an unexpected resemblance between the cranium of the human subject, and of quadrupeds. *Mem. de l'Acad. des Sc.* 1780.

In the celebrated dispute of the 16th century, whether GALEN's osteology was derived from the skeleton of man or the ape, INGRASSIAS argued for the latter side of the question, from GALEN's having ascribed an intermaxillary bone to the human subject. And the same author, in his classical "*Commentarii in Galeni Librum de Ossibus*," Panorm, 1603, fol. particularly points out the parts; "where GALEN, led astray by the dissection of apes, deviates from the true construction of the human body."



the *walrus* (*Trichecus*). In the *glires* \* it is generally remarkably large; viz. in the *beaver* and *marmot*. It is also large in the *hippopotamus*, *porpoise*, and *cachalot* (*physteter macrocephalus*). Its form is very remarkable in the *ornithorhynchus*, where it consists of two hooklike pieces, joined by a broad *fynchondrosis* <sup>14</sup>.

§ 15. The above-mentioned *anterior palatine holes*, or *foramina incisiva* are double in most mammalia, as in man. They are much larger in quadrupeds than in the human subject: in the

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\* Its great size in these animals is accounted for by the magnitude of the incisor teeth, which it contains. T.

<sup>14</sup> I cannot repeat here, what I have observed in my book *De Generis Humi. Var. Nat.* on the subject of the intermaxillary bone; of which, as is there stated, not the least trace could be discovered in the crania of some *apes* and *baboons*, although the individuals were young. Can it be supposed, that in these instances it was consolidated to the neighbouring bones at a young period of life, when all the other futures were in a state of perfection?

FISCHER could discover no trace of this bone in several mammalia of other orders; viz. the *three-toed sloth*, (*bradypus tridactylus*) and the *horse-shoe bat* (*vespertilio ferrum equinum*). See his work above quoted. Yet he admits it as possible that the bone may have been broken off, at least in the *sloth*. In short, all the exceptions, which we have just enumerated, require a more accurate investigation in numerous and perfect specimens from different periods of life. (See note (F) at the end of the chapter.)



*pecora* and the *bare* they are remarkably long and broad <sup>15</sup>.

§ 16. There are remarkable impressions in the upper jaw of most *pecora*, near the nasal bones, arising from the situation of the *sinus sebacei*. This part has a reticular structure in the *bare*, which approximates in that, as well as in many other points, to the formation of the ruminant animals.

§ 17. In the *zygoma* we observe several important differences, immediately derived from the organs of mastication <sup>16</sup>. It is commonly formed by the junction of the *cheek-bone* with the *os temporis*. In several *web-footed* and *digitated mammalia*, (viz. the *otter*, *beaver*, *opossum*, *guinea-pig*,) there is a peculiar bone interposed between these. It is straight, and almost of a thread-like slenderness in the *mole*. It is of immense strength, and includes a large space towards the cranium, for lodging the powerful muscles which move the lower jaw, in several *carnivorous animals*, as the *tiger*, and in some *glires*, as the *beaver*. In the *rat*, and some others, it is convex

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<sup>15</sup> In many instances, as in the *lion*, the openings of these large foramina are very visible in the palate, during life. See J. RIDINGER'S *Delineation of the tame lion, which was exhibited in Germany in 1760*, fol.

<sup>16</sup> See PINEL *Recherches sur une nouvelle methode de classification des quadrupèdes*, in the 1st vol. of the *Actes de la Société d'Histoire Naturelle de Paris*.



below; in the *weasel*, above. It is remarkable in the *sloth* for a large descending process, which comes from the *os malæ* \*.

§ 18. The *elephant* possesses only a kind of imitation of nasal bones. In most *apes*, and even in the *orang-outang*, there is a single, triangular, and and very small nasal bone. In the greater number of true quadrupeds, there are two *ossa nasi*, frequently of very considerable magnitude. This is the case in the *pecora* and *bare*; also in the *horse*, *pig*, &c. In the *rhinoceros*, the *ossa nasi*, which support the *horn*, are very soon consolidated together.

§ 19. The lacrymal bones (*ossa unguis*) are entirely wanting in the *elephant*. They are particularly large in the *pecora*; and above all in the *antelope*. They are also very remarkable in the *opossum*.

§ 20. The orbits differ very much in their direction, capacity, and depth. They have for the most part a lateral direction. In the *simiæ* they are directed forwards, as in man: but they lie much more closely together than in the human subject. In the *beaver* they point upwards.

They are completely closed in the quadrumanous

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\* See note (G) at the end of the chapter.



mammalia. In the *pecora* and *solidungula* they have a circular margin in front; but the outer part is deficient behind. In the *feræ* and several *glires* the outer part of their margin is also deficient. The depth of these cavities is equally various. In many cases they are so superficial as scarcely to deserve the name of orbit; viz. the *mole*, and *anteater*. HALLER'S assertion, that man possesses a larger bony orbit than any animal, is erroneous. The orbit of the *cat* is comparatively larger, as also that of several *makis*, (*lemur*). See the delineation of their crania in FISCHER'S valuable "*Anatomy of the Maki.*" Frankfort 1804, 4to\*.

§ 21. In mammalia, which have horns, these parts grow on particular processes of certain bones of the cranium. In the *one horned rhinoceros*, they adhere to a rough, and slightly elevated surface of the vast nasal bone. The front horn of the two horned species has a similar attachment; the posterior rests on the os frontis<sup>17</sup>; as those of the horned *pecora* do. Two kinds of structure are observed in the latter: there are either proper horns, as in the genera of the *ox*, *goat*, and *antelope*, or bony productions, as in the genus *cervus*, which includes animals of the deer kind. These are also called

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\* See note (H) at the end of the chapter.

<sup>17</sup> GEOFFROY in *Mémoires de la Société d'Histoire Naturelle de Paris*, an. 7. cahier 1.



*horns* in English, or sometimes *antlers*: in French *bois de cerf*. In the former, the external table of the frontal bones is elongated into a process, which contains a continuation of the frontal sinuses, except in the *antelope*. Its external vascular surface secretes the horn, which covers this process like a sheath. In the stag kind<sup>18</sup> (in the male<sup>19</sup> only in most genera), the frontal bone forms a short flattened prominence, from which the proper *antler* immediately shoots forth. It is renewed every year, and is covered, during the time of its growth, with a hairy and very vascular skin \*<sup>20</sup>. The little horns

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<sup>18</sup> I have collected about twenty instances, from the middle of the 16th century downwards, in which *horned hares* are said to have been found, with small branches like those of the *roe-buck*, both in different parts of Europe, and in the East Indies. Were this fact ascertained, it would furnish another striking point in which these animals resemble the *pecora*. The fact is suspicious, because I have not yet been sufficiently satisfied of a single instance in which the horns were on the hare's head, although every trouble has been taken to procure information; and they appear in the drawings, which I possess, by far too large for a hare.

<sup>19</sup> Anomalous instances, in which the females have possessed horns, may be seen in STAHL, *de cornu cervi deciduo*, Hal. 1699. LEOPOLD, *diss. de alce*, Bas. 1700. Hoy in the *Linnean Trans.* vol. 2. p. 356.

I possess a coloured drawing, and accurate account of a horned roe, which was shot in Hanover.

\* See note (I) at the end of the chapter.

<sup>20</sup> The annual reproduction of these horns constitutes, in many points of view, one of the most remarkable phenomena of animal physiology. It affords a most striking proof;



horns of the *giraffe* hold a middle place between these two divisions. In their form, structure, and permanent duration, they resemble the frontal processes of the proper horns: in their hairy covering they approach to the branches of the stag kind<sup>21</sup>.

§ 22. The skeleton of quadrupeds deviates more from that of man in the form of the lower jaw bone, than in any other part. This difference consists chiefly in the want of a prominent chin; that pecu-

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1st, of the power of the nutritive process, and of the rapid growth, which is dependant on this in warm-blooded animals. For the horn of a stag, which may weigh a quarter of a hundred, is completely formed in ten weeks. 2dly, of a limited duration of life in a part of an animal, entirely independent on the life of the whole animal; (which in the stag extends to about 30 years). 3dly, of change of calibre in particular vessels. For the branches of the external carotid, which supply the horn, are surprisngly dilated during its growth; and recover their former area when that process has ceased. 4thly, of a peculiar sympathy, which is manifested between the growth of the horns, and the generative functions. For castration, or any essential injury of the organs of generation, impedes the growth, alters the form, or interrupts the renewal of the horns. See RUSSELL'S experiments in his "*Economy of Nature in acute and chronic Diseases of the Glands.*" It has also been asserted, but without a sufficient proof hitherto, that injuries of the newly formed horn render the stag impotent for some time. *Berlin Soc. of Inquirers into Nature*, vol. 4. p. 360.

<sup>21</sup> The frontal process in the young giraffe, constitutes an epiphysis, which is connected to the frontal bone by a crust of cartilage; but afterwards becomes consolidated to the bone.



liar characteristic of the human countenance; which exists in every race of mankind, and is found in no other instance whatever. Man has also the shortest lower jaw in comparison with the cranium; the elephant perhaps approaching the nearest to him in this character<sup>22</sup>. The same bone is further distinguished by the peculiar form and direction of its condyle. The articulation of these processes varies according to the structure of the masticating organs. They are both situated in the same straight horizontal line in the *feræ*; their form is cylindrical; and they are completely locked in an elongated glenoid cavity, whose margins are so extended before and behind the condyle, that all rotatory motions are rendered impossible, and hingelike movements only allowed. This structure is most strikingly exemplified in the *badger*, where the cylindrical condyles are so closely embraced by the margins of the articular cavity, that the lower jaw, (at least in the adult animal,) is still retained in its situation, after the soft parts have been entirely removed by maceration. In many herbivorous animals (in the most extensive sense of the term) these condyles are really rounded eminences; viz. in the *elephant* and *beaver*. Their surface is flattened in the *pecora*, which have also the lower jaw narrower than the upper, so that the two sets of teeth do not meet together, when the mouth is shut; but are brought

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<sup>22</sup> See PINEL *sur les os de la tête de l'Elephant* in the *Journal de Physique*, tom. 43. p. 54.



into contact by the free lateral motion, which takes place in rumination. The two condyles lie parallel to each other in a longitudinal direction in many *glires*; viz. in the *bare*, where, (as in the *anteater*) the coronoid process is almost entirely wanting. This process is on the contrary very conspicuous in the *giraffe*. The *cetacea* have the articular surface of the lower jaw turned almost directly backwards<sup>23</sup> \*.

There are on the whole, few other bones in the skeleton of mammalia, of such various forms as the lower jaw. The most anomalous formation of this bone is the shovel-like surface of its anterior part in the *duck-billed animal*.

We have lastly to observe that the two halves of the lower jaw are connected throughout life, in many mammalia, by a mere synchondrosis; which is easily separated by boiling or maceration. This is the case in many *feræ*, *glires*, and *cetacea*. They are consolidated into one piece, as in the human subject, at an early period, in the *quadrumana*, as also in the *horse*, *horned cattle*, *pig*, *elephant*, &c.

§ 23. The jaws of mammalia contain teeth †<sup>24</sup>  
with

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<sup>23</sup> The singular, but very common error, of considering the halves of the lower jaw of the whale, as ribs, has been already refuted by RONDELET, *de piscibus*, p. 53.

\* See note (K) at the end of the chapter.

† See note (L) at the end of the chapter.

<sup>24</sup> See J. G. DUVERNEY, *Lettre contenant plusieurs nouvelles Observations sur l'Osteologie*, Paris, 1689, 4to.



with a very few exceptions: the proper whales, (*balænæ*), the *manis*, (*scaly lizard*), and the *American anteaters* are the only genera entirely destitute of these organs\*.

The substance and texture of the teeth are different from those of all other bones. The enamel which covers the crown of the tooth, is characterised by its peculiar hardness, (sparks of fire may be produced by striking it against steel), as well as by the want of animal matter, with which the bony part of the crown, as well as the fang of the tooth are copiously provided. It seems to be wanting in the tusks of the *elephant*, as also in those of the *walrus*, and of the *narwhal*, (*monodon, sea-unicorn*). Yet these are all surrounded by an external thin coat of a different substance from the body of the tooth. These teeth have indeed some peculiarity in their texture; the ivory of the elephant's tusks in particular is unlike any other substance †<sup>25</sup>.

In

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J. J. KOBER *de dentibus, eorumque diversitate*, August 1774. 4to.

P. M. G. BROUSSONET *Comparaison entre les dents de l'homme et celles des Quadrupedes*, in *Mem. de l'Acad. des Sc. de Paris*, 1787.

\* See note (M) at the end of the chapter.

† See note (N) at the end of the chapter.

<sup>25</sup> Not to mention other peculiarities of *ivory*, which have induced some modern naturalists to consider it as a species of *horn*, the difference between its structure and that of the bone of teeth is evinced in the remarkable pathological phenomenon, resulting from balls, with which the animal has been shot when young, being found on sawing through the tooth, imbedded



In some animals the crowns of particular teeth are distinguished by peculiar colours. The incisors of some *glires*, as the *beaver*, *marmot*, and *squirrel*, are of a nut-brown colour on their anterior surface, and the molar teeth of several *bifulca*, (cloven-hoofed animals), as well as of the elephant, are covered by a very hard black substance of a vitreous appearance <sup>26</sup>.

§ 24. It

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imbedded in its substance in a peculiar manner. HALLER employed this fact, both to refute DUHAMEL's opinion, of the formation of bones by the periosteum, like that of wood by the bark of a tree; as well as to prove the constant renovation of the hard parts of the animal machine. It is still more important in explanation of that "*nutritio ultra vasa*," which is particularly known through the Petersburg prize dissertation. Instances of the fact above-mentioned may be seen in BUFFON, 4to. ed. tom. ii. p. 161. in GALLANDAT *over de Olyphants Tandem* in the *Verhandelingen der Genootsch, te Vlissingen* p. 352. tom. 9. and in BONN *descr. thesauri Hoviani*, p. 146. In all these cases the balls were of iron. I possess a similar specimen.

But there is a still more curious example in my collection, of a leaden bullet contained in the tusk of an East Indian elephant, which must have been equal in size to a man's thigh, without having been flattened. It lies close to the cavity of the tooth; its entrance from without is closed as it were by means of a cicatrix; and the ball itself is surrounded apparently by a peculiar covering. The bony matter has been poured out on the side of the cavity in a stalactitic form. (See note (O) at the end of the chapter.)

<sup>26</sup> This black vitreous matter is sometimes covered with a crust of a metallic shining bronze colour; particularly in the domesticated



§ 24. It is difficult to frame a classification of the teeth, which shall be generally applicable, and at the same time intelligible. Their situation affords perhaps a more eligible basis of arrangement than their form, since that is the same throughout, in some instances, as the *cachalot* and *porpoise*. They may therefore be distributed into the three classes of *front teeth*, *corner teeth*, and *back teeth* \*.

§ 25. The front teeth in the upper jaw, are those which are implanted in the intermaxillary bone, (the tusks of the elephant must therefore be included); in the lower jaw, such as correspond to these, or to the anterior margin of the intermaxillary bone, in animals which have no upper incisors. Their number and form vary considerably. In the *glires* their cutting edge is formed like a chissel, particularly in the lower jaw, whence J. Hunter called these animals "*scalpris dentata*." In some cases, as the *beaver*, and the *domestic mouse*, the lower ones have remarkably long roots †. In the hare there are two very small teeth placed just behind the large ones. The crowns of the front, as well as of the back teeth, form flat prominences in the walrus. The front extremity of the lower jaw,

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domesticated horned cattle, and sheep. See STOBÆUS *de inauratione spontaneâ dentium quorundam animalium* in *Act liter. Suecic.* vol. 3. p. 83, 1733.

\* See note (P) at the end of the chapter.

† See note (Q) at the end of the chapter.

with



with its teeth, extends in the dolphin (*delphinus delphis*) much beyond the corresponding part of the upper jaw, contrary to what happens in other animals. The lower fore teeth of most mammalia have a more or less oblique position; while in man they are perpendicular. The *orang-outang* of Borneo, is the only animal, which at all approaches to the human structure in this point.

§ 26. The corner teeth (*canini*) of the upper jaw, lie close to the intermaxillary bone; hence the remarkable spiral tusk of the *narwhal*<sup>26</sup>, and the tusks of the *walrus* belong to this division. In many *baboons*, and most particularly in the larger predacious mammalia, these teeth are of a terrific size; in the latter animals, the whole profile of the anterior part of the cranium, forms a continuous line with these teeth; which is very visible in the *tiger*. The canine tusk of the *babiroussa*, which are very long, and recurved so as nearly to describe a complete circle, present the most curious structure. Their utility to the animal, appears quite obscure, when their length, direction, and smallness are considered. The small canine teeth, which are situated

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<sup>26</sup> I must refer to the 5th part of my "*Delineation of Subjects, relating to Natural History*;" for what is there said on the question, whether the *narwhal* has really one or two of these teeth. (See note (R) at the end of the chapter).



just behind the larger ones, in all the species of the bear<sup>27</sup> kind, are also remarkable.

§ 27. The back teeth are the most universal; since, when mammalia have any teeth at all, they are of this description, although the front and canine teeth may be wanting; as in the *armadillo*, and the *ornithorhynchus*. The *narwhal* makes the only exception, as it is perfectly toothless, if we except the long tusk. The form, structure, and relative situation of the back teeth vary very considerably. In many *quadrumana*, as in man, the two front ones<sup>28</sup> are smaller in the crown, and more simple in the fang than the posterior. Whence J. HUNTER calls

<sup>27</sup> This is the case in the brown bear of the Alps, of which I have three crania; with a black American; with one whose country is unknown, belonging to the National Museum at Paris; and with the Polar bear; of all which, I possess excellent drawings, through the kindness of professor CUVIER. These small teeth are wanting in the fossil remains of a prodigious bear (*ursus spelæus*), towards the osteology of which, I have a large collection, from the three most celebrated caverns in Germany, viz. that of SCHARZFELDER in the HARZ, of GAILLENREUTER in the FICHTELBERG, and of ALTENSTEINER in THURINGERWALD.

<sup>28</sup> In some *apes* and *baboons*, the front bicuspis of the lower jaw, has a peculiar formation, being elevated into a sharp point, like those of the *feræ*. See the excellent representation of the cranium of the mandril (*Simia Maimon*) in CHESELDEN'S *Osteography*.

them



them *bicuspides*, and restricts the name of *molares* to the latter <sup>29</sup>.

The molar teeth of *feræ* have the crown entirely covered with enamel <sup>30</sup>; while in several <sup>31</sup> *glires*, in the *solidungula*, *pecora* <sup>32</sup>, and most *balenæ*, bony substance may be seen at the extremity of the tooth, intermixed in a tortuous line with vertical productions of enamel <sup>33</sup> \*. In many animals, which

<sup>29</sup> I find, that the difference between the *bicuspides* and *molares*, is noticed in the first anatomical compendium, which was compiled from human bodies, viz. the celebrated *Anatomia partium Corp. human.* written by MONDINI in the first half of the fourteenth century. For he enumerates in each jaw four "*maxillares*," and six "*molares*," besides the incisor and canine teeth, p. 370, of the classical edition, which is accompanied with BERENGAR's Commentaries. I have also found, that this distinction of the two kinds of grinders, is noticed in that famous volume of admirable anatomical drawings, by the incomparable LEONARDO DE VINCI, which is preserved in his majesty's library.

<sup>30</sup> This is the case also in the monstrous fossile *animal incognitum* of the Ohio (*mammut Obioticum*), which has been called the carnivorous elephant. See the 2d part of "*Delineations of Subjects relating to Natural History*, tab. 19.

<sup>31</sup> I say, "several;" because in some, as the *marmot*, the whole crown is covered with enamel.

<sup>32</sup> For the internal structure of the molar teeth of *pecora*, see HOLLMANN *de Ossibus Fossilibus*, in the *Commentar. Reg. Soc. Scient. Götting.* t. 2. p. 263. And SCHREGER, in ISENFLAMM and ROSENMULLER's "*Contributions towards Anatomy*," vol. I.

<sup>33</sup> The specifically different forms of the layers of enamel, in the *African* and *Asiatic elephants*, may be seen in the "*Delineations*," &c. part 2. tab. 19.

\* See note (S), at the end of the volume.



feed on grafs, and do not ruminare, as the *solidungula* and the *elephant*, the broad crowns of the grinding teeth lie chiefly in an horizontal direction towards each other. In most *pecora*, on the contrary, their surface, which forms a zig-zag line, is oblique; the outer margin of the upper teeth, and the inner margin of the lower teeth, being the most prominent. In most predacious animals, particularly of the lion and dog kind, the crowns of the molar teeth are compressed, and terminate in pointed processes, the lower ones shutting within the upper; so that in biting they intersect each other, like the blades of a pair of scissars, in consequence of the firm hinge-like articulation of the cylindrical condyle.

§ 28. Certain classes of the teeth are entirely wanting in some orders, classes, and genera of quadrupeds; as the upper front teeth in the *pecora*, the lower in the *elephant*, both in the *African rhinoceros*, and the canine in the *glires*. In other instances, the different descriptions of teeth, particularly the canine and molar, are separated by considerable intervals; this happens in the *horse* and *bear*. There is no animal, in which these parts are of such equal height, and such uniform arrangement as in man\*.

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\* See note (T), at the end of the chapter.



§ 29. The want of satisfactory observations<sup>34</sup>, prevents us from saying much on the change of the teeth, particularly in wild animals. Some erroneous opinions of former times, as, for instance, that the domesticated pig changes its teeth, and that the wild animal does not, hardly require an express contradiction in the present day. During the time of change in the *feræ*, particularly in the *dog* and *otter*, the number of their canine teeth often seems doubled; since the permanent ones cut the gum, before the deciduous have fallen out. Apes, like the human subject, have no bicuspides among the deciduous teeth: but there are, instead of these, two proper molares on either side of the jaw<sup>35</sup>. The change of the teeth takes place in the *elephant*, in a very remarkable manner. The new permanent tooth comes out behind the milk tooth<sup>36</sup>; the vertical layers of which are gradually removed<sup>37</sup>, as the formation of the latter advances<sup>38</sup> \*. There is, however,

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<sup>34</sup> See the detailed description of the change of the teeth in the horse, by TENON, "*Sur une Méthode particulière d'étudier l'Anatomie*, in the *Mem. de l'Institut National*, t. 1. p. 558.

<sup>35</sup> In the skull of a young *orang-outang* of Borneo, which I possess, through the kindness of Mr. VAN MARUM, there are no bicuspides.

<sup>36</sup> This is excellently seen in the cranium of a young *African elephant*, belonging to the museum of the Academy.

<sup>37</sup> See Prof. BRUGMAN'S remarks on this subject, in VAN MAANEN, *Dis. de Absorptione Solidorum*. Lugd. Bat. 1794.

\* See note (U), at the end of the chapter.

<sup>38</sup> I have given a drawing in the Petersburg Prize Dissertation



however, perhaps no animal of this class, in which the first appearance, and subsequent removal of the deciduous teeth take place, at so late a period of life as in man.

§ 30. The crown<sup>39</sup> of the tooth is gradually worn down by the act of mastication, and receives from this cause, a kind of polished surface, which is especially observable in the canine teeth of the *pig* and *hippopotamus*. The age of the horse is determined by the appearance of the front teeth.

§ 31. From the head of mammalia, we proceed to consider the trunk, according to its division into the three principal parts of *spine*, *pelvis*, and *chest*. The former of these is the most constant part of the skeleton; as it belongs to all red-blooded animals without exception, and is not found in a single white-blooded one.

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*sertation on Nutrition*, 1789, 4to. of the peculiar formation of these vertical layers in the molar teeth of the *elephant*, before they appear through the gum; and particularly of the manner, in which the enamel exudes from the bony substance in small moleculeæ.

<sup>39</sup> Hence it has been observed in the *glires*, that when the upper or lower pair of incisors is lost, the opposite teeth grow out to a monstrous length. A similar growth takes place, when these animals are confined to soft food. See MORTON'S *Natural History of Northamptonshire*, p. 445.; and ACHARD'S *Chymico-physical Writings*, p. 161. (See note (Q), at the end of the chapter).



§ 32. It is remarkable, that the animals of this class constantly agree in the number of their cervical vertebræ. The *giraffe*, or the *horse*, have neither more nor fewer than the *mole* or *ant-eater*. They are always seven, as in the human subject. An unexpected irregularity has been discovered by CUVIER in the *three-toed sloth*; it has nine vertebræ of the neck. In some *cetacea*, on the contrary, there are only six \*; and, in these animals, four or five are generally consolidated together. The *atlas* is distinguished in the *feræ* by its immense strength, and by the vast size of its tranverse processes<sup>40</sup>: the vert. dentata is equally conspicuous for its spinous process †.

§ 33. The number of dorsal vertebræ is determined by that of the ribs, which will be spoken of presently. In the long-necked quadrupeds, as the *horse*, *giraffe*, *camel*, and other *pecora*, as well as in those animals whose head is very heavy, as the *elephant*, the spinous processes of the anterior dorsal vertebræ are exceedingly long, for the attachment of the great suspensory ligament of the neck (*ligamentum nuchæ*).

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\* See note (V), at the end of the chapter.

<sup>40</sup> The connection which this structure has with the teeth and jaws of these rapacious animals, is pointed out by Eustachius, *De Dentibus*, p. 86.

† See note (W), at the end of the chapter.



§ 34. The lumbar vertebræ vary much in number. The *elephant* has only three; the *camel* seven. Some *quadrumana*, as the *mandrill*, have the latter number. The *horse* has six; the *ass* five. (*Mules* have generally six, but sometimes only five.) Most quadrupeds have the processes of these vertebræ turned forwards (which is upwards<sup>41</sup> in the *ape*, in its ordinary position). The tranverse processes are remarkably large in many *ruminantia*, as also in the *bare*.

§ 35. The form and proportions of the *sacrum* are still more various. The number of its vertebræ, as they are called, varies in the different species of the same genus. Thus, in most<sup>42</sup> of the *simiæ*, it consists of three pieces; in the \* *orang-outang* of four<sup>43</sup>; in the *chimpanse*<sup>44</sup> of five. This bone is distinguished in the *horse* by large lateral processes at its anterior extremity; and in the *mole*

<sup>41</sup> GALEN, in his *Osteology*, describes the tranverse processes as having this direction; from which circumstance, as well as from his description of the *sacrum* and *os coccygis*, and several other passages, VESALIUS shewed that the work was drawn up from the examination of apes, not of the human subject. See his *Epistola rationem modumque propinandi radicis chynæ decocti pertrahans*, 1546. p. 49.

<sup>42</sup> VESALIUS *de Corp. Hum. Fabricâ*, p. 99.

<sup>43</sup> CAMPER states, that the *sacrum* of this animal has three pieces: in my specimen, however, there are manifestly four.

<sup>44</sup> TYSON'S *Anatomy of a Pigmy*, edition of 1751, p. 89.

\* See note (X), at the end of the chapter.



by a thin sharp edged plate, formed by the union of its spinous processes\*. As the *cetacea* have no pelvis, they cannot be said to possess a sacrum.

§ 36. The os coccygis is prolonged, so as to form the tail of quadrupeds; and consists therefore, in many cases, of a great number of vertebræ. In the *cercopithecus morta* there are 22; in the *cerc. paniscus* 32; in the *two-toed ant-eater* 41<sup>45</sup>. (See note (Y), at the end of the chapter.)

§ 37. The ossa innominata, together with the sacrum, constitute the pelvis<sup>46</sup>. There is ground for affirming, although the assertion may appear paradoxical, that no animal but man has a pelvis; for in no instance have the bones of this part that bason-like appearance, when united, which belongs

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\* A somewhat similar structure is found in the *armadillo*; in which animal, the whole pelvis has a very anomalous formation. Its skeleton, which is altogether very curious, is accurately described by WIEDEMANN, in his "*Archives of Zoology and Zootomy*," 1 vol. p. 106. There is also a delineation of the skeleton of an armadillo, prefixed to the 8th chapter of CHESELDEN'S *Osteography*.

<sup>45</sup> When an opossum or monkey loses a portion of the tail, (an accident which has often led to confusion in determining the species) a peculiar knotty excrescence, sometimes of a carious appearance, takes place at the truncated extremity.

<sup>46</sup> B. G. SCHREGER, *Pelvis Anim. Brutorum cum Humanâ Comparatio*. Lips. 1787. 4to. AUTENRIETH ET FISCHER, *Observations de Pelvi Mammalium*. Tubing. 1798-9.



to the human subject. Those *apes*, which most nearly resemble man, have the *ossa innominata* much elongated; and in the *elephant*, *horse*, &c. the length of the *symphysis pubis* detracts from the resemblance to a basin. In some instances, as in the *beaver* and *kangaroo*, the *ossa pubis* are not united by *synchondrosis*, but consolidated into one piece by a bony union\*. They are, on the contrary, separate in the *ant-eaters*, in the same manner as they are found in birds. The cavity of the pelvis is so narrow in the *mole*, that it cannot hold the organs of generation and neighbouring viscera, which lie therefore externally to the *ossa pubis*. In the *kangaroo*<sup>47</sup>, and other *marsupial*<sup>48</sup> animals, the superior, or rather the anterior margin of the *ossa pubis*, is furnished with a peculiar pair of small bones, (*ossa marsupialia*, or *cornua pelvis abdominalia*) somewhat diverging from each other, and running towards the abdomen. They have an elongated and flattened form, and belong exclusively to these animals. But in the *Philos. Transf.* of 1802, it is

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<sup>47</sup> E. HOME, *On the Mode of Generation of the Kangaroo*. *Philos. Transact.* 1795.

<sup>48</sup> DAUBENTON, vol. 10. tab. 51. (I refer here, and in other places, where a similar quotation occurs, to the original 4to. edition of Buffon's work. It cannot, with propriety, be quoted under the name of Buffon, since it is well known, that the zootomical part was furnished by Daubenton, and has been omitted in most of the subsequent editions.)

\* See note (Z), at the end of the chapter.



stated by Mr. Home, that the ornithorhynchus has something of this kind. They support the abdominal pouch in the female, but are also found in the male; at least in some species<sup>49</sup>. Cetaceous animals have no hind feet, nor ossa innominata, consequently no pelvis: they have, however, a pair of small bones at the lower part of the belly, which may be compared to the ossa pubis<sup>50</sup>.

§ 38. The thorax in most, if not all animals of the class mammalia, is narrower, and on the contrary, deeper from the spine to the sternum, than in man. The less marked flexure of the ribs of animals, and the elongation of their sternum give rise to this peculiarity. The long legged animals, as the *giraffe*, and those of the stag kind, possess this keel-

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<sup>49</sup> This is one of those instances, illustrating the subject of the *nisus formativus*, which occur so abundantly in zootomy. It shews, in the function of generation, an union of the *teleological* and *mechanical* principles, which were formerly thought to be incompatible with each other. The formation of this anomalous pair of bones, for the purpose of supporting the abdominal pouch of the female, is a clear instance of the teleological principle, that is, it shews a peculiar part, formed for a certain purpose. Their existence in the male, where the end and purpose of their formation do not exist, shews the mechanical principle; as if they had been merely framed, in compliance with some general model, for the structure of the species.

<sup>50</sup> RONDELET, *De Piscibus*, p. 461. TYSON'S *Anatomy of a Porpoise*. London, 1680, p. 28.

like



like form of the chest (*thorax carinatus*) in the most striking degree.

§ 39. In a very few mammalia, as some *bats* and *armadillos*, there is a pair of ribs less than in man; but in the greater number of this class there are more. Several *quadrumana* have 14 pairs; the *horse* 18; the *elephant* 19<sup>51</sup>; the two-toed sloth (*bradypus didactylus*) 23. The two-toed ant-eater (*myrmecophaga didactyla*) has 16 pairs, which are remarkably broad, so that the back and sides of the skeleton, as low as the *ossa innominata*, appear like a coat of mail. (See note (A a) at the end of the chapter).

§ 40. The sternum in most of the mammalia is cylindrical, and jointed. This structure occurs even in the *quadrumana* and the *bears*, whose skeletons, in other respects, resemble the human. The form of this bone is the most singular in the mole; where its anterior<sup>52</sup> extremity is prolonged into a process,

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<sup>51</sup> This at least is the case in the skeleton of the Asiatic elephant at CASSEL. BLAIR found the same number in the individuals of which he has given so excellent an account; and a manuscript Italian description of the elephant, which died at FLORENCE in 1657, confirms this statement. ALLEN MOULINS on the contrary (in his *Anatomical Account of the Elephant burned in Dublin*. London, 1682, 4to) and DAUBENTON represent the number of pairs as 20.

<sup>52</sup> It is hardly necessary to remind the readers, that the terms



process, almost resembling a ploughshare, lying under the cervical vertebræ, and parallel with them. (See the note (B b) at the end of the chapter.)

§ 41. We proceed to speak of the extremities, as they are called, which, although they vary considerably in the class of mammalia, may, on the whole, be compared to those of man in their chief component parts, and in the mode<sup>53</sup> in which these are connected together. (See note (C c) at the end of the chapter).

§ 42. The clavicle has been said, even by some

terms *anterior*, *posterior*, *superior*, and *inferior* are always applied to quadrupeds with a reference to the horizontal position of their body. Consequently the term *anterior* designates those parts, which, in the erect position of the human body, are *superior*; and so of the others.

<sup>53</sup> The passages of ARISTOTLE, *Hist. Anim.* 2. 1. and *de Incessu Anim.* c. 11. and one of PLINY ii. 102. have given rise to the singular mistake of supposing that the elbow and knee of quadrupeds are bent in a direction exactly opposite to that of the human subject. The error must have arisen from the shortness of the thigh and arm bones, which lie close to the trunk, particularly in long-legged quadrupeds, and do not project freely as in man, the *quadrumana*, the *bear*, the *elephant*, &c. Hence the different bones of the extremities in these animals, have been compared to such parts in the human body as do not in reality correspond with them. See on this subject FAB. AB AQUAPEND, *de motu locali animalium secundum totum*, in his *Oper. Anat.* p. 343, ALBINUS's ed. and BARTHEZ *des mouvemens progressifs de l'Homme* in the *Journal des Sçavans*, January 1783. p. 34.

excellent



excellent modern zoologists, to be confined to LINNÆUS's order *primates* (in which he includes *man*, the *quadrumanous animals*, and *bats*): but it exists in a great number of *mammalia*<sup>54</sup> besides these: particularly in such quadrupeds, as make much use of their front extremities; either for holding objects, as the *squirrel* and *beaver*; or for digging, as the *mole*; or for raking the ground, as the *ant-eater* and *hedgehog*<sup>55</sup>; or for climbing, as the *stoat*. Many other animals have, in its place, an analogous small bone, merely connected to the muscles<sup>56</sup>, and called by VICQ-D'AZYR *os clavicolare* to distinguish it from the more perfect clavicles. This is the case with most of the *feræ*<sup>57</sup>, and some *glires*. Lastly, the form and relative magnitude of the true articulated clavicles are subject to great variety. They are excessively long in the *bats*. Those of the *orang-outang* have the greatest resemblance to the human subject. In the *two-toed*

<sup>54</sup> J. G. HAASE, *Comparatio clavic. Anim. brut. cum humanis*. Lips. 1766, 4to. VICQ-D'AZYR *sur les clavicules and les os clavic*, in *Mem. de P Acad. des Sciences*, 1785.

<sup>55</sup> The use of the clavicles in some of the animals here enumerated is well pointed out by FAB. HILDANUS in his "*Short Description of the excellence of Anatomy*." Bern. 1624-8. p. 219.

<sup>56</sup> Hence SERAE compares it to the sesamoid bones. See his "*Works relating to Natural History*." Naples, 1766, 4to. p. 84.

<sup>57</sup> PALLAS *Specilegia Zoologica*, Fasci. 14. p. 41.



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§ 44. The remarkable varieties of the anterior extremities, properly so called, may be most conveniently considered according to the orders and genera of animals of this class. The *bat* and the *mole* present the most wide deviations from the ordinary formation of these parts. The radius<sup>58</sup> is deficient in the fore-arm of the former; or at most there is only a slender sharp-pointed rudiment of this bone; their thumb is short, and furnished with a hook-like nail: the phalanges of the four fingers, between which the membrane of the wing is expanded, are on the contrary extremely long and thin, almost like the spines of a fish, and have no nails. The *flying squirrel* has a peculiar sharp-pointed bone at the outer edge of its carpus, connected to that part by means of two small round bones; and inclosed in the lateral expansion of the integuments. The form of the os humeri in the mole is altogether unparalleled; it is thin in the middle, and surprisngly expanded at either extremity. The shovel-like paw of this animal is provided with a peculiar *falciform bone*; lying at

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<sup>58</sup> I have seen a fossil preparation in the cabinet at NUREMBERG, which formerly belonged to HAGEN, consisting of three slender tubes articulated to each other length-wise, and supposed to be the petrified wing of a bird. From observing the simplicity and thinness of the middle tube, I should not hesitate in ascribing it to a large Asiatic bat.



the end of the radius. The phalanges of the fingers are furnished with numerous processes; and have moreover sesamoid bones; all which, by increasing the angle of insertion of the tendons, contributes to facilitate muscular motion. The animals with divided claws and hoofs have some peculiarities in the *metacarpus* and *metatarsus*. In the *pig* these parts consist of four cylindrical bones. In the *pecora* before birth, there are two lying close together; but they are afterwards formed into one by the absorption of the septum<sup>59</sup>. The *horse* has a single bone (*gamba*, VEGETIUS; in French *le canon*, in English the *cannon bone* or *shank bone*;) with a pair of much shorter and immoveable ones, attached to its posterior and lateral parts, and firmly united to it, (*les poinçons* or *os epineux*, *styloid* or *splint bones*). The main bone only is articulated to the *pastern*, which may be compared to the first phalanx of the human finger; as the *coffin bone* resembles in some degree the third<sup>60</sup> phalanx; which supports the nail. This last phalanx is very various in its form, according to corresponding variations in its horny coverings; which may consist of

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<sup>59</sup> J. B. COVOLO *De Metamorphosi duorum Ossium Pedis in Quadrupedibus aliquot*, BONON, 1765, 4to. and FOUGEROUX in the *Mem. de l' Acad. des Sc.* 1772, p. 520.

<sup>60</sup> See STUBBS's most excellent "*Anatomy of the Horse*." tab. 1.



a flat nail, or claw, or hoof, &c. (See note (E e) at the end of the chapter).

§ 45. I have something to say respecting the posterior extremities. The femur of most quadrupeds is much shorter than the tibia, and hence it hardly projects from the abdomen. In some few, as the *bear*, the femur is longer; this is also the case in some *apes*, viz. the *orang-outang*, in which, as in several other apes and baboons, the bones of the arm and fore-arm are surprisngly longer than those of the thigh and leg. Some, as the *elephant*, have no ligamentum teres; consequently there is no impresson made on the head of the thigh bone; while it is found in others, as the *rhinoceros*<sup>61</sup>. The *pecora* want the fibula almost universally. The peculiar form of the *astragalus* (*talus*), in the same order is generally known from the use which the ancients<sup>62</sup> made of the bone in their celebrated game. In some quadrumana, as the *orang outang*,

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<sup>61</sup> This apparently minute circumstance, like many similar ones, has assisted me in determining concerning the great fossile bones which are occasionally found.

<sup>62</sup> ARISTOTLE, *Hist. Anim.* l. 2. c. 1. For the various appellations of this well known bone in most of the European and Oriental languages; and for its form in different animals; see TH. HYDE, *Historia Talorum* in the 2d vol. of his *Syntagma Dissertationum*. Oxon. 1767, 4to. p. 310.



the two posterior phalanges of their toes are remarkably curved in their shape; which enables them to hold the branches of trees more firmly, and is in the same degree unfavourable to the performance of progression in an erect position. Cetaceous animals have no bones in their tail fins, but they have a bony compages in their thoracic fins, which completely resembles the front extremities of the seal<sup>63</sup>. See note (F f) at the end of the chapter.

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*Additional Notes to the Second Chapter.*

(A) The bones of the head, in birds, are joined either by the squamous kind of future; or by the mere apposition of their margins: which species of union is termed *harmonia*. But they are soon consolidated into a single piece.

(B) The sphenoid bone is often divided into two parts in the *quadrumana*; one of these forms the lesser alæ, and anterior clinoid processes; the

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<sup>63</sup> This is also the case with the manati (*walrus*) whose front extremities were formerly taken for Siren's hands, thus in BARTHOLIN *Histor. Anat.* Cent. 2. p. 188.



greater alæ, the posterior clinoid processes, and basilar fossa are formed by the other portion.

The two parietal bones form a single piece in the *bat-kind*. The same circumstance occurs in the *carnivora*, in the *pig*, *tapir*, *hippopotamus*, and *horse*.

The frontal and parietal bones of the *elephant* become consolidated, at an early period, with all the other parts of the cranium; so as to form a bony cavity, in which no trace of sutures can be discerned. The parietal, occipital, and temporal bones are likewise soon joined into one piece in the *cetacea*.

The *pig*, *hippopotamus*, *tapir*, *horse*, *seal*, *walrus*, and the *rodentia* have the os frontis divided by a middle future into two portions.

That portion of the os temporis, which contains the tympanum, is separated from the rest of the bone by a future, in the *dog*, *cat*, and *horse*; also in the *ruminantia* and *rodentia*. It is so completely separated in the *cetacea*, as to be attached to the cranium only by soft parts. In the *elephant*, where the other bones are consolidated into one piece, this remains distinct.

The cranium of the mammalia possesses the same fossæ at its basis, as are found in the human subject: they are however much shallower; and the eminences, which define them, are much less strongly marked than in man. This difference is very perceptible even in the *simiæ*, where the cavi-

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ties which hold the cerebellum, are nearly on a level with the middle fossæ of the basis cranii; and the sella turcica is more superficial. The same fact is more strongly marked as we arrive at those animals, whose general structure deviates more considerably from that of man. Those mammalia, which have the *occipital foramen* situated at the back of the head, must have the *fossæ cerebelli* moved upwards; hence that margin of the fossæ, which is posterior in man, passes across the upper part of the back of the head in these animals. The bony projections, which bound this fossa in some mammalia, are described in the chapter on the brain.

The optic foramina of the elephant commence from one canal, which receives the two optic nerves.

The foramen rotundum is sometimes absent, its place being supplied by the spheno-orbitary fissure, (*foramen lacerum*) e. g. in the *elephant* and *horse*. The foramen ovale is also frequently wanting; being included perhaps in the vacancy left between the petrous portion of the temporal bone, and the body of the sphenoid. This latter opening does not exist in the *genus simia*, nor in the *carnivorous mammalia*, nor in the *ruminantia*. It is on the contrary very large in the *elephant*, and in some *rodentia*.

The carotid canal does not exist in the *rodentia*; but the artery enters at the opening between the sphenoid and temporal bones.



The structure of the cranium presents a very remarkable singularity in the *elephant*. Its two tables are separated from each other to a considerable extent, by numerous bony processes; between which are formed a vast number of cells, communicating with the throat by means of the eustachian tube, and filled with air, instead of the bloody or medullary substance, which occupies the diplœ of animals. The use of this structure in increasing the surface for attachment of those large muscles, which belong to the lower jaw, proboscis and neck; and in augmenting the mechanical power of these muscles by removing their attachments to a greater distance from the centre of motion has been very ingeniously explained by CAMPER (*Œuvres*, tom. 2). These advantages are attained by the cellular structure, which we have just described, without augmenting the weight of the head, and this precaution is particularly necessary in the present instance, as the head is on other accounts more heavy and massy in this than in any other animal. The air cells of birds in general, and particularly those which pervade the cranium in the *ostrich*, *eagle*, and *owl* presents examples of a similar formation, attended with the same uses; viz. those of increasing the bulk and strength of the bone, and diminishing its weight.

(C) The *crista occipitalis* is a sharp and prominent bony ridge, projecting from the upper and back



back part of the cranium in mammalia, chiefly for the attachment of the temporal muscle.

The size of the temporal fossa, depends upon the magnitude of the muscle, which it contains. Hence it is larger in the *carnivora* than in any other order; not only occupying the whole sides and upper part of the cranium, but being still further increased by prominent bony *cristæ*, growing from the frontal, parietal, and occipital bones. The two temporal muscles are indeed separated in many of these animals, merely by the *parietal ridge*, which would completely cover the cranium.

These ridges are not so strongly marked in any animals, as in the *carnivora*: yet they are discernible in most of the *simiæ*. They occur also in animals of the *pig kind*, and in the other *pachydermata*.

The occipital crista is found where the others do not exist; as it serves for the attachment of the muscles of the neck.

(D) The variations in the situation of the occipital foramen are important, when viewed in connection with the ordinary position of the animal's body. In man, who is designed to hold his body erect, this opening is nearly equi-distant from the anterior and posterior extremities of the skull. The head therefore is supported in a state of equilibrium on the vertebral column. The angle, formed by the two lines mentioned by DAUBENTON, is only of three degrees.



Quadrupeds, which go on all-fours, have the occipital foramen and condyles situated farther back, in proportion as the face is elongated. That opening, instead of being nearly parallel to the horizon, forms a considerable angle with it; which, measured, according to DAUBENTON, is of 90 degrees in the *horse*. The weight of the head in these animals, is not therefore sustained by the spine; but by a ligament of immense strength, which is either entirely deficient, or so weak, as to have its existence disputed in the human subject. This *ligamentum nuchæ*, or *cervical ligament*, arises from the spines of the dorsal and cervical vertebræ, (which are remarkably long for that purpose) and is fixed to the middle and posterior part of the occipital bone. It is of great size and strength in all quadrupeds, but most particularly in the *elephant*; where the vast weight of the head, so much increased by the enormous size of the tusks, sufficiently accounts for its increased magnitude. It is bony in the mole, probably on account of the use, which the animal makes of its head, in disengaging and throwing up the earth.

Animals of the genus *simia* and *lemur* hold a middle rank between man, who is constantly erect, and quadrupeds, whose body is supported by four extremities. Their structure is by no means calculated, like that of man, for the constant maintenance of the erect posture; but they can support it with greater facility, and for a longer time than other animals. Hence, in the *orang-outang*, the  
occipital



occipital foramen is only twice as far from the jaws as from the back of the head, so that DAUBENTON'S angle is only of  $37^{\circ}$ . It is somewhat larger in the other species of *simia*; and measures  $47^{\circ}$  in the *lemur*.

(E) The two organs, which occupy most of the face, are those of smelling and tasting (including those of mastication, &c.). In proportion, as these parts are more developed, the size of the face, compared to that of the cranium, is augmented. On the contrary, when the brain is large, the volume of the cranium is increased in proportion to that of the face. A large cranium and small face indicate therefore a large brain, with inconsiderable organs of smelling, tasting, masticating, &c.; while a small cranium, with a large face, shew that these proportions are reversed.

The nature and character of each animal must depend considerably on the relative energy of its different functions. The brain is the common centre of the nervous system. All our perceptions are conveyed to this part, as a *sensorium commune*: and this is the organ, by which the mind combines and compares these perceptions, and draws inferences from them; by which, in short, it reflects and thinks. We shall find, that animals partake in a greater degree of this latter faculty, or at least approach more nearly to it, in proportion as the mass of medullary substance, forming their brain, exceeds



that, which constitutes the rest of the nervous system; or, in other words, in proportion as the organ of the mind exceeds those of the senses. Since then, the relative proportions of the cranium and face, indicate also those of the brain, and the two principal external organs, we shall not be surprized to find, that they point out to us, in great measure, the general character of animals; the degree of instinct and docility which they possess. Man combines by far the largest cranium, with the smallest face; and animals deviate from these relations, in proportion as they increase in stupidity and ferocity.

One of the most simple methods (though sometimes indeed insufficient), of expressing the relative proportions of these parts, is by means of the facial line, which has been already described. This angle is most open, or approaches most nearly to a right angle in the human subject; it becomes constantly more acute, as we descend in the scale, from man; and in several birds, reptiles, and fishes, it is lost altogether, as the cranium and face, are completely on a level. The idea of stupidity is associated, even by the vulgar, with the elongation of the snout: hence the *crane* and *snipe* have become proverbial. On the contrary, when the facial line is elevated by any cause, which does not increase the capacity of the cranium, as in the *elephant* and *owl*, by the cells, which separate the two tables, the animal acquires a particular air of intelligence, and gains the

credit



credit of qualities, which he does not in reality possess. Hence the latter animal has been selected as the emblem of the goddess of wisdom. The invaluable remains of Grecian art shew, that the ancients were well acquainted with these circumstances: they were aware, that an elevated facial line formed one of the grand characters of beauty; and indicated a noble and generous nature. Hence they have extended the facial angle to 90 degrees in the representation of men, on whom they wished to bestow an august character. And in the representations of their gods and heroes, they have even carried it beyond a right angle, and made it 100°.

It must, however, be allowed, that the facial angle is of chief importance in its application to the cranium of the human subject, and of the *quadrumana*; as various circumstances affect the conclusions, which would result from employing it in other classes of mammalia. Thus in the *carnivorous*, and some of the *ruminating* animals; in the *pig*, and particularly in the *elephant*, the great size of the frontal sinuses produces an undue elevation of the facial line. In many of the *rodentia*, as the *hare*, &c., the nose occupies so large a space, that the cranium is thrown quite back, and presents no point on a front view, from which this time can be drawn.

The following are the angles formed, by drawing a line along the floor of the nostrils, and intersecting it by another, which touches the anterior margin  
of



of the upper alveoli, and the convexity of the cranium (whether the latter point be concealed by the face, or no).

European infant	-	90°
———— adult	-	85
Adult negro	-	70
Orang-outang	-	67
Long-tailed monkeys	-	65
Baboons	-	40 to 30
Pole-cat	-	31
Pug dog	-	35
Mastiff; the line passing along the outer surface of the skull		41
D° inner d°	-	30
Leopard; inner surface		28
Hare	-	30
Ram	-	30
Horse	-	23
Porpoise	-	25

In the 3d and 4th tables of CUVIER's *Tableau Elementaire de l'Histoire Naturelle*, the crania of several mammalia are represented in profile; so as to afford a sufficient general notion of the varieties in the facial angle. A similar comparative view, in one plate, is given by WHITE, in his account of the *Regular Gradation*, &c. from the work of CAMPER.

A vertical section of the head, in the longitudinal direction, shews us more completely the relative proportions of the cranium and face. In the *European*, the area of the section of the cranium is  
four



four times as large as that of the face; the lower jaw not being included. The proportion of the face is somewhat larger in the *negro*: and it increases again in the *orang-outang*. The area of the cranium is about double that of the face in the *monkeys*: in the *baboons*, and in most of the *carnivorous mammalia*, the two parts are nearly equal. The face exceeds the cranium in most of the other classes. Among the *rodentia*, the *hare* and *marmot* have it one-third larger; in the *porcupine*, and the *ruminantia*, the area of the face is about double that of the cranium; nearly triple in the *hippopotamus*; and almost four times as large in the *horse*. In reptiles and fishes, the cranium forms a very inconsiderable portion of the section of the head; although it is considerably larger than the brain, which it contains.

The outline of the face, when viewed in such a section, as we have just mentioned, forms in the human subject a triangle; the longest side of which is the line of junction between the cranium and face. This extends obliquely backwards and downwards, from the root of the nose, towards the foramen occipitale. The front of the face, or the anterior line of the triangle, is the shortest of the three. The face is so much elongated, even in the *simiæ*, that the line of junction of the cranium and face is the shortest side of the triangle; and the anterior one the longest. These proportions become still more considerable in other mammalia.

(F) The



(F) The want of the *os intermaxillare* has been regarded as a chief characteristic of the human subject; as one of the leading circumstances, which distinguish man from other mammalia. That this bone is really wanting in man must be allowed, notwithstanding the doubts of VICQ D'AZYR. The well-known transverse slit, behind the alveoli of the incisors in the human foetus, would form a very slight and remote analogy between the human structure, and that of animals: and, when we consider, that the superior or facial surface of the maxillary bones, so far from being marked by any future, does not even bear a slit like that of the inferior part, it must be put entirely out of the question.

That all other mammalia possess this bone, is not quite so clear, as that man has it not. The exceptions occur in the quadrumana. In addition to those which the author has stated, it may be observed, that the head of an *orang-outang*, in the HUNTERIAN MUSEUM, which possesses all the other futures, wants those, which separate the intermaxillary bone: that TYSON did not find this bone in his specimen of the animal, which was very young, (see his *Anatomy of the Pigmy*) and that it did not exist in a cranium, which was delineated by DAUBENTON. I have also seen the crania of other monkeys, where the other futures were all perfect and distinct, which did not possess this bone.

(G). The zygoma is wanting in the *ant-eater*; where



where the temporal and molar bones have only a slight projection instead of the usual zygomatic process. This circumstance is sufficiently explained by the want of teeth, and the consequent want of mastication. The zygomatic future is so oblique in the *carnivora*, that the temporal bone forms the whole superior margin; and the os malæ, the inferior edge of the zygoma.

The zygoma may be arched both in the vertical and horizontal directions. A curvature of the latter kind indicates the existence of a strong temporal muscle; while one of the former description shews that the masseter is large. Both these curvatures are considerable in the *carnivora*.

(H) The interval between the orbits is always smaller in the simiæ than in the human subject. In several of these, as in the monkeys, properly so called, the two orbits are separated at their posterior part by a simple bony septum. In other mammalia, these cavities are thrown towards the side of the head, and to a great distance from each other, by the ascending or nasal processes of the upper jaw-bones, which are very large.

In those mammalia, which have the orbit open at its outer and back part, so as to communicate with the temporal fossa, (such as the *carnivora*, *rodentia*, *edentata*, and *pachydermata*) the os malæ merely contributes to the formation of the zygoma, without being connected to the frontal or sphenoid bones.



bones. The superior maxilla merely forms the anterior border of the cavity, without constituting the floor of the orbit, which is indeed open below. The ossa palati, which are large, form a considerable share of the inner part of the cavity; the ethmoid bone not contributing to it.

The *ruminating animals*, as well as the *horse* and *ass*, have the 'margin of the orbit completed at its outer part by a bony circle, although the cavity is open behind to the temporal fossa.

The *mole* has not, properly speaking, an orbit. Its diminutive eyes, the very existence of which, was for a long time questioned, lie under the integuments. BLUMENBACH'S *Description of the Bones*, in German, p. 225. note. The same observation holds good of the *myrmecophaga didactyla*. Ibid.

(1) The word *horn*, which is frequently applied in English to the *antlers* of the deer kind, as well as to the real horns of other genera, would lead to a very erroneous notion on this subject. The *antler* is a real *bone*; it is formed in the same manner, and consists of the same elements as other bones; its structure is also the same.

It adheres to the frontal bone by its basis; and the substance of the two parts being consolidated together, no distinction can be traced, when the antler is completely organized. But the skin of the forehead terminates at its basis, which is marked by an irregular projecting bony circle; and there is neither skin nor periosteum on the rest of it.

The



The time of its remaining on the head is one year : as the period of its fall approaches, a reddish mark of separation is observed between the process of the frontal bone, and the antler. This becomes more and more distinctly marked, until the connection is entirely destroyed.

The skin of the forehead extends over the process of the frontal bone, when the antler has fallen : at the period of its regeneration, a tubercle arises from this process, and takes the form of the future antler, being still covered by a prolongation of the skin. The structure of the part at this time is soft and cartilaginous ; it is immediately invested by a true periosteum, containing large and numerous vessels, which penetrate the cartilage in every direction, and by the gradual deposition of ossific matter, convert it into a perfect bone.

The vessels pass through openings in the projecting bony circle at the base of the antler : the formation of this part, proceeding in the same ratio with that of the rest, these openings are contracted, and the vessels are thereby pressed, until a complete obstruction ensues. The skin and periosteum then perish, become dry and fall off ; the surface of the antler remaining uncovered. At the stated period it falls off, to be again produced, always increasing in size.

(K) As the motions of the lower jaw must be materially influenced by the form of its condyle,  
and



and by the manner in which that process is connected to the articular cavity of the temporal bone; we shall find, as might have been expected, a close relation between these circumstances, and the kind of food, by which an animal is nourished. Thus the lower jaw of the carnivora can only move upwards and downwards, and is completely incapable of that horizontal motion, which constitutes genuine mastication. Hence these animals cut and tear their food in a rude and coarse manner, and swallow it in large portions, which are afterwards reduced by the solvent properties of the gastric juice. Such mammalia, on the contrary, as live on vegetables, have, in addition to this motion, a power of moving the lower jaw backwards and forwards, and to either side; so as to produce a grinding effect, which is necessary for bruising and triturating grass, and for pulverising and comminuting grains. In all these, therefore, the form of the condyle, and of its articular cavity, allows of free motion in almost every direction. The teeth may be compared, in the former case, to scissars; in the latter, to the stones of a mill.

(L) The teeth of the human subject seem to be designed for the single purpose of mastication; and hence an erroneous conclusion might be drawn, that they serve the same office in other animals. Many exceptions, however, must be made to this general rule. Some mammalia, which have teeth



for the office of mastication, have others, which can be only considered as weapons of offence and defence, viz. the *tusks* of the *elephant*, *hippopotamus*, *walrus*, and *manati*. The large and long canine teeth of the *carnivora*, as the *lion*, *tiger*, *dog*, *cat*, &c. not only serve as natural weapons to the animal, but enable it to seize and hold its prey, and assist in the rude laceration which the food undergoes previous to deglutition. The *seal*, the *porpoise*, and other *cetacea*, as the *cachalot* (*physter macrocephalus*) have all the teeth of one and the same form; and that obviously not calculated for mastication. They can only assist in securing the prey, which forms the animal's food.

(M) Animals of the genus *balæna* (the proper whales) have, instead of teeth, the peculiar substance called *whalebone*, covering the palatine surface of the upper jaw: this resembles in its composition hair, horn, and such matters.

The lower surface of the upper jaw forms two inclined planes, which may be compared to the roof of a house reversed; but the two surfaces are concave. Both these are covered with plates of the whalebone, placed across the jaws, and descending vertically into the mouth. They are parallel to each other, and exist to the number of two or three hundred on each of the surfaces. They are connected to the bone by the intervention of a white ligamentous substance, from which they grow;

F

but



but their opposite edge, which is turned towards the cavity of the mouth, has its texture loosened into a kind of fringe, composed of long and slender fibres of the horny substance; which therefore covers the whole surface of the jaw. This structure probably serves the animal in retaining and confining the *mollusca*, which constitute its food.

The teeth of the *ornithorhynchus paradoxus* and *hystrix* deviate very considerably from those of other mammalia. In the former animal there is one on each side of the two jaws: it is oblong, flattened on its surface, and consists of a horny substance adhering to the gum. There are likewise two horny processes on the back of the tongue: these point forwards, and are supposed by Mr. Home to prevent the food from passing into the fauces, before it has been sufficiently masticated. In the *o. hystrix*, there are six transverse rows of pointed horny processes at the back of the palate; and about twenty similar horny teeth on the corresponding part of the tongue.

Mr. HOME in the *Philos. Transf.* 1800, part 2. 1802, parts 1 and 2.

(N) The substance composing these tusks, and commonly called ivory, is certainly different from the bone of other teeth. It is, generally speaking, more hard and compact in its texture. The ivory of the elephant's tusk is distinguished from all others by the curved lines, which pass in different directions



directions from the centre of the tooth, and form by their decussation, a very regular arrangement of curvilinear lozenges. It soon turns yellow from exposure to the air. The tusk of the hippopotamus is harder and whiter; and consequently preferred for the formation of artificial teeth. In the walrus, the interior of the tooth is composed of small round portions, placed irregularly in a substance of different appearance, like the pebbles in the pudding stone; and the molar teeth have a similar structure.

(O) The facts, which the author has here recounted, have been some times brought forwards in order to prove the vascularity of the teeth; a doctrine, which is refuted by every circumstance in the formation, structure, and diseases of these organs. It may be first observed, that the appearances exhibited by the teeth in question, are by no means what we should reasonably expect in such a case. When a bullet has entered the substance of the body, the surrounding lacerated and contused parts do not grow to the metal, and become firmly attached to its surface, but they inflame and suppurate in order to get rid of the offending matter. If the ivory be vascular and sensible, why do not the same processes take place in it?

We can explain very satisfactorily how a bullet may enter the tusk of an elephant, and become



imbedded in the ivory without any opening for its admission being perceptible. It will be shewn in a subsequent note, that these tusks are constantly growing during the animal's life, by a deposition of successive laminæ within the cavity, while the outer surface and the point are gradually worn away: and that the cavity is filled for this purpose with a vascular pulp, similar to that, on which teeth are originally formed. If a ball penetrate the side of a tusk, cross its cavity, and lodge in the slightest way on the opposite side, it will become covered towards the cavity by the newly deposited layers of ivory, while no opening will exist between it and the surface, to account for its entrance. If it have only sufficient force to enter, it will probably sink, by its own weight, between the pulp and tooth, until it rests at the bottom of the cavity. It there becomes surrounded by new layers of ivory; and as the tusk is gradually worn away, and supplied by new depositions, it will soon be found in the centre of the solid part of the tooth. Lastly, a foreign body may enter the tusk from above, as the plate of bone, which forms its socket is thin; if this descends to the lower part of the cavity, it may become imbedded by the subsequent formations of ivory. This must have happened in a case where a spear-head was found in an elephant's tooth. The long axis of the foreign body corresponded to that of the cavity. No opening for its admission could be discovered,  
and



and it is very clear, that no human strength could drive such a body through the side of a tusk. *Philos. Transf.* 1801. part 1.

(P) The *front teeth* are the *incisores*, or *cutting-teeth*; the *primores* of LINNÆUS. The *corner teeth* are the *canini*; *laniarii* of LINNÆUS; *cuspidati* of Mr. HUNTER. The *back teeth* are the MOLARES or grinders. The term of *tusks* is applied to such teeth as extend out of the cavity of the mouth.

(Q) The structure of the incisor teeth, in the rodentia, deserves attention on several accounts. They are covered by enamel only on their anterior or convex surface, and the same circumstance holds good with respect to the tusks of the hippopotamus. Hence as the bone wears down much faster than this harder covering, the end of the tooth always constitutes a sharp cutting edge, which renders it very deserving of the name of an incisor tooth.

This partial covering of enamel refutes, as BLAKE has observed (*Essay on the Structure, &c. of the Teeth*, p. 212), the opinion that the enamel is formed by the process of crystallization.

The incisor teeth of these animals are used in cutting and gnawing the harder vegetable substances; for which their above-mentioned sharp edge renders them particularly well adapted. Hence CUVIER has arranged these animals in a



particular order by the name of *rodentia*, or the gnawers. As this employment subjects the teeth to immense friction, and mechanical attrition, they wear away very rapidly, and would soon be consumed, if they did not possess a power of growth, by which this loss is recompenced.

These teeth, which are very deeply imbedded in the jaw, are hollow internally, just like a human tooth, which is not yet completely formed. Their cavity is filled with a vascular pulp, similar to that on which the bone of a tooth is formed; this makes a constant addition of new substance on the interior of the tooth, which advances to supply the part worn down. The covering of enamel extends over that part of the tooth, which is contained in the jaw, as we might naturally expect: for this must be protruded at some future period to supply the loss of the anterior portion. Although these teeth are very deeply implanted in the maxillary bones, they can hardly be said to possess a fang or root; for the form of the part is the same throughout; the covering of enamel is likewise continued; and that part, which at one period is contained in the jaw, and would form the fang, is afterwards protruded to constitute the body of the tooth.

The constant growth of these teeth therefore proceeds in the same manner, and is effected on the same principles as the original formation of any  
tooth;



tooth ; and can by no means furnish an argument for the existence of vessels in the substance of the part.

We cannot help being struck with the great size of these teeth, compared with the others of the same animal, or even with the bulk of the animal. Their length in the lower jaw nearly equals that of the jaw itself, although a small proportion only of this length appears through the gum. They represent the segment of a circle ; and are contained in a canal of the bone, which descends under the sockets of the grinders, and then mounts up, in some instances, to the root of the coronoid process : hence although their anterior cutting edge is in the front of the mouth, the posterior extremity is behind all the grinding teeth. No animal exhibits this structure better than the rat. The beaver also affords a good specimen of it on a larger scale. It has been drawn in this animal by BLAKE, (*Essay on the Structure, &c. of the Teeth*, tab. 9. fig. 3.) The tooth does not extend so far in the upper jaw ; it is there implanted in the intermaxillary bone, and terminates over the first grinder.

The observations which have been made respecting the constant growth of the incisor teeth of the *glires*, will apply also to the tusks of the *elephant*. These are hollow internally, through the greater part of their length, and the cavity contains a vascular pulp, which makes constant additions of suc-



cessive layers, as the tusk is worn down. One of the elephants at Exeter Change is said to have nearly bled to death from a fracture of the tusk, and consequent laceration of the vessels of the pulp. The tusks of the *hippopotamus*, and probably all other teeth of this description grow in the same manner. Farther and more accurate observation may hereafter shew, that the same mode of growth obtains also in other classes of teeth, when they are exposed to great friction. Something similar may certainly be observed in the grinders of the horse. The tooth is not finished when it cuts the gum: the lower part of its body is completed while the upper part is being worn away in mastication; and the proper fang is not added till long after. Hence we can never get one of these teeth in a perfect state, for if the part out of the gum is complete, the rest of the body is imperfect; and there are no fangs: on the contrary, when the fangs are formed, much of the body has been worn away in mastication. BLAKE also asserts that this structure is found in the grinders of the *beaver*, p. 99. tab. 9. fig. 4.

(R) This animal is found so constantly with only one tusk, that it has been called in common language, the *sea-unicorn*; and LINNÆUS has even given it a similar appellation, that of *monodon*. Yet there can be no doubt that it possesses originally two of these; one in either jaw bone: and that  
which



which is wanting, must have been lost by some accidental circumstance, as we can easily suppose, (SHAW'S *Zoology*, vol. ii. p. 473.) These tusks often equal in length that of the animal's body; which may be 18 feet or more: yet they are always slender.

(S) The distribution of the enamel, and bony substance, varies in the teeth of different animals, and even in the different orders of teeth in the same animal.

All the teeth of the *carnivora*, and the incisors of the *ruminating animals*, have the crown only covered with enamel, as in the human subject. The immense fossil grinders of the *animal incognitum* or *mammoth* have a similar distribution of this substance.

The grinders of graminivorous quadrupeds, and the incisors also of the horse have processes of enamel, descending into the substance of the tooth. These organs have also in the last-mentioned animals a third component part, differing in appearance from both the others, but resembling the bone more than the enamel. BLAKE has distinguished this by the name of *crusta petrosa*; and CUVIER calls it *cement*.

The physiological explanation of this difference in structure is a very easy and clear one. The food of the *carnivora* requires very little comminution before it enters the stomach: hence the form of  
their



their grinding teeth is by no means calculated for grinding; and as the articulation of the jaw admits no lateral motion, the molares, of which the lower are overlapped by the upper, can only act like the incisors of other animals. The food of graminivorous quadrupeds is subject to a long process of mastication, before it is exposed to the action of the stomach. The teeth of the animals suffer great attrition during this time, and would be worn down very rapidly but for the enamel, which is intermixed with their substance. As this part is harder than the other constituents of the teeth, it resists the attrition longer, and presents the appearance of prominent ridges on the worn surface, by which the grinding of the food is much facilitated.

The distinction of the three substances is seen better in the tooth of the elephant than in any animal. The best method of displaying it is by making a longitudinal vertical section, and polishing the cut surface. The *crusta petrosa* will then be distinguished by a greater yellowness and opacity in its colour; and by an uniformity in its appearance, as no laminæ or fibres can be distinguished.

The pulp of a grinding tooth of a graminivorous quadruped is divided into certain conical processes, which are united at their bases. These vary from two to six in the *horse* and *cow*. On these the bone of the tooth is formed, as on the single pulp of the  
human



human subject, but it is here divided into as many separate shells, as there are processes of the pulp: all of them however inclosed in a common capsule. The ossification commences, as in all teeth, on the points of the pulp, and extends towards the basis: when it has arrived there, the shells unite together; and they also join at their outer margins. Between the processes of the pulp other productions descend from the capsule in a contrary direction; and deposit, on the surface of the shells, enamel distinguishable by its crystalline appearance, and hence denominated by BLAKE *cortex striatus*. When these membranous productions have formed their portions of enamel, they secrete the *crusta petrosa* within the cavities left between these productions of enamel. The outer surface of the bone of the tooth is covered by enamel, which may be compared to that which invests the crown of a human tooth, except that it is deposited in an irregular waving line, in order to render the surface better calculated for grinding: and the inequalities of this surface of enamel are filled up by *crusta petrosa*. The exterior enamel, and *crusta petrosa*, (which may be so named, by way of distinguishing them from the processes within the tooth), are formed by the surface of the capsule.

If then we make a transverse section of a grinding tooth of the *horse* or *cow*, the exterior surface will be found to consist of an irregular layer of *crusta petrosa*: this is succeeded by a waving line  
of



of *enamel*, within which is the proper *bone of the tooth*. But the substance of the latter is penetrated by two productions of enamel; in the interior of each of which is *crusta petrosa*.

The *crusta petrosa* which fills these internal productions of enamel, is sometimes not completely deposited before the tooth cuts the gum: hence cavities are left in the centre of the tooth, which become filled with a dark substance composed of the animal's food, and other foreign matters. This seldom happens to any considerable extent in the grinders of the *horse*. In the *cow* and *sheep* these cavities are constantly filled with the dark adventitious matter; the *crusta petrosa* being confined to the exterior surface of the tooth, and not existing even there so plentifully as in the horse.

The lower grinders of the horse differ very much in their formation from those of the upper-jaw. Ossification commences in these by four or five points, which increase into as many small shells; yet they unite without any processes of the capsule passing down between to form internal productions of the enamel. This substance is however deposited in a very convoluted manner on the bone of the tooth, so that the same end is attained, as if productions of the cortex striatus had existed in the centre of the part. The *crusta petrosa* fills up the irregularities of this waving line of enamel. An horizontal section of such a tooth presents the three substances arranged within each other:



other: the *crusta petrosa* is external; then comes the enamel, which includes nothing but the proper bone of the tooth.

The incisors of the horse have a production of enamel in their centre; but the cavity, which this forms, containing no *crusta petrosa*, is merely filled by the particles of food, &c. As these processes of enamel descend only to a certain extent in the tooth, they disappear at last from the constant wear of the part in mastication. This is improperly called the filling up of the teeth; and hence a criterion arises of the horse's age.

The grinding teeth of the elephant contain the most complete intermixture of the three substances; and have a greater proportion of *crusta petrosa*, than those of any other animal. The pulp forms a number of broad flat processes, lying parallel to each other, and placed transversely between the inner and outer laminæ of the alveoli. The bone of the tooth is formed on these in separate shells, commencing at their loose extremities, and extending towards the basis, where they are connected together. The capsule sends an equal number of membranous productions; which first cover the bony shells with enamel, and then invests them with *crusta petrosa*; which latter substance unites and consolidates the different portions. The bony shells vary in number from four to twenty-three, according to the size of the tooth, and the age of the animal: they have been described under the term of *denticuli*, and have  
been



been represented as separate teeth in the first instance. It must however be remembered that they are formed on processes of one single pulp.

When the *crusta petrosa* is completely deposited, the different denticuli are consolidated together. The bony shells are united at their base to the neighbouring ones; the investments of enamel are joined in like manner: and the intervals are filled with the third substance, which really deserves the name bestowed on it by CUVIER, of *cement*. The pulp is then elongated for the purpose of forming the roots or fangs of the tooth. From the peculiar mode of dentition of this animal, which will be explained in a subsequent note, the front portion of the tooth has cut the gum, and is employed in mastication, before the back part is completely formed, even before some of the posterior denticuli have been consolidated. The back of the tooth does not appear in the mouth until the anterior part has been worn down even to the fang.

A horizontal section of the elephant's tooth presents a series of narrow bands of bone of the tooth, surrounded by corresponding portions of enamel. Between these are portions of *crusta petrosa*; and the whole circumference of the section is composed of a thick layer of the same substance.

A vertical section in the longitudinal direction exhibits the processes of bone, upon the different denticuli, running up from the fangs; a vertical layer of enamel is placed before, and another behind each



each of these. If the tooth is not yet worn by mastication, the two layers of enamel are continuous at the part, where the bone terminates in a point; and the front layer of one denticulus is continuous with the back layer of the succeeding one, at the root of the tooth; so that the enamel, ascending on the anterior, and descending on the posterior surface of each denticulus, forms a continued line through the whole tooth. *Crusta petrosa* intervenes between the ascending and descending portions of the enamel.

As the surface of the tooth is worn down in mastication, the processes of enamel, resisting by their superior hardness, form prominent ridges on the grinding surface; which must adapt it excellently for bruising and comminuting any hard substance.

The grinding bases, when worn sufficiently to expose the enamel, present a very different appearance in the *Asiatic* and *African* elephants. The processes of enamel, in the former species, represent flattened ovals, placed across the tooth. In the latter, they form a series of lozenges, which touch each other in the middle of the tooth.

It does not appear, that *crusta petrosa* is an essential part in the grinders of graminivorous animals. For those of the *rhinoceros* do not possess it, although the enamel descends into their substance, and forms a cavity, which is filled with the food, &c.

HOME and BLAKE likewise state, that it does not exist in the *hippopotamus*, where there are internal



productions of enamel: but Mr. MACARTNEY, the learned and ingenious lecturer on comparative anatomy at St. Bartholomew's Hospital, has found it in small quantity on the exterior surface of the tooth, near its root.

Mr. CORSE's *Observations on the different Species of Asiatic Elephants*. Philos. Transf. 1799, part 2.

*Some Observations on the Teeth of graminivorous Quadrupeds*, by E. HOME, Esq. Ibid. With Delineations of the Teeth of the *Elephant, Horse, Cow, Sheep, Hippopotamus*, and *Rhinoceros*.

BLAKE's *Essay on the Structure and Formation of the Teeth in Man, and various Animals*, with plates.

TENON *sur une Methode particuliere d'etudier l'Anatomie*, in the *Memoires de l'Institut National*, tome 1, an. 6.

CUVIER, *Léçons d'Anatomie comparée*, tome 3.

(T) All the three kinds of teeth are found in the *quadrumana*, the *carnivora*, the *pachydermata* (excepting the *two horned rhinoceros* and *elephant*), the *horse*, and those *ruminating animals*, which have no horns.

CUVIER states, that the teeth of an animal, whose bones are found in a fossile state, resemble those of man, in being arranged in a continued and unbroken series.

In the *simia*, *carnivora*, and all such as have canines longer than the other teeth, there is at least  
one



one vacancy in each jaw, for lodging the *cuspidatus* of the opposite jaw. There is a vacancy behind each canine in the *bear*.

The horned ruminating animals not only want entirely the *upper incisors*, but they are also destitute of *cuspidati*, except the *stag*, which has rudiments of these teeth; and the musk (*moschus moschifer*) where they are very long, and curved in the upper jaw.

Between the incisors and grinders of the *horse*, a very large vacancy is left, in the middle of which a small *canine tooth*, termed the *tush*, is found in the male animal; but very rarely in the female.

The elephant has *grinders* and two *tusks* in the upper jaw; but the former only in the lower. The immense tusks belong properly to the male animal; as they are so small in the female, generally speaking, as not to pass the margin of the lip. (CORSE in *Phil. Transf.* 1799, part 2. p. 208.)

The *sloths* have grinding and canine teeth, without incisors. The *dolphin* and *porpoise* have small conical teeth, all of one size and shape, arranged in a continued line throughout the alveolar margin of both jaws. The *cachalot* (*Physeter macrocephalus*) has these in the lower jaw only. The teeth of the *seal* are all of one form, viz. that of the canine kind; conical and pointed.

The *narwhal* has no other teeth than the two long tusks implanted in its os intermaxillare; of which one is so frequently wanting. A head, in which  
there



there are two of these tusks, is delineated by Dr. SHAW, in his Zoology, from a specimen in the Leverian Museum. These tusks are remarkable for the spirally convoluted appearance of their external surface. They are hollow internally, and probably have a constant growth like the elephant's tusks.

(U) The permanent teeth are generally formed in cavities near the roots of the temporary ones; and they succeed to the vacancies left by the discharge of the latter.

A different mode of succession obtains, however, in some instances. The adult molares of the human subject are not formed near any of the temporary teeth; but in the back of the two jaws; from which situation they advance successively towards the front, in proportion as the maxillary bones are lengthened in that direction. A similar, but much more remarkable species of succession is observed in the *grinders* of the *elephant*, where it was ascertained by the labours of Mr. CORSE, who has explained and illustrated the subject, in a series of beautiful engravings. See *Observations on the different Species of Asiatic Elephants, and their Mode of Dentition*. Phil. Transf. 1799, part 2.

We never see more than one grinder, and part of another, through the gum in this animal. The anterior one is gradually worn away by mastication; its fangs and alveolus are then absorbed: the posterior



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cessively perfected. But the posterior layers of the tooth are not employed in mastication, until the anterior ones have been worn down to the very fang, which begins to be absorbed. One of these grinders can never therefore be procured in a perfect state: for if its anterior part has not been at all worn, the back is not completely formed, and the fangs in particular are wanting; while the structure of the back of the tooth is not completed, until the anterior portion has disappeared.

A similar kind of succession, but to a less extent, has been ascertained by Mr. HOME, in the teeth of the *Jus Æthiopicus*.

*Observations on the Structure of the Teeth of Graminivorous Quadrupeds; particularly those of the Elephant, and Jus Æthiopicus.* Phil. Trans. 1799, part 2.

The researches of the same gentleman have also proved it to exist in the *wild boar* to a certain degree; and have rendered it probable, that it occurred likewise in the *animal incognitum* (*mammoth*).

*Observations on the Structure and Mode of Growth of the Wild Boar, and Animal Incognitum.* Phil. Trans. 1801, part 2.

(V) The numbers of cervical vertebræ is the same in the *cetacea*, as in other mammalia, according to CUVIER; but some of them are anchylosed. Thus the two first are united in the *dolphin* and *porpoise*;



*porpoise*; and the six last in the genus *physter*.  
*Léçons d'Anat. Comp.* tome 1, p. 154.

It must be accounted a singular circumstance, that the number of cervical vertebræ should be so constantly the same in animals, whose neck differs so much in length; when the number of pieces in the other regions of the spine, varies greatly in the different genera. No instance has, I believe, been recorded, in which more than seven cervical vertebræ have been found in the human subject; although the number of those in the back and loins sometimes deviates from the natural standard.

(W) These processes, which are particularly conspicuous in such carnivorous animals, as have great strength in their neck, afford attachment to the large and powerful muscles, by which the animal executes those strong and rapid motions of the head, which are necessary in attacking its prey, or defending itself. The *badger*, in this country, affords an excellent specimen of the structure alluded to.

The *mole* and *shrew* have no spinous processes in the neck. The vertebræ form simple rings, with considerable motion on each other. These processes are either very short, or altogether deficient in the long necked animals; as the *horse*, *camel*, *giraffe*, &c. They would otherwise afford an obstacle to the bending of the neck backwards.

The six last vertebræ of the neck are anchylosed in the *ant-eater* and *manis*.



(X) Most of the *simiæ*, and even some, which very much resemble the human subject, as the *orang-outang*, which CAMPER dissected, (*simia pygmaeus*), have the sacrum formed of three pieces; which consequently leave only two pair of openings for the passage of the nerves. Now, as GALEN mentions these circumstances of the human sacrum, in his work on the bones, it must appear very clearly that the description could not have been taken from the human subject; but was probably derived, as VESALIUS supposed, from the *ape*; although SILVIUS and EUSTACHIUS have endeavoured to invalidate this conclusion. See VESAL. *Epist. de rad. Chynæ*; also his great work, *De Corp. hum. Fabricâ*, p. 99.

The true *orang-outang* (*simia satyrus*) has a sacrum composed of five pieces. The *elephant* has also five. See BLAIR *Osteogr. Elephantina*, p. 29.

(Y) In *monkeys*, and even in such *simiæ* as have no tails, where the os coccygis consists at most of three pieces only; this bone is perforated by a continuation of the vertebral canal, and by openings for the transmission of nerves. This structure is ascribed by GALEN to the human coccyx; and hence VESALIUS has derived another argument, to shew that GALEN'S Osteology was not drawn from the human skeleton.

The *orang-outang*, like man, has a coccyx composed of five pieces, not perforated. TYSON'S *Anat. of a Pigmy*, p. 69.

Those



Those vertebræ of the tail of mammalia, which are nearest to the sacrum, are perforated by a continuation of the canal for the medulla spinalis. The lower ones are solid. The want of pelvis renders it impossible for us to decide the number of sacral and coccygeal vertebræ in the cetacea: but the whole number of pieces in the spine of the *dolphin* and *porpoise* is 66.

(Z) Ossification of the cartilage, which connects the two ossa pubis, is so rare in the human subject, that one case only of complete anchylosis of these bones has been hitherto recorded: (SOEMMERRING *de Corp. human. Fab.* tom. 1. p. 22. note \*\*\*) although several instances of partial bony union have been observed. See SANDIFORT, *Obs. Anat. Pathol.*, vol. 2.; WYNPRESSE *de Ancylofi*; and MICHELL *de Synchondrotomia pubis.* Amstelod. 1783. Such an occurrence is not, however, very rare in the horse.

(A a) The *onithorhynchus paradoxus* and *histris* have ribs of a very singular structure. Their true ribs, which are six in number, consist of two pieces of bone; a longer one joined to the spine, and a shorter connected to the sternum. These are united by means of a piece of cartilage; so as to constitute a structure, approaching to that of birds. The false ribs, ten in number, terminate anteriorly in broad, flattened, oval bony plates, connected together by elastic ligaments. *Phil. Transf.* 1802, part 1, plate 3.



(B b) This process may be compared to the keel-like projection of the sternum of birds. It serves for the origin of those strong muscles of the anterior extremity, which assist the animal in digging its way under ground.

(C c) We may assert, as a general observation, that the four component parts of the upper extremity, viz. the shoulder, arm, fore-arm, and hand, can be clearly shewn to exist in the anterior extremities of all mammalia; however dissimilar they may appear to each other on a superficial inspection, and however widely they may seem to deviate from the human structure.

Whenever an animal of one class resembles those of a different order in the form and use of any part, we may be assured, that this resemblance is only in externals; and that it does not affect the number and arrangement of the bones. Thus the *bat* has a kind of wings; but an attentive examination will prove, that these are really hands, with the phalanges of the fingers elongated. The *dolphin*, *porpoise*, and other *cetacea*, seem to possess fins, consisting of a single piece. But we find under the integuments of the fin-like members, all the bones of an anterior extremity, flattened in their form, and hardly susceptible of any motion on each other. We can recognize very clearly the scapula, humerus, bones of the fore-arm, and a hand consisting of five fingers: the same parts, in short, which

form



form the anterior extremity of other mammalia. See TYSON'S *Anatomy of a Porpoise*, fig. 10 and 11.: also BLASII *Anatomia Animalium*, tab. 51, fig. 3, 4.

The fore-feet of the *sea-otter*, *seal*, *walrus*, and *manati*, form the connecting link between the anterior extremities of other mammalia, and the pectoral fins of the whale kind. The bones are so covered and connected by integuments, as to constitute a part, adapted for the purposes of swimming: but they are much more developed than in the latter animals, and have free motion on each other.

The cold-blooded quadrupeds bear great analogy in the four component parts, and in the general structure of their anterior extremities, to the warm-blooded ones. See CALDESI'S *Observations on the Turtle*, tab. 3. fig. 1. 4, 5.

The bones of the wing of birds have a considerable and unexpected resemblance to those of the fore-feet of the mammalia. And the fin-like anterior member of the penguin contains, within the integuments, the same bones as the wings of other birds.

(D d) The clavicle supports the anterior extremity, and maintains the shoulder at its proper distance from the front of the trunk. It exists, therefore, in all such animals as make much use of these members, whether for the purpose of climbing, digging, swimming, or flying. It does not exist, on the contrary,  
in



in such as use their fore-feet merely for the purpose of progression; since these limbs must be brought more forwards on the chest, that they may support that part, by being placed perpendicularly under it. In the genera, which hold an intermediate rank between these; which do not enjoy such an extensive utility of the fore-feet as the first division of animals; and are not so limited in their employment as the second, the *clavicular bones*, or imperfect clavicles exist.

(E e) The humerus becomes shorter, in proportion as the metacarpus is elongated; so that in animals, which have what is called a cannon bone, the os humeri hardly extends beyond the trunk. Hence the mistakes, which are made in common language, by calling the *carpus* of the horse his fore-knee, &c.

The radius forms the chief bone of the fore-arm in the mammalia, generally speaking; the ulna is a small slender bone, terminating short of the wrist in a point, and often consolidated with the radius, as in the *horse* and *ruminating animals*. A few genera, which have great and free use of their anterior extremity, have the power of pronation and supination. But this power diminishes, as the fore-feet are used more for the purpose of supporting the body in standing, and in progression. In this case, indeed, the extremity may be said to be constantly in the prone position, as the back of the carpus and toes is turned forwards.

The



The lower end of the ulna is larger than that of the radius in the elephant; but this circumstance occurs in no other instance.

The radius and ulna exist in the *seal*, *manati*, and *whales*, but in a flattened form.

Several genera of mammalia possess a hand; but it is much less complete, and consequently less useful than that of the human subject, which well deserves the name bestowed on it by Aristotle, of the *organ of all organs*. The great superiority of that most perfect instrument, the human hand, arises from the size and strength of the thumb, which can be brought into a state of opposition to the fingers, and is hence of the greatest use in grasping spherical bodies, in taking up any object in the hand, in giving us a firm hold on whatever we seize; in short, in a thousand offices, which occur every moment of our lives, and which either could not be accomplished at all, if the thumb were absent, or would require the concurrence of both hands, instead of being done by one only. Hence it has been justly described by ALBINUS as a second hand "*manus parva majori adjutrix*," *de sceleto*, p. 465.

All the *simiæ* possess hands: but even in those, which may be most justly stiled *anthropomorphous*, the thumb is small, short, and weak; and the other fingers elongated and slender. In others, as some of the *cercopitbeci*, there is no thumb, or at least it is concealed under the integuments; but these  
animals



animals have a kind of fore paw, which is of some use in seizing and carrying their food to the mouth, in climbing, &c. like that of the *squirrel*. The genus *lemur* has also a separate thumb. Other animals, which have fingers sufficiently long and moveable for seizing and grasping objects, are obliged, by the want of a separate thumb, to hold them by means of the two fore-paws; as the *squirrel*, *rat*, *opossum*, &c. Those, which are moreover obliged to rest their body on the fore-feet, as the *dog* and *cat*, can only hold objects by fixing them between the paw and the ground. Lastly, such as have the fingers united by the integuments, or enclosed in hoofs, lose all power of prehension. The *simiæ* in general have nine bones in the carpus. RIOLANI *Anthropographia and Osteolog.* p. 908. Paris, 1626; but there are only eight in the *orang-outang*, according to TYSON. There are five carpal bones in the fin of the whale, of a flattened form, and hexagonal.

The metacarpus is elongated in those animals, where the toe only touches the ground in standing or walking; and constitutes the part, which is commonly called the fore-leg; as the carpus is termed the knee.

The number of metacarpal bones is the same with that of the fingers or fore-toes: except in the ruminating animals. Even in these, as the author observes, there are two distinct metacarpal bones, lying close together before birth; the  
opposed



opposed surfaces first become thinner, then are perforated by several openings, and at last disappear; so that the adult animal has a single cannon bone, possessing a common medullary cavity internally, and marked on the outside with a slight groove at the place of the original separation. There is therefore but one metacarpal bone in the adult for the two toes. The structure of the metatarsus is the same.

In the *horse* on the contrary, if we allow the *splint bones* to belong to the metacarpus, there will be three to a single toe. DAUBENTON considers the common bone of this animal as supplying the place of the three metacarpal bones of man: he compares the outer splint bone to the metacarpal of the little finger, and the inner to that of the thumb. STUBBS views the cannon as the metacarpal of the middle and ring fingers; and the inner splint, as that of the fore-finger. BUFFON *Hist. Naturelle*, 4to. ed. p. 362. vol. 4. STUBBS'S *Anatomy of the Horse*.

The single finger or fore-toe of the horse is composed of the usual three phalanges; the first, which is articulated to the cannon, is called the *pastern*; the 2d is the *coronet*; and the 3d the *os basis* or *coffin bone*; on which the hoof rests. There are also two sesamoid bones at the back of the pastern joint: and an additional part called the *shuttle-bone* connected to the coffin.



In those animals, which have five toes, as the carnivora, &c., that which lies on the radial side of the extremity, and is therefore analogous to the thumb, is parallel with the others; and the animal consequently has not the power of grasping any object. The last phalanx in these supports the nail of the animal; and sends a process into its cavity. These parts are so connected that the nail is naturally turned upwards, and not towards the ground; so that its point is not injured in the motions of the animal. The phalanx must be bent in order to point the nail forwards or downwards.

The order of *rodentia* have generally five toes: that which corresponds to the thumb being the shortest.

The *elephant* has five complete toes; but they are almost concealed by the thick skin.

The *pig* has four toes; two larger ones, which touch the ground; and two smaller behind these, which do not reach so far. There is also a bone, which seems to be the rudiment of a thumb.

The phalanges of the *cetacea* are flattened; not moveable, and joined together in the fin.

(F f) The length of the femur depends on that of the metatarsus; and it bears an inverse ratio to the length of that part.

Hence it is very short in the *horse*, *cow*, &c. where the same mistakes are commonly com-



mitted in naming the parts, as in the anterior extremity.

The proportions of the thigh and leg vary in different animals. The latter part exceeds the former in the human subject; and the same remark may be made respecting the arm and fore-arm. These parts are nearly of the same length in the *orang-outang*. Some persons have affirmed that the Negro forms a connecting link between the European and the *orang-outang* in these respects. (WHITE *on the regular Gradation in Man and Animals*, &c). In some other simiæ the leg and fore-arm exceed the thigh and arm. In other animals, although they are some varieties, the leg is generally longer than the thigh.

The femur of the mammalia is not arched as in the human subject: it possesses scarcely any neck; and the great trochanter ascends beyond the head of the bone.

The fibula is behind the tibia in many animals, as the *dog* and the *rodentia*. It is consolidated to that bone at its lower end in the *mole* and *rat*. It only exists as a small styloid bone in the *horse*, and becomes anchylosed to the tibia in an old animal.

The structure of the metatarsus in the ruminating animals, and the horse, is the same with that of the metacarpus.

The tarsus of the horse is composed of six bones; and is the part known in common language by the name of the *hock*.



Animals of the genus *simia* and *lemur*, instead of having a great toe placed parallel with the others, are furnished with a real thumb: i. e. a part capable of being opposed to the other toes. Hence these animals can neither be called *biped*, nor *quadruped*, but are really *quadrumanous* or *fourhanded*. They are not destined to go either on two or four extremities, but to live in trees, since their four prehensile members enable them to climb with the greatest facility. So that CUVIER has denominated them “*les grimpeurs par excellence.*” (Leçons d’Anat. Comp. vol. I. p. 493.) The prehensile tail of several species is a further assistance in this way of life. The *opossum*, and others of the genus *didelphis*, have a similar structure with the *quadrumana*; and it answers the same purpose. Here however there is a separate thumb on the posterior extremity only, whence CUVIER calls them *pedimanes*.

Man is the only animal, in which the whole surface of the foot rests on the ground: and this circumstance arises from the erect stature, which belongs exclusively to him. In the *quadrumana*; in the *bear*, *hedgehog*, and *shrew*, (which are called by CUVIER *plantigrades*), the os calcis does not touch the ground.

The heel of a species of bear belonging to this country, viz. the *badger* (*ursus meles*), is covered with a long fur, which proves that this part cannot rest on the ground; although the structure both of the bones and muscles of the lower extremity of

~~this~~

this



this animal, approaches considerably to that of man. The same fact is stated of the bear itself, properly so called, by the Parisian dissectors, *Description anatomique d'un cameleon, d'un castor, d'un ours, &c.* Paris, 1669, 4to. the plate is contained in BLASIVS's *Collection*, tab. 32.

In other animals the body is supported upon the phalanges of the toes, as in the *dog* and *cat*; in the horse and ruminating animals no part touches the ground but the last phalanx. Here the elongation of the metatarsus removes the os calcis to such a distance from the toe, that it is placed midway between the trunk and hoof.

## CHAPTER III.

## ON THE SKELETON OF BIRDS.

§ 46. **T**HE skeleton of birds has considerable uniformity in the whole class; and it exhibits, when compared with the variously formed skeletons of mammalia, a very great and unexpected similarity to that of the human subject <sup>1</sup>.

§ 47. The skull of birds is distinguished by this peculiarity, that the proper bones of the cranium <sup>2</sup>, at least in the adult animal, are not joined by sutures, but are consolidated as it were into a single piece <sup>3</sup>.

They

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<sup>1</sup> As that excellent naturalist BELON, has already shewn in his "*Histoire de la Nature des Oiseaux, avec leurs Naifs Portraits retirez du Naturel.*" Paris, 1555. fol. p. 40.

<sup>2</sup> Consult on this subject VINC. MALACARNE "*of the Parts relating to the Brain of Birds*" in the *Memoirs of the Italian Society*, tom. 1 and 2.

<sup>3</sup> A peculiarity, which seems to be confined to the *cormorants*, must be here mentioned. There is a small sabre-shaped bone at the back of its vertex, which is supposed to serve as a lever in throwing back the head, when the animal tosses the fishes, which it has taken, into the air, and catches them



They have, without exception, only a single condyle, placed at the anterior margin of the great occipital foramen. (See note (A) at the end of the chapter).

There is also, in the whole class, a bone of a somewhat square figure, (called by the French *os carré*<sup>4</sup>), by which the lower jaw is articulated with the cranium on both sides, in the neighbourhood of the ear. (See note (B) at the end of the chapter).

The *ossa unguis* are common to birds with mammalia, but appear to be more general in the former than the latter: they are of considerable size, and must be distinguished from the superciliary<sup>5</sup> bones which probably belong to the *accipitres* (or predacious birds) only.

§ 48. The jaws are completely destitute of teeth. (See note (C) at the end of the chapter). The superior maxilla, which is completely im-

in its open mouth. But the same motion is performed by some other piscivorous birds, who are unprovided with this particular bone. The whole skeleton of the *cormorant* is represented by COITER in the 4th of his excellent plates, which are attached to his edition of the "*Lectiones Fallopii de partibus Similaribus*," &c. Norib. 1575. folio.

<sup>4</sup> HERRISSANT has given it this name in the *Mem. de l'Acad. des Sc.* 1748. But COITER has pointed it out in the work before quoted.

<sup>5</sup> See MERREM'S *Observations relating to Zoology*, p. 120.



moveable in mammalia, has, with a few exceptions, more or less motion in birds<sup>6</sup>. It either constitutes a particular bone, distinct from the rest of the cranium, to which it is articulated, as is the *Pfittaci*<sup>7</sup> (birds of the parrot kind); or it is connected into one piece with the cranium, by means of yielding and elastic bony plates; as is the case with birds in general. It is quite immoveable in a very few instances; as the tetrao urogallus (cock of the woods) and the rhinoceros bird<sup>8</sup>.

§ 49. The proportionate magnitude of the bones of the cranium and jaws varies much in this class. The former are large in the owl; the latter are of vast magnitude in the rhinoceros bird<sup>9</sup>.

§ 50.

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\* HERRISSANT *Sur les Mouvements du Bec des Oiseaux* in the *Mem. de l'Acad. des Sciences*, 1748. p. 345, with excellent plates.

<sup>7</sup> LABILLARDIERE says also of the upper mandible of the *pelicanus varius*; "cette Mandibule est mobile, comme celle des *Perroquets*." *Relation du Voyage*, &c. i. p. 210.

<sup>8</sup> This at least is the case, in a skull of this extraordinary animal in my collection.

<sup>9</sup> A most remarkable sexual difference appears in the skull of the *crested hens*: in these the frontal portion of the cranium is dilated into an immense cavity; on which the crest of feathers is placed. This degeneracy of the formative impulse, which is propagated to the offspring, is quite unparalleled in the whole animal kingdom. See STORÆUS in



§ 50. One of the peculiar characteristic differences of the cranium of birds when compared to each other<sup>10</sup>, consists in the mode of separation of the orbits, which are of great size in the whole class. In some they are separated by a membranous partition only; in others by a more or less complete bony septum. The relation, which the nasal and palatine openings bear to the upper jaw varies much, even in the different species of the same genus. They are small in the *stork*; and on the contrary so large in the *crane* that the longest portion of the jaw appears to consist merely of three thin portions of bone, placed far apart from each other, and converging towards the point of the bill.

§ 51. The want of motion in the back of birds, (their dorsal vertebræ have the spinous, and even the transverse processes, often ankylosed) is compensated by a larger number, and greater mobility of the cervical vertebræ; of which, to

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*Act. Liter. Succ.* v. 3. 1730. PALLAS *Spicileg. Zoolog.* fas. 4.  
SANDIFORT *Museum Lugd. Batav.* vol. 1. p. 306.

I have lately examined several heads of such hens in a fresh state, and have found that this peculiar dilatation of the cranium is filled by the hemispheres of the cerebrum; and it is separated from the posterior part, which holds the cerebellum, as in the common hen, by an intermediate contracted portion.

<sup>10</sup> See J. T. KLEIN, *Stemmata Avium.* Lips. 1759. 4to.



quote a few instances, the *raven* has 12, the *cock* 13, the *ostrich* 18, the *stork* 19, and the *swan* 23.

§ 52. The trunk of birds has fewer cartilaginous parts than the corresponding division of the skeleton in mammalia. That part of the spine, which belongs to the trunk is short and rigid, and has no true lumbar vertebræ. Neither has any bird an os coccygis prolonged into a true jointed tail\*.

§ 53. The pelvis of birds is chiefly formed by a broad and simple os innominatum; the lateral portions of which are of different figures in the several genera; but, instead of uniting below to constitute a symphysis pubis, they are quite distant from each other. The *ostrich* alone forms a remarkable exception to this rule; in as much as its pelvis, like that of most quadrupeds, is closed below by a complete junction of the ossa pubis.

§ 54. Birds have fewer ribs than mammalia: the number, I believe, never exceeds ten pairs. The false ribs, i. e. those, which do not reach to the sternum, are directed forward; the true ones are joined to the margin of the sternum by means of small intermediate bones. The middle pairs are

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\* See note (D), at the end of the chapter.



distinguished by a peculiar flat process, which is directed upwards and backwards.

§ 55. The sternum of these animals is prolonged below into a vertical process, (*crista*) for the attachment of the strong pectoral muscles. In the male wild swan (*anas cygnus*), and in some species of the genus *ardea*, as the *crane*, this part forms a peculiar cavity for the reception of a considerable portion of the trachea. The *crista* is entirely wanting in the *ostrich* and *cassowary*; where the sternum presents a plane and uniformly arched surface\*.

§ 56. The wings are connected to the trunk by means of three remarkable bones<sup>11</sup>. The clavicles, which are always strong, constitute straight cylindrical bones. Their anterior extremities are connected to the sternum, by means of a bone peculiar to birds; viz. the *forklike bone*, or, as it is more commonly termed, the *merry thought*. (*Furcula*, in

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\* This peculiarity of structure is accounted for by observing, that these birds have not the power of flying. The wings, which are very small, assist in balancing the body, as they run.

<sup>11</sup> For an account of several differences in their structure, See VICQ D'AZYR in his "*Memoires pour servir a l'Anatomie des Oiseaux*," in the *Mem. de l'Acad. des Sc.* 1772. p. 626.



French *la lunette*, or *fourchette*)\*. (See note (E) at the end of the chapter.)

§ 57. The bones of the wing may be compared on the whole to those of the upper extremity in man, or the quadrumana; and consist generally of an os humeri; two bones of the forearm; two of the carpus; two, which are generally consolidated together, of the metacarpus; one bone of the thumb; and two fingers; of which that which lies towards the thumb consists of two portions, the other only of one. The most remarkable deviation from this structure, in respect to the number, as well as the formation and relative proportion of the bones, is found in the fin-like wings of the *penguins*. All the bones are here of a very remarkable flattened form, as if they had been pressed; there are two supernumerary bones at the elbow; and the bone of the thumb is entirely wanting.

§ 58. The bony structure of the lower extremities is more simple in birds, than in mammalia. In general it comprehends only the following

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\* The *ostrich* and *casowary* have indeed no separate *furcula*; but on either side of the front of the chest, an elongated flat bone, consisting of a rudiment of the *furcula*, with the clavicle and scapula consolidated into one piece.



bones, viz. the femur, the tibia, (to which, in some instances, is added a small, thin, closely adhering pointed fibula) one metatarsal bone, and the toes. The place of the patella is supplied, in many cases, by a process of the tibia. As birds have neither a true fibula, nor tarsus, their tibia is immediately articulated with the metatarsus. There is, in most of this class, a peculiar progressive increase in the number of phalanges of the toes: the great toe has two; the next three; the middle one, four; and the outer one, five<sup>12</sup>. The *psittaci* have, however, a peculiar cross-bone, belonging to the great toe\*.

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*Additional Notes to the Third Chapter.*

(A) This structure gives the head a great freedom of motion, particularly in the horizontal direction. It enables the bird to place its bill between the wings, when asleep; a situation, in which none of the mammalia can bring the snout.

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<sup>12</sup> Several excellent remarks on this, as well as other parts of the osteology of this class, may be found in Professor SCHNEIDER's instructive work, "*Commentar. ad reliqua Librorum Frederici 2ndi Imperatoris*, p. 30.

\* See note (F), at the end of the chapter.

(B) The



(B) The *os quadratum* has a true articulation, both with the lower mandible and with the cranium. Another small bone is connected to it, and rests by its opposite end against the palate. Hence, when the square bone is brought forwards, which it is by the depression of the lower mandible, and in a greater degree by some particular muscles, the second bone presses against the palate, so as to elevate the upper jaw.

(C) The bill of birds may be considered, in some degree, as supplying the place of teeth; yet, as none of these animals masticate their food, but swallow it whole, the bill can only be compared to the incisors of such animals, as use them for seizing and procuring their food.

It consists of a horny fibrous matter, similar to that of the nail, or of proper horns; and is moulded to the shape of the bones, which constitute the two mandibles, being formed by a soft vascular substance, covering these bones. Its form and structure are as intimately connected with the habits and general character of the animal, as those of the teeth are in the mammalia. Hence an enumeration of its different figures and consistence, belongs properly to the department of natural history, where it forms the foundation of classic distinctions.

The accipitres, or rapacious birds, have it very hard, hooked at the end, and furnished with a process on either side; calculated, therefore, in all respects,



spects, for seizing and lacerating their prey. Those of the *parrot* kind have it also hard, for bruising the firmer vegetable fruits; and the *wood-pecker*, *nut-hatch*, &c. for penetrating the bark of trees.

Those birds, which take a softer kind of food, and which require a sense of feeling in the part, for distinguishing their food in mud, water, &c. have it approaching to the softness of skin. Such are the *duck*, *snipe*, *woodcock*, &c.

In several classes, particularly the *accipitres* and *gallinæ*, the base of the bill is covered with a soft skin, called the *cire*, of unknown use.

(D) The number of cervical vertebræ in birds, varies from ten to twenty-three; those of the back from seven to eleven. From hence to the tail, they are consolidated into one piece with the *os innominatum*. The tail has from seven to nine pieces.

The length of the neck increases in general, in proportion to that of the legs.

The cervical vertebræ are not articulated by plane surfaces, but by cylindrical eminences, which admit a more extensive motion, as they constitute real joints, instead of *synchondroses*. Four or five of the upper pieces only bend forwards; while the lower ones are confined to flexion backwards. Hence the neck of a bird acquires that double bend, which makes it resemble the letter S. It is by rendering the two curvatures more convex, or  
more



more straight, that the neck is shortened or elongated. The great mobility of the neck, enables birds to touch every point of their own body with the bill, and thus to supply the want of the prehensile faculty of the superior extremity.

(E) The point of the fork-like bone is joined to the most prominent part of the keel of the sternum; and the extremities of its two branches are tied to the humeral end of the clavicles, and the front of the scapulæ, just where these bones join each other, and are articulated with the humerus. Hence it serves to keep the wings apart in the rapid motions of flying. “As a general observation, it may be stated, that the *fork* is strong and elastic; and its branches wide, arched, and carried forwards upon the body, in proportion as the bird possesses strength and rapidity of flight; and accordingly the *struthious birds* (*ostrich* and *cassowary*), which are incapable of this mode of progression, have the fork very imperfectly formed. The two branches are very short, and never united in the *African ostrich*, but are anchylosed with the scapula and clavicle. The *cassowary* has merely two little processes from the side of the clavicle, which are the rudiments of the branches of the fork. In the *New Holland ostrich* there are two very small thin bones, which are attached to the anterior edge of the dorsal end of the clavicles by ligament; they are directed up-  
wards



wards towards the neck, where they are fastened to each other by means of a ligament, and have no connection whatever with the sternum."

MACARTNEY, in REES'S *Cyclopædia*. Article BIRDS, *Anatomy of*.

(F) Birds certainly have a fibula, contrary to the assertion of the author; but it is small, and soon anchylosed to the tibia.

The lower end of the bone, which answers to the tarsus and metatarsus, forms as many processes as there are toes; and each of these has a pulley, for articulation, with its corresponding toe.

The vast length of the leg in the wading birds (*grallæ*), the *ostrich*, and *cassowary*, is produced by the tibia, and common bone of the tarsus and metatarsus; for the femur is comparatively short.

"The *stork*, and some others of the *grallæ*, which sleep standing on one foot, possess a curious mechanism, for preserving the leg in a state of extension, without any, or at least with little muscular effort. There arises from the fore-part of the head of the metatarsal bone, a round eminence, which passes up between the projections of the pulley, on the anterior part of the end of the tibia. This eminence affords a sufficient degree of resistance to the flexion of the leg, to counteract the effect of the oscillations of the body, and would prove an insurmountable obstruction to the motion of the joint,

joint, if there were not a socket within the upper part of the pulley of the tibia, to receive it when the leg is in the bent position. The lower edge of the socket is prominent and sharp, and presents a sort of barrier to the admission of the eminence, that requires a voluntary muscular exertion of the bird to overcome, which being accomplished, it slips in with some force, like the end of a dislocated bone."

MACARTNEY, loco citato.



## CHAPTER IV.

## ON THE SKELETON OF AMPHIBIA.

§ 59. **T**HE general form of the body, and consequently the structure of the skeleton varies so much, in the first place, in the two orders of this class, viz. the *four-footed amphibia*, and the *serpents*; and secondly, in the three leading classes of the first order, namely, the *testudines*, the *frogs*, and the *lizards*; that it will be best to arrange our observations on this subject, according to the natural divisions of the orders and classes.

§ 60. The *testudines* (turtles and tortoises), whose whole skeleton<sup>1</sup>, and indeed whose whole body has a very peculiar structure, are entirely toothless; they have, however, a kind of os intermaxillare in the upper jaw. The horny covering of the jaws, particularly the upper one, has some

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<sup>1</sup> Good representations of the whole skeleton may be found in COITER, CHESELDEN, and particularly in J. D. MEYER'S "*Pastime, with Considerations of curious Representations of all Kinds of Animals,*" &c. v. 1. p. 29. v. 2. p. 62. The individual parts are represented in GIOV. CALDESI'S *Anatomical Observations relating to Turtles*. Florence, 1687. 4to.

resemblance to the horse's hoof, in the mode of its connection with the jaw. The cavity, containing the brain, is extremely small, in comparison with the size of the skull; the greatest part of which, in the turtle, is occupied by the large lateral hollows, holding the eye, and the powerful muscles that move the lower jaw. (See note (A) at the end of the chapter.)

§ 61. The trunk is consolidated with the two great shells of the animal; the dorsal vertebræ and ribs being attached to the upper, the sternum being fixed in the lower or abdominal shell. The upper bony covering, or that of the back, consists of about fifty pieces; which are partly connected together by real futures.

§ 62. The same bones are found in the pelvis of these animals, as in the mammalia; but the proportion of their relative size is inverted. For instance, the ossa pubis are so deep and broad, that they form the largest flat bones in the whole skeleton, while the ilia are the smallest.

§ 63. The form and position of the scapula and clavicle are the most extraordinary. The former has a most anomalous situation towards the under part of the animal, just behind the abdominal shell; the latter consists of two pieces, joined at an acute angle, to which the humerus is articulated.



§ 64. *Frogs* and *toads*<sup>2</sup> have no teeth<sup>3</sup>. Their spine is short, terminates behind in a straight and single bone, which is received into the middle of the somewhat fork-like os innominatum.

§ 65. They have no ribs; but the dorsal vertebræ are furnished with broad tranverse processes. The scapula, which is thin and flat, and a pair of bones, corresponding to the clavicle, are joined to the sternum.

§ 66. The bone of the fore-arm and of the leg have a peculiarity of structure, in these animals, which deserves observation. These bones consist of a single piece, which is solid in the middle, but divided at either extremity, into two conical portions, having manifest medullary cavities<sup>4</sup>.

<sup>2</sup> Skeletons of the frogs and toads of this country (Germany), may be seen in the well-known chef d'œuvre of ROESEL, "*De Ranis Nostratibus.*" The singular skeleton of the *rana pipa* (Surinam toad), is accurately described and delineated in the first fascic. of Professor SCHNEIDER's *Histor. Amphibior.* It is particularly distinguished by the large lateral processes of the sacrum, and by a bony cavity (*cista Schneid.*) of unknown use, placed behind the sternum, and belonging exclusively, as it should seem, to this animal.

<sup>3</sup> It must be understood, that we speak here of real teeth; and not of what are called the denticulated margin of the jaws.

<sup>4</sup> See TROJA's "*Memoir, concerning the singular Structure of the Tibia and Ulna in Frogs and Toads;*" in his "*Experiments on the Regeneration of Bones,*" in Italian. Naples, 1779. p. 250.



§ 67. The *crocodile*<sup>5</sup> may be taken as an example of the class of *lizards*<sup>6</sup>, on account of some remarkable peculiarities of structure. In no other animal are the jaws of such immense size, in comparison with the extremely small cavity of the cranium. The anterior part of the upper jaw, consists of a large intermaxillary bone; and the lateral portions of the lower maxilla, are formed of several pieces joined together. The lower jaw<sup>7</sup> is articulated, in a peculiar manner, in these animals: it has an articular cavity, in which a condyle<sup>8</sup> of the upper jaw is received.

§ 68. Their numerous teeth have this peculiarity of structure; that, in order to facilitate their change,

<sup>5</sup> The skeleton of the *crocodile*, is represented in N. GREW'S "Museum Regalis Societatis." Lond. 1681. Also in FAUJAS ST. FOND, *Histoire Naturelle de la Montagne de St. Pierre de Maestricht*.

<sup>6</sup> The skeleton of the common *green lizard*, may be seen in COITER, pl. 4; MEYER, tome 1. pl. 56; that of the *salamander* and *waternewt* are also given in MEYER; that of the *chameleon* is prefixed to CHESELDEN'S 6th ch.

<sup>7</sup> The commencement of this kind of articulation, is seen in the jaw of the testudines.

<sup>8</sup> The condyle resembles, in some measure, the pulley at the inferior extremity of the humerus (the *trochlea*, or *rotula* of ALBINUS); this, at least, is the case in the skull of an *alligator*, which I have before me.

The old error, of supposing that the upper jaw of the *crocodile* is moveable, and the lower, on the contrary, incapable



change, there are always two, of which one is contained within the other <sup>9</sup>.

§ 69. But the most surprising singularity in the skeleton of the crocodile, consists in an abdominal sternum, which is quite different from the thoracic sternum, and extends from the ensiform cartilage to the pubis, apparently for the purpose of supporting the abdominal viscera <sup>10</sup>.

§ 70.

ble of motion, which has been adopted even by such anatomists as VESALIUS and COLUMBUS, has perhaps arisen from this peculiar mode of articulation. An examination of the cranium shews, that if the lower jaw remains unmoved, the whole remainder of the skull may be carried backwards and forwards by means of this joint. And such a motion is proportionally easier in the present instance, than in any other animal, both on account of the very great relative size of the lower jaw, as well as from its anomalous mode of articulation. There is, however, no motion of the upper jaw-bone only, similar to that which occurs in most birds, serpents, and fishes.

<sup>9</sup> Sometimes three, according to RETZIUS, *Animadvers. circa Crocod.* 1797. 4to.

<sup>10</sup> In the skeletons of three *East Indian crocodiles*, which I have examined, there were ten pairs of true, and two of false ribs. The former had bony appendages; and a third, intermediate portion between the chief piece of the rib and the appendix. The abdominal sternum consisted of seven pairs of a cartilaginous arches connected together. The six front pairs were interrupted by open intervals; and the space between the last pair and the pubis, was filled by a broad piece of cartilage. A somewhat similar structure in the *crocodile*



§ 70. The serpents<sup>11</sup> have an upper jaw, unconnected with the rest of the skull, and more or less moveable of itself.

§ 71. We find in their teeth, the important and clearly defined difference, which distinguishes the poisonous species of serpents, from the much more numerous innoxious tribes.

The latter have, in the upper jaw, four maxillary bones, beset with small teeth, which form two rows, separated by a considerable interval from each other. One of these is placed along the front edge of the jaw; the other is found more internally, and is situated longitudinally on either side of the palate.

The external row is wanting in the poisonous species; which have, in their stead, much larger tubular fangs, connected with the poison bladder, and constituting, in reality, bony excretory ducts, which convey the venom into the wound, inflicted by the bite of the animal<sup>12</sup>.

*of the Nile*, is described by S. VESLINGIUS, in his *Observ. Anat.* p. 43; and in the *alligator*, by PLUMIER, in the *Memoires de Trevoux*, of January 1704.

<sup>11</sup> Skeletons of several snakes are contained in the work of MEYER, above quoted.

<sup>12</sup> Specimens are delineated, for the sake of comparison, in the 4th part of my "*Delineations*," &c. tab. 37, where the heads of a rattlesnake (*crotalus*) and a *boa*, are represented with their mouths open.



§ 72. It appears, in general, that the number of vertebræ in red-blooded animals, is in an inverse proportion with the size and strength of their external organs of motion. Serpents, therefore, which entirely want these organs, have the most numerous vertebræ; sometimes more than 300. (See note (B) at the end of the chapter).

The last vertebræ of the tail, in the *rattlesnake*, are broad, and covered by the first hollow pieces of the *horny rattle*: the succeeding portions of this singular and mysterious organ<sup>13</sup>, are connected to each other in a most curious way.

§ 73. Serpents possess by far the greatest number of ribs; which amount, in some, to 250 pairs. It is necessary to mention here the *costæ scapulares* of the *cobra di cabelo* (*coluber naiaë*), which enable the animal to inflate its neck<sup>14</sup>.

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<sup>13</sup> For the probable use of this organ, which belongs so exclusively to the *rattlesnake*; and for the assistance, which it may afford to this inactive animal, by drawing towards it the frightened birds (which, indeed, may have given rise to the stories concerning its supposed power of fascination). See VOIGT'S *Magazine, for the newest Occurrences in Natural History*, vol. 1. p. 37. "On the fascinating power of the rattlesnake, particularly with respect to a work of Dr. Barton's," in German.

<sup>14</sup> This is also the case with other species of the *coluber*; namely, the Egyptian *coluber haje*, which can dilate its neck very considerably, when enraged.



Serpents are the only red-blooded animals, which have no sternum\*.

proportion with the size and strength of their external organs of motion. Serpents, therefore, which entirely want these organs, have the most numerous

vertebræ. *Additional Notes to the Fourth Chapter.* (B) at the end of the chapter.

(A) This circumstance is still more remarkable in the *crocodile*. The cranium of an individual, measuring thirteen or fourteen feet, will hardly admit the thumb: and the area of its section does not constitute the twentieth part of that of the whole head.

The *chameleon* affords another instance of the same structure: its brain, according to the description of the Parisian dissectors, does not seem larger than a pea; and the whole of the head, which is of considerable size, consists of the large maxillary bones, the orbits, and immense temporal fossæ, which, not being separated by any partition, give the cranium a very singular appearance.

See the *Description anatomique d'un Camelcon*, &c. or BLASIUS'S *Collection*, tab. 14.

(B) It may be observed in confirmation of this remark, that the number of vertebræ is very great

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\* For some others remarks, concerning the head of the amphibia, see note (C) at the end of the chapter.



in fishes of an elongated form; viz. in the *eel*, which has above one hundred. The *porpoise*, which has no organs of motion, which deserve mentioning, has between sixty and seventy.

Birds, which have such vast power of locomotion by means of their wings, have very few vertebræ, if we consider the anchylosed ones as forming a single piece. And the *frog*, with its immense hind extremities, has a very short spine, consisting of still fewer pieces.

(C) The occiput is connected to the atlas by a single condyle in the *crocodile* and *turtle*: in the *lizard* and *tortoise* there is a slight appearance of division into two surfaces: in the *frog* and *toad* there are two condyles; and in the *serpents* there are three articular surfaces on a single tubercle.

The condyle of the turtle being deeply imbedded in the atlas, the motions of the articulation must be limited: the protraction and retraction of the head in this animal is effected by the flexion and extension of the vertebræ of the neck.

The lower jaw is articulated with an eminence of the cranium in the *lizards*, *turtles*, *frogs*, *salamanders*, *blindworms*, (*anguis fragilis*) and *amphisbæna*; besides the crocodile in which the author mentions it. This bony eminence, is compared by CUVIER to the *os quadratum* of birds. The lower jaw only is moveable in these animals. Its articulation in

the turtle is by means of a ginglymus. In all the venomous serpents the upper jaw is moveable on the head, as in birds: these animals require as extensive an opening of the mouth as possible, since they swallow others whole, actually larger than their own body.

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 single condyle in the vertebral and cervical vertebrae  
 forward and backward there is a slight appearance of division  
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 the cranium in the middle, (Jugum, Jugum, Jugum)  
 (Jugum, Jugum, Jugum) and (Jugum, Jugum, Jugum);  
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 to the quadratum of birds. The lower jaw only  
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## CHAPTER V.

## ON THE SKELETON OF FISHES.

§ 74. WE should naturally conclude, from observing the great diversity in the general form of fishes, that the structure of their skeleton must be equally various<sup>1</sup>. They agree together, however, on the whole, in having a spine, which extends from the cranium to the tail-fin; and in having the other fins, particularly those of the thorax and abdomen, articulated with peculiar bones, destined to that purpose. They have in general many more bones unconnected with the rest of the skeleton, than the animals of the preceding classes<sup>2</sup>.

§ 75.

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<sup>1</sup> Delineations of the skeleton of most marine fishes are still wanting. A beautiful view of the *skate* is given by CHESELDEN in the beginning of his work. MEYER has represented the skeletons of twenty-five fresh-water fishes in the two first volumes of his book, which has been frequently quoted. That of the *carp* may be seen in DUHAMEL *Traité des Pêches*, (a part of the great work entitled, *Description des Arts and Metiers*,) pl. 2. sect. 1. tab. 3.

<sup>2</sup> There are some excellent remarks on the skeleton of fishes

§ 75. The cranium in several cartilaginous fishes, (in the *skate* for instance) has a very simple structure, consisting chiefly of one large piece. In the bony fishes, on the contrary, its component parts are very numerous; amounting to 80 in the head of the *perch*. Most of the latter have a more or less moveable under-jaw.

§ 76. Great variety in the structure of the teeth is observed in this class. Some genera, as the sturgeon, are toothless. Their jaws, which are distinct from the cranium, form a moveable part, capable of being thrust forwards from the mouth, and again retracted.

§ 77. Those fishes, which possess teeth, differ very much in the form, number, and position of these organs. Some species of *sparus*, (as the *S. probato-cephalus*) have front-teeth almost like those of man<sup>3</sup>; they are provided with fangs, which

fishes in general, by Profr. AUTENRIETH in WIEDEMANN'S *Archives*, vol. 1. p. 2.

On the skeletons of particular orders of fishes, see VICQ D'AZYR, in the 7th vol of the "*Memoires présentés à l'Acad. des Sciences.*" It is translated into German, with remarks and additions by Professor SCHNEIDER, in his "*Collection of Anatomical Observations and Remarks towards elucidating the History of Fishes.*" Leipzig, 1795. 8vo.

<sup>3</sup> AUGUSTIN SCILLA *de Corporibus Marinis lapidescentibus*. Rome, 1759. 4to. tab. 2.

are



are contained in alveoli. In many genera of fishes, the teeth are formed by processes of the jaw-bones covered with a crust of enamel. In most of the sharks, the mouth is furnished with very numerous teeth for the supply of such as may be lost. The *white shark* has more than two hundred, lying on each other in rows, almost like the leaves of an artichoke. Those only, which form the front row, have a perpendicular direction, and are completely uncovered. Those of the subsequent rows are, on the contrary, smaller; have their points turned backwards, and are covered with a kind of gum. These come through the covering substance, and pass forward when any teeth of the front row are lost<sup>4</sup>. It will be understood from this description, that the teeth in question cannot have any fangs.

The saw-fish only (*Squalus pristis*) has teeth implanted in the bone on both sides of the sword-shaped organ, with which its head is armed.

In some fishes the palate, in others the bone of the tongue (as in the *frog-fish*), in others (as in several of the ray-kind) the aperture of the mouth forms a continuous surface of tooth<sup>5</sup>. (See note (A) at the end of the chapter.)

## § 78.

<sup>4</sup> See HERISSANT in the *Mem. de l'Acad. des Sc. de Paris*, 1749, p. 155. And W. ANDRE in the *Philos. Transf.* vol. 74. p. 274.

<sup>5</sup> One of the most surprising formations about the mouth occurs



§ 78. In the long shaped fishes with short fins, the spine consists of a proportionally greater number of vertebræ; of which the eel, for instance, has more than 100, and some sharks even more than 200. The main-piece, or body, as it is called of these vertebræ, is of a cylindrical figure, with a funnel shaped depression on both surfaces, and concentric rings, which are said to vary in number, according to the age of the animal. The spinal marrow passes above these, in a canal formed at the roots of the spinous processes.

The ribs are articulated with what are called the dorsal vertebræ in most of the spinous fishes; but in some they are without this connection; and in the cartilaginous fishes proper ribs cannot be said to exist.

§ 79. Of the peculiar bones, which serve as a basis for the fins, that of the pectoral fin may be compared to the scapula, and that of the abdominal in some measure with the os innominatum<sup>6</sup>.

§ 80.

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occurs in a West Indian species of skate (*raia flagellum*): it is described and delineated in the *Philos. Transf.* vol. 19. p. 674. by SLOANE, as the tongue of the animal. The specimen, which I possess, consists of a flat bone, about five inches long, two broad, and of the thickness of the thumb. It is composed of 15 curved portions, connected together lengthwise; and each of these arches is covered above with 60 small teeth, which lie close together.

<sup>6</sup> I possess a specimen of the singular bone, relating to this subject,



§ 80. Lastly, many fishes are furnished with merely muscular bones (*osicula muscullorum* of ARTEDI) which are sometimes bifurcated, are always situated among the muscles, and facilitate their motion.

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*Additional Note to the Fifth Chapter.*

(A) Great variety exists in the teeth of fishes; and their structure, formation, and mode of growth have been but imperfectly explained hitherto.

Many fishes have simple teeth, formed of a *bony substance*, covered by *enamel*, and probably formed

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subject, which has been represented in the *Museum Wormianum*, p. 270, in the *Museum Regium* of *Jacobæus*, and in *OLEARIUS, Gottorf. Kunstkammer*; and which, for a long time has been considered as a very obscure subject. It is thick, of a roundish flat form, and nearly resembling a smooth chestnut in form and size. It forms on one side a bony point; and on the other is articulated, by means of a very remarkable ginglymus, with two small bones of different magnitude, and resembling the point of an arrow. It belongs most probably to an East Indian *chatodon*, (probably to the *Ch. arthriticus* SCHNEID); the larger piece being the basis of the back-fin, and the smaller constituting the first radii of that fin. See W. BELL's *Description of a Chatodon, called by the Malays, Ecan Bonna*, in the *Philos. Transf.* 1793.



as in the mammalia. These are the most common, and may be seen in the *pike*. When the crown has completely appeared, the root becomes ankylosed to the jaw.

In other cases they adhere to the gum only, or at least to a firm cartilaginous substance, which covers the jaw. This is exemplified in the *shark*. These teeth seem not to be formed, as those of the mammalia are, by the deposition of successive layers one within the other; but in a manner more nearly resembling the formation of bone. They are at first soft and cartilaginous, and pass by successive gradations, into a state of hardness and density, not inferior to that of ivory.

A third kind of teeth consists of an assemblage of tubes, covered externally by enamel, and connected to the jaw by a softer substance, which probably sends processes or vessels into those bony tubes. This is the case with the pavement, as we may call it, of teeth, that covers the jaws of the *skate*.

A similar structure is observed in the *anarrhichas lupus*; where the teeth, composed of bony tubes, are connected to spongy eminences of the jaws, which may be compared to epiphyses; and on their separation leave a surface like that from which the antler of the deer falls off.

Besides the two jaws, fishes have teeth implanted in the bones of the palate; in that which corre-



ponds to the vomer; in the os hyoides; in the bones which support the franchiæ; and in those which are placed at the top of the pharynx. The *salmon* and *pike* have them in all these situations.

## CHAPTER VI.

## ON THE OESOPHAGUS AND STOMACH.

§ 81. AFTER the comparative view, which we have now taken, of the skeleton, as influencing the general form of the red-blooded animals, we proceed to consider the other parts of the animal structure, and their functions. The ordinary division into four classes of functions may be here retained, as sufficiently applicable on the whole, although it is in strictness subject to much limitation. The particular classes of animals will be considered in the subdivision of each chapter, according to the arrangement most usually followed in teaching zoology.

§ 82. The *natural functions*, as they are called, which include, in their most extensive sense, the whole process of nutrition, very properly take the lead on this occasion. In the first place, they exist in all classes of animals without exception; they are indeed common to plants and animals: secondly, the peculiar mode of their performance in animals, constitutes the most distinguishing character of an animal. For they seek their food by  
voluntary



voluntary motion, and convey it into the stomach through a mouth<sup>1</sup>.

MAM-

Partial exceptions to this general rule may be drawn; 1st, From those animals in which no mouth has been hitherto discovered; for instance, as some *animalcula infusoria*, and in a certain sense some *medusæ*, which, instead of possessing a simple opening, take in their nourishment through many apertures. 2dly, From those, in which no manifest voluntary motion has been hitherto observed, as in several real *hydatids*. Physiologists have lately gone further, and have declared certain organized bodies, in which neither of the above-mentioned characters, neither a mouth nor voluntary motion could be discovered, to be animals. Such, for example, are the dropical bladders, occasionally found in the abdomen of persons, who have laboured under ascites, (rarely in any animal except man,) in vast numbers, and of various sizes from that of a goose's egg, to the head of the smallest needle. I have examined a great number of these, which were found in a dropical old man, whose disease and dissolution are related by RICHTER, in LODER's *Surgical Journal*, vol. 3. p. 415. These differ in their whole structure, and particularly in the formation of their membranes, much more from the true *hydatids*, than from some simple morbid watery cysts, which are met with not unfrequently in warm-blooded animals, and consist so indisputably of a mere unnatural formation of vessels and membranes, that no person could think of ascribing to them an independent animal existence. I have now before me similar cysts from a hen, the largest of which, (about the size of a small hen's egg), like those of the above-mentioned patient, were quite unattached; the rest appeared, on the first examination, from their connection with the ovarium, to be nothing else but *calyces*, containing from a morbid cause, lymph instead of yolk.



## (A) MAMMALIA.

§ 83. We have already shewn, in the second chapter, the most important circumstances relating to the mouth. Many species of the genus *simia*, as well as the *hamster*, (*marmota cricetus*) and some similar species of the *marmot*, are provided with *cheek pouches*, in which the former, who live on trees, place small quantities of food as a reserve: the latter employ these bags to convey their winter provision to their burrows<sup>2</sup>. (See note (A) at the end of the chapter).

§ 84. The peculiar glandular and moveable bag, (*bursa faucium*), which is placed behind the palate, has hitherto been only observed in the camels of the old world: and it probably serves

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I have however lately dissected a *simia cynomolgus*, whose lungs, liver, and omentum were beset with an abundance of watery cysts of various sizes. The fluid of these cysts contained an innumerable quantity of microscopical bodies, which were found, by the employment of strong magnifying powers, to be *hydatids*, with a well-formed circle of hooks, and mouth, and consequently must be considered as true independent animals.

<sup>2</sup> An accurate description and delineation of these bags may be found in SULZER'S "*Essay towards the Natural History of the Hamster*," in German, p. 41. 58. tab. 3. One of the most masterly zoological and zootomical monographs that has ever been published.



to lubricate the throat of these animals in their abode in the dry sandy deserts which they inhabit<sup>3</sup>. (See note (B) at the end of the chapter.)

§ 85. The œsophagus of quadrupeds is distinguished from that of the human subject by possessing two rows of muscular fibres, which pursue a spiral course, and decussate each other. In those carnivorous animals, which swallow voraciously, as the *wolf*, it is very large; on the contrary, in many of the larger *herbivora*, and particularly in such as ruminant, its coats are proportionally stronger<sup>4</sup>.

The opening of the œsophagus into the stomach is marked by some differences, both with regard to its size, and to the mode of termination. We understand, from observing these points, why some animals, as the *dog*, vomit very easily, while others, as the *horse*, are scarcely suscepti-

<sup>3</sup> See HOME'S *Life of J. HUNTER*, prefixed to the posthumous works of the latter, on "*the blood, inflammation,*" &c. p. 41. According to CUVIER, the common camel only, with one protuberance (*the dromedary*), possesses this œsophageal pouch, and thrusts it forwards only at the rutting season. *Ménagerie du Muséum National*, pl. 1.

<sup>4</sup> GREW may be consulted respecting the œsophagus, as well as the whole alimentary canal of several animals of the different classes. See his *Museum Regalis Societatis*.



ble of this process<sup>5</sup>, except in extremely rare instances<sup>6</sup>.

§ 86. The form, structure, and functions of the stomach, are subject to great variety in this class of animals. In most carnivorous quadrupeds<sup>7</sup>, particularly those of a rapacious nature, it bears a considerable resemblance, on the whole, to that of the human subject: its form, however, differs in some cases, as in the seal (*phoca vitulina*), where the œsophagus enters directly at the left extremity, so that there is no blind sac formed in the stomach. In some animals, as in the lion, bear, &c. it is divided by a slight contraction in its middle, into

<sup>5</sup> See Professor NEBEL, *De Nosologia Brutorum cum Hominum Morbis comparatâ*. Giefs. 1798.

<sup>6</sup> It seems extraordinary on the first consideration, that the ruminating animals, in whom the passage of the food from the first stomach into the œsophagus is very easy, should not be excited to vomit without such difficulty.

I possess, through the kindness of Mr. HANEMANN, director of the veterinary school at Hanover, an hair-ball which was discharged by vomiting from the stomach of a cow, which laboured under an affection of the digestive powers. The substance in question was discharged with violence, after the employment of some white hellebore placed under the integuments of the breast. A more detailed account will be found in VOIGT'S "Magazine for the newest Occurrences in Natural History." vol. 2. p. 637.

<sup>7</sup> H. C. SCHROEDER, *De Digestione Animalium Carnivororum*, Goett. 1755, 4to.



two portions. Its coats, particularly the muscular one, are very strong in the carnivora<sup>8</sup>.

§ 87. In some *herbivora* the stomach has an uniform appearance externally; but it is divided into two portions internally, either by a remarkable difference in the two halves of its internal coat<sup>9</sup>, as in the *horse*<sup>10</sup>, or by a valvular elongation of this membrane, as in several animals of the mouse-kind. This is also the case in the *hare* and *rabbit*, where also the food in the two halves of the stomach, differs very much in appearance, particularly if the animal has been fed about two hours before death. (See note (C) at the end of the chapter).

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<sup>8</sup> We must not however trust implicitly to ROEDERER, when he says that "the bear has two stomachs, the first and largest of which is formed like that of a carnivorous animal, the second and smaller like that of birds, which feed on hard feeds."

<sup>9</sup> On the whole internal surface of the horse's stomach, there are found, in vast abundance, particularly in spring, the larvæ of two species of æstus; viz. the *æstus equi* (which LINNÆUS called *æstus bovis*), and the *æ. hæmorrhoidalis*, the true history of which has been elucidated for the first time in modern days, by that excellent veterinary surgeon, Mr. BRACY CLARK, in the *Transactions of the Linnæan Society*, vol. 3. Figures of the *æ. equi* and its larvæ are given in my "*Delineations, &c.*" pl. 5.

<sup>10</sup> BERTIN in the *Mem. de l'Acad. des Sc. de Paris*, 1746.



§ 88. In some other mammalia, particularly the herbivorous ones, this organ consists of two or more portions manifestly distinct externally, and forming as many stomachs. There are two of these in the *hamster*<sup>11</sup>; three in the *kangaroo*<sup>12</sup> and *tajacu*<sup>13</sup>; four in the *sloths*<sup>14</sup>.

The carnivorous cetacea have also a complicated stomach, consisting in some species of three, in others of four, and even of five subdivisions<sup>15</sup>.

§ 89. The most complicated and artificial arrangement, both with respect to structure and mechanism, is found in the well known four stomachs of the ruminating animals with divided hoofs; of this, we shall take as examples, the *cow* and *sheep*<sup>16</sup>.

The

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<sup>11</sup> This is excellently described by SULZER, in his work above quoted.

<sup>12</sup> *Voyage a la Recherche de la Perouse.* T. 1. p. 134.

<sup>13</sup> TYSON in the *Philos. Trans.* vol. 13.

<sup>14</sup> DAUBENTON, vol. 13. p. 54. and 63. and WIEDEMANN'S *Archives*, vol. 1.

<sup>15</sup> TYSON'S *Anatomy of a Porpoise*, London, 1680. 4to. HUNTER in SCHNEIDER'S "*Contributions towards the Natural History of Whales.*" in German, pt. 1.

<sup>16</sup> From the multitude of writers, who have treated on the stomach of ruminating animals, and its functions, I refer to the following only, on account of the plates which they have given, particularly such as exhibit the vast increase of size



The first stomach, or *paunch*, (*rumen, penula, magnus venter, ingluvies*), is by far the largest in the adult animal; not so however in the recently born calf or lamb. It is divided externally into two faccular appendices at its extremity, and it is slightly separated into four parts on the inside. Its internal coat is beset with innumerable flattened papillæ<sup>17</sup>.

This

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size in the first stomach compared with the fourth, in the early periods of life.

*Observ. Anat. Collegii privati Amstelodamensis*, pl. 1. p. 12.

PERRAULT, *Essais de Physique*, vol. 3. p. 211.

J. C. PEYER, *Merycologia*, Basil. 1685, 4to.

J. J. HARDERUS *Apiarium*, ib. 1687, 4to. p. 16.

DAUBENTON, tom. 4. tab. 15—18.

To which may be added, Mr. HOME's observations on the camel's stomach; which contain two excellent views of the cow's stomach by Mr. Clift, besides those of the camel. *Philos. Transf.* 1806, pl. 15, 16.

<sup>17</sup> It is generally in this first stomach, seldom in the second, that morbid concretions are formed, of a globular, or elongated but yet rounded figure. They are composed of three kinds of substance: viz. of hairs, of the undigested fibrous parts of plants, or of stony matters.

The hair-balls, particularly in the cow, are formed of the animal's own hair, which is licked off, and gradually accumulated in the stomach. These either retain a hairy appearance externally, or they are covered with a dark polished substance, similar to that which accumulates round their molar teeth. (See § 23).

The balls of the *chamois* (*agagropila*), consisting of vegetable matters, particularly of the macerated fibres of the *athusa meum*, are found in the animals from which they de-



This is followed by the second stomach, *honey-comb bag, bonnet, or king's-hood, (reticulum, ollula)*, which may be regarded as a globular appendage of the paunch; but is distinguished from the latter part by the elegant arrangement of its internal coat, which forms polygonal and acute-angled cells, or superficial cavities.

The third stomach, which is the smallest, is called the *manyplus*, which is a corruption of *manyplies (echinus, conclave, centipellio, omasum)*: it is distinguished from the two former, both by its form, which has been compared to that of a hedgehog when rolled up, and by its internal structure. Its cavity is much contracted by numerous and broad duplicatures of the internal coat, which lie lengthwise, vary in breadth in a regular alternate order, and amount to about 40 in the sheep, 100 in the cow.

The fourth, or the *red, (abomasum, faliscus, ventriculus intestinalis)*, is next in size to the

rive their name, and are generally of a fine spongy texture, covered externally with a smooth black coat.

Of the stony concretions, which constitute the *bezoars*, the oriental ones are derived from the *wild goats*. Others come from the South American species of camel. The latter are of a yellow-grey colour; the former of a greenish-black, with concentrical strata, and generally containing for a nucleus a small bit of rice-straw.

In a large *oriental bezoar*, which I sawed through, the nucleus consists of a red-brown, fine but compact, spongy substance, like that of the vegetable balls.

paunch,



paunch, of an elongated pyriform shape, with an internal villous coat like that of the human stomach, with large longitudinal rugæ.

§ 90. The three first stomachs are connected with each other, and with a groove-like continuation of the œsophagus, in a very remarkable way. The latter tube enters just where the paunch, the second and third stomachs approach each other; it is then continued with the groove, which ends in the third stomach. This groove is therefore open to the first stomachs, which lie to its right and left. But the thick prominent lips, which form the margin of the groove, admit of being drawn together so as to form a complete canal: which then constitutes a direct continuation of the œsophagus into the third stomach.

§ 91. The functions of this very singular part will vary, according as we consider it in the state of a groove, or of a closed canal. In the first case, the grass, &c. is passed after a very slight degree of mastication, into the paunch, as into a reservoir. Thence it goes in small portions into the second stomach, from which, after a further maceration, it is propelled, by a kind of antiperistaltic motion, into the œsophagus, and thus returns into the mouth. It is here ruminated, and again swallowed, when  
the



the groove <sup>18</sup> is shut, and the morsel of food, after this second mastication, is thereby conducted directly into the third stomach <sup>19</sup>. During the short time, which it probably stays in this situation between the folds of the internal coat, it is still further prepared for digestion, which process is completed in the fourth or true digestive stomach <sup>20</sup>. See note (E).

§ 92.

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<sup>18</sup> This supposes a power of voluntary motion in the part. And indeed the influence of the will in the whole affair of rumination, is incontestable. It is not confined to any particular time, since the animal can delay it according to circumstances, when the paunch is quite full. It has been expressly stated of some men, who have had the power of ruminating, (instances of which are not very rare,) that it was quite voluntary with them. I have known two men, who ruminated their vegetable food: both assured me that they had a real enjoyment in doing this, which has also been observed of others: and one of them had the power of doing it, or leaving it alone, according to circumstances.

<sup>19</sup> These facts were understood by SEVERINO, who says in his instructive *Zootomia Democritea* "A penula et ollula media revomitur ad os, hinc ruminatum ad conclave descendit, et hinc postremo ad ventriculum propriè dictum."

<sup>20</sup> I have already, on another occasion, observed that the final purpose of rumination, as applicable to all the animals, in which it takes place; and the chief utility of this wonderfully complicated function in the animal economy, are still completely unknown; what has been already suggested on these points, is quite unsatisfactory.

FABRICIUS AB AQUAPENDENTE has sufficiently refuted the old dream of ARISTOTLE and GALEN; that rumination supplies



§ 92. There are still two peculiarities in the stomachs of some mammalia, which must be mentioned here, before we proceed to consider that of birds. (For the account of the camel's stomach, see note \*\*, at the end of the chapter.)

In the *opossum*, the two openings of the stomach are placed as near, or even nearer together than in many birds; contrary to the usual rule, in this class of animals.

There is a peculiar glandular body at the upper orifice of the *beaver's* stomach, about the size of a florin, full of cavities, that secrete mucus. It resembles, on the whole, the *bulbus glandulosus* of birds; and assists in the digestion and animalization of the dry food, which this curious animal takes, consisting chiefly of the bark and chips of trees, &c. See note (F).

The stomach of the *pangolin* (*manis pentadactyla*) is almost as thick and muscular as that of the gallinaceous fowls, and contains, like that of granivorous

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plies the place of incisor teeth, the materials of which, are applied, in these animals, to the formation of horns. PER-RAULT and others supposed, that it contributed to the security of these animals, which generally eat much, and are timid, by shewing the necessity of their remaining long employed in chewing, in an open pasture. But the *Indian buffalo* ruminates, although it does not fly even from a lion, but rather attacks, and often vanquishes that animal. And the *wild goat* dwells in Alpine countries, which are inaccessible to beasts of prey.

birds,



birds, small stones and gravel, which are probably swallowed, for the same purpose, as in those birds<sup>1</sup>. See note (G).

### (B) BIRDS.

§ 93. As we have spoken above of the *cheek-pouches* of some mammalia, we must here take notice of the *throat sack*, which is found in the male<sup>2</sup> *bustard*, under the integuments of the front of the neck; and opens by a wide aperture under the tongue; its use has not been hitherto discovered<sup>3</sup>. See note (N).

§ 94. The *œsophagus*, which generally descends on the right of the trachea, as well as its opening into the stomach, is of immense size in

<sup>1</sup> That is to say, they are not swallowed, as BURT supposed, in the 2d vol. of *Asiatic Researches*, to afford nourishment; but in order to kill and bruise the insects, &c. which form the ordinary food of the animal, and which might otherwise, by means of their vitality, resist the chemical action of the gastric juice; as the *intestinal worms* and *water-newts*, which have been swallowed, do in man and other mammalia.

<sup>2</sup> The late Dr. BLOCH supposed, that he had found this part in the female bird. This was probably a mistake; for I have lately examined a female bustard, in which there was no trace of the part.

<sup>3</sup> EDWARDS'S *Natural History of Birds*, tom. 2. tab. 73. and SCHNEIDER, *Comment. ad reliqua Librorum, Frider. 2ndi*, p. 9.



many carnivorous birds; considerably larger indeed than the intestinal canal. The capaciousness of this tube, enables it hold for a time<sup>4</sup> the entire fish, and large bones, which these birds swallow, and which cannot be contained in the stomach; and to facilitate the discharge, by vomiting the indigestible remains of the food, which form balls of hair, feathers, and bony matter. See note (I).

§ 95. The œsophagus expands just before the sternum into the *crop* (*ingluvies, prolobus, le jabot*), which is furnished with numerous mucous, or salivary glands, disposed in many cases in regular rows. In such birds, as nourish their young from the crop, the glands swell<sup>5</sup> remarkably at that time, and secrete a greater quantity of fluid<sup>6</sup>. This part is found in *land birds* only, but not in all of these; it exists in all the *gallinæ*, and in some birds of prey<sup>7</sup>. See note (K).

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<sup>4</sup> A *sea-gull*, which I kept alive for some years, could swallow bones of three or four inches in length, so that the lower end only reached the stomach, and was digested, whilst the rest projected into the œsophagus, and descended gradually, in proportion as the former was dissolved.

<sup>5</sup> HUNTER *on the Animal Economy*, p. 193.

<sup>6</sup> This takes place in an inverse ratio to the age of the young pigeon, as long as the old birds keep their food in the *crop*. See *Viridet du bon Chyle, pour la Production du Sang*, t. 1. p. 78.

<sup>7</sup> See WOLF, in VOIGT'S *Magazine*, vol. 1. p. 72.



§ 96. There is another glandular and secretory organ, much more common than the crop, belonging indeed most probably \* to the whole class. This is the *bulbus glandulosus* (*echinus, infundibulum, proventriculus, corpus tubulosum*), which is situated before the entrance of the œsophagus into the proper stomach, and whose form and structure vary considerably in the different genera and species. In the *ostrich*, for example, its magnitude and form give it the appearance of a second stomach<sup>9</sup>. In some other birds, as the *psittaci, ardeæ* (crane, stork, &c.), its appearance is different from that of the proper stomach, but its size is larger; while, on the contrary, in gallinaceous fowls, it is much smaller<sup>9</sup>. See note (L).

§ 97. In most birds, the stomach lies at the upper<sup>10</sup> part of the abdomen, that is, close to the spine, and rests, in a manner, on a stratum of intestines; in the *cuckoo*, on the contrary, it lies below. This peculiarity does not, however, belong

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\* It appears, however, that the *bulbus glandulosus* is wanting in some birds, as the *king's-fisher*.

<sup>8</sup> Hence VALISNIERI calls it in this animal, "*the first stomach*;" see his "*Anatomy of the Ostrich*," in Italian, 1713, p. 159.

<sup>9</sup> For an account of several other variations in the structure of this part, in different birds, see the Parisian "*Mémoires pour servir à l'Histoire Naturelle des Animaux*."

<sup>10</sup> See note I. § 40.



exclusively to that curious bird<sup>11</sup>; for I have found it in the *ramphastos*, and the *corvus caryocatactes* (the nut-cracker).

A deviation from the natural structure, which is completely unparalleled, occurs in the stomach of the cuckoo. The gizzard of this bird is covered internally with an abundance of short, bristly, and spiral hairs, lying close together.

§ 98. The structure of the stomach differs most widely in the different orders and genera of this class. It appears merely as a thin membranous bag, in several of those which feed on flesh and insects, when compared with the thick muscular globes of the granivorous genera. But there are both many intermediate links<sup>12</sup> between these extremes, and at the same time considerable analogies in the structures, which are apparently the most opposite. This is particularly observable, in the course of the muscular fibres<sup>13</sup>, and in the callous structure and appearance of the internal coat<sup>14</sup>; in which

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<sup>11</sup> HERISSANT thought this circumstance peculiar to the cuckoo; and hence explained, why that bird does not incubate. *Mem. de l'Acad. des Sc.* 1755.

<sup>12</sup> HALLER has collected a Number of these in his *Element. Physiolog.* t. 7. p. 115.

<sup>13</sup> DUVERNEY, *Oeuvres Anatomiques*, tom. 2. p. 447.

<sup>14</sup> WEPFER, *Cicutæ Aquaticæ Historia et Nexæ*, p. 174. This is, on the whole, a most instructive work in this branch of zootomy.



points, many of what are called membranous stomachs, have a great resemblance to those of the *gallinæ*.

§ 99. Both parts, but particularly the muscular, are very strong in the gizzard (*ventriculus bulbosus*) of granivorous birds<sup>15</sup>. We find here, instead of a muscular coat, four immensely thick and powerful muscles: viz. A large hemispherical pair at the sides (*laterales*), and two smaller ones (*intermedii*) at the two ends of the cavity. All the four are distinguished, both by the unparalleled firmness of their texture<sup>16</sup>, and by their peculiar colour, from all the other muscles of the body.

The internal callous coat must be considered as a true *epidermis*; since, like that part, it becomes gradually thicker from pressure and rubbing<sup>17</sup>. It forms folds and depressions towards the cavity of the stomach: and these irregularities are adapted to each other on the opposed surfaces. The cavity of this curious stomach, is comparatively small; its lower orifice is placed very near the upper. Every part of the organ is, indeed, calculated for producing

<sup>15</sup> J. C. PEYER, *Anatome Ventriculi Gallinacei*, in his *Exercit. de Glandulis Intestinor.* Scahus. 1677, 8.

<sup>16</sup> W. G. MUYS, *De Carnis Musculose Structurâ.* Leid. 1741. 4to. tab. 1.

<sup>17</sup> MONRO'S *Essay on Comparative Anatomy.*



very powerful trituration<sup>18</sup>; and this is still further promoted, by the well-known instinctive practice of granivorous birds, of swallowing small hard stones with their food<sup>19</sup>.

### C. AMPHIBIA.

§ 100. The capacious œsophagus of the turtle, has a very striking peculiarity in its structure: its  
internal

<sup>18</sup> The numerous experiments, which REAUMEUR performed, in order to determine the extent of this tritulative power, are universally known. There are two curious observations on this subject, less generally known. FELIX PLATER found an *onyx*, which had been swallowed by a hen, to be diminished by one-fourth in four days; and a *Louis d'or* lost in this way 16 grains of its weight. See SWAMMERDAM, *Biblia Naturæ*, p. 168.

<sup>19</sup> The end and use of swallowing these stones, have been very differently explained. CÆSALPINUS considered it rather as a medicine than as a common assistance to digestion. BOERHAAVE, as an absorbent, for the acid of the stomach. REDİ, as a substitute for teeth. According to WHYTT, it is a mechanical irritation, adapted to the callous and insensible nature of the coats of the stomach. SPALLANZANI rejected all supposition of design or object, and thought that the stones were swallowed from mere stupidity. I think there is not much sagacity to be discovered in this opinion, when we consider that these stones are so essential to the due digestion of the corn, that birds grow lean without them, although they may be most copiously supplied with food. This paradoxical opinion has, however, been already refuted by J. HUNTER, in his "*Animal Economy*," p. 155.; and G. FORDYCE, on *Digestion*, p. 23.



internal coat is beset with <sup>1</sup> innumerable large, firm, and pointed processes of a white colour. Their points are all directed towards the stomach; and they probably serve to prevent the return of the food, which can only enter the stomach gradually.

§ 101. The œsophagus of the *crocodile* is of the funnel shape; the stomach of the animal resembles, although not very closely, that of the granivorous birds, in the nearness of its two apertures, and the thickness of its coats.

§ 102. The stomach of serpents can hardly be distinguished from the œsophagus, except that it is somewhat larger. It is very short, when compared with the great length of that tube. (See note (M).)

#### (D) FISHES.

§ 103. The œsophagus is short in most of this class. But this character is not universal, as ARIS-

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The use of swallowing these stones, seems to me, to consist in this, that they kill the grain, and deprive it of its vitality, which otherwise resists the action of the digestive powers. (See § 92, note 1.) Thus it has been found, that if the oats and barley given to horses, are previously killed by heating, the animal only requires half the quantity, and yet thrives equally.

<sup>1</sup> RUYSCU, *Tthesaurus Anatomicus*, 8vo. tab. 2.



TOTLE supposed<sup>2</sup>; nor is a long œsophagus peculiar to fishes of an elongated form. (See note (N).

§ 104. The size and form of the stomach vary<sup>3</sup> very considerably in this class. Its coats are thin in most fishes; but in some they are very thick and muscular<sup>4</sup>, and have a callous internal covering: still, however, the resemblance between these and the stomachs of granivorous birds is very remote.

(E) INSECTS.

§ 105. I have already observed, on another occasion<sup>1</sup>, that the business of nutrition in insects, does not seem to have for its object, the mere preservation of the individual, as in most red-blooded animals; but chiefly the consumption of organised matter; which will appear clearly, from considering the structure of their alimentary canal. In most of those, which are subject to a metamorphosis, the stomach, in the larva state, is of a great size, in

<sup>2</sup> See FABRICIUS AB AQUAPENDENTE, p. 101. of the edition quoted above.

<sup>3</sup> Representations of the stomach of several fishes, may be seen in the 2d vol. of COLLINS'S *System of Anatomy*. Lond. 1685, and in the "*Mémoires présentés*," &c. by VICQ D'AZYR.

<sup>4</sup> RONDELET, p. 70.

<sup>1</sup> In the "*Manual of Natural History*," in German, p. 298. edition 6th.



comparison with the short intestinal canal: while those on the contrary, which take little or no nourishment in their perfect state, have this organ remarkably diminished, and as it were contracted<sup>2</sup>.

§ 106. Our limits will allow us to take but little notice here of the endless varieties, and peculiarities of internal structure, which occur in the different genera and species of this multiform class of animals. We shall therefore only bestow two words<sup>3</sup> on those of the œsophagus and stomach. In several cases, the commencement and termination of the alimentary canal, the œsophagus and rectum, are surrounded by an anular portion of the spinal marrow.

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<sup>2</sup> Compare, for instance, the stomach of the larva of the *papilio urticae*, with that of the perfect *butterfly*, in SWAMMERDAM, *Biblia Naturæ*, tab. 34. fig. 4. and tab. 36. fig. 1.

<sup>3</sup> There are several delineations of the stomach, in the different orders of this class, viz. that of the *scarabeus nasicornis*, in SWAMMERDAM, tab. 27. Of the *earth-beetle*, in RÖSEL, vol. 2. tab. 8. Of the *stag-beetle* (*lucanus cervus*), *ibid.* tab. 9. Of the *earwig*, in C. F. POSSELT, *Tentamina circa Anatomiam forficulae Auriculariae*. Jen. 1800, 4to. fig. 26. Of the *gryllus verrucivorus*, in RÖSEL, vol. 2. tab. 9. Of the *silkworm*, in MALPIGHI, *de Bombyce*, 1669, 4to.; in RÖSEL, vol. 3. tab. 9.; and BIBIENA, in the *Comment. Instit. Bonon.* tom. 5. part 1. tab. 2 and 3. Of the *coffus*, in LYONET's chef d'œuvre, "*Anatomie de la Chenille*," &c. Of the *ephemera horaria*, in SWAMMERDAM, tab. 15. Of the larva of the *musca chamalcon*, *ibid.* tab. 41. Of the *musca putris*, *ibid.* tab. 43. Of the *louse*, *ibid.* tab. 2.



In the earwig (*forficula auricularia*), the upper orifice of the stomach is furnished with two rows of teeth <sup>4</sup>.

In some of the *grylli* (grasshoppers), the stomach itself is small, but the œsophagus much larger.

In some species of that genus, particularly in the *gryllus gryllotalpa*, the stomach consists of three or four vesicular portions <sup>5</sup>, which have been compared with the stomachs of the ruminating mammalia <sup>6</sup>.

We have already (§ 1, note 1.) mentioned the stomach of the *lobster*, and some other species of the genus *cancer* <sup>7</sup>; which is provided with several portions of bone. It contains also three teeth, which, together with the stomach itself, are annually reproduced, at least in the *craw-fish* (*cancer astacus*). (See note (O).

#### (F) VERMES.

§ 107. We can only select a few instances <sup>8</sup>,  
as

<sup>4</sup> POSSELT, in the work above quoted, p. 27. fig. 27.

<sup>5</sup> CUVIER, in the *Mémoires de la Société d'Hist. Nat. de Paris*, an. 7. tab. 4.

<sup>6</sup> SWAMMERDAM, *Algem. Verhandel. van de Bloedeloofse Dierkens*. Utrecht, 1769, 4to.; and G. H. VELSCHII, *Hecatostæ Obs.* Aug. Vind. 1675, 4to. p. 71.

<sup>7</sup> See WILLIS, *De Anima Brutorum*, for a representation of this in the *craw-fish*. Also RÖSEL, vol. 3. tab. 58.

<sup>8</sup> The following zootomists have given us representations of



as examples of this class, which includes a great number of creatures, differing widely from each other.

The *aphrodite aculeata* (sea-mouse), which is well-known, on account of its beautiful colours, possesses a very remarkable stomach. The form and size of the viscus, resemble those of a date, while in strength and compactness of texture, it approaches to that of granivorous birds<sup>2</sup>.

The œsophagus is expanded into a *crop* in many *testacea*, particularly among the *bivalves*; and it is covered internally with numerous small teeth<sup>3</sup>.

of the stomach, in the different orders of *vermes*: viz. TYSON, of the round worm (*lumbricus teres*, *ascaris lumbricoides*), in the *Philos Transf.* vol. 13. No. 137; which may be compared with WERNER, *Vermium Intestin. Expositio.* Lips. 1782. tab. 7. WILLIS, of the *earth-worm*, tab. 4. Also VANDELLI, *Diff. de Aponi Thermis*, &c. Patav. 1758, 8vo. MORAND, of the leech, in the *Mem. de l'Acad. des Sc.* an. 1739. As well as BIBIENA, in the *Comm. In'it. Bonon.* tom. 7, p. 102. Of the *slug*, SWAMMERDAM, tab. 9. Of the *cuttle-fish*, *ibid.* tab. 51. As also MONRO, *On the Physiology of Fishes*, tab. 31. POLI, of several *testacea*, in his "*Testacea utriusque Siciliae*," viz. the *pholas dactylus*, tom. 1, tab. 7.; the *tellina planata*, tom. 1. p. 14. *Mastra Neapolitana*, tom. 2. tab. 19.; the *venus chione*, tab. 20. Of the *snail*, SWAMMERDAM, tab. 5. Of the *sea hedge-hog* (*echinus esculentus*), MONRO, tab. 32.

<sup>2</sup> See PALLAS, *Miscellanea Zoologica*, tab. 7.

<sup>3</sup> For instance, in the *chiton cinereus*, see POLI, tom. 1. tab. 3. Compare also the œsophagus of the *cuttle-fish*, which is furnished with teeth in the same manner. See TURBERVILLE NEEDHAM'S "*Nouvelles Observations Microscopiques*," tab. 3.

The



The powerful stomach of the *bulla lignaria*, contains three hard calcareous shells, by which the animal is enabled to bruise and masticate the other testacea, on which it feeds <sup>4</sup>.

In most of the proper *mollusca*, the stomach is of a simple membranous structure, and of very different comparative magnitudes. I have found it very large in the *scyllæa pelagicum*. It occupies the greatest part of the body in the *leech*, and is divided internally by means of ten imperfect partitions, into somewhat separate portions.

Lastly, the armed polypes (*hydra*), and other similar *zoophytes*, can hardly be considered as any thing more than a mere stomach, having its opening furnished with tentacula. (See note (P) at the end of the chapter.)

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*Additional Notes to the Sixth Chapter.*

(A) A cheek-pouch exists also in the *ornithorhynchus paradoxus*. Phil. Transf. 1800, part 1, tab. 2. fig. 2.

The *salivary glands* of the mammalia exhibit

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<sup>4</sup> DRAPARNAUD, in the new *Journal de Physique*, tom. 7. p. 146. This stomach, was lately taken by some naturalists, for a peculiar genus, of an entirely new order of *three-shelled testacea*.



very few variations in structure. They are small in the *carnivora*, as mastication, properly so called, can hardly be said to take place in them. On the contrary, the *ruminantia* and *solipeda* have them very large. The size of the sub-maxillary gland, in particular, is remarkable in the *cow* and *sheep*: it extends along the side of the larynx, quite to the back of the pharynx.

The parotid and sublingual glands do not exist in the *amphibious mammalia*, as the *seal*: the teeth of that animal are only adapted for seizing their prey, and must be utterly incapable of mastication. The same remark may be made on the *cetacea*, where the salivary system seems to be altogether deficient.

The mucous glands, which constitute the *labiales* and *buccales* of man, are larger and more distinct in some animals. There is a row of these opposite to the molar teeth of the *dog* and *cat*, penetrating the membrane of the mouth by several small openings. There is also a considerable gland in the *dog*, under the zygoma, and covered by the masseter. Its duct, equal in size to that of the parotid, or sub-maxillary glands, opens at the posterior extremity of the alveolar margin of the upper jaw. The molar glands and their openings, are very conspicuous in the *pig*. The *cow* and *sheep* have an assemblage of similar glands in the zygomatic fossa: their excretory ducts open behind the last superior molar tooth.



(B) No mammalia possess an uvula, except *man*, and the *fimiæ*. As the *cetacea* possess no nostrils, they have not of course any velum palati.

The parts about the pharynx exhibit a very singular structure in these animals. The larynx is elongated, so as to form a pyramidal production, on the apex of which, its opening is found. The projection of this part will divide the pharynx; and the food must pass on either side of the pyramid. A muscular canal extends from the pharynx to the blowing holes, and is attached to the margin of those apertures. The circular fibres of this tube, form a sphincter muscle; which, by contracting round the pyramid, cuts off the communication between the blowing holes and the mouth and pharynx.

(C) In the animals alluded to in this paragraph, the left half of the stomach is covered with cuticle, while the other portion has the usual villous and secreting surface. The cuticular covering, forms amore or less prominent ridge at its termination. The left portion of the cavity may be regarded as a reservoir, from which the food is transmitted to the true digestive organ; and the different states, in which the food is found in the two parts of the cavity, justify this supposition. Hence these stomachs form a connecting link between those of  
ruminating



ruminating animals on one side; and such as have the whole surface villous, on the other.

(D) The larvæ of the *æstrus equi* (the large horse-bot), attach themselves to every part of the stomach, but are in general most numerous about the pylorus; and are sometimes, but much less frequently, found in the intestines. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, where they adhere, by means of two small hooks, or tentacula. When removed from the stomach, they will attach themselves to any loose membrane, and even to the skin of the hand; for this purpose, they draw back their hooks almost entirely within the skin, till the two points of these hooks come close to each other; they then present them to the membrane, and keeping them parallel till it is pierced through, they expand them in a lateral direction; and afterwards, by bringing the points downwards, or towards themselves, they include a sufficient piece of the membrane with each hook, and thus remain firmly fixed, for any length of time, without any further exertion of the animal. They attain their full growth about the latter end of May, and are coming from the horse from this time to the latter end of June. On dropping to the ground, they soon change to the *chrysalis*, and in six or seven weeks the fly appears. This bot is larger and whiter than that of the *æstrus hæmorrhoidalis*,



*morhoidalis*, which has a reddish cast; but in its structure, and situation in the animal, resembles the former. It is found, however, to hang about the rectum, previously to quitting it, which the large horse-bot never does.

Veterinary practitioners do not seem to have decided hitherto, whether these animals are prejudicial to the horse; nor even whether they may not be actually beneficial. Their almost universal existence at a certain season, even in animals perfectly healthy, shews that they produce no marked ill effect: yet the holes which they leave, where they were attached to the stomach, could hardly be made, without causing some injurious irritation.

For the mode, in which these bots gain admission into the stomach, as also for a most interesting general account of their history and structure, see REES'S *Cyclopædia*, art. BOTTS; which was furnished by Mr. CLARKE, and from which the preceding account is borrowed.

(E) The food of carnivorous animals approaching in its constituent elements more nearly to those of the animal, than that of the herbivorous tribes; is more easily reduced into the state, which is required for the nourishment of the body, in the former than in the latter case. Hence arises a leading distinction between the stomachs of these classes. In the latter animals, the œsophagus opens considerably to the right of the great extremity, so as  
to



to leave a large cul de sac on the left side of the stomach; and the small intestine commences near the cardia, leaving a similar blind bag on the right. The food must be detained for a long time in such a stomach, as the passage from the œsophagus, to the pylorus is indirect and highly unfavourable to speedy transmission. Animals of the *mouse* kind, and the *rodentia* shew this structure very well; it is very remarkable in the *mus quercinus*, (CUVIER *Léçons*, &c. tom. 5. pl. 36. fig. 11.) In the *carnivora*, the stomach, which is of a cylindrical form, has no cul de sacs; the œsophagus opens at its anterior extremity, and the intestine commences from the posterior; so that every thing favours a quick passage of the food. Animals of the *weasel* kind, which are very truly carnivorous, exhibit this structure the most completely. The *seal* also exemplifies it; and the *lion*. (CUVIER, pl. 36. fig. 7).

(\*\*) The peculiar structure of the stomach in the *camel* and *lama*, which enables these animals to take at one time a sufficient quantity of water to last them for two, three, or more days, and thereby renders them adapted to inhabit the dry and sandy deserts, which constitute their natural abode, has been entirely omitted by the author. The fluid, which they drink, is deposited in numerous cells formed in the substance of their first and second stomachs, by strong bands of muscular fibres



fibres crossing each other at right angles. It should seem that the animal has the power of closing these cells, by the contraction of those fibres which form the mouths of the cavities; or of expelling the contained fluid by putting the other portions of fibres in action.

This cellular structure is found in two parts of the first stomach; and it occupies the whole of the second. It was found in a dead camel, that these cavities would hold two gallons of fluid: but they were probably more capacious during life, as the animal in question always drank six or seven gallons of water every other day, and took more in the intermediate time. Mr. BRUCE states in his travels, that he procured four gallons from one which he slaughtered in Upper Egypt. (*SHAW'S Abridgment of Bruce's Travels*, ed. 3. p. 371).

As all the food which the animal takes passes into the first stomach, the water of the cells in that part becomes turbid; but it remains perfectly pure in the second, where it resides in the greatest quantity: which circumstance accounts for travellers being able to drink it on an emergency. The muscular bands, which form the groove described at § 90, are particularly strong; and by drawing the third stomach to the cæso-phagus, convey the ruminated food through the second, without polluting the water in its cells. Hence the food that has been macerated in the paunch must be sent back to the  
mouth



mouth directly from that cavity, without passing into the second stomach, as it does in the *cow*. See "Observations on the camel's stomach, respecting the water which it contains," &c. by E. HOME, Esq. *Philos. Transf.* 1806.

The cells are described and delineated, but very imperfectly, by the Parisian dissectors. *Description Anatomique*, &c. p. 80.

The structure of these parts in the *lama*, according to the account which CUVIER has given of them, from the examination of a fetus, does not seem to differ essentially from that of the camel.

*Léçons d'Anat. Comp.* tom. 3. p. 397.

Mr. HOME also describes a projecting glandular body in the fourth stomach, near the pylorus, both in the *cow* and *camel*. He states that it may shut that aperture. The same body is represented as very large in the *lama*, by CUVIER *loc. cit.*

(F) According to CUVIER, there is a gland, as large as the head of a man, situated between the coats of the stomach in the *manati* (*tricheus manatus borealis*). It is placed near the œsophagus, and discharges, on pressure, a fluid like that of the pancreas by numerous small openings.

*Léçons d'Anat. Comp.* tom. 3. p. 401.

Mr. HOME is of opinion, that a glandular structure exists in the stomach of the *sea-otter* near the pylorus. *Philos. Transf.* 1796. pl. 2. And Mr. MACARTNEY has discovered an arrangement of glandular



glandular bodies in the *dormouse*, round the œsophagus just before its termination, similar in situation and appearance to the gastric glands of birds.

(G) The stomach of the *ornithorhynchus bystrix* is covered with cuticle, and possesses sharp horny papillæ near the pylorus. The animal swallows sand, which may probably assist in the reduction of the food, as the gravel does, which is swallowed by the gallinaceous birds. HOME in the *Philos. Transf.* 1802. p. 2.

(H) A very remarkable dilatation of the fauces occurs in the *pelican*. An immense pouch, capable of holding several quarts of water, lies between the branches of the lower mandible, and constitutes a reservoir for the food, which consists of fishes. By means also of this bag, the animal feeds its young, until they are of sufficient strength to provide for themselves.

(I) Proper salivary glands, such I mean, as secrete that clear and limpid fluid constituting the saliva, do not exist in birds. For mastication, or the comminution of the food, and its reduction into a soft paste, to which function these glands are entirely subservient, is not performed in the mouth of these animals, but in their gizzard. Birds however have a very copious apparatus of those mucous follicles, which form the glandulæ labiales, buccales,



buccales, linguales, &c. of the human subject. The sides of the tongue, the under surface of that organ, and the entrance of the œsophagus, are beset with numerous openings of these glands, which furnish an abundant supply of viscid mucus to defend the tender lining of these parts from the hard bodies, which constitute the food of several birds. These apertures are very conspicuous in the gallinæ. The *ostrich* in particular, has two flattened bodies at the upper and back part of the palate, which may be compared in some respects to tonsils. The surface of these is covered with innumerable foramina, from which a tenacious mucus may be expressed. The soft palate, &c. are entirely deficient in birds: the nostrils open on the bony palate by longitudinal slits, the sides of which are guarded by soft pointed papillæ.

(K) The crop of the *common fowl*, and of the other *gallinæ*, is of a globular form, and placed just in front of the chest. The œsophagus, which opens at its upper part, commences again about the middle of the bag, so that the crop itself forms a cul de sac, or bag out of the regular course of communication between the two openings of the œsophagus. In the *pigeon* there is a spherical bag formed on both sides of the œsophagus; which tube itself is very large in the *pouting pigeon*, and admits of being distended with air, so as to cause the appearance from which the name of the bird is derived.

In



In the birds, which we have now mentioned, the crop must be considered as an organ for macerating the dry and hard vegetable substances, which constitute the food of these animals. The *accipitres* also have this dilatation; but it must be regarded in them merely as a reservoir for the food, which does not require any previous softening. It is wanting in the piscivorous birds; but its place is supplied by the great size of the œsophagus, in which entire fishes are held until they can pass into the stomach. The *heron, cormorant, &c.* exemplify this.

(L) The term *bulbus glandulosus* (*ventricule succenturié*, CUVIER) is applied to a small portion of the œsophagus, just before its termination in the stomach. This part is obviously rather larger and thicker in its coats than the rest of the tube. Its structure may be most clearly discerned in the gallinaceous genera. The œsophagus consists, as in other parts, of its two coats, the muscular and villous: but a vast number of *glandular bodies*, cylindrical in form, and arranged in close apposition to each other, are interposed between these tunics, and entirely surround the tube; constituting the “*zone of gastric glands*” of Mr. MACARTNEY, (REES'S *Cyclopædia*, Art. BIRDS). These bodies have a hollow internally, and they open into the cavity of the *bulbus*. The fluid secreted by them, which from their number and size, must be furnished



in great abundance, passes into the gizzard, and mixes with the food in proportion as it is triturated by that organ. These glands are much less distinct in those birds which live on animal food, as the *accipitres*, and the *piscivorous genera*, but they exist universally, and their openings can always be discerned. The *ostrich* affords an opportunity of examining them to great advantage. In the *African* species, of which I dissected an individual, the œsophagus was dilated into an immense bag, capable of holding several pints of water, and five or six times larger than the gizzard itself, which was placed on the right and anterior part of this dilatation. The glands did not surround the tube, so that the term of *zone* would be here inapplicable. They formed a long but narrow band, commencing at the termination of the œsophagus, and running along the front of the bag towards the gizzard. This band measured about twelve inches in length, and not more than three at its greatest breadth. The size of the individual glands varied: they were largest in the middle, and decreased towards either margin of the band. Some of them equalled a large pea; and their openings were in proportion. They were arranged in close apposition to each other, and the inner surface of the pouch was covered by a continuation of the insensible lining of the gizzard, which separated very easily from the surface.



(M) Reptiles resemble birds in having their nostrils terminate by two longitudinal flits on the palate; and in the want of velum palati, and epiglottis.

The œsophagus of the serpent kind is of immense magnitude; for these reptiles swallow animals larger than themselves, which are retained for a considerable time in the tube, and descend into the stomach by degrees, where they are slowly subjected to the action of the gastric juice. The whole process sometimes occupies many days or even weeks.

(N) From the peculiar formation of the nose of fishes; and from their respiring by means of gills, their fauces have no connection with any nasal cavity, or glottis.

The œsophagus is of great width in fishes; and is distinguished with difficulty in many cases from the stomach. These animals swallow their food whole, without subjecting it to any mastication; and if the stomach will not hold the whole, a part remains in the œsophagus, until that, which has descended lower, is digested. The alimentary canal is generally very short; sometimes extending straight from the mouth to the anus with very little dilatation; as in the lamprey (*Petromyzon marinus*).



(O) The crustacea, and some insects, are furnished with organs of mastication of similar structure. Their mouth is formed of two or more pairs of jaws placed laterally. These move from without inwards, and vice versa; whereas those of red-blooded animals move from above downwards, and back again. The parts, which are termed the lips of insects, are two bodies; of which one is placed above or in front of the jaws, and the other below or behind them. The palpi or feelers are articulated to the jaws. All insects, which have jaws, possess the power of masticating hard animal and vegetable substances; for these parts are of a firm horny texture, and in many cases are very large, when compared with the size of the animal.

The locusts (*grylli*), the dragon-fly (*libellula*), the beetles, and particularly the *lucanus cervus*, or stag-beetle, and the *staphylinus maxillofus*, are examples in which the jaws are very large and manifest, and often possess denticulated edges. All the genera of the following orders have jaws; viz. the *coleoptera*, *orthoptera*, *neuroptera* and *hymenoptera*. The insects of the remaining orders derive their nourishment chiefly from liquids; which they get either from animal or vegetable substances by means of a spiral and tubular tongue, or a soft proboscis, (as in the *lepidoptera*), with a broad opening, admitting of extension and retraction,



(the *hemiptera*), or a horny pointed tube, containing sharp bristly bodies internally (the *diptera* and *aptera*).

The stomach of the *bee* is a transparent membranous bag, in which the nectar of the flowers is elaborated and converted into honey. The animal vomits it up from this reservoir, and deposits it in the hive.

The stomach of the *crab* and *lobster* is a very singular organ. It is formed on a bony apparatus, in short a species of skeleton; and does not therefore collapse when empty. To certain parts of this bony structure, round the pylorus, the teeth are affixed. Their substance is extremely hard, and their margin is ferrated or denticulated: as they surround the tube, near the pylorus, nothing can pass that opening, without being perfectly comminuted. These bones and teeth are moved by peculiar muscles.

(P) In those mollusca, which possess jaws, these parts are fixed in the flesh of the animal, as there is no head to which they can be articulated. They are two in number in the *cuttle-fish*, are composed of a horny substance, and resemble exactly the bill of a parrot. They are placed in the centre of the lower part of the body, and are surrounded by the tentacula, which enable the animal to attach itself to any objects. By means of these parts, the shell-fish, which are taken for food, are completely



trituated. The *common snail* and *slug* have a single jaw, femilunar in its form, and denticulated. The *tritonia* has two jaws, which act like the blades of a pair of scissars. The other *mollusca* possess no organs of this kind; but have, in some instances, a sort of proboscis; as the *buccinum*, *murex*, *voluta*, *doris*, *scyllæa*, &c.

In the *worms*, properly so called, there are sometimes hard parts forming a kind of jaws or teeth. Thus in the *nereis*, the mouth possesses several calcareous pieces. The *aphrodite* (*sea-mouse*), has a proboscis, furnished with four teeth, which it can extend and retract at pleasure. Within the mouth of the *leech* are three semicircular projecting bodies, with a sharp denticulated edge: by this apparatus the animal inflicts its wound of the well-known peculiar form in the skin.

The teeth of the *echinus*, (*sea-hedgehog*) are of a very singular arrangement; a round opening is left in the shell for the entrance of the food; a bony structure, on which five teeth are placed, fills up this aperture; and as these parts are moved by numerous muscles, they form a very complete organ of mastication.

The stomach of the *vermes* is, in general, a membranous bag; but in some cases its structure is more complicated. In addition to the instances mentioned by the author, we may observe that the *belix stagnalis*, and the *onchidia*, have gizzards. The *aplysia* has three strong muscular stomachs, provided



provided with pyramidal bony processes. This structure, together with that of the *bulla lignaria*, and of the *lobster* and *crab*, presents a new analogy, as CUVIER has observed, between the membranes of the intestines, and the integuments of the body. This is particularly strengthened by the annual shedding of the lobster's teeth, when its crustaceous covering falls off.



## CHAPTER VII.

## ON THE INTESTINAL CANAL.

## (A) MAMMALIA.

§ 108. **T**HE intestinal canal (which is the most common part in the whole animal kingdom after the stomach), is distinguished in this class, by two peculiarities, which depend on the mode of nutrition. It is comparatively shorter in *carnivorous animals*, and there is also in these, less difference to external appearance, between the small and the large intestine, than in the *herbivora*. Yet these rules are not without their exceptions. For the *seal* has very long, and the *sloth* very short intestines; the *badger*, which is not a proper carnivorous animal, and several true *herbivora*, as, for instance, the *weasel* (*glis esculentus*), have no distinction between the large and small intestine, &c. (See note (A) at the end of the chapter).

§ 109. The valvulae conniventes of the small intestine are more faintly marked in most mammalia than in man; in some indeed they do not exist at all, and this happens both in carnivorous  
and



and herbivorous animals. In the *cetacea*, on the contrary, the internal surface of the intestines has longitudinal folds of a zig-zag appearance.

The possession of a villous coat for the absorption of the chyle constantly distinguishes the small from the large intestine, which seems to be merely destined for the reception of the fæces. The villi are remarkably long and numerous in the bear\*.

The Fallopian valve (*valvula coli*) is wanting in a few animals only of this class, as, for instance, in the hedgehog†.

§ 110. There is great variety with respect to the cæcum in this order, even in the different species of the same genus. Many, particularly of the *carnivora*, have none; it is also wanting in some herbivora, as the *rell-mouse*. In others of the latter description, it is often of enormous size. Thus in the *hare* and *rabbit* it is longer than the whole animal, and furnished internally with a peculiar spiral valve. The *marmot of the cape* has first

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\* There is an account of the structure of this villous coat, in several species of all the four classes of red-blooded animals, in R. A. HEDWIG'S *Disquisitio Ampullularum Lieberkühni*, Lips. 1797, 4to. and in K. A. RUDOLPHI'S *Anatomico Physiological Transactions*, in German, p. 41.

† ROEDERER gives an accurate description of this valve in our domestic animals, "*De Valvula coli*." Argent, 1768, 4to. p. 46.

a large



a large cæcum, and then, further on, two other conical blind appendices.

The *appendicula vermiformis* is wanting in many mammalia; even in some of the simiæ. (See note (B) at the end of the chapter.)

§ III. In most herbivorous animals of this class, the colon is large, long, and divided into cellular compartments. This is remarkably the case with the *elephant* and *horse*. The large intestine of the latter is 24 feet long; while, on the contrary, in a moderate sized dog it is about six or eight inches. The rectum of the latter has strong transverse folds which contract it, and render the evacuation of the fæces difficult.

In a few instances, as the *beaver* and *sloth*, the rectum and urethra have a common termination, which may be compared to the cloaca of birds<sup>2</sup>.

This

<sup>2</sup> As we have spoken above of the *bezoars* and other concretions formed in the stomach, we must here take notice of the intestinal stones, which occasionally occur in horses, and of the valuable fecal concretions of the pikeheaded whale or cachalot. (*Physeter Macrocephalus*).

The former are commonly of a yellowish grey colour; of a globular form, shining externally, but of a dead and earthy appearance in their fracture; not very hard; and in their average size about equal to a billiard ball; although they have been found as large as a man's head: all these external characters vary indeed considerably. The most remarkable



This similarity is however the most striking in the cloaca of the ormithorhynchus. (Home in the Philos. Transf. for 1802, pl. 1.)

## (B) BIRDS.

remarkable circumstance relating to them, is their composition; according to FOURCROY and BARTHOLDI they consist in the proportion of one half, of phosphate of magnesia. They are often found in millers' horses, which have been fed for a long time with bran and mill-dust; there is usually only one, but sometimes more; they are most frequent in the colon, and have very seldom been found in the stomach (at least of the same sort, which has been now described). They are not discovered in general until the death of the animal. But I find an instance, in the "*Epistola de Re Numismaticâ ad Z. GOEZIUM*, of a horse, which voided a stone of the above-mentioned kind, as large as a hen's egg, every month with his fæces.

A species of globular concretions, very different from these intestinal stones, is occasionally found in the colon, and cæcum of the horse. It is composed of fine vegetable fibres, and resembles, on the first view, the balls of the *chamois*, (see note 17, § 89). Hence LAFOSSE, who has described and delineated them, calls them *agagropilæ*, by way of distinction from the true intestinal stones, which he terms *bezoar equinum*, see his "*Cours d' Hippieutique*," p. 158. tab. 51. Like the balls of the *chamois*, they are much lighter than intestinal stones; and two of them are not unfrequently found together, one being inclosed within the other.

The fecal indurations of the *cachalot* form the valuable substance, known by the name of *ambergris*, which was formerly considered as an animal excrement, but has been supposed latterly by some to be a fossile substance, by others to be a vegetable resin: its animal origin is now placed beyond all doubt. Sir Jos. BANKS informed me, some time ago, that, according to what he could learn from the English South-



## (B) BIRDS.

§ 112. The alimentary canal, in this class, is much shorter than in the mammalia; it is also generally shorter in carnivorous birds than in such as derive their food from the vegetable kingdom. There is hardly any perceptible external difference between the large and small intestine; indeed, the commencement of the canal is often larger than the termination.

§ 113. Most birds have two cæca, which are of considerable length in some species of the gallinaeous and aquatic birds. They are characterized in the ostrich<sup>3</sup>, by a remarkable spiral valve. Some few aquatic birds have only a single cæcum; and some, particularly among the birds of prey, want it entirely.

§ 114. The rectum ends in a part called the cloaca; which is an expanded portion, containing

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South-Sea whalers, the fæces of the cachalot, which are nearly fluid in a healthy state, are hardened into this ambergris, by a kind of constipation; hence, it is only found in weak and exhausted animals; and the firmest and most valuable, comes from such as seem to have died of the complaint, which it has occasioned.

<sup>3</sup> See VALISNIERI, *Anatomy of the Ostrich*, tab. 2.



the terminations of the ureters, the genital organs, and the *bursa* FABRICII. This latter part varies in form in the different species, being oval, or elongated, &c.; it is largest in young birds, and is so contracted in older ones, that it will hardly hold a millet-seed<sup>4</sup> in an old cock. (For a further account of it, see note (C) at the end of the chapter).

(C) AMPHIBIA.

§ 115. We shall take only one species of each of the two chief divisions of this class, by way of examples.

The intestinal canal of the hawksbill turtle (*testudo caretta*), is five times as long as the whole animal; the small intestine, as it is called, is larger than the short portion of large intestine. Both portions have longitudinal<sup>5</sup> folds internally, and are covered with an abundance of mucus<sup>6</sup>, (which is the case in the whole class).

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<sup>4</sup> DE GRAAF, *De Mulierum Organis Generat. Inservientibus*, tab. 17.; and G. G. TANNENBERG, *Spicileg. Observ. circa Partes Genital. Masculas Avium*, Gött. 1789, 4to. tab. 2 and 3.

<sup>5</sup> I found these folds, so large and numerous in the rectum, that a transverse section of the gut, presented the appearance of a broad radiated ring.

<sup>6</sup> That portion of the small intestine, which corresponds to the jejunum, was beset, in the animal which I dissected, with innumerable small processes, like the *appendiculae epiploicae*, which are occasionally found in some mammalia.



§ 116. In the *coluber natrix*, the whole length of the intestinal canal does not equal that of the animal. The small intestine forms a very considerable *fallopian valve*, by a prolongation at its entrance into the large. The termination of the small, as well as the large intestine, the stomach, and œsophagus (which is one-third of the length of the whole animal) have longitudinal folds<sup>7</sup> internally.

(D) FISHES.

§ 117. The intestinal canal of this class, with a very few exceptions, is extremely short. In some, as the *torpedo*<sup>8</sup>, it is only half as long as the stomach. However, the passage of the chyle, and afterwards of the fæces, through the intestine, is lengthened in this, and some other cartilaginous fishes, by a spiral valve<sup>9</sup> \*.

<sup>7</sup> See CHARAS, *Nouvelles Experiences sur la Vipère*. Par. 1672, 8vo.; and TYSON'S *Anatomy of a Rattlesnake*. Philof. Transf. vol. 13, No. 144.

<sup>8</sup> LORENZINI, "Observations relating to the *Torpedo*," in Italian. Flor. 1678, 4to. tab. 2.

<sup>9</sup> It is delineated, from another species of *ray*, by SWAMMERDAM, in the 4th edition of BARTHOLIN'S *Anatomy*. Lugd. Bat. 1673, p. 297; which contains much valuable information in zootomy. PERRAULT has represented it in a *shark*, *Essais de Physique*, v. 3.

\* For an account of the structure of the coats of the alimentary canal, see note (D) at the end of the chapter.



§ 118. The *appendices pyloricæ*, (which are found in all fishes, with a very few exceptions, as the *pike*) sometimes open at the lower orifice of the stomach, but generally at the commencement of the intestinal canal, and secrete a fluid, which seems to have considerable influence on the business of digestion and chylication<sup>10</sup>, which is performed in these animals in a very short time. They have generally the appearance of small blind appendices<sup>11</sup>, and their number varies in the different species, from one to several hundreds. In some cartilaginous fishes, they are, as it were, consolidated into a glandular body<sup>12</sup>, which has been compared to the pancreas of warm-blooded animals.

(E) INSECTS.

§ 119. Similar blind appendices (*vasa varicosa* of SWAMMERDAM), are found on the short alimen-

<sup>10</sup> The leading work, on this subject, is very rare, "*Pars altera Observ. Anat. Collegii privati, Amstelod.*" which was produced almost entirely by SWAMMERDAM.

<sup>11</sup> In some, as the BURBOT, they appear almost like a finger. Hence the part has been called the *burbot's hand* or foot. See CHR. ENCELIUS, *De Re Metallicâ*. Francof. 1551, p. 241; which contains, I believe, the first delineation of the part.

<sup>12</sup> The consequences, which may be drawn from this circumstance, towards the elucidation of the business of secretion, have been already pointed out in my *Instit. Physiol.* p. 367.



tary canal of several insects<sup>13</sup>; which is particularly distinguished from that of red-blooded animals, by the want of mesentery<sup>14</sup>.

(F) VERMES.

§ 120. Several *mollusca* have these appendices on both sides of their short intestinal tube, viz. the *aphrodite aculeata*. Those testacea, which remain fixed in one situation, have a shorter and more simple intestinal canal than those which have the power of locomotion. The rectum, according to POLI, passes directly through the heart in most of the bivalves. In the slug (*limax*), as well as in the similar animal, which inhabits a shell (*helix*), the rectum opens on the front of the *limbus*, close to the air-hole. The *leech* can hardly be said to possess an intestine; yet it has an anus at the end of the tail, from which some little fecal matter is discharged, most of this being evacuated by the mouth. The *armed polypes* have no opening of this kind\*.

<sup>13</sup> Some zootomists have considered these as small intestines; others as biliary ducts; and others as lacteal vessels.

<sup>14</sup> On this subject, as well as on several of the following chapters, the references contained in the notes to the 106th and 107th paragraphs, may be consulted.

\* For a further account of the alimentary canal, in the lower orders, see note (E) at the end of the chapter.



*Additional Notes to the Seventh Chapter.*

(A) In considering the proportionate lengths of the intestinal canal, and the relation which these bear to the kind of food, on which the animal subsists, many circumstances must be taken into the account, besides the mere measure of the intestine. Valvular projections of the internal membrane; dilatations of particular parts of the canal; and a large general diameter, compensate for shortness of the intestine; and vice versâ. The structure of the stomach must also be considered; as, whether it is formed of more than one cavity; whether the œsophagus and intestine communicate with it in such a manner, as to favour a speedy transmission of the food; or, whether there are cul de sacs, which retain the aliment for a long time in the cavity. The formation of the jaws and teeth, and the more or less perfect trituration and comminution, which the food experiences in the mouth, must likewise be viewed in connection with the length and structure of the alimentary canal.

The whole length of the canal is greater in the *mammalia* than in the other classes. It diminishes successively, as we trace it in *birds*, *reptiles*, and *fishes*, being shorter than the body in some of the latter animals, which is never the case in the three first classes.



In omnivorous animals, the length of the canal holds a middle rank between those which feed on flesh, and such as take vegetable food. Thus, in the rat, its proportion to the body is as 8 to 1; in the pig 13 to 1; in man 6 or 7 to 1. The diminution in length, in the latter case, is compensated by other circumstances, viz. the numerous *valvulæ conniventes*, and the preparation which the food undergoes, by the art of cookery.

In carnivorous animals, every circumstance concurs, to accelerate the passage of the alimentary matter. It receives no mastication; it is retained for a very short time in the stomach; the intestine has no folds or valves; it is small in diameter; and the whole canal, when compared to the body, is extremely short, being 3 or 5 to 1.

The ruminating animals present the opposite structure. The food undergoes a double mastication, and passes through the various cavities of a complicated stomach. The intestines are very long; 27 times the length of the body in the *ram*. Hence the large intestines are not dilated, or cellular; nor is there a *cæcum*. The *solipeda* have not such a length of canal, nor is their stomach complicated; but the large intestines are enormous, and dilated into *sacculi*: and the *cæcum* is of a vast size; equal, indeed, to the stomach. The *rodentia*, which live on vegetables, have a very large *cæcum*, and a canal 12 or 16 times as long as the body. In the *rat*, which can take animal, as well as vegetable



food, the canal is shorter than in the other ro-  
dentia.

There are some exceptions to the rule, which we have just mentioned, respecting the length of the canal in carnivorous and herbivorous animals. The *seal*, which takes animal food, has very long intestines: the *sea-otter* resembles it in this respect, and differs therein most remarkably from the common otter, which resembles other carnivorous animals in the shortness of its intestinal tube. The length of canal in the former, is twelve times that of the animal; and only three times and a quarter in the latter. (HOME, in the *Philos. Transf.* 1799, part 2.) *Whales* have likewise a longer canal than other carnivorous mammalia; their stomach is complicated, and the intestine has longitudinal folds. It seems, therefore, that a considerable length of intestinal canal is found in all mammalia, which live much in the water, although they are carnivorous.

The *plantigrade* animals, which have carnivorous teeth, but feed equally well on vegetables, have a long canal: but it is very narrow, and possesses no cæcum, nor distinction of large intestine.

A species of bat (*vespertilio noctula*), seems to have the shortest intestinal canal of any mammalia: it is only twice the length of the animal's body. On the contrary, the *rouffette* (*vesp. vampyrus* LINN. v. *caninus* BLUM.) which lives entirely on vegetables, has it seven times as long.

A remarkable difference is observed, in the length



of the canal between the wild and domesticated breeds of the same species. In the *wild boar* the intestines are to the body as nine to one; in the tame animal, these proportions are as thirteen to one. In the *domestic cat*, five to one; in the *wild cat*, three to one. In the *bull* twenty-two to one; in the *buffalo*, twelve to one. They are, on the contrary, longer in the wild than in the tame rabbit; the proportions in the former being eleven; and in the latter nine to one.

The proportion of the intestinal canal to the length of the body in *birds*, is as two, three, four, or five to one. It is not always longest and largest in the graminivorous species; as many piscivorous birds have it equally long.

It is hardly twice the length of [the body in many *reptiles*; and not so much in the *frog*, although it is nine times as long as the space between the mouth and the anus in the *tadpole*.

The alimentary canal of some fishes, is continued straight from the mouth to the anus, and does not therefore equal the length of the body. The *lamprey*, *skate*, and *sbark* are thus circumstanced.

(B) Most of the animals, which have a vertebral column, have the intestine divided into two parts; viz. the large and small. The latter is commonly the longest, smallest in its diameter, and villous on its internal surface. The former is often thicker in its coats, and very rarely villous. In those mam-  
malia,



malia, which have this distinction, the separation is marked by one or more appendages, which have the name of *cæcum* when large; of *vermiform appendix* when slender. *Man*, the *orang-outang*, and the *phascolome* (a species of rat having an abdominal pouch, from New Holland,) are the only animals, which have both *cæcum* and appendix. The *ornithorhynchus hystrix* has an appendix only: and most other mammalia have only a *cæcum*. All the *simiæ*, except the *orang-outang*, have a *cæcum*, like that of man, but want the appendix vermiformis.

Several possess neither *cæcum* nor appendix, as the *edentata*, (except the proper *ant-eaters*); the *tardigrada*, the *bats*, the *plantigrada*, except the *ichneumon*, the *mustelæ*, and the *myoxi* (dormice); and the *cetacea*.

A *valvula coli* shews the distinction between the large and small intestine, where the *cæcum* is wanting: as in the *sloth* and *armadillo*. When this distinction does not exist, the large intestine is characterised by the want of villi, by a greater thickness of its coats, and particularly by a strong layer of longitudinal muscular fibres.

In animals, which have a *cæcum*, this part appears to be merely a prolongation of the large intestine below the termination of the small. Yet in some cases, the large intestine retains only for a short space, the same structure, which the *cæcum* possessed, as in the flying lemur (*galeopithecus*), the



*opossum*, most of the *rodentia* and *ruminantia*. In the herbivorous mammalia, the cæcum is generally large and cellular; and it is even so in omnivorous animals, as in *man*, in the genus *simia*, and *lemur*. In the *ruminantia*, where the stomach is very complicated, the cæcum is of a moderate size, and uniform. It is large and cellular in the *flying lemur*, and *opossum*, which are supposed to live much on animal substances.

The cæcum of the true carnivorous mammalia is constantly small, and uniform in its cavity; and the rest of the large intestine has the same characters. The large intestine of the herbivora is cellular; excepting the *ruminantia*, and some of the *rodentia*.

It may therefore be stated as a general rule, that the existence of a large cæcum shews that the animal feeds on vegetables: and that carnivorous mammalia have either none, or a very small one.

The *ornithorhynchus paradoxus* and *hystrix* have the end of the rectum forming a cloaca as in birds. The urinary bladder opens into this part. The penis of the male is contained within it; and the horns of the uterus open into it in the female. HOME in the *Philos. Transf.* 1802, pt. 1. of the *o. paradoxus*, pt. 2. of the *o. hystrix*.

(C) The *bursa Fabricii* is an oval membranous bag; situated at the upper or back part of the  
cloaca,



cloaca, into which it opens by a slit-shaped aperture. Its size is proportionate to that of the animal; being one inch and a quarter long in the goose, and half an inch broad: and about a quarter of an inch in length in the sparrow. According to the accurate observations of Mr. Macartney, its coats contain numerous glandular bodies, which furnish a mucous secretion. (Article BIRDS in Rees's Cyclopædia).

(D) In the structure and formation of the coats of the intestinal canal, there are not many differences in the *mammalia*. True *valvulae conniventes* seem peculiar to *man* and the *monkeys*. But the internal surface of the intestine is always villous, and generally deserves that appellation more than in the human subject. Some of the *carnivora*, as the *dog*, have very long villi: and this class has in general more muscular intestines. A considerable number of mucous glands is found near their cæcum, when they have one. But the *seal* has these glands in greatest number, and most distinct. They form, in that animal, a regular and unbroken series through the whole length of the lower portion of the small intestine; and are very visible on account of their colour.

The villous coat of the intestine forms numerous oblong processes in the *rhinoceros*. (Philos. Transf. 1801. pt. 1.)



The villi in the small intestine of birds are remarkably long, numerous and elegant. They are most distinct, and clearly developed in the *graminivorous* birds. In the *ostrich* they are rather flat thin laminae than villi; but at the same time long and numerous, so as to present a very elegant structure. The large intestine of birds is uniform on its surface; but the *ostrich* presents a very remarkable deviation, for its large intestines, which are very long, have numerous transverse folds like the *valvulae conniventes* of man.

The intestine of the *turtle* is covered with innumerable thin longitudinal processes, lying close together, and increasing the surface of the gut to a vast extent. These are most numerous in the upper part of the intestine, and gradually diminish in number below, until they cease altogether. In this respect they resemble the *valvulae conniventes* of man; and the villi of all animals. For these structures are always most distinct at the commencement of the canal, where absorption of the chyle goes on to the greatest extent. As the alimentary matter becomes deprived more and more of its nutritious parts, as it descends in the intestine, a less complicated apparatus for absorption exists in the lower part of the canal, and is sufficient for taking up the small remains of really nutritious parts. This circumstance is illustrated in the longitudinal folds of the cetaceous animals. At the commencement



ment of the intestine, there are four or five of these: at different distances we meet with four, three, two, one, and lastly the surface is completely uniform.

(E) As the part of his work, which the author has devoted to the alimentary canal of the lower orders of animals, is very short, and as the subject is interesting in many points of view, it seems right to subjoin a somewhat more ample account.

The simple globular *hydatid*, which is frequently found in the different viscera, both of man and quadrupeds, has been supposed by some to be an animal consisting entirely of a stomach. Doubts, however, have lately been raised, whether or no this be really an animal. The reader, who wishes to see the arguments on both sides of the question, may consult the "*Observations on the Manner in which Hydatids grow and multiply in the Human Body,*" by J. HUNTER, M. D. in the 1st vol. of the *Transactions of a Society for the Improvement of Medical and Churgical Knowledge*; and the note to the 82d paragraph of this work. Even if it were allowed that these bags are animals, it does not follow that their cavity is a stomach; and the attachment of the young to the sides would rather justify us in considering it as the organ of generation.

The *hydatid*, which is more frequently found in  
animals,



animals; which possesses a head and mouth like the tænia, enabling it to attach itself to parts, and which can be seen to move when placed in warm-water, is generally allowed to possess an independent vitality. But whether the bag of water, which forms its body, be a stomach, is certainly doubtful.

The most simple form of an alimentary cavity exists in the common fresh-water polype (*hydra*). It appears to be excavated in the substance of the body, and has a single opening, situated in the centre of the space surrounded by the tentacula. The nutritive matter soaks immediately into the body, and imparts its colour to the animal.

The large masses of gelatine, called *medusæ*, which resemble in form mushrooms, and are found floating in the sea; have a somewhat similar structure. A stomach is hollowed out in the pedicle; and vessels, commencing from its cavity, convey the nutritious fluid over the body. Sometimes the stomach has a simple opening: in other cases there are branching tentacula, on which canals commence by open orifices; these unite together to form larger tubes, and the successive union of these vessels forms at last four trunks, which open into the stomach, and convey the food into that cavity. This very singular structure constitutes a remarkable analogy to the roots of trees; and CUVIER has formed a new genus under an appellation derived from



from this comparison; viz. the *rhizostoma*, from  $\rho\iota\zeta\eta$  a root, and  $\sigma\omicron\mu\alpha$  a mouth.

The star-fish (*asterias*) has a membranous cavity in the centre of its body, communicating externally by a single opening. Two canals extend from this into each of the branches, or as they sometimes called the fingers of the animal, where they subdivide, and form numerous blind processes.

The tape-worm (*tænia*) has a small canal running on each side of its body: the two tubes are joined together by transverse productions at each joint.

The *ascaris lumbricoides* (round-worm) has a simple canal running from one extremity of the body to the other.

The leech (*hirudo sanguisuga* or *medicinalis*) has a short œsophagus and a very large stomach, divided by numerous membranous septa, which are perforated in the centre. It has been generally supposed that this animal has no anus; but CUVIER says, that it possesses a very small one. (*Léçons d'Anat. Comp.* tom. 4. p. 141.): DUMERIL, on the contrary, denies its existence. (*Zoologie Anatomique*, p. 298.)

The common earth-worm (*lumbricus terrestris*) has a long canal, divided by several partitions.

The aphrodite aculeata has an intestine running according to the length of the body, and sending off



off on each side several blind processes, which enlarge at their termination.

In the proper mollusca, besides the stomach, which has been already noticed there, is an intestine, seldom of considerable length, making some turns in its course: it passes in all the acephalous mollusca through the heart.

The intestinal canal of insects varies very much in the different genera and species. It may be stated on the whole, that a long and complicated intestinal tube, denotes that the insect feeds on vegetables; while the contrary characters indicate animal food.

Great difference is found, in some instances, between the larva, and the perfect insect. The voracious larvæ of beetles, (*scarabæi*), and butterflies, have intestines ten times as large as the winged insects, which are produced from them.

In the dragon-fly (*libellula*), which is very carnivorous, the intestine is not longer than the body. There is a small but muscular stomach.

The *orthoptera*, (which class contains the locusts, &c., well known for their destructive powers,) have a long and complicated alimentary apparatus. They have first a membranous stomach. This is succeeded by another cavity covered internally with scales or teeth, and possessing a very thick muscular coat; in short, a true gizzard.

Round



Round the end of this the cæcal processes are attached. There is, lastly, an intestinal canal differing in length and diameter.

The alimentary canal runs straight along the body in the *crustacea*, and is uniform in its dimensions, excepting the stomach.



## CHAPTER VIII.

## ON THE LIVER, SPLEEN, AND OMENTUM.

§ 121. WE may conveniently collect together, in this chapter, whatever is to be said concerning the liver, spleen and omentum; since these parts are connected with each other in their functions.

The spleen and omentum seem to be less constantly found in the animal kingdom, than the liver, and to be in a manner subservient to the latter viscus: which, on the contrary, exists in every class and order of animals that is provided with a heart and circulating system.

## (A) MAMMALIA.

§ 122. Besides the less important, and indeed constant variations in size, colour, division into lobes<sup>1</sup>, &c., the liver of these animals is dif-

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<sup>1</sup> It deserves to be remarked here, as a peculiarity of the liver of some four-footed mammalia, which live in or about the sea; namely, the *polar bear*, and some *seals*; that it seems to possess some poisonous or noxious qualities when employed for food. HEEMSKERK'S Companions experienced this in the former instance at *Nova Zemlia*; and LORD ANSON'S Squadron in the latter, on the coast of *Patagonia*.



tinguished by two chief differences: first, in some genera and species it transmits all the bile immediately into the duodenum. Secondly, in several others a part of this fluid is previously collected in the gall bladder. Animals of the *horse*<sup>2</sup> and *goat* kind, and the *cetacea* afford instances of the want of this receptacle.

On the contrary in some of those which have it, there are *hepatico-cystic ducts*, which convey the bile immediately from the liver into this bladder: as in the *horned cattle*. (See note (A) at the end of the chapter).

In the *ox* and *sheep*, the spleen is distinguished by a peculiar cellular<sup>3</sup> structure from the merely vascular texture which it possesses in other animals of this class.

*Mammalia* alone<sup>4</sup> possess a true and proper omentum. And the part, which has been called a  
spleen

<sup>2</sup> Some have considered the large hepatic duct of the *horse* as a gall-bladder. See Sir THOMAS BROWN'S *Pseudodoxia Epidemica*, p. 119. ed. of 1672. This might with more truth be said of the *elephant*, where the hepatic duct has a considerable expansion just at its entrance into the intestine. *Oeuvres de Pierre Camper*, tom. 2. ch. 4. § 3.

<sup>3</sup> STUKELY on the *Spleen*, tab. 3. and 4.

The hepatico-cystic ducts, and the cellular structure of the spleen, are the more worthy of mention, as they have given rise to errors in physiology.

<sup>4</sup> I quote only a single instance of the peculiar appearances of the omentum in particular species; viz. that of the *racoon*,  
(*ursus*



spleen in other animals is very different in its structure, connections, &c. from the same viscus as it exists in this class.

### (B) BIRDS.

§ 123. The liver is much larger in domesticated, than in wild birds<sup>s</sup>. It is well-known that the gall-bladder is wanting in many species of this class, (for instance in the *pigeon*, *parrot*, &c.): and sometimes in particular individuals of a species, which commonly has it; as in the *common fowl*. (See note (B) at the end of the chapter).

A roundish lump of fat, which covers the intestines of some aquatic birds, has been considered as an omentum.

### (C) AMPHIBIA.

§ 124. The liver, in these animals, is universally of considerable size; and in some instances, as

(*urfus lotor*), which has a very remarkable structure; and which I received from that zealous zootomist Dr. ALBERS, of *Bremen*. It is comparatively large, and consists of innumerable stripes of fat, disposed in a reticular form, and connected by an extremely delicate membrane, resembling a spider's web.

<sup>s</sup> B. ROBINSON, *on the Food and Discharges of Human Bodies*, London, 1748-8. p. 97.



the *salamander*, of immense magnitude. I know no species in which the gall-bladder is wanting.

The yellow appendices, (*ductus adiposi, appendices luteæ*) which are found in the *frog*, on either side of the spine, and sometimes form one mass, sometimes are divided into several smaller portions, were considered by MALPIGHI as a kind of omentum<sup>6</sup>. That this resemblance is very remote, appears from several circumstances; and particularly from the constant and remarkable variations of size which occur in these parts at the pairing season.

#### (D) FISHES.

§ 125. In many animals of this class, the short intestinal canal is surrounded, and as it were consolidated with a long liver. Some fishes, which are almost destitute of fat in the rest of their body, have an abundance of oil in the liver; as, for instance, the *skate* and *cod*. It is wanting in some few species. (For an account of the situation of the spleen, see note (C) at the end of the chapter).

#### (E) INSECTS.

§ 126. An organ secreting bile, and which

<sup>6</sup> *De Omento et Adiposi Ductibus*, Oper. tom. 2. p. 35, &c.



may therefore be regarded as a liver, is found in such animals only of this class, as have a heart and system of vessels; viz. in the genus *cancer*<sup>7</sup>. We have already observed (§ 119.—note 12), that the blind appendices, found in several others, have been considered as biliary organs. See note (D).

The large adipose substance, which occupies the greatest part of the body of larvæ, and of several insects, has appeared to some zootomists to resemble the omentum<sup>8</sup>.

#### (F) VERMES.

§ 127. The organs, which secrete and contain the fluid of the *cuttle-fish*, have been regarded as of a biliary nature. Thus the *mytis* has been called the liver, and the *ink-bag* the gall-bladder<sup>9</sup>.

Several *testacea*, particularly among the *bivalves*, have a liver surrounding their stomach, and pouring its bile into the cavity<sup>10</sup> of that organ. In

<sup>7</sup> WILLIS *De Animâ Brutorum*, tab. 3. RÖSEL, vol. 3. tab. 58 and 59.

<sup>8</sup> LYONET, *Anatomie de la Chenille*, &c. tab. 5 and 12.

<sup>9</sup> Compare the representations, which have been given by SWAMMERDAM, TURBERVILLE NEEDHAM, and MONRO.

<sup>10</sup> See POLI, vol. 1. where he represents this fact in several of the *testacea*.



many snails it occupies the upper turns of the shell<sup>11</sup> \* †.

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*Additional Notes to the Eighth Chapter.*

(A) The liver of mammalia is in general divided into more numerous lobes; and the divisions are carried deeper into its substance, than in the human subject. This is particularly the case in the *carnivora*, where the divisions of the lobes extend through the whole mass. But the utility, which MONRO has assigned to this structure; viz. that of its allowing the parts to yield and glide on each other in the rapid motions of the animal, carries very little plausibility with it. (*Essay on comparative Anatomy*, p. 11.)

In many animals of this class, as the *horse*, the *ruminantia*, the *pachydermata*, and *whales*, the liver is not more divided than in man.

The *ductus choledochus* forms a pouch between

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<sup>11</sup> SWAMMERDAM, tab. 5. of the *helix pomatia*.

\* For a further account of the liver of this class, see note (E).

† For some remarks on the pancreas, see note (F).



the coats of the intestine, for receiving the pancreatic duct, in the *cat* and *elephant*.

All the *quadrumana*, *carnivora*, and *edentata* have a gall-bladder.

Many *rodentia*, particularly among the rats, want it. The *tardigrada*; the *elephant*, *rhinoceros*, and *pecari* among the *pachydermata*; the genus *cervus* and *camelus* among the ruminating animals; the *solipeda*; the *trichecus* and *porpoise* also want this part. It does not exist in the *ostrich* and *parrot*; but is found in all the *reptiles*. CUVIER, thinks that it belongs particularly to carnivorous animals; that it is connected with their habit of long fasting; and serves as a reservoir for the bile.

All the *mammalia*, which want it, except the *porpoise*, are vegetable eaters: and most reptiles, which universally possess it, live on animal food, *Léçons d'Anat. Comp.* tom. 4. p. 37.

The valvular transverse folds of the cystic duct belong only to the *simia*, besides the human subject.

(B) The liver of birds is divided into two equal lobes. The hepatic duct opens separately from the cystic; and its termination is generally, but not always preceded by one or more pancreatic ducts, and followed by that of the cystic duct.

The fundus of the gall-bladder receives branches  
from



from the hepatic duct, (*ductus hepaticystici*); but that tube sometimes unites with the cystic, as in the *duck*.

(C) The spleen gradually diminishes in size from the mammalia to fishes. In the *porpoise* there are several small spleens; supplied from the arteries of the first stomach. It is always attached to the first, when there are several stomachs.

In birds it is always near the *bulbus glandulosus*; but does not lie constantly very close to the stomach in reptiles; as it is found in the mesentery of the *frog*. Neither is it very uniformly situated in fishes.

(D) The blind processes, which are attached to the alimentary canal of insects, are supposed by many to form a substitute for the liver. They generally contain a yellow bitter fluid. Their number and situation vary. They terminate for the most part near the stomach, but not constantly so. They are short and numerous in the *dragon-fly*, and open near the anus. In the mole-cricket (*gryllus gryllotalpa*), they form a bundle, and have a common opening in the middle of the intestine.

In the crustacea the liver is large, and consists of blind tubes, opening into the commencement



of the intestine. It forms the soft high flavoured substance of the crab and lobster.

(E) A liver exists in all the mollusca, and is very large; but this class has no gall-bladder. The liver is supplied with blood from the aorta, and there is consequently no *vena portarum*.

It is a completely mistaken notion, that the black fluid of the *cuttle fish* is its bile. The *ink-bag* is indeed found between the two lobes of the liver in the *sepia octopus*: and in front of them in the *calmar*; but in the common cuttle-fish (*sepia officinalis*), it is at a considerable distance from this organ.

The real bile is poured, as usual, into the alimentary canal.

In the gasteropodous mollusca, as the *snail*, the liver is very large, and consists of several lobes, having each an excretory duct. They surround the stomach and intestine, and open by several mouths into its cavity. The *aplysia*, *onchidium*, *doris*, &c. have a similar structure.

In the acephalous division of this class, it surrounds the stomach, and pours its secreted liquor into that cavity by many openings, the *oyster* and *muscle* exemplify this.

The proper worms (*vermes* of CUVIER); the *echinodermata* and *zoophytes* have nothing analogous to this gland.

(F) The



(F) The author has entirely omitted speaking on the pancreas in this part of his work; probably because there are no remarks of any importance or interest to be made on the subject. The structure of this gland in the mammalia, in birds, and in reptiles is the same, on the whole, as in the human subject: its form and size, its colour and consistence, and its division into lobules exhibit some slight and unimportant variations.

The termination of its duct or ducts, is distinct in birds from that of the *d. choledochus*. In the mammalia they generally open together, or there is a branch terminating in the *d. choledochus*, and another opening into the intestine, as in the *dog* and *elephant*, or they may be quite distinct, as in the *bare*, *porcupine*, and *marmot*. They may be separate or distinct in different individuals of the same species, as in the *monkeys*.

The *skate* and *shark* have a pancreas similar to that of the three first classes of red-blooded animals. In other fishes the situation of this organ is occupied by the *cæcal appendices* or *pyloric cæca*; which afford a copious secretion, analogous, no doubt, to the pancreatic liquor. (These are mentioned in § 118.) The internal surface of these tubes becomes very red on injection, and possesses a glandular and secreting appearance.

The appendices, which form separate tubes in most fishes, are collected in the *sturgeon* into one



mass, which is surrounded by muscular fibres. In this body, which has a very manifest glandular structure, the tubes join together, and open into the intestines by three large orifices.



## CHAPTER IX.

## ON THE URINARY ORGANS.

§ 128. **T**HESSE emunctory organs do not exist in several animals, which have a biliary apparatus. They are confined to the red-blooded classes; all of which have kidneys, while some orders and genera have not an urinary bladder.

## (A) MAMMALIA.

§ 129. In some animals of this class, as the *bears*<sup>1</sup>, the kidney resembles a bunch of grapes, being composed of several<sup>2</sup> small and distinct portions, which are connected by means of their blood-vessels and ureters, with the common trunks of those vessels. The urinary bladder is more loose<sup>3</sup> in the abdomen of most quadrupeds, than in the human subject. It is comparatively much smaller in carnivorous than in herbivorous animals; and

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<sup>1</sup> EUSTACHIUS, *Tab. Anat.* tab. 4.

<sup>2</sup> In the *bear* there are fifty or more, see H. F. FLEMING; *German Huntsman*, Leipzig, 1719, p. 120.

<sup>3</sup> VESALIUS *Anatomicarum Fallopii Observationum Examen.* p. 126. RIOLANI *Anthropographia*, p. 241.



is particularly large in the ruminating bifulca and the *hare* <sup>4</sup>. (See note (A) at the end of the chapter.)

### (B) BIRDS.

§ 130. The kidneys <sup>5</sup> of this class (with a few exceptions, as the *cormorant*, &c.) form a double row of distinct but connected glandular bodies <sup>6</sup>, placed on both sides of the lumbar vertebræ, in cavities of the ossa innominata. The urinary bladder is wanting in the whole class; and the ureters open into the cloaca.

### (C.) AMPHIBIA.

§ 131. Animals of the genus *testudo* and *rana* have an urinary bladder; which is double in many

<sup>4</sup> Urinary stones, often of very considerable size, are found not unfrequently in horses, whose intestinal concretions have been already noticed. Their composition differs considerably, according to the investigations of FOURCROY and VAUQUELIN from the urinary stones of man; since they contain neither phosphoric, nor lithic, but carbonic acid.

<sup>5</sup> ALOYS. GALVANI in the *Comment. Instit. Bononiens.*, tom. 5. pl. 9. p. 508.

<sup>6</sup> One of the most instructive examples of the remarkable analogy between the structure of the secreting viscera, properly so called, and the conglomerate glands. See the *Institutiones Physiologiæ*, § 470 and 471.



of the frogs properly so called. The *crocodile* on the contrary, and several true *lizards* have none. The same remark applies to the serpents, in whom the ureters open into the cloaca. See note (B).

(D) FISHES.

§ 132. The glandulæ suprarenales are wanting in this class; and they seem therefore to be confined to such animals as breath with lungs. Although we cannot perceive of what use an urinary bladder can be to fishes, and animals which live in water, several genera and species have one.

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*Additional Notes to the Ninth Chapter.*

(A) The structure of the kidney in mammalia displays two very opposite varieties; which may be called the *simple* and the *conglomerated* kidneys. In the former there is a single papilla, which is surrounded by an exterior crust of the cortical substance. This is the case in all the *feræ*; and in some other animals, as many *rodentia*. The other kind of kidney consists of an aggregation of small kidneys, connected by cellular substance. It appears that this form of the gland is found in all those mammalia,



mammalia, which either live in, or frequent the water. I have observed it in the *seal* and *porpoise*, where the small kidneys are extremely numerous, and send branches to the ureter without forming a pelvis. Mr. HUNTER states that it belongs to all the whales. (*Philos. Transf.* 1807. pt. 2.) The *otter* has the same structure; but its small kidneys are not so numerous as in the animals above-mentioned. (HOME, of the *sea-otter*. (*Lutra marina*). *Philos. Transf.* 1796. pt. 2.) It is remarkable that the brown bear (*ursus arctos*) which lives on land, should have this structure as well as the white polar bear (*ursus maritimus*), which inhabiting the coasts, and floating ice of the northern regions, spends much of its time in the water. Mr. HUNTER (loco citato) concludes, that it is because Nature wishes to preserve an uniformity in the structure of similar animals. But the badger, (*ursus meles*), which is a very similar animal, has the uni-lobular kidney. The number of small kidneys in the bear is 50 or 60: and it appears that each consists of two papillæ. (See the account of the dissection of a bear, by the French Academicians: which is also given in BLASIUS'S Collection. *Anatom. Animal.* tab. 32. fig. 2, 3, 4.)

(B) The two large bags, which the author, and also CUVIER, (*Léçons d'Anat. Comp.* tom. 5. p. 237.) represent as urinary bladders of the *frog and toad*, are stated by TOWNSON to have no connection



nection with the ureter. Indeed it is very clear that the ureters open at the posterior part of the rectum, while these two receptacles terminate on the front of that intestine. (See his *Tracts and Observations*, p. 66. tab. 3.) He states that the fluid contained in these reservoirs is a pure water. The size of these bags, which exceeds all ordinary proportion to the bulk of the kidney, renders it likewise probable that they are not receptacles of urine. Either of the bags is at least twenty or thirty times as large as the kidney.



## CHAPTER X.

## ON THE EXTERNAL INTEGUMENTS.

§ 133 **A**MONG the various objects and functions of the common integuments, as they are called, one of the most important, and most general, in red blooded animals, is the office which they perform as emunctory organs. Hence we may introduce here with propriety what we have to say on the subject.

§ 134. The basis of all the other coverings consists in the proper skin (*cutis vera*), which is common to the four classes of red-blooded animals, and may be regarded as the condensed external surface of the cellular substance, with nerves, blood-vessels, and absorbents interwoven in its texture. This is covered externally by the cuticle, which is very uniform in its structure, at least in such animals as breathe by means of lungs. (See note (A) at the end of the chapter.) The rete mucosum lies between these; but it can only be shewn, as a distinct layer of the skin in warm-blooded animals. (See note (B.) Lastly, the cuticle is furnished in the different classes with peculiar organs for the formation and excretion of particular matters; viz. *hairs* in mammalia, *feathers* in birds.

(A) MAM-



## (A) MAMMALIA.

§ 135. The cutis of this class varies infinitely in thickness. It is extremely thin and delicate in the wing of the *bat*, and on the contrary, monstrously thick in the *rhinoceros*, *elephant*, &c. also in the web-footed animals, particularly the *walrus*.<sup>1</sup> The form of the papillæ on its external surface is very various in the different animals of this class, as, indeed, in different parts of the same animal. They are sometimes threadlike, as on the paws of the *bear*, and are very elegant on the teats of the true whale<sup>2</sup> (*balæna mysticetus*). See note (C.)

The colour of the rete mucosum varies, even in individuals of the same species, as in the different races of mankind. It is thickest in some cetacea.<sup>3</sup>

In some spotted domestic animals, particularly

<sup>1</sup> Hence the old Normans used to make their almost imperishable cables from the skin of this animal. See J. SPELMAN, *Vita Ælfridi magni Anglorum Regis*. p. 205.

<sup>2</sup> I have observed this in several macacos (*simia cynomolgus*) and mandrills (*Papio Maimon.*).

<sup>3</sup> I have had an opportunity of examining the skin of the cetacea in a *Balæna boops*, and in a dolphin, (*delphinus delphis*) In both the rete mucosum was very thick; but by no means equal to the breadth of a finger, as is represented in the *Museum Gaubianum*. 1783, 8, p. 14.



the *sheep*, *rabbit*, and *dog*, there is a remarkable connexion between the colour of the palate, and even, sometimes of the iris, and that of the skin; for spots of similar descriptions are found in both parts.<sup>4</sup>

The cuticle is often of very unequal thickness in particular parts, from the different purposes to which it is destined. Thus, it is very thin on the points of the fingers in *apes* and *baboons*, when compared with its great thickness where it covers the callosities on which they sit. In some thick skinned animals, particularly the elephant, it forms a kind of horny processes,<sup>5</sup> lying close together in several parts of the body. But differences of this kind are too numerous to admit of their being all noticed in this work.

§ 136. Hairs, at least single ones, are found in all adult mammalia, even without excepting the cetacea. In various states of thickness and strength, they constitute every intermediate substance, from

<sup>4</sup> See among other works SCHNEIDER's additions to his German translation of MONRO's *Physiology of Fishes*.

<sup>5</sup> These processes, as I observed them on the proboscis of the elephant, appeared very similar to the warty cuticle of the two English *porcupine men*, whom I lately saw, and have described in VOIGT's *new Magazine*, vol 3, pt. 4. See also W. G. TILESIIUS's *Description and Delineation of the two Porcupine men*, in German, Altenburg, 1802, folio.



the finest wool to the strongest quills of the porcupine. Thick bristles, and hairs, as they are found, for instance, in the tail of the elephant, and other animals, resemble horn, or fish bones in texture; while on the other hand, both these substances may be easily split into a kind of bristles. Hairs are commonly cylindrical; some, however, are broad with two sharp edges; as in the toes of the *ornithorhynchus*, and the common *porcupine*. Others, as the whiskers of the *seal*,<sup>6</sup> are also flat, but have rounded and denticulated margins, so that they have a kind of knotty, or jointed appearance. Something similar may be observed in the hair of some cloven hoofed<sup>7</sup> animals, and most remarkably in that which covers the scent-bag of the musk *Goat*. (*moschus moschiferus*). These are at the same time filled with a very loose medullary texture, and consequently very brittle. Some are thick and firm, but perforated by a narrow tube, which runs through their axis, as the long stiff whiskers of the

<sup>6</sup> ALBINI *Annotat. Academ.* lib. 3. p. 66.

<sup>7</sup> In consequence of a degeneration of the formative impulse, which seems to reside chiefly in an unnatural formation of the skin, the hair of the human subject may assume an unusual appearance, similar to that of some quadrupeds, particularly of the *goat* and *deer* kind. This was the case with a woman from Triers, who was shewn here, as well as in many parts of Europe, in her seventeenth year. See LAVATER'S *Physiognomical Fragments*, in German, part 4, p. 68. And the supplement to BUFFON, vol. 4, p. 571.



*phoca ursina*. The hairs on the tail of some species of porcupine are entirely hollow, like the quill of a feather.

The hair is the most incorruptible part of the body, and possesses in great perfection, both kinds of reproductive power; viz. the *natural*\*, which takes place in a healthy state, and the *extraordinary*, which is exerted after an accidental loss.<sup>9</sup> It is electrical in some species, and serves in those animals which possess much of it, as a mode of excreting superfluous phosphoric acid.<sup>9</sup>

There are secretions from the integuments in some species of mammalia, manifesting themselves by peculiar smells, which constitute specific characters in some of the horse and dog-kind, as completely as the national smell of certain varieties of the human race.<sup>10</sup>

## (B) BIRDS.

§ 137. The integuments of birds have the

\* For an explanation of these terms, see note G at the end of the chapter.

<sup>8</sup> *Manual of Natural History*, in German, p. 28 of the 6th edition.

<sup>9</sup> FOURCROY *Système des Connoissances Chirurgiques*. v. 9. p. 270.

<sup>10</sup> I have said more on this subject in the third edition of my work *De Generis Humani varietate Nativa*. p. 163.



same three parts with those of mammalia. Some are furnished with hair in particular situations; as the *vultur barbatus*, the *raven*, and the *turkey*. Others, as the *cassowary*, have long spines like fish bones in their wings, which approach in the tubular structure of their roots, to the formation of feathers; the universal and peculiar covering of this class of animals. The particular differences in the formation of the feathers are innumerable. Among the most remarkable, are the small scale-like feathers of the *penguin's* wing; and the horny, flat, and pointed processes on the tip of the neck, and wing-feathers of the *common fowl* in its wild state; and on those of the Bohemian chatterer, (*ampelis garrulus.*) Several birds in different orders, have two or more feathers arising from a common quill.<sup>11</sup>

The periodical renewing of the feathery covering, at what is called the moulting season, takes place in a short space of time, and comes therefore more under our observation, than the change of the hair in mammalia. This process has afforded a very interesting physiological remark, which has been often made in several species of those birds, in which the male and female have different plumage;

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<sup>11</sup> In a young *ostrich*, which had just quitted the egg, and which now lies before me, there are as many as twenty feathers on the back, proceeding from a single barrel.



viz. that as the latter ceases in her old age to lay eggs, she obtains the male plumage.

Lastly, the integuments of birds serve the office of emunctory organs, which is proved even by the process of moulting, as well as by the separation of peculiar matters from the skin. Thus the cockatoo (*Psittacus cristatus*), as well as some other species of *Psittaci*, and several birds of different orders, have a large quantity of white mealy dust discharged from their skin, particularly at the pairing time.

### (C) AMPHIBIA.

§ 138. The very various integuments, which are found in the different orders and genera of this class, consisting of shields, rings, scales or simple skin, are covered externally with cuticle, which is frequently separated in many of these animals, as in the snake, (forming what is called in German, *Natterhemd*, i. e. snakes-shirt) and *water-newt*.

This process of separation is repeated every week for some time in the latter animal, particularly in spring and autumn. Some which have small fine scales, as the *chameleon*, or a simple skin, as some *frogs* change their colour occasionally, either from difference in the light or warmth, or from the effect of their passions. (For a peculiarity in the skin of the toad, see note (D)).



## (D) FISHES.

§ 139. All fishes, without exception, are covered with scales, which are bare in those which inhabit the open sea, but on the contrary are covered with a mucous membrane in those which live on coasts, or in fresh water. It is remarkable, that the colour of the skin in some fishes, as for instance, the *mullet*, (*mullus barbatus*) depends on that of the liver.<sup>12</sup> The scales are not changed like hair and feathers, but are perennial; and are said to receive yearly, an additional layer to their laminated texture, from the number of which the age of the animal may consequently be determined. (For some account of the epidermis in the lower orders see note E. and of the various insensible coverings note (F).

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*Additional Notes to the Tenth Chapter.*

(A) The epidermis of the cetacea is quite smooth, and marked with none of those lines, which are so often seen in the other mammalia.

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<sup>12</sup> SANTORINI *Obs. Anatom. Venet.* 1724, 4. p. 4.



It is detached from the surface, in the form of small scales, in all the mammalia, except the whales. And in some this happens chiefly at the season when their hair is shed. It gives the skin a brauny appearance.

(B) It is in the rete mucosum that the colour of the skin resides; but this part possesses in very few instances, any brilliancy of colour in the mammalia. It is of a beautiful red and violet on the nose and buttocks of some *baboons*: and silvery white on the abdomen of the *cetacea*. It is remarkably thick on these animals; being about the sixteenth of an inch on the back, and such parts as are of a black colour.

(C) Villi, or papillæ of the skin are found on those parts which correspond to the toes and fingers of man. They exist also on the trunk of the elephant, and on the snout of the mole and pig.

The cutis of mammalia is much thicker on the back than on the belly.

(D) The skin of the frog and toad does not adhere to the subjacent parts, as in other animals; but is attached to them only at a few points, and is unconnected elsewhere: so that it may be compared to a bag containing the animal.

(E) The lower orders possess in general an epidermis. In the *testacea* it usually covers the surface



face of the shell, and obscures the brilliancy of that part, until it is removed. It maybe seen by plunging a snail-shell into boiling water. It is very thick and villous in some species, as in the *arca pilosa*.

*Crustacea* have it; also insects both in their perfect and larva states. It is shed in the latter several times before the change to the state of chrysalis: (seven times in most of the *butterflies* and *bombyces*).

It is very distinct in the vermes; as in the common *earthworm* and *leech*, which often shed it. In the *sipunculus saccatus* it is loose and not adherent to the surface.

(F) Hairs are formed in small bulbous bodies implanted in the true skin, and grow from their base.

If one of the large hairs, which grow on particular parts of some animals be examined with glasses, its surface appears grooved, as if it were composed of several filaments; and one or two canals are discovered in the substance of the hair, containing a kind of fluid, which has been called the medulla.

In the *hedgehog*, *porcupine*, &c. these filaments are covered with a layer of horny substance; and the cavity is filled with a white spongy matter.

The colour of the hair is influenced in great measure by that of the rete mucosum: and this circumstance is particularly observable in the human



subject. Its texture is much modified by climate and mode of life. The *dog* in Siberia, and the *sheep* in Iceland are covered with a kind of long and stiff hairs, while the same animals, in very hot countries, as in Guinea, lose this covering altogether. A species of *goat* furnishes the long and silky hair, which is manufactured into the valuable shawls of Cashmere. The *cat*, *rabbit*, and *goat* are covered with a very long and peculiar kind of hair in Angora, a small district of Asia Minor; and the superior qualities of the Spanish wool are well known.

This seems to be the proper place for considering, in a cursory manner, the other insensible parts, which are found on the surface of the body.

The *horns* of the mammalia are generally formed on processes of the frontal bone; which they cover in the manner of a sheath, as a glove does the finger. They consist of a solid, insensible, and elastic substance; which in many cases has a fibrous appearance, as if it were composed of an aggregation of hairs. This structure is most particularly remarkable in the rhinoceros; where the horn is solid, and situated over the nasal bone. The fibres analogous to hairs are very distinct, and are observable at the base of the horn, detached from its substance in the form of bristles. The mass of the horn is entirely pervaded by innumerable pores.

In those animals which have a long process within the horn, the os frontis begins to form a tubercle, about the seventh month of conception. This being  
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ing gradually elongated, elevates the integuments, which become callous, and harden, as the horn is lengthened. Between the bone and the latter part a soft vascular substance is interposed: from which the horn is produced, by means of successive additions to its base and internal surface.

The *nails* and *claws* of animals are formed just like horns; they cover a process of the last phalanx, which is analogous to the frontal process of the horn; and grow from the root or base, to which the integuments are attached, while they wear away at the loose edge.

The *hoof* of the *horse*, *ass*, &c. is a horny covering of the last phalanx; similar, in its structure and formation, to the parts just mentioned, but including the whole of the bone. Its internal surface in the horse is formed into a vast number of thin plates, which are placed alternately with corresponding laminæ of the vascular substance, and constitute a most close connection between the two parts. This union is so firm, that, when the inferior portion of the hoof has been removed, a horse may be trotted roughly without the foot being separated from the upper part of the hoof.

The body of a bird which has just quitted the egg, is covered with hair instead of feathers. Fasciculi of hairs are produced from one common bulb, which is the rudiment of the future feather. In a few days a black cylinder appears, which opens at its extremity, and gives passage to the feather.

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The opposite end receives those blood-vessels, which supply the vascular substance in the barrel of the feather; when the stalk of the feather has received its complete growth, this vascular body is dried up, and presents the well-known appearance in the barrel of quills.

The parts which have been just described, as well as the epidermis, and the scales, or other hard coverings of reptiles and fishes possess neither vessels nor nerves; and therefore the whole superficies of an animal's body is really insensible, and constitutes a dead medium, through which impressions are conveyed to the subjacent living parts.

(G) I introduce the following quotation from the 2d chapter of the author's *Manual of Natural History* (*Handbuch der Naturgeschichte*, ed. 6, Göttingen, 1799) because it explains the terms made use of in the 136th paragraph; represents the subject in an interesting point of view, and contains the result of some curious experiments.

“In speaking of the growth of organized bodies, we must notice their power of reproduction,—that wonderful property, of restoring or renewing parts, that have been mutilated or entirely lost. This is one of the wisest provisions of nature for guarding animals and plants against the numerous dangers, by which they are surrounded. Hence, when viewed in connection with the system of growth altogether, it constitutes one of those grand characters, which



which distinguish the machines that proceed from the hand of the Creator, from all the productions of human skill. The springs and wheels of mechanical instruments have no power of repairing themselves when injured or worn; but such a power, in different degrees is imparted to every animal and plant.

At different periods of the year, several organized beings lose by a spontaneous and natural process certain parts of their body, which are subsequently renewed. Examples of this occur in the fall of the Stag's horns; in the moulting of birds; in the renewal of the cuticle of serpents, and of the larvæ of insects, and that of the shell of the crustacea; the fall of the leaves of trees, &c. This may be called *ordinary* or *natural* reproduction.

The second, or *extraordinary* kind of reproductive power is that, by which wounds, fractures, or any accidental mutilation or loss of parts of an organized body, are remedied or restored. Man indeed, and such animals as are nearly allied to him, possess this property in a very limited degree, while its strength and perfection are truly astonishing in several cold-blooded animals, as the water-newt, the crab and lobster, snails, earth-worms, (*lumbricus terrestris*,) sea-anemones, (*actinia*), the starfish, (*asterias*,) fresh-water polipes (*hydra*), &c.

Some experiments on this reproductive power require a hand exercised in such employments, together with various precautions, and a favourable combination



combination of circumstances, for their success. Hence persons must be cautious in concluding against the truth of any statement, because their own experiments do not succeed. After several fruitless attempts on this subject, I have lately succeeded in observing the reproduction of the whole head of the snail (*helix pomatia*) with its four horns; which occupied about six months.

I preserve in spirits a large water-newt (*lacerta palustris*), from which I extirpated nearly the whole eye several years ago. All the humours were discharged, and then four-fifths of the emptied coats were cut away. In the course of ten months an entirely new eye-ball was formed; with cornea, iris, crystalline lens, &c.; and this is only distinguished from the same organ on the opposite side, by being smaller." (See the *Gottingen Literary Notices* for 1787) p. 28, 30.



## CHAPTER XI.

## ON SEVERAL PECULIAR SECRETIONS.

§ 140. IT is necessary that we should take notice of some organs, destined for the secretion of peculiar fluids, the use of which is not hitherto sufficiently determined. These occur in particular classes, or in certain genera and species of animals; and may be most conveniently considered here, at the end of that division, which treats of the natural functions.

## (A) MAMMALIA.

§ 141. Besides the well-known salivary glands, there is another, which has been described by NUCK in the orbit, particularly of the *dog*, and some other predacious animals, which has an excretory duct opening near the last tooth of the upper jaw<sup>1</sup>.

§ 142. Both sexes of both species of the *elephant*, viz. the *African* and *Indian*, have a consider-

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<sup>1</sup> NUCK *Sialographia*, tab. 3 and 6.



## CHAPTER XI.

able gland<sup>2</sup> at the temple, between the eye and meatus auditorius, secreting in the rutting season a brownish juice, which is discharged through an opening in the skin<sup>3</sup>.

As far as regards the structure of the organ, this secretion resembles most, that of the gland placed at the back of the Mexican musk hog or pecare (*fus tajaqu*). (See note (A), at the end of the chapter).

§ 143. Several ruminating *bifulca*, and the *bare*, have, in the part which has been noticed above (§ 16.), *sebaceous sinuses*, which have received that name from the adipous and viscous substance, which is separated there in great abundance in some animals, and which is well known in the *stag*, where it is supposed to be of a lacrymal nature<sup>4</sup>.

§ 144. In most of the *ruminating animals*, and

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<sup>2</sup> See the *Histoire des Animaux* of the Parisian academicians, part 3. p. 138, and CAMPER's plates on the anatomy of the elephant, which were prepared in his 70th year.

<sup>3</sup> This circumstance has been remarked of old, and has been noticed in the Indian Mythology. See WILFORD in the *Asiatic Researches* vol. 3. p. 443.; it occurs likewise in STRABO. Compare also BEAULIEU *Voyage aux Indes Orientales*, p. 105. (in the collection of THEVENOT the elder, vol. 2.) and J. W. HEYDT's "*East Indian Theatre*," in German, p. 212.

<sup>4</sup> See professor SCHNEIDER in the *Leipsig Magazine for Natural History*, in German, 1787, p. 436.



in the *bare*, there are cavities in the groins, near the genitals, called by Pallas *antra inguinatia*; and containing a strong-scented sebaceous substance secreted from glands which lie under the integuments<sup>5</sup>.

§ 145. Some other mammalia have pouches on the abdomen, covered internally with a fine hair, and containing fatty secretions of peculiar odours. Of this kind are the bags near the anus of the *badger*; and that which contains the teats of the female marsupial animals<sup>6</sup>.

§ 146. There are also in the *badger*, and the *opossums*, as well as in several other carnivorous animals, (both among those, which are furnished with separate toes (*digitata*), and those which are web-footed (*palmata*) peculiar glands and bags at the end of the rectum, secreting a yellow substance of a strong and disagreeable smell in its recent state, and which frequently gives to their excrement a kind of musk-like odour<sup>7</sup>. (See note (B).

<sup>5</sup> Ibid, p. 430.

<sup>6</sup> The yellow matter contained in this pouch, was compared by TYSON with that which is secreted in the axilla of the human subject. *Phil. Transf.* vol. 20. p. 120.

<sup>7</sup> See GREW *Museum Regalis Societ.* tab. 23. where he represents these bags in the *polecat*, *weasel*, *fox*, and *cat*. DAUBENTON tom. 9, tab. 4. in the *lion*, tab. 16. in the *panther*, tab. 33. in the *civette*, tom. 7. tab. 13. in the *otter*.



§ 147. These anal glands must be distinguished from another kind of similar glands and bags, which also secrete strong-scented matters, but seem to be rather connected with the genitals<sup>8</sup>. These are found in some of the same carnivorous animals, which possess the anal glands, as the *lion*, the *civet*, &c.; also in many herbivora, which want the latter organs; in some of whom they exist in both sexes, as in the *beaver*<sup>9</sup>, the *ondatra*<sup>10</sup> (*mus zibethicus*), &c. in others they are peculiar to the male, as in the musk animal<sup>11</sup>, whose pouch is found in the prepuce near the navel. (See note (C).

§ 148. We must also mention here the glandular cavities, covered internally with hair, which are found in the feet of several ruminating bisulca, and particularly in the sheep. They have an excretory duct opening at the junction of the toes<sup>12</sup>;

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<sup>8</sup> TYSON, who first carefully examined the different kinds of what he calls "*scent bags*," has not distinguished them from each other. See PLOT'S *Natural History of Oxfordshire*, p. 305. and the *Philos. Transf.* vol. 13 and 20. also HALLER *Elem. Physiol.* tom. 7. p. 147, &c.

<sup>9</sup> DAUBENTON, tom. 8. tab. 41. 42.

<sup>10</sup> SARRAZIN in the *Mem. de l'Acad. des Sci.* 1725. tab. 12. 13.

<sup>11</sup> PALLAS *Spicileg. Zoolog.* 13. tab. 6.

<sup>12</sup> R. LIVINGSTONE in the 2d vol. of the *Transf. of the Society of New York*, p. 140.

and



and the obstruction of this, particularly from a long continuation of wet weather, occasions troublesome symptoms.

(B) BIRDS.

§ 149. Although birds do not masticate their food, several of them, particularly among the *pici*, have considerable *salivary glands* at the sides of the lower mandible. The secretion of these glands serves to facilitate the numerous and strong motions performed by the tongue in deglutition. (See note (D).

The *pancreas* is of considerable size particularly in those birds of prey, which do not drink: its form and structure vary considerably.

§ 150. The glands which secrete the oil, on the upper part of the tail, are largest in aquatic birds; in some of which, as the *anas moschata*, the secreted substance has a musk-like odour. In that race of the common fowl, which has no tail, (the *Gallus ecaudatus*) this organ no longer exists.<sup>13</sup> (See note (E).

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<sup>13</sup> REAUMEUR, *Art de faire éclore les Oiseaux Domestiques*. tom. 11. p. 332.



## (C) AMPHIBIA.

§ 151. I do not think it probable, that the part, which has often been considered as a *pancreas* in this and the following classes of animals, really deserves that name <sup>14</sup>.

*Anal glands*, which disseminate a strong specific odour at certain times are found in some animals of this class; for instance in the Cayman (*Lacerta Alligator*), and the rattlesnake <sup>15</sup>.

§ 152. An acrid fluid exudes through numerous pores of the skin in some reptiles, when they are irritated; as in the *salamander* and in *toads*. It is said that the *gecko* secretes a really venomous fluid between its toes. But there is a much more dangerous kind of poison formed in some serpents, which are distinguished from the innocent ones by the organs pointed out in the 71st paragraph. (See note (F)).

## (D) FISHES.

§ 153. The most universal secretion in this class, which comes under the present chapter, is

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<sup>14</sup> Zootomists have not been able to agree on this point. CHARAS took that to be the pancreas of serpents, which TYSON with the ancients called the spleen.

<sup>15</sup> TYSON in the Philof. Transf. vol. 13. p. 58.



that of the mucus, which besmears their skin and scales, and which is formed in canals<sup>16</sup> lying near the *lateral lines*, and in the same direction with them; one or more of these canals running on each side from the head to the tail-fin. In some fishes the mucus is poured out in the intervals of the scales; but in others those parts are perforated by regular openings for its discharge<sup>17</sup>. (See note (G).

### (E) INSECTS.

There are no true conglomerate glands, nor analogous parts in insects; but their different secretions are performed by loose vessels<sup>18</sup>. Besides the different secretions of peculiar matters, which belong exclusively to single species, as the vapour, which some carabi (*carabus crepitans*, *marginatus*, &c.) discharge, and the strong odours with which several of the bug-kind defend themselves in case of necessity, two kinds of secreted fluids deserve to be particularly remarked in this class: the silk

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<sup>16</sup> See the two classical works of STENO, who discovered these parts: *de musculis et glandulis*, p. 42. and *elementor. myolog. specimen*. p. 72.; also LORENZINI, p. 7. and 21.

<sup>17</sup> A. Q. RIVINUS in the Leipzig *Acta Eruditorum*, 1687. p. 161. and PERRAULT *Essais de Physique*, tom. 3. tab. 20.

<sup>18</sup> CUVIER in the *Memoires de la Societe d'Hist. Nat. de Paris*. an. 7. p. 40.



which is formed by the larvæ of phalenæ<sup>19</sup> (moths) and by spiders<sup>20</sup>; see note (H) and the *poison* with which several hymenopterous<sup>1</sup> and apterous<sup>2</sup> insects are armed. See note (I).

The wax, which is prepared by the honey-bees, and by the Indian *coccus mellificus*, deserves to be enumerated among the secretions, which are peculiar to animals of this class.

### (F) VERMES.

§ 155. The most remarkable secretions in this class take place in the testacea. There is one of these common to the whole class; viz. the formation of the calcareous matter of their shells<sup>3</sup>, which takes place in a peculiar viscus lying near the heart (*sacculus calcarius* SWAMMERD. *glandula testacea* POLI.) The celebrated purple<sup>4</sup> colour is formed in some marine genera; as the

<sup>19</sup> See LYONET, tab. 5. and 14.

<sup>20</sup> RÖSEL, tom. 4. tab. 29.

<sup>1</sup> See SWAMMERDAM's plates of the organ in the bee, tab 18 and 19.

<sup>2</sup> RICH. MEAD, *Opera Medica*, tom. 2. tab. 3.

<sup>3</sup> SWAMMERDAM, tab. 5. of the *Helix Pomatia*. POLI, tom. 2. tab. 20. of the *Venus Chione*, tab. 26. of the *Arca Pilosa*.

<sup>4</sup> See STRÖM of the *Buccinum Lapillus* in the 11th vol. of *Kiöbenh. Selsk. Skrifter*. p. 30.



*Buccinum lapillus* and *echinophorum*, *murex brandaris* and *trunculus*, *Helix ianthina*, *arca nucleus*, &c. Lastly some bivalves, under extraordinary circumstances form pearls<sup>5</sup> on the inner surface of their shell. (See note (K) for an account of the silk, secreted by mollusca, and note (L) for the ink of the cuttle fish.)

*Additions to Chapter the Eleventh.*

(A) This remarkable gland is found on the back of the animal, over the sacrum. It is of a considerable size (between two and three inches long, and above an inch broad), and is composed of several lobules, whose ducts join into one canal, which penetrates the skin. It furnishes a secretion of a very pleasant musk-like odour, from which TYSON denominated the animal *aper moschiferus*. The opening of this part on the back has been described by many authors as the navel (BARTHOLIN. *Cent. 2. Hist. Med.* 96.)

TYSON in the *Philos. Transf.* No. 153, or in his *works*, London, 4to. 1751, with a good delineation of the gland.

<sup>5</sup> Pops, tom. 1. Introduction, p. 19.



(B) These anal bags are of a spherical form, and have a small round opening just at the margin of the anus. They seem to belong particularly to the carnivorous animals. They may be seen very well in the cat. Their secretion possesses that strong disagreeable odour, which characterises so remarkably many animals of this order, as the fox and all the weazel tribe; and which has even made the polecat proverbial in common language, and has bestowed on it its scientific name, *mustela putorius*. Some American species exceed the fetor even of the polecat. This is the case with the *viverra mephitica* and *coasse* (the skunk and squash). They pour out the fetid matter when pursued; and are thereby effectually defended, as neither man nor animal can approach them.

These parts are not however confined to the carnivora, as several rodentia possess them.

(C) It is from these glands, and not from the testicles, as naturalists have absurdly supposed, that the substance called *castoreum* is produced. A delineation of the parts, from the dissection of the Parisian academicians, may be seen in the collection of BLASIUS. *Anatom. Animalium*. tab. 13.

That valuable article of the materia medica, *musk*, is produced from similar glands in the *moschus moschifer* (in English the musk), an animal  
found



found in the mountains of Thibet, and the southern parts of Siberia.

(D) I have already stated that salivary glands, in the proper sense of the term, do not exist in birds; and that the parts which the author mentions here, must be regarded in a different point of view. (See the note to § 94.)

(E) TYSON states that the ostrich has this gland situated not on the rump, but further forwards, (Anatomy of the Mexican Musk-hog, p. 39.) I have observed in the situation, which he mentions, a pretty considerable bag with hard callous sides, and nothing glandular in its coats. It contained a brown and unctuous, but nearly solid matter, and I could discover no external opening; but it had been somewhat cut before I examined it. It cannot I think be very well compared with the oil bag of the rump.

(F) There is found in the crocodile, on each side of the lower jaw, and just under the skin, a gland, whose duct opens externally. It secretes a substance smelling like musk.

(G) CUVIER represents the tubes which open in the course of the *linea lateralis* of fishes, as the excretory ducts of two glands placed above the orbits. (*Léçons d'Anat. comparée.*) tom. 5. p. 260.



In the *skate* the openings are not confined to any particular part, but are scattered over the surface. The tubes radiate from one point, just above the angle of the jaw; and the third branch of the fifth pair of nerves is distributed at that part; its filaments accompanying the tubes.

For an account of the electrical organs of fishes, which must be considered as parts secreting the electrical matter, see § 217: and for their swimming bladder, in which a secretion of air is effected, § 186.

(H) Almost all the larvæ or caterpillars spin for themselves some kind of covering before their metamorphosis; but it is the silkworm only (*bombyx mori*), that furnishes the materials of our various silk manufactures, as the thread which it forms is very pliant and abundant, and can be easily unrolled.

The secretory organs, which furnish this matter of silk, are the same in all larvæ. They consist of two long tubes, at first small and tortuous, but growing gradually larger to form a kind of reservoir, and terminating in a single very small tube, which opens under the lower lip. It is by moving its head from side to side, that the animal draws out the silk.

(I) In those insects, which possess stings, the  
irritating



irritating or poisonous fluid is formed in a peculiar bag, which sends a duct to the sting. The latter part is hollow, and its tube opens externally. It is contained in a sheath, and barbed at the sides of its point, so that it usually remains in the wound, which it inflicts. A delineation of these parts in a magnified view may be seen in SWAMMERDAM, tab. 27. of the English translation.

(K) Several acephalous mollusca produce a kind of silk, similar to that of the larvæ of insects. It is sometimes called the *beard*; and is employed by the animal in order to attach itself to rocks, &c. It is formed by a conglomerate gland, placed near the foot; which latter part draws out the silk from the excretory duct, and moulds it in a groove on its surface. The sea muscle (*mytilus*) the *pinna*, and *perna*, exemplify this structure. The *pinna* produces it in such quantity, and of such quality, as to admit of its being manufactured into gloves, which is done at Messina and Palermo (BLUMENB. *handbuch der Naturgeschichte*. ed. 6. p. 438.)

(L) The black inky fluid of the cuttle-fish, which has often been supposed to be the bile, is a very singular secretion, that must be noticed in this place. The bag, in which it is contained, has a fine callous internal surface, and its excretory duct opens near the anus. The fluid itself is thick, but miscible with water to such a degree, that a  
 very



very small quantity will colour a vast bulk of water; and the animal employs it in this way to elude the pursuit of its enemies. According to CUVIER, the *Indian ink* (which comes from China) is made of this fluid. (*Léçons d'Anat. Comp.* tom. 5. p. 262.)



...of the heart and lungs...  
...of the heart and lungs...  
...of the heart and lungs...

...A PERFECT circulation...  
...of the one hand...  
...to be converted into blood...  
...on the other side...

**THE**

**VITAL FUNCTIONS.**

...of such a system...  
...and certain vessels...  
...found in some parts of the...  
...of the...

**(A) Mammalia.**

...The internal structure of the heart is...  
...the same as in man...  
...but its location is...

...It is interesting that...  
...the lungs...  
...the heart...  
...the lungs...



very small quantity will color a tall bulk of  
 water, and the amount employed is in the way to  
 color the portion of it exposed. According to  
 Currier, the colorant (which comes from China)  
 is made of the root of *Liquidambar* (Comp. med. 5  
 337-8)

THE

VITAL FUNCTIONS.



beds and comes distant from that which it has  
 the human subject. It is in the former more  
 lengthwise with respect to the body; taking rather  
 on the human system. Hence

**CHAPTER XII.**

**ON THE HEART AND BLOOD-VESSELS.**

§ 156. **A** PERFECT circulating system, to which  
 on the one hand fluids are brought by the absorb-  
 ents, to be converted into blood; and from which  
 on the other side, various juices are separated in  
 glands, and viscera of a glandular structure, ap-  
 pears to belong universally and exclusively to red-  
 blooded animals. A pericardium exists in all these  
 animals.\* Parts of such a system, particularly a  
 heart, and certain vessels connected with it are  
 found in some genera of the two white-blooded  
 classes.

(A) MAMMALIA.

§ 157. The internal structure of the heart is  
 the same as in man; but its situation in quadru-

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\* It is surprising that so many good anatomists should  
 have denied the existence of a pericardium in the hedgehog.  
 BLASIUS, PEYER, HARDER, TOZZETTI, &c. are among these.  
 The membrane is indeed very delicate in this animal, and it  
 requires some care to avoid tearing it in opening the chest.



pedes and cetacea differs from that which it has in the human subject. It is in the former more lengthwise with respect to the body; resting rather on the sternum than on the diaphragm. Hence the pericardium of these animals is not connected with the diaphragm<sup>2</sup> as in the human subject; the portion of the inferior vena cava within the chest is proportionably longer.<sup>3</sup> (See note (D) at the end of the chapter.)

§ 158. The larger adult bisulca, and the pig have two small flat bones, (which have been called, particularly in the stag, *bones of the heart*) where the aorta arises from the left ventricle. The common notion that they serve as a support to the valves,<sup>4</sup> does not much elucidate the subject. (See note (B).)

§ 159. It has been supposed, that the amphibious animals of this class and the cetacea have an open *foramen ovale*, like that of the fœtus, in their septum auricularum. And the necessity of such an opening has been inferred from their way of

<sup>2</sup> See MORGAGNI in his *Epist. Anat.* p. 302, edit. 1764.

<sup>3</sup> On the proportionate length of the heart to that of the whole body. See T. H. BERGMAN, *Præfixæ lineæ Pathologiæ Comparatæ.* Gött. 1804, 4.

<sup>4</sup> C. I. KEUCHEN, *de Officulis e Cordibus Animalium.* Groning. 1772, 4.

life;



life; since they often pass a considerable time under water without breathing. This supposition has been fully refuted by the repeated dissection of adult animals of this kind; which has shewn that an exception from the general rule very rarely occurs.<sup>5</sup> (See note (C)).

In several genera and species, of web-footed mammalia, and cetacea (that is, in the common and sea-otters, in the dolphin, &c.) particular vessels have been observed to be considerably and constantly enlarged, and tortuous. This structure has been principally remarked in the inferior vena cava; where there can be no doubt that it serves, while the animal is under water, to receive a part of the returning blood, and to retain it until respiration can be again performed, and the lesser<sup>6</sup> circulation be thereby again put in action.

§ 160. There are some remarkable circumstances in the distribution of particular arteries in certain animals of this class. We may notice, as

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<sup>5</sup> I possess through the kindness of Dr. ALBERS, of Bremen a very singular heart of an adult seal. The *foramen ovale* and *ductus arteriosus* are completely open. Both the arterial trunks, and particularly the aorta, form large, and as it were aneurysmatic expansions. The same fact was observed by SEGER in the latter vessel in a seal, of which he has given an account in the *Ephem. Nat. Curios*, Dec. 1. an 9. p. 252.

<sup>6</sup> KULMUS in the *Acta Acad. Natur. Curios.* tom. 1. p. 25.



the most singular of these, the rete mirabile, formed by the internal carotid at its entrance into the cranium, in several ruminating biscula<sup>7</sup>, and carnivorous animals: and that division of the arterial trunks of the extremities, which has been observed by Mr. CARLISLE<sup>8</sup> in the slow-moving animals, viz. the sloths, and lemur tardigradus. The arteries of the arm and thigh in these cases, divide as they leave the trunk into numerous parallel branches, which are united again towards the elbow and knee. \* (See note (D)).

### (B) BIRDS.

§ 161. The whole of this class without exception, possess a very remarkable peculiarity in the structure of the heart. The right ventricle, instead of having a membranous valve (such as are found in both ventricles of mammalia, and also in the left of birds), is provided with a strong, tense, and

<sup>7</sup> It is represented by MONRO in the stink calf. *Obs. on the Nervous System, tab. 1.*

<sup>8</sup> In the *Philos. Trans.* for 1800, p. 98.

\* The most curious and elegant distribution of veins occurs in the foot of the horse; where these vessels run in innumerable parallel branches on the anterior surface of the coffin bone, and form a reticular plexus of anastomoses on the under part which completely covers the surface of the bone.

nearly



nearly triangular muscle. This singular structure assists in driving the blood with greater force, from the right side of the heart into the lungs : since the expansion of the latter organs by respiration, which facilitates the transmission of the carbonated<sup>9</sup> blood in mammalia, does not take place in birds, on account of the connection which their lungs have with the numerous air-cells, which will be afterwards described.<sup>10</sup>

### (C) AMPHIBIA.

§ 162. The frogs, lizards, and serpents, of this country at least, have a simple heart, consisting of a single ventricle and auricle.<sup>11</sup> See note (E).

§ 163. The structure of this part is very different in the turtle;<sup>12</sup> and has given rise to more controversy than that of any order of animals.

<sup>9</sup> The reasons which have induced me to substitute the terms, *carbonated* and *oxygenated*, for those of venous and arterial blood have been explained in the *Instit. Physiol.* p. 13.

<sup>10</sup> I have spoken more largely of this part, in the *Comment. Reg. Soc. Scient.* Gotting. vol. 9, where there is also a representation of the muscle in the heron, p. 128.

<sup>11</sup> SWAMMERDAM gives the clearest representation of the heart of the frog, and of the vessels, which are most immediately connected with it, tab. 49.

<sup>12</sup> I have lately opened a tortoise from Morocco, which came to me alive, and for which I am also indebted to Dr.



Their heart possesses two auricles,<sup>13</sup> which are separated by a complete septum, like those of warm-blooded animals, and receive their blood in the same manner, as in those animals; viz. the two venæ cavæ terminate in the right auricle, the pulmonary veins in the left. Each pours its blood into the corresponding ventricle, of which cavities there are two: thus the structure of the heart hitherto resembles that of mammalia.

The characteristic peculiarities, which distinguish the heart of these animals, consist in two circumstances. First, both the ventricles communicate together; there is a muscular, and as it were tubular

ALBERS. The structure of its heart, concerning which MORGAGNI himself was in doubt, exactly resembled that of the turtle in the most important circumstances: viz. in the union of the two ventricles by an intermediate opening, in the origin of the large arteries from the right ventricle, as well as in the distribution of the aorta, and the union of its two chief branches in the abdomen. The cavities of the ventricles were equally small; their parietes equally spongy. The intermediate opening of the ventricles was more simple as it had not the valvular structure, which is found in the heart of the turtle. The auricles were loose and thin as in the *testudo caretta*; not strong and spongy as in the *mydas*.

" A remarkable difference exists in the structure of the auricles between the *testudo caretta* and *mydas*, both of whose hearts now lie before me. The auricles of the former are thin, like those of warm-blooded animals; in the latter they are very firm, and have almost as thick and strong parietes as the ventricles.

valve,



valve, going from the left to the right cavity, by means of which the former opens into the latter. Secondly, the large arterial trunks arise all together from the right ventricle only (no vessel coming from the left). The aorta, forming three grand trunks<sup>14</sup>, is situated towards the right side and the upper part; the pulmonary artery comes as it were from a particular dilatation<sup>15</sup>, which is not situated in the middle of the basis of the heart, but lower; (it must be understood, as we have already observed, that we apply these terms according to the horizontal position of the animal.)

We can now comprehend how this wonderful and anomalous structure, by which all the blood is propelled from the right ventricle only, is accommodated to the peculiar way of life of the animal, which subjects it frequently to remaining for a long time under water. For the greater circulation is so far independent of that, which goes through the lungs, that it can proceed, while the animal is under water, and thereby prevented from respiring,

<sup>14</sup> Two of these go to the abdomen; the right is the proper *aorta abdominalis*, the left is the *ductus communicativus* of MERY, who compared it to the *ductus arteriosus* of the foetus

<sup>15</sup> MERY considered this dilatation as a third ventricle, *ventriculus intermedius*; hence it has happened, that some zoötomists have ascribed to the turtle a single ventricle, (on account of the communication); some two, and others three.



although the latter is impeded. In warm-blooded animals, on the contrary, no blood can enter the aorta, which has not previously passed through the lungs, into the left ventricle; and hence an obstruction of respiration most immediately influences the greater circulation<sup>16</sup>.

#### (D) FISHES.

§ 164. The heart in this class of animals is extremely small in proportion to the body. Its structure is very simple, as it consists of a single auricle and ventricle, which correspond with the right side of the heart in warm-blooded animals. The ventricle gives rise to a single arterial trunk (which is expanded in most fishes into a kind of bulb as it leaves the heart), going straight forwards to the *branchiæ*, or organs of respiration. The blood passes from these into a large artery, analogous to the aorta, which goes along the spine and supplies

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<sup>16</sup> The best and most intelligible delineations of the turtle's heart are those by MERY in the *Mem. de l'Acad. des Sc.* 1703. Although he made an erroneous application of them to the course which he supposed the blood to take in the heart of the human fœtus. I conclude from a comparison with my own preparations, that his drawings were taken from the *testudo caretta*.



the body of the animal. It is then returned by the venæ cavæ into the auricle<sup>17</sup>.

§ 165. Most cold-blooded animals, as fishes, and the amphibia of this country, have a much smaller proportion of blood, and fewer blood-vessels than those with warm blood. On the contrary, they have a much greater number of *colourless vessels* arising from the arterial system.

### (E) INSECTS.

§ 166. A true heart, and system of vessels connected with it, are found in a very few of what are called white-blooded animals. In this class they seem to belong only to some genera of insects

<sup>17</sup> Representations of the heart of a fish are given by PERRAULT in the *Essais de Physique*, tom. 4. tab. 19. : by DUVERNEY, in his posthumous "*Œuvres Anatomiques*", tom. 2. tab. 9. : by GOVAN *Historia Piscium*, tab. 4. (all these however call the trunk of the *branchial artery*, the *aorta*) and by MONRO in his "*Structure and Physiology of Fishes*."

<sup>18</sup> In an experiment which I made on this subject, I obtained from 24 adult water-newts (*lacerta palustris*) which has been just caught, and weighed  $1\frac{1}{2}$  oz. three scruples and a half of blood. The proportion therefore of this fluid to the weight of the body was as  $2\frac{1}{2}$  to 36; while the same proportion in an adult and healthy man is as 1 to 5.



which have no wings; as the genus *cancer*,<sup>19</sup> and *monoculus*. Several of the older zootomists considered the dorsal vessel of the larvæ, &c. to be a heart; but this opinion has been already refuted by LYONET. In the genera which we have mentioned, there seems to be no passage of the arterial extremities into the origins of veins, and consequently no true circulation. (On the mode of nutrition in these animals, see note (F)).

(F) VERMES.

§ 167. In many genera of this class, particularly among the *mollusca*<sup>20</sup> and *testacea*,<sup>1</sup> there is a very manifest heart<sup>2</sup>, which is sometimes of a singular structure. It consists, for instance, in the *cuttle-fish*, of one ventricle, and two auricles, which lie at some distance from the ventricle, near the gills.

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<sup>19</sup> WILLIS *De Animâ Brutorum*, tab. 3. fig. 1. RÖSEL'S *Insects*, vol. 3, tab. 58.

<sup>20</sup> See SWAMMERDAM of the *limax maximus*, tab. 9. of the *sepia officinalis*, tab. 52. MONRO *on Fishes*, tab. 31.

<sup>1</sup> See POLI *testacea utriusque Siciliae*, Vol. 1, and 2, for a representation of this in several testacea. WILLIS in the work above quoted, tab. 2. of the *oyster*. SWAMMERDAM, tab. 5, of the *helix pomatia*.

<sup>2</sup> CUVIER divides the whole class of *vermes*, according as they are furnished with a heart, and vascular system, or are destitute of these organs, into two families: the former he calls *mollusca*, the latter *zoophita*.



Some bivalves are said by POLI to have two auricles, and some even four. But in all these instances, there has been no connection hitherto discovered between the arteries and veins;<sup>3</sup> while on the other hand some genera in other orders of this class have a connected system of vessels without a heart;<sup>4</sup> and the proper *zoophytes* cannot be said to possess either; as their nutrition seems to be effected by an immediate derivation of the nutritive fluid from their abdominal cavity into the gelatinous parenchyma of their body<sup>5</sup>. \*

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<sup>3</sup> See POLI, tom. 2, tab. 25, of the *arca noæ*, and tab. 27, of the *ostrea jacobæa*, also tom. 1, introduction, p. 39.

<sup>4</sup> B. F. BENING *de hirudinibus*. Harderov. 1776, 4to. a very excellent monograph. The *medusæ* also have no heart, but a manifest circulating system of arteries and veins. See MITCHILL in *Albers's American Annals*, in German, pt. 1. p. 121.

<sup>5</sup> SPALLANZANI, FONTANA, and MULLER, have considered the dark portion in the body of the wheel animal (*vorticella rotatoria*) to be a heart; although it has voluntary motion, which is influenced by that of the radi. And they have employed this by a curious *petitio principii*, to prove that there are animals which have a voluntary power of setting their heart in motion, or leaving it at rest. I have shewn twenty-three years ago, that this remarkable organ can by no means be looked upon as a *heart*, but is really an *alimentary canal*.

\* On the circulating system of the vermes, see note (G) at the end of the chapter.

Addi-



*Additional Notes to the Twelfth Chapter.*

(A) The heart of the *orang outang* is placed obliquely like that of the human subject; but in other *simiæ* the apex only is a little inclined to the left, and just touches the diaphragm.

(B) The right auricle receives in the *porcupine* and *elephant* two anterior venæ cavæ; the left of which opens near the communication with the ventricle.

(C) The question, whether or no the *foramen ovale* be open in such animals, as have the power of diving, and remaining for some time under water, seems to be as yet not completely decided. In addition to the affirmation of the author, § 159, the evidence of CUVIER may be quoted; he states that in several *porpoises*, in a *dolphin*, and a *seal*, he found this opening closed. (*Léçons d'Anat. Comp. tom. 4. p. 201.*) The Parisian dissectors also found it closed in a *beaver*. (*Description Anatom. d'un castor. &c. p. 68.*) It was perfectly shut in a *porpoise* and young *seal* which I examined: and according to Mr. HOME, (*Philos. Transf. 1802*) it is closed in the *ornithorhynchus*. On the other side of the question, besides the fact mentioned in note 5, which is very striking, we may adduce Mr. HOME's authority for the existence of the *foramen ovale*, in



an open state, in the *sea otter*. He found it so in two instances; one of which was in an adult animal. But the *ductus arteriosus* was closed. (*Philos. Trans.* 1796, pt. 2). This may perhaps be nothing more than a casual occurrence; as a small opening is not unfrequent in the human subject; and I lately met with the communication as free as in the fetal state, in a person, who had no symptom of disease, or defect in the circulating system during life.

(D) Plexuses or convolutions of the arteries are found in some parts of the cetacea; as in the intercostal arteries, in the branches which go from the subclavian to the chest, in those which supply the medulla spinalis, and the eye. HUNTER in the *Philos. Trans.* 1789, pt. 2.

(E) The account which CUVIER gives of the anatomy of the heart in the amphibia, does not exactly accord with that of the author. CUVIER describes and delineates the heart of the crocodile as being formed nearly like that of the turtle (tom. 5. pl. 45); he says that the iguana has a similar structure, and that it obtains likewise in the serpents, (tom. 5. p. 221-225.) He does not mention the more simple form as existing in any lizard or serpent.

(F) It appears that insects possess neither blood-vessels, nor absorbents. CUVIER has examined, by means of the microscope, all those organs in this class,



class, which in red-blooded animals are most vascular without discovering the least appearance of a blood-vessel; although extremely minute ramifications of the tracheæ are obvious in every part. And LYONET has traced and delineated in the caterpillar, parts infinitely smaller than the chief blood-vessels must be, if any such existed. *Anatomie de la Chenille, &c.*

Yet insects, both in their perfect, and in their larva state, have a *membranous tube* running along the back, in which alternate dilatations and contractions may be discerned. From this circumstance it has been supposed to be the heart: but it is closed at both ends, and no vessels can be perceived to originate from it.

It is obvious from these data, that the functions of nutrition and secretion must be performed, in the animals which we are now considering, in a very different manner from that which obtains in the more perfect classes. CUVIER expresses the mode, in which he supposes growth and nutrition to be effected, by the term "*imbibition.*" And he explains from this circumstance, the peculiar kind of respiration, which insects enjoy. Since the nutritive fluids have not been exposed to the atmosphere, before they arrive at the parts for whose nourishment they are destined; this exposure is effected in the parts themselves, by means of the air-vessels, which ramify most minutely over the whole body. "En un mot, le sang ne pouvant aller



aller chercher l'air, c'est l'air, qui va chercher le sang." (*Léçons d'Anat. Comp.* l. 23, sect. 2, art. 5).

The heart of the *crustacea* according to CUVIER has no auricle; and it is what he calls an *aortic heart*. For it expels the blood into the arteries of the body; and this fluid passes through the gills previously to its reaching the heart again. The different parts of the system are here found under a mode of connection exactly the reverse of what we observe in fishes; where the blood is sent into the gills, and passes subsequently into the aorta. The circulating organ in that class is therefore a *pulmonary heart*.

I do not comprehend what the author means by stating, that there is no communication between the arteries and veins in the crustacea. If the blood is sent out in the one system of vessels, and returns by the other; does not this prove the communication?

(G) According to CUVIER, the cuttle-fish has three hearts, neither of which possesses an auricle. Two of these organs are placed at the root of the two *branchiæ*: they receive the blood from the body, (the vena cava dividing into two branches, one for each lateral heart) and propel it into the *branchiæ*. The returning veins open into the middle heart; from which the aorta proceeds.

The other mollusca have a simple heart, consisting of one auricle and ventricle. The vena cava assumes the office of an artery, and carries the re-  
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turning blood to the gills; whence it passes to the auricle; and is subsequently expelled into the aorta. Here therefore, as in the crustacea, the heart is a *pulmonary* one.

The *vermes* of CUVIER have circulating vessels, in which contraction and dilatation are perceptible; without any heart. They can be seen very plainly in the *lumbricus marinus*. The *leech*, *naias*, *nereis*, *aphrodite*, &c. are further examples of the same structure. This anatomist is of opinion that the *mollusca*, *crustacea*, and *vermes*, possess no absorbing vessels; and he thinks that the veins absorb, as he finds them to have communication with the general cavity of the body, particularly in the cuttle-fish. Hence the above mentioned classes will hold an intermediate rank, between the *vertebral animals*, which possess both blood-vessels, and absorbents; and the *insects* which have neither. (*Léçons*, &c. l. 23. sect. 2. art. 4).



## CHAPTER XIII.

## OF THE ABSORBING VESSELS.

§ 168. IT was regarded as an axiom even by VALSALVA, that those animals, which have true blood-vessels, have also an absorbing or lymphatic system. It appears also that the converse of this proposition is true: viz. that those classes only have true lymphatic vessels, which possess at the same time a perfect circulating system of blood-vessels; that is, only the four classes of red-blooded animals.

In many of what are called white-blooded animals, there is a kind of absorption very evident; as in the armed polypes, whose parenchyma becomes tinged in a short time with the colour of those insects, which have been swallowed. The existence of absorption is inferred by analogy from other phenomena, as the metamorphosis of larvæ, &c. But no true system of real absorbing vessels has been hitherto demonstrated in these animals<sup>r</sup>.

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<sup>r</sup> SHELDON has ascribed absorbing vessels to the silk-worm and other larvæ: see his history of the absorbent system. Part I. p. 28.; and MONRO to the *echinus esculentus* (sea hedgehog) in his *Physiol. of Fishes*. p. 88.



§ 169. This system (which comes most properly under consideration in the present chapter, on account of its relation to the circulation of the blood), consists of the *lacteal* vessels, which arise from the small intestines, and of the proper *lymphatic* vessels, which belong to the rest of the body. It includes also the *conglobate glands*, which are found in most of the animals, which have this system, and seem to consist merely of a congeries of the vessels; and lastly, the *thoracic duct*, which is the chief canal for conveying the fluids from the lymphatic system into the blood. (See note (A) at the end of the chapter.)

(A) MAMMALIA.

§ 170. All the parts of the absorbing system, which have been just enumerated, are most perfect and manifest in this class of animals<sup>2</sup>. When their lacteals contain chyle, they are distinguished by their white colour from the other absorbing vessels, the contents of which are either limpid, or of a slight yellow tinge. The former vessels run together in considerable trunks, particularly in the sheep and goat: the latter, or true lymphatics, may be seen

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<sup>2</sup> It is well known that all the chief parts of this important system of vessels have been first discovered in mammalia.



to advantage on the hind-leg of the horse, where they follow a tortuous course.

The thoracic duct is double in some quadrupeds<sup>3</sup>, as in the dog, and forms at its commencement, more constantly than in the human subject, a vesicular enlargement, called the *cisterna* or *receptaculum*<sup>4</sup> *chyli*. (See note (B)).

In many mammalia, particularly of the order *feræ*, the mesenteric glands are collected into one mass, which is known by the inappropriate name of *Pancreas Asellii*<sup>5</sup>.

### (B) BIRDS.

§ 171. The chyle is transparent in this class; therefore the lacteals are only distinguished from the lymphatics by their situation and office. There are no glands in the mesentery, although conglo-

<sup>3</sup> PECQUET *Experimenta Nova Anatomica*, p. 21. Ed. of 1654.

<sup>4</sup> The course and distribution of the thoracic duct vary in quadrupeds, at least in our domestic animals, as much as in the human subject. It forms not unfrequently, in the dog, a kind of annular portion at its upper, or more properly, anterior end, which trivial variety VAN BILS transformed into a constant and important circumstance, and called "*receptaculum tortuosum*," &c. He has represented it in a very beautiful plate, as far as the engraving goes, in his *Responsio ad Admonitiones* JO. AB. HORNE. Roterod. 1661. 4. p. 7.

<sup>5</sup> ASELLIUS *de lactibus*. tab. 1, and 2.



bate glands are found in other parts in several of the larger birds. Their thoracic duct is double <sup>6</sup>.

(C) AMPHIBIA.

§ 172. Lacteals are found in great number in the delicate mesentery of the turtle. The thoracic duct is double. There seem to be no lymphatic glands at all <sup>7</sup>. (See note (C)).

(D) FISHES.

§ 173. The lymphatics of these animals seem to be destitute of glands and valves: they want also the lymphatic glands, and their thoracic duct divides at least towards its anterior part, into two chief branches <sup>8</sup>.

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*Additional Notes to the Thirteenth Chapter.*

The structure and offices of the absorbent glands have been illustrated by the observations of Mr. ABERNETHY on the formation of these parts in the whale. He found the mesenteric glands of that

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<sup>6</sup> HEWSON in the *Philos. Transf.* vol. 57. tab. 10. of the *cock*.

<sup>7</sup> MONRO's *Physiol. of Fishes*, tab. 30.

<sup>8</sup> HEWSON and MONRO in the works quoted above. See also BARTHOLIN, *Anat. renov.* p. 609, of the *Cylopterus Lumpus* (Lumpfucker).



animal to consist of large spherical bags, into which several of the lacteals opened. Numerous vessels ramified on these cysts; and the injection passed from their secerning extremities into the cavity. In the groin and axilla of the horse he also found them to consist of one or more cells. Hence there can be no doubt that the absorbed fluid must receive an addition in its passage through these bodies. *Philos. Transf.* 1796. pt. 1.

It has been much questioned, whether the lymphatics have any communication with the venous system, prior to the termination of the thoracic duct. The observations of that ingenious veterinary surgeon, Mr. BRACY CLARK, have determined this question in the affirmative; as he has found the trunk of the lymphatic system to have several openings into the lumbar veins in the horse. REES'S *Cyclopædia*, article ANATOMY VETERINARY.

(B) Mr. HOME has found that in the *sea-otter* the receptaculum chyli sends two trunks to form the thoracic duct. These have frequent communications; so that there are sometimes three, frequently four, and never fewer than two trunks running parallel to each other. *Philos. Transf.* 1796, pt. 2.

(C) The distribution of the lymphatics on the intestine of the turtle forms one of the most elegant preparations in comparative anatomy. By fixing  
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the injecting tube in a vessel near the intestine, and waiting with a little patience, the quicksilver will gradually find its way into the minute ramifications of the lacteals. The peritoneal surface of the gut is covered with very minute straight parallel branches, running according to the length of the intestine. Its inner surface is no less thickly covered with lacteals of a different appearance. When dried it seems as if the quicksilver were contained in small cells, covering the whole internal surface of the intestine so completely that the point of a pin could scarcely be placed between them.



## CHAPTER XIV.

## ON THE ORGANS OF RESPIRATION.

§ 174. **T**HE incessant continuation of the great chemical process, by which *oxygen*, the true pabulum vitæ, is exchanged for *hydrogen* and *carbone*, is essentially necessary to the wellbeing of the greater part of animals. Yet the organs and mechanism, by which this wonderful function is carried on, vary very considerably'. In the mammalia after birth; in birds, when they have left the egg; and in amphibia when completely formed, the chief organ of this function is the *lungs*: in fish it is performed in the *gills*; in most insects, in their *tracheæ*; in the vermes, in analogous, but at the same time very different parts.

## (A) MAMMALIA.

§ 175. The lungs of quadrupeds agree on the whole in structure, form and connection, with

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' AUG. BROUSSONET *Varie Positiones circa Respirationem*. Monspel. 1778, 4. it is also contained in LUDWIG'S *Delectus Opusculor. ad Scient. Naturalem spectant.* Lipsiæ, 1790, 8. p. 118.



those of the human subject. In the cetacea on the contrary, and in the web-footed mammalia, (as the *manati*), which approach most nearly to them, they are distinguished by a firmer texture, particularly of the investing membrane, and by their peculiar form; since they are not divided into lobes, but have an elongated and flattened appearance. They are adherent to the pleura, as well as to the very strong and muscular diaphragm<sup>2</sup>.

### (B) BIRDS.

§ 176. The respiratory organs of this class constitute one of the most singular structures in the animal economy, on account of several peculiarities, which they possess; but more particularly in consequence of their connection with the numerous air-cells, which are expanded over the whole body<sup>3</sup>.

The lungs themselves are comparatively small, flattened, and adhering above to the chest, where they seem to be placed in the intervals of the ribs; they are only covered by the pleura on their under surface, so that they are in fact on the outside of the cavity of the chest, if we consider that cavity as being defined by the pleura\* : a great part of the

<sup>2</sup> TYSON'S *Anatomy of a Phocæna*. p. 30.

<sup>3</sup> LADISL. CHERNAK *de Respiratione Volucrum*. 1773, 4to.

\* See note (A) at the end of the chapter.



thorax, as well as the abdomen is occupied by the membranous air-cells<sup>4</sup>, into which the lungs open by considerable apertures. Those of the thorax are divided, at least in the larger birds, by membranous transverse septa, into smaller portions<sup>5</sup>; each of which, as well as the abdominal cells has a particular opening of communication with the air-cells of the lungs, and consequently with the trachea. The membranes of these cells in the larger birds are provided here and there with considerable fasciculi of muscular fibres, which have been regarded as a substitute for the diaphragm, which is wanting in this class of animals<sup>6</sup>. They also serve very principally, as we may ascertain by examining large birds in a living state<sup>7</sup>, to drive back again into the lungs, the air which they received in inspiration; whence the repletion and depletion of the

<sup>4</sup> Discovered by HARVEY, "*De Generatione Animalium.*"

P. 4.

<sup>5</sup> PERRAULT *Essais de Physique*, tom. 3, tab. 18. of the ostrich.

<sup>6</sup> CASP. BARTHOLIN *Diaphragmatis Structura Nova*. Paris, 1676, 8, p. 31. Modern zootomists have been divided on this question; which of the membranes, in or about the chest of the bird, can be properly compared to the diaphragm. See J. HUNTER in the *Philos. Transf.* vol. 64, pt. 1, p. 207. And MICH. GIRARDI in the "*Memoirs of the Italian Society,*" in Italian, tom. 2, pt. 2, p. 739.

<sup>7</sup> WEPFER *Cicute Aquaticæ Historia*, p. 171.



thoracic cells must alternate with those of the abdominal cavities<sup>8</sup>.

§ 177. Besides these cells, a considerable portion of the skeleton is formed into receptacles for air, in most birds (for there are indeed exceptions and considerable variations in the different genera and species). This structure is particularly marked in the larger cylindrical bones, as the scapula, clavicle and femur. It is also found in most of the broad and multangular bones of the trunk, as the sternum, ossa innominata, dorsal vertebræ, &c. All these are destitute of marrow<sup>9</sup> in the adult bird, at least in their middle; so that the cylindrical bones form large tubes, which are only interrupted towards the extremities, by a sort of transverse bony fibres: the broad bones are filled with a reticulated bony texture, the cells of which are empty. They have considerable apertures<sup>10</sup> (most easily shewn in those extremities of the cylindrical bones, which are turned towards the sternum) communicating with the lungs by small air-cells; which facts may

<sup>8</sup> J. B. DU HAMEL *Historia Academ. Reg. Scient.* p. 141.

<sup>9</sup> This fact was known to the Emperor FREDERIC 2ND. See his treatise *de Arte Venandi cum Avibus*, p. 39, of SCHNEIDER'S edition.

<sup>10</sup> CAMPERS' *smaller writings*, in German, vol. 1, pt. 1. tab. 1, and 4.



be shewn by various experiments on living and dead birds<sup>11</sup>.

These receptacles of air probably serve the purpose of lightening the body of the bird in order to facilitate its motions. This effect is produced in most birds to assist their flight<sup>12</sup>; in some aquatic species, for the purpose of swimming; in the ostrich and some others, for running. Hence we find the largest and most numerous bony cells in birds which have the highest and most rapid flight, as the eagle, &c. And hence also the bones of the bird which has just left the egg, are filled with a bloody marrow, which is absorbed soon after birth, entirely in some, in others, particularly among the aquatic species, at least for the greater part.

We may however conclude on the other hand, that all these bony receptacles of air are not, like those of the thorax and abdomen, immediately connected with the respiration of the animals. For in many birds the interval between the two tables of the cranium contains air, while the apertures for its admission are not connected with the lungs, but merely with the Eustachian tube.

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<sup>11</sup> There are some curious experiments on this subject by Dr. ALBERS. He made living birds respire the different gases through the air-cells of their bones by means of an apparatus invented for the purpose. See his "*Contributions to the Anatomy and Physiology of Animals*," in German, pt. 1. Bremen, 1802. 4. p. 110.

<sup>12</sup> WILLIS *de Anima Brutorum*, p. 30.



§ 178. The immense bill of some birds, which are for that reason called *levirostres*, is provided with air from the same quarter. This structure is not therefore connected, as some anatomists<sup>13</sup> have supposed, with the organ of smelling, but forms a part of the air-cells.

§ 179. Lastly the barrels of the quills also contain air<sup>14</sup>. These are filled, in the bird which has just quitted the egg, with a bloody marrow; but they become hollow after its absorption, and can be filled with air, or emptied at pleasure. Hence arises the quick and voluntary erection of the plumage in the *turkey*, *bullfinch*, &c. (See note (B).

§ 180. Besides the uses, which have been already pointed out, these receptacles of air diminish the necessity of breathing frequently in the rapid and long continued motions of several birds, and in the great vocal exertions of the singing birds<sup>15</sup>. They are also obviously serviceable in the evacuation of the fæces, and probably assist in the expulsion of the egg.

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<sup>13</sup> CAJET. MONTI in the *Comment. Infit. Bonon.* tom. 3. p. 298.

<sup>14</sup> *Manual of Natural History*, 1st edit. p. 154.

<sup>15</sup> WILLIS *de Anima Brutorum*, p. 30.



## (C) AMPHIBIA.

§ 181. The lungs of amphibia<sup>16</sup> are distinguished from those of warm-blooded animals, both by a great superiority in point of size, as well as by a greater looseness of texture<sup>17</sup>: which circumstances are serviceable in swimming in many of these animals. (See note (C).)

§ 182. They have numerous projecting processes in the chameleon<sup>18</sup>; and terminate behind in an elongated bladder in the newt. The serpents, at least for the most part, have only a single lung, which forms an elongated bag<sup>19</sup>.

<sup>16</sup> Those of the testudines are delineated by CALDESI, in his "*Observations*," &c. tab. 8.

<sup>17</sup> It is well known, that the lungs of turtles and frogs do not collapse on opening the animals, like those of mammalia, but often remain expanded, at least partially, for some time. MALPIGHI, and lately TOWNSON, (*de Amphibiis*, Goett. 1794-4,) have explained this phenomenon by the action of the constrictor muscles of the glottis. BREMOND thought this insufficient according to his experiments; and ascribed much effect to the peculiar vitality of the lungs. See also on the same subject RUDOLPHI's experiments in his *Anatomico-Physiological Transactions*, p. 119.

<sup>18</sup> VALLISNIERI's "*History of the Cameleon*," in Italian. p. 68, tab. 3.

<sup>19</sup> In a coluber of four feet and a half long, the lung measured one foot, one inch; its anterior half resembled a mus-



§ 183. In the tadpole, and the young of such lizards as bring forth in water<sup>20</sup>, there are two organs, which somewhat resemble the gills of a fish (*appendices simbriatæ* SWAMMERDAM)<sup>1</sup>. They are connected to the sides of the neck, and hang loose from the animal; they are not permanent, but are gradually withdrawn into the chest, (within a few days, in the reptiles of this country), where their remains may still be perceived for some time<sup>2</sup> near to the true lungs<sup>3</sup>. Instead of the branchial opening, by

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cular intestine in appearance, and had an elegantly reticulated internal surface (which resembled on a small scale, the inner surface of the second stomach of the ruminating animals). The posterior part formed merely a simple and long cavity with thin sides.

<sup>20</sup> It has been doubted whether the young of the true salamander are provided with these appendices; and LATREILLE, in his "*Histoire Naturelle des Salamandres de France*," p. 19, and seq. has the following question "*Les jeunes Salamandres Terrestres ont elles des Branchies? voila une Question que je mets encore au rang des Problemes*" I answered this question in the affirmative fifteen years ago; having observed that the young of some pregnant salamanders, whom I kept in my room in glasses, and who brought forth under my inspection, had considerable branchial appendices. See the *Specimen Physiologia comparatæ* in the 8th vol of the *Göttingen Commentaries*.

<sup>1</sup> *Biblia Naturæ*, p. 822. RÖSEL tab. 2. fig. 18.

<sup>2</sup> SWAMMERDAM, loc. citat. ROSEL, p. 82, tab. 19, fig. 2.

<sup>3</sup> That doubtful animal the *siren lacertina* from Carolina, has, according to HUNTER's dissection, two bladder-like lungs, besides the external branchiæ. *Philos. Transf.* vol. 65, p. 307.



by which fishes again discharge the water, which they have taken in at the mouth, some tadpoles have for this purpose a canal on the left side of the head near the eye<sup>4</sup>; which must be distinguished from the small tube on the lower lip, by which they attach themselves to aquatic plants<sup>5</sup>.

(D) FISHES.

§ 184. Instead of *lungs*, this class of animals is furnished with *gills* or *branchiæ*; which are placed behind the head, on both sides, and have a moveable gill cover (*opurculum branchiale*), which is wanting in the order of *pisces chondropterygii* only. By means of these organs, which are connected with the throat, the animal receives its oxygen from the air contained in the water<sup>6</sup>; as those animals which breathe, derive it immediately from the atmosphere.

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The same circumstance holds good respecting that no less mysterious creature, the *proteus anguinus*, from the Cirknitz or Sitticher lake of Carniola; whose remarkable internal structure has been described and delineated by Dr. SCHREIBERS in the *Philos. Transf.* for 1801.

<sup>4</sup> RÖSEL, tab. 18, fig. 7, 8. This organ is very conspicuous in the large larvæ of the *rana paradoxa*.

<sup>5</sup> RÖSEL, tab. 14. fig. 17.

<sup>6</sup> This has been noticed by MAYOW, whose wonderfully acute genius penetrated the mystery of the chemical process of respiration. *De Thermis Bathoniensibus* in his *Traëtatus Medicophysici*, p. 1, p. 259.

They



They afterwards discharge the water through the branchial openings (*aperturæ branchiales*); and therefore they are distinguished from animals of the three preceding classes by this circumstance; viz. that they do not respire by the same way that they inspire.

§ 185. We have already shewn (§ 164) how the gills receive the venous blood by means of the branchial artery, and how this blood is sent into the aorta after its conversion into the arterial state. The distribution of these vessels on the folds and divisions of the gills constitutes one of the most delicate and minute pieces of structure in the animal economy<sup>7</sup>.

Each of the gills consists in most fishes<sup>8</sup> of four divisions, resting on the same number of arched portions of bone or cartilage, connected to the os hyoides. Generally there is only a single opening for the discharge of the water; but in many cases, particularly among the cartilaginous fishes, there are several.

§ 186. Many animals of this order possess a single or double swimming bladder<sup>9</sup>; which, at least

<sup>7</sup> FISCHER'S *Fragments of Natural History*, vol. 1, p. 213.

<sup>8</sup> It is represented by MONRO in the *haddock* and *salmon*, tab. 25 and 26.

<sup>9</sup> See GOTT. FISCHER *on the swimming Bladder of Fishes*.  
Leipzig,



least in the fishes of this country, contains azotic gas. It has not been hitherto determined, whether it be subservient to any other functions, besides that well-known one, from which its name is derived. In the mean time, like the air-receptacles of birds it may be considered without impropriety in the present division of the work.

It is placed in the abdomen, and closely attached to the spine. It communicates generally with the œsophagus, and sometimes with the stomach; by a canal (*ductus pneumaticus*), containing in some instances, as the carp, valves which seem to allow the passage of air from the bladder, but not to admit its entrance from without.

#### (E) INSECTS.

§ 187. That white-blooded animals indispensably require a species of respiration, would have been inferred by analogy from the wonderful apparatus of gills or tracheæ, which have been discovered in most orders of both classes of these beings. But in many cases direct proof has been obtained on this

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Leipzig, 1795, 8vo. and additions to it in his *Fragments of Natural History*, vol. 1, p. 229, &c. In both these works he delineates the bladders of several fishes. Representations of several others may be seen in NEEDHAM *de Formato Fœtu*, tab. 7. REDI, *de Viventibus intra Viventia*, tab. 3, 6. and the *Obs. Anat. Collegii privati Amstelod.*, pt. 2. tab. 10.

point:



point: experiment has actually proved the exchange of carbone for oxygen<sup>10</sup>.

White-blooded animals are moreover distinguished from those which have red-blood, by this circumstance; that none of the former, as far as we hitherto know, take in air through the mouth.

§ 188. Many aquatic insects<sup>11</sup> as the genus cancer have a species of gills<sup>12</sup> near the attachment of their legs. The others, and particularly the land-insects, which constitute, as is well known, by far the greatest number of this class of animals, are furnished with air-vessels, or tracheæ, which ramify over most of their body. These tracheæ are much larger and more numerous in the larva state of such insects, as undergo a metamorphosis, (in which state also the process of nutrition is carried on to the greatest extent) than after the last, or, as it called, the perfect change has taken place.

§ 189. A large air-tube (*trachea*) lies under the skin on each side of the body of larvæ, and

<sup>10</sup> See the two following very valuable works: F. L. A. SORG, *Disquisitio Physiologica circa Respirationem Insectorum et Vermium*. And FR. HAUSSMANN *Tentamen solutionis a Societat. Reg. Scientiar. Gotting. circa Respirationem Insectorum propositæ Questionis*.

<sup>11</sup> I. F. MARTINET *de Respiratione Insectorum*. Lugd. Batav. 1753. 4.

<sup>12</sup> They are represented in the *crawfish* by WILLIS *de Anima Brutorum*, tab. 3, fig. 2 and 3. And in RÖSEL'S *Insectenbelustigungen*, part 3, tab. 58, fig. 9, II. tab. 59, fig. 17.



opens externally by nine apertures (*stigmata*): it produces on the inside the same number of trunks of air-vessels (*branchiæ*), which are distributed over the body in innumerable ramifications<sup>13</sup>.

Both the tracheæ and branchiæ are of a shining silvery colour; and their principal membrane consists of spiral fibres. The most numerous and minute ramifications are distributed on the alimentary canal; particularly on the above-mentioned corpus adiposum. (§ 126).

§ 190. There is great variety in the number and situation of the external openings, by which insects receive their air<sup>14</sup>.

In most instances the stigmata are placed on both sides of the body. The atmospheric air enters by

<sup>13</sup> LYONET *Anatomie de la Chenille*, &c. tab. 4, 5, 6, 7, 10 and 11. The same organs have been represented by SWAMMERDAM in the *Scarabeus Nasicornis*, tab. 29, fig. 9, 10, tab. 30, fig. 1, 10. In the *lucanus cervus* (stag-beetle) by MALPIGHI *de bombyce*, tab. 3, fig. 2. in a *cicada* *ibid.* fig. 3. In a *gryllus* (grasshopper) *ibid.* tab. 4. fig. 1. also by CUVIER in the *Mem. de la Soc. d'Hist. Naturelle de Paris*, an. 7. p. 39. In the silk-worm by MALPIGHI, tab. 3, fig. 1. In a *libellula* by CUVIER, in the work just quoted, fig. 2, 5, 6. In the *ephemera* by SWAMMERDAM, tab. 14, fig. 1. tab. 15, fig. 1, 4, 7. In the bee, *ibid.* tab. 17, fig. 9, 10. tab. 25, fig. 10. tab. 24, fig. 1, 2, 3. In the *æstrus bovis* by Mr. B. CLARK in the *Transact. of the Linnean Society*, vol. 3, tab. 23, fig. 25. In the maggot of the fly by SWAMMERDAM, tab. 40, 41, 42, 43. In the louse *ibid.* tab. 1, fig. 8, 4, 7.

<sup>14</sup> See the work above quoted, by HAUSSMANN.



an opening at the end of the abdomen in several aquatic larvæ, and even perfect insects. A very remarkable change in this respect takes place in several animals of this class during their metamorphosis. Thus in the larva of the common gnats (*Culex pipiens*), the air enters by an opening on the abdomen: while in the nymphe of the same animal, it gains admission by two apertures on the head<sup>15</sup>.

(F) VERMES.

§ 191. In this class, which comprehends such very different animals, the structure of the respiratory organs is proportionally various<sup>16</sup>. Some orders, as those which inhabit corals, the proper zoophytes, and perhaps the intestinal worms, appear to be entirely destitute of these organs; so that if any vital function, analogous to respiration, is carried on in these animals, it must be effected by methods which yet remain to be discovered.

§ 192. Those vermes, however, which are furnished with proper organs of respiration, have the same variety in their structure, which was remarked

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<sup>15</sup> SWAMMERDAM *algem. verhandel. Van de Bloedeloofe Dierkens*, tab. 2.

<sup>16</sup> The reader may consult on this subject, CUVIER in the *Journal d'Histoire Naturelle*, 1792, tom. 2, p. 85. and in his *Tableau d'Histoire Naturelle des Animaux*, p. 384. also SORG and HAUSSMANN in their works quoted above. And SPALLANZANI *Mémoires sur la Respiration*. Geneve, 8vo, 1803.



in insects. Some, as the *cuttle fish*<sup>17</sup>, *oyster*<sup>18</sup>, &c. have a species of gills, varying in structure in different instances. But the greatest number have air-vessels or tracheæ.<sup>19</sup> Several of the testaceous vermes have both kinds of respiratory organs. In some of the inhabitants of bivalve shells, as the genus *venus*<sup>20</sup>, the air-vessels lie between the membranes of a simple or double tubular canal, found at the anterior part of the animal, and capable of voluntary extension and retraction. It serves also for other purposes, as laying the eggs. The margins of its mouth are beset with the openings of the tracheæ. See note (E).

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*Additional Notes to the Fourteenth Chapter.*

(A) The cartilaginous annuli of the trachea, which are in general more complete, in the other

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<sup>17</sup> SWAMMERDAM, *Biblia Naturæ*, tab. 51, fig. 1. MONRO, tab. 4, fig. 1. And particularly Dr. C. F. G. TILESIIUS *de Respiratione Sepiæ Officinalis*. Lips. 1801-4, tab. 1, 2.

<sup>18</sup> WILLIS, tab. 2.

<sup>19</sup> Examples of this structure in testaceous vermes may be seen in the *lepas balanus* (acorn-shell) Poli, tab. 4, fig. 20, 22. In the *pholas dactylus* (pierce-stone) *ibid.* tab. 8, fig. 61. In the *solen strigilatus* (razor-shell), tab. 13, fig. 5. In the *helix pomatia* (snail), SWAMMERDAM, tab. 4, fig. 1.

The common slug affords an instance in the mollusca, see SWAMMERDAM, tab. 8, fig. 7, tab. 9, fig. 1, and the leech in the intestinal worms, BENING, *de Hirudinibus*, p. 20.

<sup>20</sup> In the *venus lata*, POLI, tab. 2, fig. 17.



mammalia, than in man, are perfect circles in birds, and overlap each other at their upper and lower margins. Hence the diameter of this part is not affected by any twisting motion of the neck.

The air-vessels are considerably larger than in the mammalia; and the substance of the lungs is not divided into lobuli. The cartilages of the trachea are lost before that tube enters the lung; and some of its large branches open on the surface of the viscous. I have observed in the ostrich that this aperture was surrounded by circular muscular fibres, which do not seem to have been hitherto noticed.

(B) Besides the air-cells of the circumscribed cavities, and of the bones, these cavities are formed in some instances in the soft parts. They often extend from the axillary cell under the pectoral muscles, and those of the scapula. “ In the eagle, hawk, “ stork, lark, and other high flying birds, these cells “ are very large; and in many of those birds there “ are still larger cells, ascending under the integu- “ ments of the neck, and passing beneath the skin of “ the inside of the arm, and back of the shoulder. “ In the stork we found these cells large enough to “ admit the finger to pass a considerable way “ down upon the inside and back of the wing. “ They are also large in the owl and other birds of “ prey.” MACARTNEY in REES’s *Cyclopaedia*, art. BIRDS.



The whole of this subject is explained at great length, and with minute details in the above-quoted article.

(C) The amphibia are distinguished in all instances by the great size of their air-vesicles. In the *frogs*, *lizards*, and *serpents*, the lung consists of a cavity, the sides of which are cellular. The lower or posterior part of the organ either forms a mere membranous bag (the parietes of which are not cellular) or else the vesicles are larger at that part than elsewhere. In the *serpents* the lung has that elongated form, which characterises all the viscera of these animals. A considerable portion of it is a simple membranous cavity; and this is supplied with arteries from the surrounding trunks. The *turtles* have a more complicated structure; or one which approaches more nearly to that of the warm-blooded classes. The lungs are uniform in their texture throughout; but the vesicles are very large. The cartilaginous annuli of the bronchi terminate before these vessels enter the lungs.

(D) *Fourcroy* found azotic with a small proportion of carbonic acid gas in the carp: *LACEPEDE* met with hydrogen in the tench; and pure oxygen has been found in the shark. (*DUNCAN'S Annals*, vol. 1, p. 393).



The air-bladder does not exist in many fishes; whence CUVIER argues with justice against the opinion which assigns this part an important office in respiration. Indeed it seems much more probable that it is subservient to the motions of the animal. For it is largest in such fishes, as swim with considerable velocity. It is wanting in the flat fishes; where the large lateral fins supply its place, and in the shark, where its absence is compensated by the size and strength of the tail. It does not exist in the lamprey, which possesses none of these compensations for its absence: that fish therefore creeps slowly at the bottom of the water.

It is found in some species of *scomber*; while others want it: viz. the mackerel (*scomber scombrus*). Its form varies ad infinitum in the different genera and species. Its cavity is generally uniform: but sometimes divided by septa, as in the *silurus*; and being even very cellular in the *diodon*.

Its sides vary considerably in thickness; and are sometimes bony, as in the *cobitis fossilis*.

There is generally a vascular and glandular body situated in the cavity; which probably secretes the contained air. In the *perca labrax* are two bodies on the outside of the bag; giving rise to several vessels, which contain air. These unite together, and open into the cavity.

(E) In



(E) In the terrestrial gasteropodous mollusca, of which we may instance the snail and slug, there is a cavity in the neck receiving air by a small aperture, which can be opened or shut at the will of the animal. The pulmonary vessels ramify on the sides of the cavity.



## CHAPTER XV.

## ON THE ORGAN OF THE VOICE.

§ 193. ARISTOTLE has correctly observed, that those animals only, which possess lungs, consequently the three first classes of the animal kingdom, possess a true voice. Several genera and species even of these are either entirely dumb; as the *anteater*<sup>1</sup>, the *mans*, the *cetacea*<sup>2</sup>, the genus *testudo*, several *lizards* and *serpents*; or they lose their voice in certain parts of the earth; as the *dog* in some countries of America, and *quails*<sup>3</sup> and *frogs*<sup>4</sup> in several parts of Siberia.

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<sup>1</sup> In a preparation—a dried one indeed—of the larynx and lungs of the two-toed anteater, I find the larynx entirely bony, that is, of the same substance with the os hyoides. The trachea, which is extremely short, is a merely membranous canal, without any perceptible trace of cartilaginous rings.

<sup>2</sup> JNO. HUNTER found no thyroid gland in the whales, which he dissected. This coincides with that hypothesis, which considers this gland to be connected with the formation of the voice. (CUVIER however states its existence in the *dolphin* and *seal*, tom. 4. p. 533. T.)

<sup>3</sup> PENNANT'S *Arctic Zoology*, tom. 2. p. 30.

<sup>4</sup> MULLER'S *Collection of Russian Discoveries*, vol. 7. p. 123. J. C. BECKMANN'S *Historical Description of the Chur and Mark of Brandenburg*, vol. 1. p. 590.



## (A) MAMMALIA.

§ 194. Most animals of this class<sup>s</sup> have the following circumstances in common: their rima glottidis is provided with an epiglottis, which in most instances has a peculiar muscle, arising from the os hyoides, and not found in the human subject: the margins of this rima are formed by the double ligamenta glottidis, (*ligamenta thyreo-arytænoidea*); between which the ventriculi laryngis are formed. The epiglottis does not exist in most of the bat kind: and in some mouse-like animals, as the rell-mouse (*glis esculentus*), it is hardly discernible. The superior ligamenta glottidis, as well as the ventriculi laryngis are wanting in some bifulca, as the ox and sheep.

§ 195. Some species of mammalia have a peculiar and characteristic voice; or at least certain tones, which are formed by additional organs. Of this kind are certain tense membranes in some animals; and in others peculiar cavities, opening

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<sup>s</sup> Besides the two old, and highly valuable works on the organ of the voice, by CASSERIUS and FAB. AB AQUAPENDENTE; and the writings which we shall have occasion to quote in the sequel, I refer the reader to M. J. BUSCH *Dissert. de Mechanismo Organi Vocis*. Groning. 1770, 4to. which contains several excellent observations by CAMPER.



into the larynx, and sometimes appearing as continuations of the ventriculi laryngis.

The neighing of the horse, for example, is effected by a delicate, and nearly falciform membrane, which is attached by its middle to the thyroid cartilage, and has its extremities running along the external margins of the rima glottidis<sup>6</sup>.

The peculiar sound, uttered by the as, is produced by means of a similar membrane; under which there is an excavation in the thyroid cartilage. There are moreover two large membranous sacs opening into the larynx<sup>7</sup>.

The mule does not neigh like the mare, by which it was conceived; but brays like the as, which begot it. It possesses exactly the same larynx as the latter, without any of the peculiar vocal organs of the mother; a fact, which like many others, cannot be at all reconciled with the supposed pre-existence of previously formed germs in the ovarium of the mother<sup>8</sup>.

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<sup>6</sup> HERISSANT in the *Mem. de l'Acad. des Sc.* 1753. tab. 9.

<sup>7</sup> Ibid. tab. 10.

<sup>8</sup> I have adduced this essential, and really specific difference in the structure of the larynx of the horse and as; as one of the many arguments, which overthrow that rule, adopted by RAY, BUFFON, and others, of ascribing to one and the same species, all such animals, as produce by copulation an offspring capable of subsequent generation. See the 7th ed. of the *Manual of Natural History*, p. 26.



The cat has two delicate membranes lying under the ligamenta glottidis; which probably cause the the purring noise peculiar to these animals<sup>9</sup>.

The pig has two considerable membranous bags above and in front of the ligamenta glottidis<sup>10</sup>.

Several apes<sup>11</sup> and baboons<sup>12</sup>, as also the reindeer<sup>13</sup>, have on the front of the neck, large single or double laryngeal sacs, of various forms and divisions, communicating with the larynx by one or two openings between the os hyoides and thyroid cartilage.

Some of the cercopithecii, as the *C. Seniculus*, and *beelzebub*, have the middle and anterior part of the os hyoides formed into a spherical bony cavity<sup>14</sup>, by which the animals are enabled to produce those

<sup>9</sup> VICQ-D'AZYR in the *Mem. de l'Acad. des Sciences*, 1779, tab. 11. fig. 17.

<sup>10</sup> CASSERIUS *de Vocis auditusque Organis*, tab. 10. fig. 9, 10. p. 55. "ad grunitum in porcis efficiendum." HERISSANT *loco citato*, tab. 11.

<sup>11</sup> As the orang-utang. See CAMPER'S *Natural History of that animal—the Simia inuus* see LUDWIG'S *Natural History of Man*. In a common ape (*simia sylvanus*) I found the right laryngeal sac three inches long, and two inches in circumference; while the left was not larger than a nutmeg. The larynx of the *simia cynomolgus* may be seen in the work above quoted of CAMPER.

<sup>12</sup> It is represented in the Mandril (*Papio Maimon*) by VICQ-D'AZYR *loco citato*, tab. 7.

<sup>13</sup> CAMPER *loco citato*, tab. 8. fig. 7.

<sup>14</sup> VICQ-D'AZYR *loc. cit.* tab. 9. 10. CAMPER, tab. 4.



terrific and penetrating tones, which can be heard at vast distances, and have gained them the name of the howling apes.

### (B) BIRDS.

§ 196. The most striking peculiarity in the vocal organs of this class, and which belongs to all birds with a very few exceptions; consists in their possessing, what is commonly called, a *double larynx*, but which might be more properly described, as a larynx, divided into two parts, placed at the upper and lower ends of the trachea. They have also two *rimæ glottidis*.

§ 197. The superior, or proper *rîma glottidis* is placed at the upper end of the trachea; but is not furnished with an *epiglottis*<sup>15</sup>. The apparent want of this organ is compensated in several cases by the conical *papillæ* placed at both sides of the *rîma*.

§ 198. The apparatus, which is chiefly concerned in forming the voice of birds, is found in the

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<sup>15</sup> The part which WARREN has described in the 34th vol. of the *Philos. Transf.* p. 113. as the *epiglottis* of the ostrich, is merely a slight elevation at the root of the tongue. See CUVIER in the *Ménagerie du Muséum National & Histoire Naturelle.* no. 1. tab. 3.



inferior or bronchial larynx<sup>16</sup>. This contains a second rima glottidis, formed by tense membranes; which may be compared in several cases, particularly among the aquatic birds, to the reed at the mouth of musical instruments. It is furnished externally with certain pairs of muscles, varying in number in the different orders and genera; and with a kind of thyroid gland. The course and proportionate length of the trachea, and particularly the structure of the inferior larynx, vary very considerably<sup>17</sup> in the different species, and even in

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<sup>16</sup> Hence the division of the trachea below the upper rima glottidis scarcely produces any change in the voice of several birds: as they can still utter sounds by means of the bronchial larynx. See DUVERNEY in the *Hist. de l'Acad. des Sciences*, tom. 2. p. 7. GIRARDI in the *Memoirs of the Italian Society*, tom. 2. pt. 2. p. 737. and CUVIER in the *Magazin Encyclopedique*. Ann. 1. tom. 2. p. 357.

<sup>17</sup> On the subject of the bronchial larynx, the reader may consult HERRISSANT, VICQ-D'AZYR and CUVIER in their works already quoted: also another dissertation by the latter author in the 2nd vol. of the 4th year of the *Magazin Encyclopedique*. SCHNEIDER in the *Leipsig Magazine* for 1786 and 1787, and in his valuable *Commentary on the Works of FREDERIC II.* pp. 32. 211.

ALDROVANDI has described that of the wild swan. *Ornitholog.* tom. 3. p. 13.

That of the goose has been most excellently described by HALLER *de partium corp. humani fabricâ et functionibus*, tom. 7. p. 321, which may be compared with the beautiful delineations of HERRISSANT, *loc. citat.* tab. 12.



the two sexes, especially among the aquatic birds. Thus, for example, the tame or dumb swan, (*anas olor*) has a straight trachea; whilst in the male of the wild or whistling swan (*cygnus*), this tube makes a large convolution, which is contained in the hollow of the sternum (see § 55). In the spoonbill (*Platalca leucorodia*) as also in the *Phasianus motmot*, and others, similar windings of the trachea are found, not enclosed in the sternum. The males of the two genera *anas* and *mergus* have at their inferior or bronchial larynx a bony cavity,<sup>18</sup> which contributes to strengthen their voice.<sup>19</sup> See note (A), at the end of the chapter.

### (C) AMPHIBIA.

§ 199. The structure of the vocal organs in this last class of animals, which possess a voice, is on

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<sup>18</sup> Besides HERISSANT and CUVIER, loc. citat. the reader may consult ALDROVANDI *ornithol.* tom. 3. p. 190. WILLOUGHBY *ornithol.* tab. 73. BLOCH in the *Transactions of a Society for Inquiries concerning Natural History*, at Berlin, tom. 4. p. 579, tab. 16. and in his works, tom. 3. p. 372. tab. 7. LATHAM in the *Transactions of the Linnæan Society*, vol. 4. p. 90. tab. 9. 16.

<sup>19</sup> See FABRICIUS HILDANUS on the *Excellence of Anatomy*, p. 323.



the whole very simple; although it varies in several genera and species, and sometimes in the two sexes. See note (B).

§ 200. The trachea forms different convolutions in some of the testudines,<sup>20</sup> and of the crocodile kind. It is very short in the frog; but longer in the male, than in the female: the rima glottidis is also larger in the former. Ligamenta glottidis exist in all the animals of this class<sup>21</sup>.

§ 201. The males of some frogs are distinguished by peculiar membranous bags. The tree frog (*rana arborea*) has a large sac in its throat; and the green frog (*rana esculenta*) has two considerable pouches in the cheeks, which it inflates at the time

<sup>20</sup> BLASII *Zootomia*, Amst. 1677, 8vo. tab. 17. fig. 5. The tortoises (at least the *testudo Græca*) may be said to have two tracheæ: for the short common trunk divides at the third cervical vertebra into two long branches, which descend far into the chest before they enter the lung. Each of them makes a large lateral convolution, over which the two *aortæ abdominales* bend their course.

<sup>21</sup> VICQ-D'AZYR, loc. citat. tab. 13. fig. 45, 46. represents these fragments in the testudines; fig. 41, 42, 44. in frogs; fig. 47—52 in serpents.

The larynx of the rattlesnake is represented in TYSON'S *Anatomy of a Rattlesnake*. *Philos. Transf.* vol. 13. no. 144. fig. 5.



of copulation by two openings close to the rima glottidis<sup>22</sup>. See note (C).

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*Additional Notes to the Fifteenth Chapter.*

(A) “ A very little comparison of the mechanism of wind musical instruments, with the organs of the voice in birds, will shew how nearly they are allied to each other; and it may be observed, that the sound produced by some of the larger birds is exactly similar to the notes that proceed from a clarionet or hautboy in the hands of an untutored musician. The inferior glottis exactly corresponds to the reed, and produces the tone or simple sound. The superior larynx gives it utterance, as the holes of the instrument; but the strength and body of the note depend upon the extent and capacity of the trachea, and the hardness and elasticity of its parts. The convolution and bony cells of the windpipe, therefore, may be compared with the turns of a French horn, and the divisions of a bassoon; and they produce the proper effects of these parts in

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<sup>22</sup> See the German Collection of CAMPER'S *smaller works*, vol. 1. pt. 1. p. 144. tab. 3. fig. 1—4.



the voices of those birds, in which they are found."

REES'S *Cyclopaedia*, art. BIRDS.

(B) All the amphibia want the epiglottis.

(C) The *chordæ vocales* are very large and distinct in the frog.







THE  
ANIMAL FUNCTIONS.



ANIMAL FUNCTIONS.

THE



## CHAPTER XVI.

ON THE BRAIN AND NERVOUS SYSTEM IN  
GENERAL.

§ 202. THIS class of functions which constitutes the leading character of animals, and has derived its name from that circumstance, affords to our observation a more clear and manifest gradation, from the most simple to the most compound structure, than any others in the animal economy <sup>1</sup>.

§ 203. In some of the most simple animals of the class *vermes*, particularly among what are called *Zoophytes*, little or no distinction of similar parts<sup>2</sup> (or structures) can be discerned; and we are unable to recognize any thing as a particular nervous

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<sup>1</sup> On the subject of this class of functions, the reader should consult the two first volumes of that masterly work, the *Lectures on comparative Anatomy* of PROFESSOR CUVIER; which have been translated into German, by PROFESSOR FISCHER.

<sup>2</sup> By the term *partes similes*, the ancients denoted those homogeneous organic structures, which form nerves, muscles, tendons, bones, cartilages, &c.; the combination of which constitutes the *partes dissimiles* of the animal body; i. e. the limbs, viscera, &c.



system, or even as a part of such a system. The power of sensation and voluntary motion, which these possess, as well as any other order or class of the animal kingdom, proves that the nervous matter must be uniformly spread throughout their homogeneous substance. The almost transparent polypes (*hydra*), which are often found in this country, with a body of an inch in length, and arms or tentacula, of a proportionate size, appear to consist, when surveyed in the best light by the strongest magnifying powers, of nothing but a granular structure (something similar to boiled Sago) connected into a definite form by a gelatinous substance.

§ 204. In many other vermes, and in insects, particular nerves can be distinguished, arising in general from what is called the spinal marrow, the superior extremity of which part, slightly enlarged, constitutes the brain. The latter organ, however, in both classes of cold and red-blooded animals, and still more in those which have warm blood, has a much more complicated structure, and a far greater relative magnitude: all animals are however exceeded in both these points by the human subject, which, according to the ingenious observation of the learned SÖMMERRING<sup>3</sup>, possesses by far the largest

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<sup>3</sup> See his *Dissertatio de basi Encephali*, Goetting. 1778. p. 17, and his *Tabula basios Encephali*, Francof. 1799, p. 5. Alia J. G.



largest brain in proportion to the size of the nerves which arise from it.\* (See note (A) at the end of the chapter.)

(A) MAMMALIA.

§ 205. The two large processes of the dura mater, which form the falx and tentorium, possess a very peculiar structure in some animals of this class. A strong plate of bone, which is a process of the neighbouring bones of the cranium, is contained between their two laminae.

We have hitherto ascertained only one example of such a formation of the falx, in the quadrupeds

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J. G. EBEL, *Observ. Neurol. ex Anatome comparat.* Francof. ad V adrum, 1788-8.

\* The small size of the brain in proportion to the rest of the nervous system has a very considerable influence on the whole animal economy of cold-blooded, when viewed in comparison with warm-blooded animals. It explains the diminished sympathy between the two parts; and the consequently weak powers of motion of their whole machine. It enables us also to understand the remarkable independence of the vitality of their parts upon that of the brain; and their possession of considerable individual powers of life: as also the extraordinary extent of their reproductive powers. I have treated at greater length on all these points in my *Specimen Physiologiae comparatae inter Animentia calidi et frigidi Sanguinis*, in the 4th vol. of the Goettingen Commentaries; and in the *Manual of Natural History*, p. 225. of the 7th edition. (See note (B) at the end of the chapter.)



of this class : and this I discovered in the *ornithorhynchus*, an animal which abounds in instances of anomalous structure. Something similar is found in the cetacea, at least in the porpoise<sup>5</sup>. The falx itself descends to various depths between the hemispheres in the different species<sup>6</sup>.

A bony tentorium cerebelli is found in a great number of mammalia : but its size and extent vary in the different species. It is formed by peculiar osseous plates, extending from the vitreous table of the parietal bones, and the petrous portions of the ossa temporum. Its formation exhibits two kinds of variety.

In some animals, for instance, it constitutes an uniform bony partition, which leaves a quadrangular opening into the lower part of the cranium. This is the case in most species of the cat and bear kind ; in the martin (*mustela martes*) ; in the coaita (*cercopithecus paniscus*)<sup>7</sup> and others.

<sup>5</sup> A similar structure, constituting an unique specimen of anatomical variety, is exhibited in the skull of a female, belonging to my collection. The vitreous table of the frontal bone has a long falciform bony crista, at the attachment of the falx.

<sup>6</sup> See on this subject SÖMMERRING, *on the Brain and Spinal Marrow*, in German. Mentz, 1788-8. A work, which is extremely valuable for its comparative anatomy.

<sup>7</sup> JOSEPHI'S *Anatomy of Mammalia*, in German. *Contributions to the first vol.* p. 34. tab. 4.



It consists of three separate portions in other animals, one of these pieces projects from the upper and back part of the cranium, like a tile; the two lateral portions arise from the petrous part of the temporal bone. This structure is exemplified in the seal<sup>8</sup>, dog, and horse.

In some cases, as in the pig, the rabbit, some mice, &c. a rudiment of the last mentioned lateral portions may be observed; or at least the ridge of the temporal bone is much sharper than usual<sup>9</sup>.

§ 206. The peculiarities, which distinguish the brain of the human subject from that of the mammalia<sup>10</sup>, consist chiefly in the circumstance, which has

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<sup>8</sup> In the cranium of a young seal, which I possess, the anterior or upper surface of the tile-shaped piece is connected by means of a strong perpendicular bony plate; extending to the middle of the lambdoid suture, with the inner surface of the occipital bone, where the falx terminates.

<sup>9</sup> I have already described the chief varieties of the bony tentorium, and have mentioned the uses assigned to this structure, which appear however improbable, in the description of the bones, p. 117; and in the *Institut. Physiol.* p. 160, ed. of 1798. (See note (C) at the end of the chapter.)

<sup>10</sup> The reader may consult the following delineations of the brain of mammalia, besides those which will be referred to in subsequent notes. Of the chimpanzé (*simia troglodytes*) by TYSON in his excellent "*Anatomy of a Pigmy*," fig. 13, 14. Of the dog, by COLLINS, *Syst. of Anatomy*, vol. 2. tab.



has been already noticed, of its possessing a much greater bulk in proportion to the nerves, which arise from it; and in its being much larger when compared with the cerebellum, and medulla spinalis <sup>11</sup>. (See note (D) at the end of the chapter.)

§ 207. Moreover, that remarkable and enigmatical collection of sandy matter, which is found in the pineal gland <sup>12</sup> of the human brain, almost invariably after the first few years of existence, has been hitherto observed in a very few other mammalia, and those among the *bifulca* <sup>13</sup>.

53. fig. 1; and EBEL, *loc. cit.* tab. 1, fig. 7. Of the cat, by COLLINS, tab. 53, fig. 2; and EBEL, tab. 1, fig. 3. Of the horse, by VICQ-D'AZYR, *Mem. de l'Acad. des Sciences*, 1783, tab. 7; EBEL, tab. 1, fig. 1. Of the sheep, by VICQ D'AZYR, tab. 8, fig. 1; and EBEL, tab. 1, fig. 8. Of the ox, VICQ-D'AZYR, tab. 8, fig. 2; EBEL, tab. 1, fig. 6 and 9. Of the pig, COLLINS, tab. 54; EBEL, tab. 1, fig. 10.

<sup>11</sup> The delineation, which I have given of the brain of the mandrill (*Papio Maimon*), in the two first editions of my work, *de Generis Humani Varietate Nativâ*. tab. 1, fig. 1, shews how striking this difference is, even in the *quadrumana*, which from their great general resemblance to the human subject have been called *Anthropomorpha*.

<sup>12</sup> SÖMMERRING *de lapillis, vel prope, vel intra Glandulam pinealem sitis*. Mentz, 1785. 8vo.

<sup>13</sup> SÖMMERRING has found it in the fallow-deer (*cervus dama*): see his *Diff.* p. 10. And MALACARNE in the goat: "*Dissection of the Brain of some Quadrupeds*:" in Italian, Mant. 1795 4. p. 31.



§ 208. In the proper quadrupeds (the *quadrumana* therefore being excepted), the anterior lobes of the brain form two large processes (*processus mamillares*)<sup>14</sup>, from which the olfactory nerves of the first pair proceed. These are of very considerable magnitude, particularly in the herbivorous animals<sup>15</sup>. They contain a continuation of the lateral ventricle; which circumstance has formerly given rise to great physiological errors<sup>16</sup>.

§ 209. The structure of the *corpora quadrigemina*, and *candiantia* distinguishes the brain of herbivorous from that of carnivorous quadrupeds. The *nates* very considerably exceed the *testes* in size, in the former class while these proportions are reversed in the latter instance. The herbivora have a single large *eminentia candicans*: there are two small ones in the carnivora<sup>17</sup>. (See note (E) at the end of the chapter.)

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<sup>14</sup> See METZGER *Specimen Anatomie comparatæ primi paris Nervorum*, in his *Opusc Anat. and Physiol.* Götting. 1790, 8vo. p. 100.

<sup>15</sup> This part is represented in the bifurca, and in the hare-kind in COLLINS'S *System of Anatomy*, vol. 2, tab. 51. EBEL *loc. cit.* WILLIS *Anatome Cerebri*, fig. 2. MONRO *on the Nervous System*, tab. 9 and 24.

<sup>16</sup> These were first refuted by that excellent anatomist C. V. SCHNEIDER of Wittenberg. See his classical work *de Offe Cribriformi*, 1655. 12mo.

<sup>17</sup> SÖMMERING *on the Brain*, &c. p. 91.



## (B) BIRDS.

§ 210. The dura mater forms, in some birds, a falciform process; which has been erroneously asserted to be deficient in the whole class<sup>18</sup>. In the cock of the woods (*tetrao urogallus*)<sup>19</sup> it has a bony structure, resembling that of the *ornithorhynchus*.

§ 211. The brain itself, considered altogether, resembles that of the former class (even in forming in some instances a kind of *processus mamillares*), while, on the contrary, it is strikingly distinguished from that of the following order. It differs, however, from that of the mammalia, not only in the smoothness of its surface, and the want of convolutions, but also in the structure of the optic thalami. These eminences, which are nearly spherical, and hollow internally, are not contained in the proper brain or cerebrum, but lie behind and below that part. This structure is common to birds

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<sup>18</sup> This mistake has even been committed by HALLER *de Partium Corp. Hum. Fabricâ and Functionibus*, tom. 8, p. 163.

<sup>19</sup> The brain of this bird is remarkably small in proportion to the size of its head and whole body; while we know, that in some other animals of this class, particularly among the singing-birds, the brain exceeds that of the human subject in these points of view.

with



with the two classes of cold and red-blooded animals. Those eminences also, which in the mammalia are justly termed *corpora striata*, are of an uniform colour in birds. (See note (F) at the end of the chapter.)

§ 212. The brain of birds does not possess several parts, which are found in that of the mammalia; and the opinions of anatomists are much divided concerning others, on account of variations in their structure and appearance. The corpus callosum, pons varolii, &c. come under the description of parts, which are certainly absent. The existence of the fornix, pineal gland, corpora candidantia, and quadrigemina, is a matter of dispute<sup>20</sup>.

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<sup>20</sup> See HALLER'S valuable observations *de cerebro avium*, in the *Opera Minora*, vol. 3. And MALACARNE'S long commentary on them in the three first volumes of the *Memoirs of the Italian Society*.

Several authors have given representations of the brain of birds. That of the gooselhawk, the owl, the finches (*Fringilla*), the pigeon, the partridge, and the goose has been delineated by EBEL, *loc. citat.*

That of the kingsfisher, the red bird (*loxia cardinalis*), the turkey, the bustard, the woodcock, snipe, and others of the genus *scolopax*, the swan, goose, and duck, by COLLINS, *loc. citat.* tab. 49, 56, 57, and 58.

That of the raven and common cock by VICQ-D'AZYR, in the *Mémoires de l'Acad. des Sciences*, 1783, tab. 9 and 10.

That of the goose in a lateral and internal view, by LUDWIG, *de Cinereâ Cerebri Substantiâ*, Lips. 1779, 4to. fig. 1.



## (C) AMPHIBIA.

§ 213. Anatomists have hitherto bestowed but little labour, comparatively speaking, on the brain of amphibia. It is small and simple, and consists of five roundish eminences: viz. the two hemispheres, the two thalami nervorum opticorum, lying behind these, and separate from them, and excavated by a ventricle; and the cerebellum, which in both classes of cold red-blooded animals contains no arbor vitæ. The spinal marrow, compared with the brain, is of astonishing magnitude in most amphibia<sup>1</sup>. (See note (G) at the end of the chapter.)

## (D) FISHES.

§ 214. In this class of animals the brain does not fill the cranium. Between the pia and dura mater (which in most of the large fishes approaches to a cartilaginous firmness) there is collected a salt and greasy fluid, contained in a loose cellular texture, which seems to supply the place of the tunica arachnoidea<sup>2</sup>.

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<sup>1</sup> The brain of the tortoise has been delineated by CALDESI in his *Observations*, &c. tab. 2, fig. 5. That of the frog by LUDWIG, VICQ-D'AZYR, and EBEL, *locis citatis*: and that of the viper by VICQ-D'AZYR, tab. 10, fig. 8.

<sup>2</sup> CASSERIUS has given an excellent view of the cranium of a pike laid open, *de Auditu*, tab. 12.



§ 215. The structure of the brain varies in the different genera and species; sometimes even in the individuals of the same species. It consists of several tubercles or lobuli disposed in pairs; and of these, the five, which were described in the brain of the amphibia, are the most constant<sup>3</sup>.

§ 216. In most fishes the optic nerves decussate, (just like two fingers laid crosswise); a remarkable peculiarity which has given rise to several physiological investigations, and inferences<sup>4</sup>. (See note (H) at the end of the chapter.)

These

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<sup>3</sup> HALLER *de Cerebro Piscium* in the *Opera Minora*, tom 3, p. 198. COLLINS has given representations of the brain in almost all the orders of fishes; but his views are chiefly of the upper external surface, tab. 60 to 70. That of the *skate* is delineated in the 2nd vol. of CAMPER's *smaller writings*, tab. 3: by MONRO in his *Physiology of Fishes*, tab. 1, 34 and 37; and by SCARPA *de Auditu et Olfactu*, tab. 1, fig. 1. That of the shark, by STENONIS *Elementa Myolog.* tab. 5 and 7. and by SCARPA, *loc. cit.* tab. 2. That of the frog-fish (*Iophius piscatorius*) by CAMPER, *loc. citat.* tab. 1.

That of the conger-eel, turbot, and pike, by VICQ-D'AZYR, *loc. citat.* tab. 10. That of the cod, by CAMPER, *loc. citat.* and MONRO. That of the haddock, by MONRO, *on the Nervous System*, tab. 32. That of the silurus, by EBEL, *loc. cit.* tab. 2, fig. 4. That of the pike by CASSERIUS, EBEL, and SCARPA, *locis citatis*. That of the carp by EBEL and SCARPA.

<sup>4</sup> See SÖMMERRING in the *Hessian Literary Contributions*, vol. 1, pt. 2, p. 205. also his *Dissert. de Decussatione Nervor.*



These nerves have in some fishes the uncommon structure of an investment of pia mater containing very elegant longitudinal folds<sup>5</sup>.

The olfactory nerve sometimes forms a ganglion just before it is distributed to the nose. The *gadus merluccius* and the carp<sup>6</sup> afford examples of this structure, which is remarkable inasmuch as no ganglia have been hitherto observed in the nervous system of fishes.

§ 217. We must lastly mention those nerves, which are distributed, in the electrical fishes, to that wonderful apparatus of membranous cells, filled with a gelatinous substance like white of egg, and performing the office of a Leyden jar, or electrical battery. These curious organs occupy the

*Opticor.* Mogunt. 1786, p. 24. COOPMAN'S *Neurolog.* p. 38. Professor RUDOLPHI in WIEDEBMANN'S *Archives*, vol. 1, pt. 2, p. 156, and several of the delineations quoted in the preceding note.

<sup>5</sup> See EUSTACHII *Offium Examen*, p. 227, and a representation from the saw-fish (*Squalus pristis* in MALPIGHI *de Cerebro*). In order to compare this, with the ordinary structure of other nerves, see the representation of the physiological preparation of the commencement of the fifth pair in the elephant, in A. K. BOERHAVE, *Historia Anatomica (prior) infantis, cujus pars Corporis inferior Monstrofa*. Petersburg, 1754, 4to. tab. 1.

<sup>6</sup> SCARPA, *loco citato*.



lateral fins of the torpedo<sup>7</sup>, and receive their nervous supply from the fifth pair. In the electrical eel (*gymnotus*), the electrical organ is found towards the posterior part of the abdomen<sup>8</sup>, and its nerves come from the medulla spinalis. In the *silurus electricus*, it is placed between the skin and muscles over the whole body, and its nerves are derived from the eighth pair<sup>9</sup>.

(E) INSECTS.

§ 218. The general structure of the nervous system in this class has been already mentioned (§ 204).

The larvæ, in which the subject has been most completely investigated<sup>10</sup>, have a brain consisting of two ganglia, contained in a horny cavity larger than itself. The nervous cord, which in red-blooded animals constitutes the medulla spinalis, proceeds

<sup>7</sup> HUNTER in the *Philos. Transf.* vol. 63, p. 481, tab. 20; and GIRARDI in the *Memoirs of the Italian Society*, tom. 3, p. 553.

<sup>8</sup> HUNTER in the *Philos. Transf.* vol. 65, p. 395, tab. 9.

<sup>9</sup> GEOFFROY in the *Bulletin de la Société Philomatique*, 6<sup>e</sup> année, tom. 3, p. 169.

<sup>10</sup> See LYONET's excellent account of the larva of the *Phalena Cossus*, tab. 9, 10, and 18. That of the silkworm by SWAMMERDAM, tab. 28, fig. 3. (which is better than MALPIGHI's representation); and by BIBIENA in the *Comment. Insit. Bonon.* tom. 5, pt. 1, tab. 4. That of the butterfly, by BIBIENA, *ibid.*



from this point along the abdomen, forming in its passage twelve simple ganglia, from which, and from the two ganglia forming the brain, the nerves derive their origin <sup>11</sup>.

(F) VERMES.

§ 219. Excepting those animals, which inhabit corals, and the proper zoophytes, most genera of the other orders of this class are found to possess a distinct nervous system <sup>12</sup>: although former  
anato-

<sup>11</sup> The nervous system of the larva of the stag-beetle, may be seen in SWAMMERDAM, tab. 28, fig. 1; and in RÖESEL, tom. 2, tab. 8. That of the *ephemera*, in SWAMMERDAM, tab. 14, fig. 1, tab. 15, fig. 6. That of the male bee, *ibid.* tab. 22, fig. 6. That of the *musca chamæleon*, in the different stages of its metamorphosis, *ibid.* tab. 40, fig. 5, tab. 41, fig. 7. That of the larva of the *musca putris*, *ibid.* tab. 43, fig. 7. That of the louse, tab. 2, fig. 7. That of the lobster, WILLIS *de Animâ Brutorum*, tab. 3, fig. 1.

HUMBOLDT'S *Experiments on the Irritation of Muscular and Nervous Fibres*, in German, vol. 1, contain several excellent anatomical and physiological remarks on the nervous system of some insects, p. 273, 286.

<sup>12</sup> See JOS. MANGILI *de Systemate Nerueo Hirudinis, Lumbrici Terrestris, aliorumque Vermium*. Ticini, 1795. A German version of this work is given in the 2nd vol. of REIL'S *Physiological Archives*.

The nervous system of the leech has been shewn by REDI *de Viventibus intra Viventia*, tab. 14, fig. 9; and BIBIENA *Comment. Instit. Bonon.* tom. 7, tab. 2, fig. 5, tab. 3, fig. 6. BE-



anatomists have expressly declared in several instances that no such parts existed<sup>13</sup>. The structure and distribution of the nerves possess in many cases a surprising analogy to those of insects. The nervous system of the sea-mouse (*Aphrodite aculeata*), for example, is very similar to that of the larvæ<sup>14</sup>. In others, it is more anomalous: thus, in the cuttle-fish, two large nervous chords arise from the brain, and form in the breast two club-shaped ganglia; from which numerous nerves proceed<sup>15</sup>. (See note (1)).

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*Additions to the Sixteenth Chapter.*

(A) As the works in which this most important physiological position is confirmed and eluci-

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NING'S excellent work on the leech, and MANGILI'S book may also be consulted.

The nerves of the slug are represented by SWAMMERDAM, tab. 9, fig. 2. and those of the *helix pomatia*, *ibid.* tab. 4, fig. 6; tab. 6, fig. 1; which may be compared with the drawing by SPALLANZANI, in the *Memoirs of the Italian Society*, tom. 2, pt. 2, p. 545.

<sup>13</sup> See the remarks of HUMBOLDT in his work above quoted, p. 259, and CUVIER'S classical work, which I here quote once for all, tom. 2, p. 298.

<sup>14</sup> PALLAS, *Miscellanea Zoologica*, tab. 7, fig. 13.

<sup>15</sup> SWAMMERDAM, tab. 52, fig. 2. MONRO *on the Physiology of Fishes*, tab. 41, fig. 3. SCARPA, *loc. citat.* tab. 4, fig. 7. TILLESIIUS in ISENFLAMM and ROSENMULLER'S *Contributions to Anatomy*, in German, vol. 1, pt. 2, tab. 2.



dated, are not very generally known in this country, I shall take the liberty of explaining it in a somewhat more detailed form.

The vast superiority of man over all other animals in the faculties of the mind, which may be truly considered as a generic distinction of the human subject, led physiologists at a very early period to seek for some corresponding difference in the brains of man and animals. They naturally investigated the subject in the first instance, by comparing the proportion, which the mass of the brain bears to the whole body : and the result of this comparison in the more common and domestic animals was so satisfactory that they prosecuted the inquiry no further, but laid down the general proposition, which has been universally received since the time of ARISTOTLE, that man has the largest brain in proportion to his body. Some more modern physiologists however, in following up this comparative view in a greater number of animals, discovered several exceptions to the general position. They found that the proportion of the brain to the body in some birds exceeds that of man ; and that several mammalia (some quadrumana, and some animals of the mouse kind) equal the human subject in this respect.

As these latter observations entirely overturned the conclusion, which had been before generally admitted, SÖMMERRING has furnished us with another point of comparison, that has hitherto held  
good



good in every instance : viz. that of the ratio, which the mass of the brain bears to the nerves arising from it.

Let us divide the brain into two parts; that which is immediately connected with the sensorial extremities of the nerves; which receives their impressions, and is therefore devoted to the purposes of animal existence. The second division will include the rest of the brain, which may be considered as connecting the functions of the nerves, with the faculties of the mind. In proportion then as any animal possesses a larger share of the latter, and more noble part; that is, in proportion as the organ of reflexion exceeds that of the external senses; may we expect to find the powers of the mind more vigorous and more clearly developed. In this point of view man is decidedly pre-eminent: here he excels all other animals that have hitherto been investigated.

All the *fimixæ*, says SÖMMERRING, are placed far behind man in this respect. Although the brain in some instances, particularly among the smaller kinds, which have prehensile tails, is larger in proportion to their body than that of the human subject; yet a very large share of that brain is required for the immense nerves, which supply their organs of sense and mastication. Let us remove that portion of the brain, and a very small quantity will remain.

The researches of the same author on animals in



general have led him to conclude, that the quantity of brain, over and above that which is necessary for a mere animal existence—that part, in short, which is devoted to the faculties of the mind, bears a direct ratio, to the docility of the animal; to the rank which it would hold in a comparative scale of mental powers.

The largest brain, which SÖMMERRING has found in a horse, weighed  $\text{lb. } 4 \text{ oz.}$  and the smallest, which he has seen in an adult man, was  $\text{lb. } 5\frac{1}{2} \text{ oz.}$  Yet the nerves arising from the former brain were at least ten times larger than those of the latter.

Generally speaking small animals have a larger brain in proportion to their body than larger ones. The pachydermata have it very small; and in red-blooded animals, its size is very trifling when compared with the body.

It forms in man from  $\frac{1}{12}$  to  $\frac{1}{11}$  of the body.

In some simiæ	"	$\frac{1}{12}$
the Mole	"	$\frac{1}{36}$
Bear	"	$\frac{1}{108}$
Dog	"	$\frac{1}{108}$
Cat	"	$\frac{1}{48}$
Hare	"	$\frac{1}{36}$
Rat	"	$\frac{1}{72}$
Mouse	"	$\frac{1}{12}$
Elephant	"	$\frac{1}{300}$
Pig	"	$\frac{1}{120} - \frac{1}{60}$



In the Horse	-	$\frac{1}{206}$
Dolphin	-	$\frac{1}{163}$
Eagle	-	$\frac{1}{166}$
Sparrow	-	$\frac{1}{23}$
Chaffinch	-	$\frac{1}{27}$
Redbreast	-	$\frac{1}{32}$
Blackbird	-	$\frac{1}{68}$
Canary-bird	-	$\frac{1}{14}$
Cock	-	$\frac{1}{5}$
Duck	-	$\frac{1}{237}$
Goose	-	$\frac{1}{366}$
Tortoise	-	$\frac{1}{2140}$
Turtle	-	$\frac{1}{3688}$
Coluber natrix	-	$\frac{1}{792}$
Frog	-	$\frac{1}{173}$
Shark	-	$\frac{1}{2496}$
Pike	-	$\frac{1}{1363}$
Carp	-	$\frac{1}{366}$

(B) The following is the passage to which the author refers in his "*Manual of Natural History*". "The extraordinary strength of the reproductive power in several amphibia, (see note (G) to § 136) and the astonishing facility, with which the process is carried on, must be explained, if I mistake not, from the great magnitude of their nerves, and the diminutive proportion of their brain. The former



parts are in consequence less dependent on the latter; hence the whole machine has less powers of motion, and displays less sympathy: the mode of existence is more simple, and approaches more nearly to that of the vegetable world, than in the warm-blooded classes:—but, on the contrary, the parts possess a greater individual independent vitality. Since, in consequence of this latter endowment, stimuli, which operate on one part, or one system, do not immediately affect the whole frame by sympathy, as in warm-blooded animals; we are enabled to explain the peculiar tenacity of life, which is displayed under various circumstances in this class; viz. frogs still continue to jump about after their heart has been torn out; and turtles have lived for months after the removal of the whole brain from the cranium. The long continued power of motion in parts, which have been cut off from the body, as in the tail of the water-newt, and blind-worm, may be explained upon the same principles". Edit. 6th, § 98, p. 221.

(C) "It is difficult, (says the author in his *description of the bones*) to give a physiological explanation of the use of this bony tentorium. The opinion, which has been generally adopted by anatomists, that the structure in question belongs to such animals only, as jump far, or run with great velocity, and that it serves the purpose of protecting the cerebellum from the pressure of the cerebrum

in



in these quick motions, is obviously unsatisfactory. It exists in the bear, which is not distinguished for its activity: while several animals, which excel in jumping or springing, do not possess it; viz. the wild goat, (*capra ibex*), in which I could not discover the least trace of such a structure. CHESELDEN ascribes it to predacious animals only (*Anat. of the Bones*, cap. 8); but I have already enumerated several others. It may perhaps obviate the concussion, which would arise from strong exertions in biting; for such exertions are made in all the animals, which possess this structure; even by the horse in his wild state." p. 118.

I have quoted these remarks on the generally assigned use of the bony tentorium, because a similar mechanical explanation has been given, of the falx and the tentorium of the human subject; viz. that the former protects the hemispheres from mutual pressure when the person lies with his head resting on one side; and that the latter provides against the compression of the cerebellum by the superincumbent cerebrum. These explanations are assigned in the present day by anatomists of such distinguished reputation as SÖMMERRING and CUVIER (*de Corporis Humani Fabricâ*, vol. 4, p. 27. *Léçons d'Anat. compar.* tom. 2, p. 178). If the utility of this piece of physiology were not sufficiently proved by considering that the cranium is accurately filled, and that there is consequently no



room for its contents to fall from one side to the other; it must immediately be rendered manifest by Mr. CARLISLE's case; in which the falx was entirely absent, and the two hemispheres united throughout in one mass, without any perceptible inconvenience during the patient's life. (*Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. 2, p. 212). I have met with four instances, in which the anterior half of the falx was deficient. This production of the dura mater commenced in a narrow form about the middle of the sagittal future; and gradually expanding, had acquired the usual breadth at its termination in the tentorium. The two hemispheres adhered by the pia mater covering their opposed plane surfaces; but were formed naturally in other respects. A want of the falx has also been recorded by GARENGEOT (*Splanchnologie*, tom. 2, p. 24.)

(D) The proportion of the weight of the cerebrum, to that of the cerebellum, is generally, although not universally, greater in the human subject than in mammalia, as will appear from the following instances taken from the second vol. of CUVIER. In the human subject the cerebellum is to the cerebrum, as

-	-	1	to	9
In the <i>simia sciurea</i> (squirrel-)	}	1	-	14
monkey)				

Other,



Other simiæ	-	-	1 to 6, 7 or 8
Dog	-	-	1 to 8
Cat	-	-	1 — 6
Beaver	-	-	1 — 3
Mouse	-	-	1 — 2
Hare	-	-	1 — 6
Boar	-	-	1 — 7
Cow	-	-	1 — 9
Sheep	-	-	1 — 5
Horse	-	-	1 — 7

The proportion of the cerebrum to the medulla oblongata, as ascertained by a comparison of their diameters, exhibits a more constant superiority in the human subject over the other mammalia, than the ratio of the Vererum to the cerebellum.

In man the breadth of the medulla oblongata, after the pons varolii, is to that of the brain,

as	-	-	1 to 7
Simiæ	-	-	1 to 4 or 5
Dog	-	-	6 to 1
Cat	-	-	8 — 22
Rabbit	-	-	3 — 8
Pig	-	-	5 — 7
Deer	-	-	2 — 5
Cow	-	-	5 — 13
Horse	-	-	8 — 21

Yet the dolphin forms a remarkable and single

ex-



exception to the general rule on this subject; for in that animal the proportions are as 1 to 13. In birds they are rather more than one to three.

(E) With the exception of man, and the simiæ, the mammalia cannot be said to have posterior lobes of the brain. The cerebellum is seen behind the cerebrum. The consequence of this is, that the digital cavity or prolongation of the lateral ventricle into the posterior lobe, is wanting.

The convolutions of the cerebrum do not exist in the rodentia. The simiæ only have an olfactory nerve, arising, like that of man, in a distinct chord from the brain. Other mammalia have a large cortical eminence (*processus mamillaris*) filling the ethmoidal fossa. As the cetacea have no organ of smelling, their brain has neither olfactory nerve, nor mamillary process.

(F) CUVIER represents the brain of birds to consist of six tubercles visible exteriorly: viz. the two hemispheres, the optic thalami, a cerebellum, and medulla oblongata.

(G) The dura mater forms no processes in the amphibia, nor in the fishes.

(H) In the skate, the right nerve goes through a fissure in the left; in bony fishes the decussation  
is



is more manifest, as one nerve merely lies on the other without any intermixture of substance. The fact has been noticed by COLLINS, WILLIS, and several others: it is represented by EBEL in the pike, carp, and *Silurus glanis* (*Obs. Neurol. ex Anat. comp.* tab. 2, fig. 2, 3, and 4: this dissertation is contained in the 3d vol. of LUDWIG'S *Scriptores Neurol. Minores*). It does not seem to have been much investigated in birds and the amphibia. In eight instances, where the eye of an animal had been destroyed or injured, the optic nerve was found to be altered in structure and appearance as far as the union: and beyond that point the alteration extended along the opposite nerve to the opposite thalamus. (See EBEL loc. cit. tab. 1. fig. 1, and 2.) A similar appearance has been found in a man. SÖMMERRING *de Decussat. Nerv. Optic.* in LUDWIG'S Collection, tom. 1.

(I) In the class of insects, and of vermes, the upper ganglion of the nervous chord, which represents the brain, is usually placed near the mouth or œsophagus: which tube is surrounded by a nervous chord proceeding from that ganglion.



## CHAPTER XVII.

ON THE ORGANS OF THE SENSES IN GENERAL,  
AND ON THAT OF THE SENSE OF TOUCH IN  
PARTICULAR.

§ 220. FEW subjects in comparative anatomy and physiology have given rise to more various and contradictory opinions, than the organs of sense in some classes of animals<sup>1</sup>. Much misunderstanding on this point has clearly arisen from the inconsiderate and unconditional application of inferences, drawn from the human subject, to animals<sup>2</sup>. Thus it has been supposed that those, which possess a tongue, must have it for the purpose of tasting; and that the sense of smell must be wanting, where we are unable to ascertain the existence of a nose. Observation and reflection will soon convince us, that the tongue, in many cases (in the ant-eaters among the mammalia, and almost universally in

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<sup>1</sup> Much useful information on the organs of sense, and indeed on comparative physiology in general, may be found in P. BODDAERTS' *Natuurkundige Beschouwing der Dieren*. Utrecht, 1778, 8vo.

<sup>2</sup> On the relation of the senses in the different classes of animals, the reader may consult Dr. TROXLER'S *Researches on Organic Physics*, in German. Jena, 1804. 8vo.

birds),



birds), cannot from its substance and mechanism be considered as an organ of taste; but must be merely subservient to the ingestion and deglutition of the food. Again in several animals, particularly among insects, an acute sense of smell seems to exist, although no part can be pointed out in the head, which analogy would justify us in describing as a nose.

§ 221. However universally animals may possess that feeling, which makes them sensible to the impressions of warmth and cold, very few possess, like the human subject, organs exclusively appropriated to the sense of touch, and expressly constructed for the purpose of feeling, examining, and exploring the qualities of external objects.

This sense appears, according to our present state of knowledge, to exist only in three classes of the animal kingdom; viz. in most of the mammalia, in a few birds, and probably in insects.

#### (A) MAMMALIA.

§ 222. The structure of the organ of touch is the most perfect, and similar to that of the human subject, in the quadrumana. The ends of their fingers, particularly of the posterior extremities, are covered with as soft, and delicately organized a skin, as that which belongs to the corresponding parts in man.

Several



Several of the *digitata* are probably provided with this sense. The organization of the under surface of the front toes of the racoon (*ursus lotor*), and the use which the animal makes of those parts, prove this assertion.

It is not so clear that we are authorized in considering the snout of the mole<sup>3</sup> and pig<sup>4</sup>, not to mention the tongue of the solidungula and bifulca<sup>5</sup>, or the snout of these and other animals<sup>6</sup>, as true organs of touch according to the explanation above laid down<sup>7</sup>.

§ 223. There would be more reason for ascribing this sense to the proboscis of the elephant. (See note (A) at the end of the chapter.)

I think, however, that the ornithorhynchus clearly possesses an organ of touch. In this curious animal, as in the duck, &c. the sense in question

<sup>3</sup> DERHAM'S *Physico. Theology*, p. 206, not 60.

<sup>4</sup> DARWIN'S *Zoonomia*, tom. 1, p. 162.

<sup>5</sup> BUFFON *Histoire des Oiseaux*, tom. 1, p. 47.

<sup>6</sup> BUFFON *Histoire Naturelle*, tom. 3, p. 360.

<sup>7</sup> Much less can we suppose the long bristly hairs, which constitute the whiskers of the cat-kind, and other mammalia, to be organs of touch in the sense we are now considering, although they may be serviceable, when they come in contact with any object, in warning, and making the animal attentive. See DARWIN, *loc. cit.* WIEDEMANN in the *Göttingen Literary Notices*, 1798, p. 210. ALBERS, *ibid.* 1803, p. 603. and VROLIK *over het nut der Knevels by viervoetige Dieren*. Amsl. 1800. 8vo.



resides in the integuments, which cover the expanded portion of its jaws, particularly the upper one; this part is most copiously supplied with nerves from the fifth pair, and chiefly from its second branch, distributed just in the same manner as they are on the corresponding parts of the swimming birds.

### (B) BIRDS.

§ 224. The structure of the organ of touch in the ornithorhynchus, which has been just described, is exactly similar to that of geese and ducks. The bill of these birds is covered with a very sensible skin, supplied with an abundance of nerves from all the three branches of the fifth pair. This apparatus enables them to feel about for their food in mud, where they can neither see nor smell it.

### (C) AMPHIBIA.

§ 225. It has been said of serpents<sup>s</sup> with more ingenuity than truth, that their whole body is a hand; by which they gain just notions of the tangible properties of bodies. There is much more foundation for stating that the sense of touch, which is here meant, does exist in any of the amphibia.

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<sup>s</sup> GIRTANNER in his Exposition of the DARWINIAN system, pt. I, p. 124.



## (D) FISHES.

§ 226. Concerning this class, the remark, which was made on the amphibia, may be repeated; although several fishes possess an acute feeling on the abdomen, and in the lips<sup>9</sup>.

## (E) INSECTS.

§ 227. All the observations and investigations of the structure of the antennæ, those peculiar organs, which exist universally in the more perfect insects; and of the use, which these animals generally apply them to; lead us inevitably to the conclusion, that they really are, what their German name<sup>10</sup> imports, proper organs of touch; by which the animal examines and explores surrounding objects<sup>11</sup>. Such organs are particularly necessary to insects, on account of the insensibility of their external coat, which is generally of a horny consistence; and also from their eyes being destitute in most instances, of the power of motion.

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<sup>9</sup> LA CEPEDE, *Histoire Naturelle des Poissons*, tom. 1. Discours. p. 65.

<sup>10</sup> *Fühlhorner*: the literal translation of which is *Feeling Horns*.

<sup>11</sup> See LEHMANN *de Antennis Insectorum*. Diff. 1, 2. Lond. 1799. 8vo. and KNOCK'S *New Contributions to the Knowledge of Insects*. pt. 1. Leipzig, 1801. 8vo. p. 33.



## (F) VERMES.

§ 228. It seems more doubtful whether the tentacula of several vermes, and particularly the arms of the cuttle-fish <sup>12</sup>, can be considered as organs of touch, in the more limited sense, to which we have confined that word <sup>13</sup>.

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*Additional Note to the Seventeenth Chapter.*

(A) Bats have been supposed to possess a peculiar power of perceiving external objects, without coming actually into contact with them. In their rapid and irregular flight amidst various surrounding bodies, they never fly against them: yet it does not seem that the senses of hearing, seeing, or smelling, serve them on these occasions; for they avoid any obstacles with equal certainty when the ear, eye, and nose are closed. Hence

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<sup>12</sup> BUFFON, *Histoire Naturelle*, tom. 3, p. 360.

<sup>13</sup> See LEHMANN *de Sensibus Externis Animalium Exsanguium*. Goetting. 1798. 4to. p. 43. F. I. SCHELVER *Essay towards the Natural History of the Organs of Sense in Insects and Vermes*. Goett. 1798. 8vo. p. 28; and DRAPARNAUD, *Tableau des Mollusques Terrestres and Fluviales de la France*. Montpellier. 1801. 8vo. p. 8.



naturalists have ascribed a sixth sense to these animals. It is probably analogous to that of touch. The nerves of the wing are large and numerous, and distributed in a minute plexus between the integuments. The impulse of the air against this part may possibly be so modified by the objects near which the animal passes, as to indicate their situation and nature.



## CHAPTER XVIII.

## ON THE TONGUE.

§ 228. **WE** are not justified in considering the tongue as an organ of taste in all animals, because it is subservient to that function in the human subject, and in some other instances. We have already observed, that this organ in many cases merely serves for taking in the food<sup>1</sup>; and it is at least very doubtful whether it possesses the sense of taste in several others. Yet, on the contrary, we should not be warranted in denying the existence of the sense in these animals, nor even in such as are entirely destitute of a tongue: for this function may be exercised by other parts<sup>2</sup>. Less, however, can  
be

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<sup>1</sup> The lingual bone (*os hyoides*) of the three first classes of animals, varies according to the different methods in which they take their food. Many excellent remarks on this subject may be seen in FAB. AB AQUAPENDENTE *de Larynge*, p. 276; and in CASSERIUS *de Vocis Organis*, with excellent delineations.

The curious lingual bone of the walrus and porpoise will be described in the 2nd vol. of DR. ALBER'S *Contributions*.

<sup>2</sup> I have seen an adult, and in other respects well-formed man, who was born without a tongue. He could distinguish



be concluded with any certainty à priori, on this, than on any of the five senses.

(A) MAMMALIA.

§ 229. No animal possesses a tongue exactly like that of the human subject. The form of the organ differs considerably in the simiæ, being longer and thinner; and the papillæ, which cover its upper surface, are very different<sup>3</sup>.

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nevertheless very easily the tastes of solutions of salt, sugar, and aloes, rubbed on his palate, and would express the taste of each in writing. Why then may not those animals, which either have no tongue, or one not calculated for an organ of taste, possess this sense in some of the neighbouring parts? I cannot however agree with that ingenious anatomist GREW (in his *comparative anatomy of stomachs and guts*, p. 26.), when he considers the internal surface of the three first stomachs of the bisulca, to be an organ of taste; particularly since WEPFER and others have remarked the enjoyment, which is connected with the second mastication of the food in ruminating animals.

<sup>3</sup> Thus the length of the tongue of the commonest kind of tailless ape (*simia sylvanus*), which now lies before me, is three times greater than its breadth. It has three *papillæ pedicellate*, or *fungiformes*, at its posterior part, arranged in the form of a triangle. Before these, and along the two sides of the tongue, are about two hundred *papillæ obtusæ*, appearing like white grains. These are not all of the same size; but they may be distinguished from the *papillæ conicæ*, which cover the rest of the tongue's superior surface, much more easily than in the human tongue.



§ 230. Most of the herbivorous mammalia, particularly among the bifulca, have their tongue covered with a firm and thick cuticular coat; which forms numberless pointed papillæ directed backwards. These must assist, according to their consistence and direction, at least in the animals of this country, in tearing up the grass. Animals of the cat kind have their tongue covered with sharp and strong prickles, which must enable the animal to take a firm hold. Similar pointed processes are found in some other animals; as in the bat-kind, and the opossum.

There seems to be no doubt that in all the mammalia which we have now considered, the tongue is an organ of taste, at least towards its anterior part.

The toothless animals, on the contrary, as the ant-eater\* and manis, which swallow their aliment

whole,

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\* The tongue of a two-toed ant-eater, which I dissected, was three inches and a half long, and no larger than a crow-quill at its root. It was, generally speaking, cylindrical; but marked with a scarcely perceptible groove on its superior surface. Two very small foramina cæca were found near the root. The lingual bone was strong, but not remarkably large, and in shape like a horse-shoe. Its muscles, on the contrary, as the geniohyoideus, mylohyoideus, and particularly the genioglossus, were remarkably large and strong.



whole, have a long worm-like tongue, which is obviously capable of no other use than that of taking their food.

(B) BIRDS.

§ 232. All birds possess a tongue: for even the pelican, in which its existence has been denied, possesses a manifest rudiment of the organ. Probably, however, it serves the purpose of an organ of taste in very few genera. Yet this is the case with some predacious and swimming birds; as also with most of the psittaci; which possess a soft thick tongue covered with papillæ, and moistened with a salivary fluid: they really taste different fluids, and soft kinds of food, and select that which is the most agreeable,

§ 233.

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As we are now considering the tongue in its office of assisting in taking in the food, this seems to be the proper place for noticing the worm, as it is called, of the dog's tongue. It is a tendinous fasciculus of fibres running lengthwise under the tongue, as far as its apex, and lying rather loose in a kind of membranous sheath, without being connected, like a true tendon, to any of the neighbouring muscles. By an old prejudice, which has subsisted at least since the time of PLINY, its extirpation is considered as a preservative against hydrophobia. Concerning the structure of this curious, and in some respects enigmatical part, see MORGAGNI *de Sedibus et Causis Morborum*, tom. 1, p. 67. Venet. 1761, folio. CASSERIUS thought that it assisted the dog in lapping  
up



§ 233. In several other birds, on the contrary, the tongue is horny, stiff, not supplied with nerves, and consequently unfit for an organ of taste. One striking example will supply the place of many. The tongue of the toucan (*Ramphastos*) is sometimes several inches in length, yet scarcely two lines broad at its root. It has the appearance, throughout, of a piece of whalebone; and its margins are fibrous.

§ 234. The form<sup>4</sup> and mechanism of the tongue vary much in the different genera and species of this class. Two instances deserve particular notice: that of the wood-pecker, and the cock of the woods. The tongue of the former bird is generally said to be very long; but it is not so. That part, which corresponds to the tongue of other birds, is remarkably short: it is merely a sharp-pointed horny portion, with its sides barbed. Behind this is a very singular os hyoides; of a slender appearance, but having very long crura. It consists of five cartilaginous portions; viz. one single piece, and two pairs. In the quiescent state of the organ, the for-

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up fluids in the peculiar way which they do: and his opinion is supported by this circumstance, that an opossum, which I kept alive for some time, and which took fluids in the same manner as dogs do, had a similar part under the tongue.

<sup>4</sup> See the plates in J. C. SCHOEFFER'S *Elementa Ornithologica*. Ratisbon, 1774. 4to.



mer lies in a fleshy, and very extensile sheath of the bill. The first pair of cartilages is articulated with this; and they are placed at the sides of the neck. The second pair, commencing from these, run completely over the cranium, under the integuments; and advancing from behind, forwards, their converging extremities are placed together in a kind of groove, and commonly terminate anteriorly by an attachment to the right side of the upper jaw. This posterior pair of cartilages may therefore be compared to steel springs, which actuate the whole organ<sup>5</sup>. When the tongue is to be darted out, the anterior pieces are drawn together, and enter the sheath of the single portion, extended for their reception. The tongue is thus elongated, and admits of being thrust out some inches.<sup>6</sup>

The tongue of the cock of the woods is still more singular: that organ, together with the larynx, lies deep in the œsophagus, but admits of being quickly elevated and thrust forth by means of considerable muscles<sup>7</sup>.

(C) AM-

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<sup>5</sup> This is an elegant example of the great share, which mere elasticity possesses in the performance of some functions of the animal economy.

<sup>6</sup> See MERY, in the *Memoires de l'Acad. des Sciences*, 1709, p. 85. WALLER, in the *Philos. Transf.* vol. 29, p. 509: and WOLF, in VOIGT'S *Magazine*, pt. 2, of the new series, p. 468.

<sup>7</sup> FRISCH on the *German Birds*, tab. 108. SCHNEIDER'S



## (C) AMPHIBIA.

§ 235. We shall select a few examples of the chief varieties in this class of animals.

The crocodile's tongue (the very existence of which has been denied from the time of HERODOTUS down to HASSELQUIST) is small; possesses very little motion; and is in a manner adherent between the two sides of the lower jaw<sup>8</sup>. The salamander resembles this. A very different structure is presented in the curious tongue of the chamæleon; the mechanism of which may be compared in some respects with that of the woodpecker. Yet its form is very different; for the anterior extremity of the organ is club-shaped; and is hollowed out on its upper surface<sup>9</sup>. (See note (A) at the end of the chapter.)

The tongue of some testudines is thickly co-

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*Commentary on the Works of FREDERIC II.* tab. 2; and GILIBERT, *Médecin Naturaliste*. Lyons, 1800, 8vo. p. 294.

<sup>8</sup> C. G. DE RHOER, *de Fide Herodoti rité affirmanda*, in the *Verhandelingen van Teylers tweede Genootschap*, pt. 7, p. 104. L. V. HAMMEN, *de Herniis*, p. 105. *Nouvelles de la République des Lettres*, Oct. 1688, p. 1125.

<sup>9</sup> Besides the works which have been already quoted on the anatomy of this animal, see HUSSEM in the *Verhandelingen van de Maatschappye te Haarlem*, v. 8, pt. 2, p. 228. DUVERNOY in the *Bulletin de la Soc. Philom.* tom. 3; and MILLER *Icones Animal. et Plantar.* tab. 2.



vered on its anterior margin with long fibrous papillæ<sup>10</sup>.

The soft, flat, and fleshy tongue of the frog, lies, in the quiescent state, in a direction from before, backwards. It is firmly attached behind the arch of the lower jaw; and its loose end is turned backwards, so that the semilunar notch of its anterior margin corresponds to the rima glottidis. They seize their prey by turning the tongue forwards, and thrusting it out of the mouth.

§ 236. The tongue of serpents is attached, and situated in the same manner as in the frog<sup>11</sup>: but it is round and slender: its apex is bifid, and the root rests in a kind of fleshy sheath, being capable of protrusion and retraction at pleasure<sup>12</sup>.

#### (D) FISHES.

§ 237. There is little to be said concerning the tongue of this, and the two following classes. It is

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<sup>10</sup> I have observed this in the *Testudo Græca* from Mogador. The form of the os hyoides in the testudines may be seen in CALDESI, tab. 8.

<sup>11</sup> SEETZEN in MEYER'S *Zoological Archives*, pt. 2, p. 65.

<sup>12</sup> *Delineations of Objects in Natural History*, pt. 4. tab. 37, in the boa and rattle-snake. The curious os hyoides of serpents, with two cartilaginous portions running along the trachea, is represented by TYSON, *Philos. Transf.* vol. 13, p. 68, fig. 5.



doubtful whether it be an organ of taste, and in what degree it may serve that purpose.

It appears at least in fishes to possess no manifest papillæ<sup>13</sup>; and in many of this class is covered with teeth.

That, which is commonly called the tongue in some fishes, as the carp, is a glandular body, attached to the palate, and extremely irritable in the living animal<sup>14</sup>.

### (E) INSECTS.

§ 238. The organ which is commonly considered as the tongue of insects<sup>15</sup>, merely serves for taking in the food<sup>16</sup>. But the accurate observations of professor KNOCH<sup>17</sup>, render it very probable that the posterior pair of palpi, or feelers, possesses the power of taste in several of this class.

<sup>13</sup> LORENZINI'S *Observations on the Torpedo*, in Italian, p. 41.

<sup>14</sup> *Observat. Colleg. privat. Amstelod.* vel 1, p. 40.

<sup>15</sup> A very accurate account of this part, and its varieties, illustrated with numerous figures, by an excellent entomologist, J. C. G. KARSTEN, of Rostock, now lies before me in manuscript, and will soon be made public.

<sup>16</sup> SCHELVER, *loco citato*, p. 39. A. W. KNOCH, *Contributions to the Knowledge of Insects*, pt. 1, 1801, 8vo. p. 40, tab. 1, fig. 30. The tongue of the May-beetle (*Scarabæus Melolontha*) is represented.

<sup>17</sup> *Loc. cit.* p. 32, tab. 1, fig. 9, of the *Scarabæus Frischii*, tab. 8, fig. 4, of the *Carabus unicolor*.

### (F) VER-



## (F) VERMES.

§ 239. In the mouth of some mollusca,<sup>18</sup> and snails<sup>19</sup>, an organ is found, which has generally from its situation been taken for the tongue. But none of the observations, which have been hitherto adduced respecting its functions, are sufficiently decisive to justify us in setting it down as an organ of taste.

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*Additional Note to the Eighteenth Chapter.*

(A) The tongue of the chameleon displays a very curious mechanism. It is contained in a sheath at the lower part of the mouth; and has its extremity covered with a glutinous secretion. It admits of being projected to the length of six inches; and is used in this manner by the animal, in catching its food; which consists of flies, &c. It is darted from the mouth with wonderful celerity and precision; and the viscous secretion on its extremity, entangles the small animals which constitute the food of the chameleon.

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<sup>18</sup> SWAMMERDAM of the cuttle-fish, p. 882, tab. 50, fig. 4, 5.

<sup>19</sup> Of the *helix pomatia*, *ibid.* p. 109, tab. 5, fig. 3.



## CHAPTER XIX.

## ON THE ORGAN OF SMELLING.

§ 240. **T**HE sense of smelling prevails much more extensively in the animal kingdom, than that of taste: since it not only assists several genera in selecting their food, which they have not afterwards the power of tasting; but is also of service in finding out proper objects for the satisfaction of their sexual appetite. Yet there is much doubt respecting the organs of this sense in the two classes of white-blooded animals<sup>1</sup>.

§ 241. We can determine the degree of acuteness of this sense by the inspection of the cranium, in the four-footed mammalia<sup>2</sup>, (taking the term in its most extensive sense, in which it will include the

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<sup>1</sup> On the organ of smelling in several genera of the four classes of red-blooded animals, see the 2nd vol. of CUVIER'S *Leçons d'Anat. comp.* SCARPA, *Disquisitiones Anatomicae de Auditu et Olfactu.* And HARWOOD'S *System of comparative Anatomy and Physiology*; which is translated into German, with remarks and additions, by C. R. WIEDEMANN, Berlin, 1799, 4to.

<sup>2</sup> F. C. ROSENTHAL *Diff. de Organo Olfactus quorundam Animalium*, Jena, 1802, 4to.



quadrumana and bats. Three circumstances principally determine our judgement on this point.

1st, The structure of the ethmoid bone, and particularly the number and arrangement of those openings in its superior or horizontal lamina, which transmit the filaments of the olfactory nerve. 2ndly, The formation of the inferior conchæ narium, or turbinated bones. 3rdly, The existence and relative magnitude of those cavities of the internal nose, particularly the frontal sinuses, which contribute to the organ of smelling.

§ 242. The hedge-hog and mole, the animals of the weasel, bear, dog, and cat-kinds, most of the bisulca, and the elephant, afford examples of a very complicated formation of the ethmoid bone; both in regard to the elegant structure of its cribriform lamella, and to the wonderful convolutions of its turbinated portions; which procure as large a surface as possible within the confined space of the nasal cavity, for the application of the Schneiderian membrane. All these animals are well known for the remarkable acuteness of their sense of smelling.

The ethmoid bone is remarkably narrow, and imperfectly developed in most of the quadrumana. As there is not sufficient space left for it between the orbits, which lie close together<sup>3</sup>, (§ 20.) it is placed

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<sup>3</sup> In the skull of a *cercopithecus capucinus* in my possession, the partition between the two orbits, which space in the human



placed deeper in the nose; so that the olfactory nerves descend between the orbital portions of the frontal bone, as in a canal, the bottom of which is formed by the cribriform lamella, small and inconsiderable, and perforated by few apertures<sup>4</sup>.

The cetacea have no ethmoid bone. They want also the first pair of nerves; and the first branch of the fifth pair seems to perform its functions.

§ 243. The *conchæ narium inferiores* are more or less convoluted, in proportion to the greater or less complication in the structure of the upper ones. They are remarkably large in the bifulca<sup>5</sup>; and much convoluted in most of the predacious animals<sup>6</sup>. They are both large and wonderfully complicated in the seal<sup>7</sup>.

human cranium is filled by the ethmoid cells, and superior turbinated bones, contains a large opening, which in the recent state was probably closed by a portion of periosteum.

<sup>4</sup> JOSEPHI, *Anatomy of the Mammalia*, vol. 1, p. 179, &c.

<sup>5</sup> See CASPAR BARTHOLIN, *Analecæ Observationum*, in his *Specimen Historiæ Anatomicae*, tab. 3, fig. 3, 4, of the sheep; and MORAND, in the *Mem. de l'Acad. des Sciences*, an. 1724, tab. 24, of the ox.

<sup>6</sup> CASP. BARTHOLIN, *loco citato*, fig. 5, 6, of the hound, (*canis venaticus*).

<sup>7</sup> An excellent delineation of this part in the walrus, will appear in the 2nd part of ALBERS'S Contributions



§ 244. The frontal sinuses<sup>8</sup> of the elephant<sup>9</sup> are larger than those of any other animal; the pig, which has an acute sense of smelling, comes next in order in this respect. Most of the mammalia, which possess proper horns, have these cavities extending more or less into those processes of the frontal bone, on which the horns are formed: this structure is particularly observable in the wild goat (*capra ibex*). They are generally large in the bifulca<sup>10</sup>, the solidungula, and in most of the carnivorous mammalia. They are absent on the contrary in the seal; in most of the rodentia; and the cetacea.

§ 245. The anomalous structure of the elephant's proboscis, or trunk, and the blowing-holes of the cetacea, must be noticed here; as these parts constitute prolongations and external openings of the nose.

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<sup>8</sup> I have considered, in a more detailed manner, the structure of these cavities in several genera and species of the different orders of mammalia in my *Profusio de Sinibus Frontalibus*, Goetting, 1779, 4to, where I have endeavoured to shew, from comparative anatomy, that their use is to strengthen the sense of smelling; and that they are not subservient to the formation of the voice.

<sup>9</sup> STUKELY, in his *History of the Spleen*, p. 101, tab. 5, fig. 2.

<sup>10</sup> They receive in the sheep, as is well known, the larvæ of the *œstrus ovis*; and cases are not very uncommon in which other insects, particularly the *scolopendra electrica*, have accidentally gained admission into them in the human subject, and have caused distressing and tedious symptoms.



The former organ consists of two canals, separated from each other by an intervening partition. Innumerable muscular fasciculi running in two directions, occupy the space between these and the integuments. There are fibres of a transverse course, passing like radii from the canals to the integuments<sup>11</sup>; and others, which run in a more longitudinal direction, but have their extremities turned inwards<sup>12</sup>. The former extend the trunk, without causing any contraction of the canals; the latter bend or contract it; and both tend to bestow on it that wonderful mobility, which it possesses in every direction. (See note (A) at the end of the chapter.)

The blowing hole of the cetacea is not a peculiar organ, distinct from the nasal openings, as several naturalists have imagined, but one and the same with these<sup>13</sup>. It does not however seem to be designed for an organ of smelling, but merely to be subservient to respiration, and to the expulsion of the water which enters the mouth with the food<sup>14</sup>. (See note (B).)

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<sup>11</sup> *Hist. des Animaux*, tom. 3, tab. 22, fig. 9; STUKELY, *loc. cit.* tab. 1, fig. 2.

<sup>12</sup> *Hist. des Animaux*, *loc. cit.* STUKELY, tab. 5, fig. 1.

<sup>13</sup> This has been correctly stated by TYSON in his *Anatomy of a Porpesse*, tab. 2, fig. 8, 9.

<sup>14</sup> CUVIER in the *Magasin Encyclopedique*, an. 3, tom. 2, p. 299.



## (B) BIRDS.

§ 246. The nostrils open in the several genera of this class in very different parts of the upper mandible; in some, as the puffin (*alca arctica*), the openings are placed at the margins of the bill, and are so small, that they might be easily overlooked<sup>15</sup>.

§ 247. Birds have no proper ethmoid bone: their olfactory nerves pass through the orbits to the nose, and are distributed on the pituitary membrane, which covers two or three pairs of bony<sup>16</sup> or cartilaginous<sup>17</sup> conchæ narium (*bullæ turbinatæ* or *tubulatæ vesicæ*<sup>18</sup>) of various forms and sizes<sup>19</sup>. (See note (C)).

## (C) AMPHIBIA.

§ 248. The organ of smelling is less clearly developed in this class of animals. Yet we discover

<sup>15</sup> This may serve as an excuse for the erroneous representation of BUFFON, that several birds are entirely unprovided with nostrils, and that they smell by means of the palatine openings of the nasal cavity.

<sup>16</sup> The crane has very large turbinated bones.

<sup>17</sup> This is the case in the toucan, (*Ramphastos*).

<sup>18</sup> They are excellently described under this name by SCHNEIDER, *de Offe Cribriformi*, p. 180.

<sup>19</sup> See SCARPA'S representation of the nerves of the nose in the goose, turkey, and heron, *de Auditu et Olfactu*, tab. 3.



two cartilaginous eminences, which may be compared to the conchæ of warm-blooded animals<sup>20</sup>. (See note (D)).

(D) FISHES.

§ 249. Most of these seem to have double nostrils on each side: for the openings are furnished with a valve-like moveable membrane, which appears like a partition<sup>1</sup>.

§ 250. Behind these is generally found, instead of conchæ narium, a very elegantly plaited membrane, disposed in semicircular folds, and having the olfactory nerves distributed on it<sup>2</sup>.

<sup>20</sup> SCARPA, tab. 5, in a turtle and viper.

<sup>1</sup> It was formerly supposed, that this part served also for the organ of hearing in fishes; and this erroneous opinion has been revived even in modern times; but it cannot be necessary to refute such an absurdity now.

<sup>2</sup> See representations of this part, in the *raia clavata*, by SCARPA, tab. 1, fig. 2: in the skate (*raia batis*) by HARWOOD, tab. 7: in the shark, by STENONIS, in his *Specimen Myologie*, tab. 7, fig. 1: in the *Squalus Catulus*, by SCARPA, tab. 2, fig. 6, 7: in the frog-fish (*lophius piscatorius*) *ibid.* tab. 1, fig. 3: in the pike, by CASSERIUS, *de Auditus Organis*, tab. 12; by CAMPER, in his *smaller Writings*, pt 2, tab. 2, fig. 1; SCARPA, tab. 2, fig. 1, 2; and HARWOOD, tab. 5, fig. 4: in the carp, *ibid.* tab. 2, fig. 4, 5.

Some detached remarks on the organ of smelling, in particular fishes, are given by MORGAGNI in his *Epist. Anat.* p. 350, Padua, 1764, fol.



## (E) INSECTS.

§ 251. Numerous facts have long ago proved that several insects can distinguish the odorous properties of bodies even at considerable distances. But the organ, in which this sense resides, has not hitherto been clearly pointed out.

Since all red-blooded terrestrial animals smell only through the medium of the air, which they take in in inspiration, several naturalists have supposed, that the stigmata of insects are to be considered as organs of smelling<sup>3</sup>. Others ascribe this office, and with some probability, to the anterior pair of palpi<sup>4</sup>.

## (F) VERMES.

§ 252. Several animals of this class appear to have the sense of smelling: as many land-snails (*helix pomatia*<sup>5</sup>, &c.). But the organ of this sense is hitherto unknown; perhaps it may be the stigma thoracicum.

<sup>3</sup> This was the opinion of S. REIMARUS, "on the Instincts of Animals," in German, p. 308, ed. 3rd. See also DUMERIL in the *Magasin Encyclopédique*, an. 3, tom. 2, p. 435.

<sup>4</sup> KNOCH, in his *new Contributions to the Knowledge of Insects*, p. 32, tab. 1, fig. 8, and tab. 8, fig. 3, of the *scarabæus frischeii* and *carabus unicolor*.

<sup>5</sup> SWAMMERDAM, p. 110.



*Additional Notes to the Nineteenth Chapter.*

(A) CUVIER has given a more detailed description of the elephant's trunk in the last vol. of his *Leçons d'Anat. comp.* p. 283—289; and has also represented the part in the 29th plate of the same volume.

The more longitudinal fibres are divided at short intervals by tendinous interfections, which enable the animal to bend any part of the organ, and to give it any requisite degree of curvature. The same structure will confer a power of bending different parts of the trunk in opposite directions; indeed there is no kind of curvature which may not be produced by these longitudinal fibres. These fasciculi occupy the external surface of the organ. The transverse fibres are not all arranged like radii round the canals; but some pass across from right to left, and must therefore affect the diameter of those tubes by their action. The whole of these muscular fasciculi are surrounded and connected together by a white, uniform, adipous substance. The transverse ones are not more than a line in thickness. If the number of these, which appears on a transverse section, be ascertained; and if those portions of the longitudinal fasciculi, which pass from one tendon to another, be reckoned as separate muscles, (for they must have a separate power of action) the



whole trunk will contain about thirty or forty thousand muscles; which will account satisfactorily for the wonderful variety of motions which this admirable organ can execute, and for the great power which it is capable of exerting.

(B) The blowing-hole of the whales serves as well for respiration, as for the rejection of the water which enters with their food. In consequence of its situation at the top of the head, it is easily elevated beyond the surface of the sea, while the mouth is usually entirely under water.

The opening in the bones of the head is divided into two by a partition of bone; and is furnished with a valve opening outwards. On the outside of this opening are two membranous bags, lined with a continuation of the integuments, and opening externally. The water, which the animal wishes to discharge, is thrown into the fauces, as if it were to be swallowed; but its descent into the stomach is prevented by the contraction of the circular fibres of the œsophagus. It therefore elevates the valve placed at the entrance of the blowing holes, and distends the membranous bag, from which it is forcibly expelled by surrounding muscular fibres.

This apparatus occupies the situation, which in other mammalia is filled by the nose; which organ, together with the sinuses of the head, the olfactory nerve, &c. is entirely wanting in these animals.

(C) The



(C) The olfactory nerve of birds comes off from the anterior extremity of the front lobe of the brain, and has therefore some analogy with the processus mamillaris of quadrupeds. It passes along a canal to the nose, and is distributed in a very beautiful and distinct manner on the pituitary membrane in many instances, as in the crane.

(D) The origin and course of this nerve are much the same in reptiles as in birds. In the turtle it is a large, strong, and fibrous nerve, and its ramifications in the nose are easily traced.



## CHAPTER XX.

## ON THE ORGAN OF HEARING.

§ 253. **W**E should naturally expect to find an organ of hearing in most classes of animals<sup>1</sup>, when we consider the various services, which this sense performs; as, that of indicating the approach of danger, of conducting predaceous animals to their prey, and of bringing the two sexes together for the purpose of copulation, &c. Red-blooded animals, without any exception, possess this organ. Analogous parts are found in some of the white-blooded; and several others certainly can hear,

<sup>1</sup> The following works may be consulted for an account of the organ of hearing in the different classes of animals.

CASSERIUS *de Vocis Auditusque Organis*. Ferrara, 1600, fol. (The part relating to the ear is also contained in his *Pentasteseion*.)

PERRAULT, *Essais de Physique*, tom. 2.

GEOFFROY *sur l'Organe de l'Ouïe*, &c. Amsterd. 1788-8.

SCARPA *de Auditu et Olfactu*.

COMPARETTI, *Observationes Anatomicae de Aure Internâ comparata*. Patav. 1789-4.

MONRO'S *three Treatises on the Brain, Eye, and Ear*. Edin. 1797-4.

HOME in the *Philos. Transf.* 1800, pt. 1.



although the organ of that sense has not been hitherto been ascertained.

(A) MAMMALIA.

§ 254. The four-footed mammalia are the only animals, which possess true external ears; and, even here, several instances occur, in which these parts are wanting; particularly among such as live in the water, or under ground. They are not met with, for instance, in most of the seals, in the walrus, manati, duck-billed animal (*ornithorhynchus*), and mole. On the contrary some have been said to want external ears, who really possess them, as the *marmota* or *mus citillus*. Another error has been committed, in representing the ears of a species of bat, belonging to this country, (*vespertilio auritus*) as double<sup>2</sup>: whereas they are only of an immense size. The essential parts of the external ear agree on the whole with those of the human subject\*; but their general form is subject to great variety. In very few, except the quadrumana, do they resemble those of man; but this is

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<sup>2</sup> Still more erroneous is an observation of HALLER; that these ears are to be considered as an accidental monstrosity.

\* The *lobulus* of the external ear is found in no animal but man.



the case in the porcupine. The cartilage is stronger, and more elastic in its structure in the human ear, than in that of any other animal, in proportion to its size. In some instances, as the opossum (*didelphis marsupialis*), they are merely membranous.

§ 255. The external auditory passage is furnished with a valve in such animals as go frequently into the water, by which they can close it when they dive. The water-shrew (*forex fodiens*) affords an example of this structure. The length, breadth, and direction of the meatus vary considerably in the different genera. It is very long and singularly tortuous in the duck-billed animal<sup>1</sup>. (See note (A), at the end of the chapter.)

§ 256. It is hardly necessary to state that all mammalia have a *membrana tympani*, a *tympanum* situated within this, and an *Eustachian tube* passing from that cavity to the fauces; except in the cetacea, where it opens in the blowing hole. (§ 245.) The membrane is rather concave on its outer surface, being slightly depressed in the middle. All the animals of this class are furnished with the two *fenestræ*; the *f. ovalis*, which is filled by the base of the stapes; the *f. rotunda*, at which the scala tympani of the cochlea commences.

<sup>1</sup> HOME in the *Philos. Transf.* 1802, pt. 1, p. 70.



§ 257. In most of the four-footed mammalia, there is connected with the tympanum, another cavity; which, according to the situation of the bony organ that contains it, must be compared to the mastoid cells in the temporal bone of man.

In several animals this organ forms a mere bony cavity (*bullæ ossæ*): viz. in the dog, cat, martin, squirrel, hare, and some of the bifulca. An attempt at this structure is to be seen in the cerco-pithci. In the horned cattle, on the contrary, and in the pig, the cavity is divided into cells by numerous bony plates, which somewhat resemble the divisions in a ripe poppy head<sup>4</sup>.

§ 258. Warm-blooded quadrupeds have, like the human subject, three<sup>5</sup> *officula auditus*; which on the whole resemble in form those of man. But the duck billed animal, whose structure in every respect is so anomalous, has only two<sup>6</sup>; and on the contrary one or two additional small bones are

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<sup>4</sup> VESALIUS. *Anatomicarum Fallopii Observationum examen*. Venet. 1764, 4to, p. 20.

<sup>5</sup> That the *lenticulus* or fourth bone is only a process of the incus, I have already shewn in my "*History and Description of the Bones of the Human Body*," in German. p. 144. (See note (B).)

<sup>6</sup> HOME, *loco citato*.



occasionally found, particularly in some *bifulca*<sup>7</sup>. (See note (C).

§ 259. The part which is termed the labyrinth of the ear, as far as it has been hitherto investigated in the four-footed mammalia, seems to agree on the whole, in its essential parts, with that of the human subject. But the cochlea (which belongs indeed exclusively to this class) has in some cases a turn more than in man; not to mention other differences of less importance<sup>8</sup>.

§ 260. In addition to what has been observed respecting the Eustachian tube of the cetacea, some other parts of the organ of hearing exhibit such peculiarity in these animals, and deviate so widely from those of warm-blooded quadrupeds, that they require particular notice<sup>9</sup>.

Their

<sup>7</sup> ADAIR in COWPER'S *Myotomia Reformata*. Lond. 1694, 8vo. p. 70. fig. 9.

TEICHMEYER, *Vindiciæ quorundam Inventorum Anatomicorum*. Jenæ, 1727-4. fig. 5.

<sup>8</sup> The reader may consult on this subject the following works, besides those which have been already referred to. SCARPA *de Structurâ Fenestræ Rotundæ Auris*. Mutin. 1777, 8vo. p. 94. P. F. MECKEL *de Labyrinthi Auris Contentis*. Argent. 1774-4.

<sup>9</sup> On the organ of hearing in the true whale (*balæna*), see CAMPER'S *smaller Writings*. vol. 2, pt. 1. In the spermaceti whale (*physeter*) *ibid.* vol. 1, pt. 2. In the dolphin (*delphinus delphis*),



Their want of external ear is well known. The opening of the meatus is remarkably small. The bony part of the organ is loosely connected to the skull in the dolphin and porpoise; and it is completely separate in the proper whales (*balænæ*) and cachalot (*physeter*).

The hard bony substance, which was formerly very erroneously called *lapis manati* or *tiburonis*, is merely the tympanum, and *bulla ossæ* of the whale.

The ossicula auditus, and the labyrinth, particularly the bony canals (*canales semicirculares*), which for this very reason were long overlooked, are remarkably small in the cetacea.

## (B) BIRDS.

§ 261. This whole class<sup>10</sup>, as well as the following ones, has no cartilaginous external ear, which belongs, therefore, exclusively to the mammalia.

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*delphis*), KLEIN Hist. Nat. Piscium. pt. 1, p. 29, tab. 5, fig. 1-4, and 7-9 In the spermaceti whale, porpoise (*delphinus phocæna*), and dolphin: MONRO's *three Treatises*, &c. tab. 5, 6. and his *Physiology of Fishes*, tab. 35.

<sup>10</sup> On the organ of hearing in this class, see ALLEN MOULINS in the *Philos. Transf.* vol. 17, p. 712. VICQ. D'AZYR in the *Mem. de l'Acad. des Sciences*, 1778, p. 381. SCARPA *de Structurâ Fenestræ Rotundæ Auris*, p. 101. and *de Auditu*. GALVANI in the *Comment. Inslit. Bonon.* tom. 6. p. 420.

This



This apparent deficiency is compensated in birds, particularly in those of the rapacious kind, by the regular arrangement of the feathers round the opening of the meatus. Several also, chiefly of the last mentioned class, and particularly among the owls, have a peculiar valve placed at the opening, partly of a membranous, partly of a muscular structure<sup>11</sup>.

§ 262. The *membrana tympani* of birds is convex on its outer surface; and the *tympana* of the two ears are connected together by the air-cells of the cranium<sup>12</sup>.

They have a single *officulum auditus*, connecting the *membrana tympani* with the fenestra ovalis, and consequently supplying the place of the malleus and stapes of the mammalia.

The part corresponding to the malleus, is generally cartilaginous, and not provided with any *tensor tympani*.

The *eustachian tubes* have a kind of common opening on the arch of the palate.

§ 263. The *labyrinth* is distinguished by large

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<sup>11</sup> KLEIN *Stemmata Avium*. tab. 10, fig. 2. COMPARETTI, tab. 2, fig. 2, he compares this part to the concha of the human ear.

<sup>12</sup> Mr. HOME has observed the same kind of communication, by the means of the cells of the cranium, in the ele-



canals, projecting from the cranium, and not hollowed out of a hard bony substance, as in the mammalia; and by the want of *cochlea*. Instead of the last mentioned part, birds have a short, obtuse, and hollow bony process, passing obliquely backwards from the vestibulum; and divided by a partition, like the cochlea of mammalia, into two *scalæ*, one of which terminates at the fenestra rotunda. This part receives a portion of the auditory nerve, as the cochlea does.

(C) AMPHIBIA.

§ 264. The different orders, and genera of this class<sup>13</sup> exhibit greater variety in the structure of the organ of hearing than the two former, or the following class. Hence the principal variations must be separately considered.

§ 265. Turtles, frogs, and most species of the lizard kind, possess, besides semicircular canals, a tympanum and eustachian tube, like warm-blooded ani-

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<sup>13</sup> In the 7th vol. of the *Comment. Infit. Bonon.* BRUNELLI has described and delineated the organ of hearing in the turtle, tortoise, frog, lizards, and serpents. COMPARETTI has also exhibited figures of these genera and orders, tab. 2, fig. 13-35. And SCARPA has given most beautiful engravings of the ear in the turtle, crocodile, green lizard, salamander, viper, and blind-worm, *de Auditu*, tab. 5. See also MONRO on the turtle in the *Physiology of Fishes*.



mals. Both the latter parts, however, as well as the *officula auditus*, are wanting in the salamander.

The *membrana tympani* of the turtle resembles a mass of cartilage; and is covered externally by the common integuments. Their single *officulum* resembles that of birds.

Frogs have a large *membrana tympani* level with the surface of the body; a wide opening the Eustachian tube at the fauces; two cartilaginous *officula*; and a rudiment in the vestibulum of those soft stony substances, which are found in a more conspicuous form in the lizards and serpents, and in the three following classes.

The crocodile is the only instance, in which there is a sort of external meatus in the class amphibia. This animal, as well as the lizards, possesses *officula*, and the above-mentioned stony concretions in the vestibulum.

The want of tympanum in the salamander has been already mentioned. The foramen ovale in this animal is merely closed by a portion of cartilage, and the vestibulum contains a soft stone.

§ 266. The serpents, with a very few exceptions, as the blind-worm<sup>14</sup> (*anguis fragilis*) have neither tympanum, nor Eustachian tube. They have a kind of rudiment of *officulum*.

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<sup>14</sup> SCARPA, *loco citato*, p. 26.



## (D) FISHES.

§ 267. It is only in some genera of cartilaginous fishes, viz. the skate and shark, that a tubular appendix of the vestibulum is continued backwards and outwards, so as to represent a rudiment of a tympanum.

§ 268. The other animals of this class<sup>15</sup> have no similar part; but their organ of hearing consists of three large canals, which are generally seen to project into the cavity of the cranium. Opposite to the termination of the auditory nerves on the vestibulum, one, two, or three neatly formed stones are found. These are as white as porcellaine, particularly in several of the bony fishes, and very dry and brittle in their texture<sup>16</sup>.

<sup>15</sup> See KLEIN, *Mantissa Ichthyologica*, Lips. 1746, 4to.

KÖLREUTER in the *Nov. Comment. Acad. Petrop.* tom. 17, p. 521. Of the sturgeon, and beluga (*acipenser sturio*, and *buso*).

CAMPER'S *smaller Writings*, vol. 1, pt. 2, tab. 2, of the cod; vol. 2, pt. 2, tab. 1-3, of the frog-fish, (*lophius piscatorius*), pike, and skate.

The organ is delineated in several fishes, in the work of COMPARETTI, tab. 3; in SCARPA, tab. 1, 2, 4; and in MONRO'S two works. See also J. HUNTER'S *Observations on the Animal Economy*, p. 69.

<sup>16</sup> KLEIN, *Hist. Piscium*, pt. 1, tab. 2.



§ 269. The internal ear of fishes is distinguished from that of the other three classes of red-blooded animals, by this remarkable peculiarity; that it grows, as the fish increases in size, and consequently that its magnitude is in the direct ratio of the bulk and age of the animal. (See note (D).

(E) INSECTS.

§ 270. There is no doubt that several insects possess the sense of hearing<sup>17</sup>; but the organ of this sense is very uncertain. In some of the larger animals of the genus cancer a part can be distinguished, which seems to be analogous to the vestibulum of the former classes<sup>18</sup>. A small bony tube is found on each side at the root of the palpi: its external opening is closed by a firm membrane; and it contains a membranous lining, on which a nerve arising from a common branch with that of antennæ, is expanded. The latter circumstance

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<sup>17</sup> See the works of LEHMAN and SCHELVER, which I have already often quoted.

<sup>18</sup> P. A. MINASI, *Dissertations on various of the less obvious Facts of Natural History*, in Italian. Nap. 1775, 8vo. fig. 4, of the *cancer pagurus*. SCARPA *de auditu*, tab. 4, fig. 4, 5, 6, of the crawfish. COMPARETTI, tab. 3, fig. 26-28, of several other species. But whether the parts represented in the other figures of this table, on the heads of several insects, as beetles, butterflies, common flies, &c. are really organs of hearing, is extremely doubtful.



might favour an opinion that the antennæ themselves are organs of hearing : but this is refuted by considering the exquisite sense of hearing, which some insects possess, who have no true antennæ, as the spiders ; and by experiments on others, which shew that the sense of hearing is not weakened by removing the antennæ <sup>19</sup>.

(F) VERMES.

§ 271. In the sepia only has any thing been hitherto discovered at all like an organ of hearing. In the cartilaginous ring, to which the large tentacula of the animal are affixed, two oval cavities appear. In each of these is a small bag containing a bony substance, and receiving the termination of nerves, like those of the vestibulum in fishes <sup>20</sup>.

*Additional Notes to the Twentieth Chapter.*

(A) The cetacea are the only mammalia, which have not a bony external meatus. The tube

<sup>19</sup> LEHMANN *de Antennis Insectorum*, dissert. poster, p. 45.

<sup>20</sup> SCARPA, *loc. cit.* tab. 4, fig. 7-II. COMPARETTI tab. 3, fig. 10 and 16.



is cartilaginous in these animals, and so small that its external orifice will about admit a pin in the dolphin. It arrives at the tympanum after a winding course through the fat, which lies under the skin. It is probable that the sound gains admission to the ear in these animals, rather through the Eustachian tube, than through this very narrow meatus externus. That tube opens at the blowing hole, and its furnished with a valve that prevents the admission of the water, which the animal expels through this opening.

(B) The following is the passage to which the author refers as expressing his opinion on this subject. I insert it in this place, because the work in which it is found is not common in this country, and is in the German language. “Anatomists generally describe a fourth bone (the *lenticulus*, or “*os orbiculare*) as intervening between the long “leg of the incus, and the head of the stapes. “Repeated and accurate examinations have convinced me that this part is only an epiphysis of “the incus. It is often wanting, even in such “*ficula auditus*, as appear in other respects to be “of the most perfect formation; for instance, in “those of negroes and North American savages, which I have now before me. When it “exists in the adult subject, it can only be separated by the employment of some force; and a  
“ mi-



“ microscopical examination of the surfaces shews  
 “ that the lenticulus has been broken from the incus.  
 “ Sometimes, indeed, I have found a really separate  
 “ ossiculum between the incus and stapes ; but this  
 “ cannot, in my opinion, be considered as belong-  
 “ ing to the ordinary natural structure, any more  
 “ than those other supernumerary ossicula, which  
 “ are found not infrequently, both in man and  
 “ animals.” *Beschreibung der Knochen*, p. 144.

(C) CUVIER describes a portion of bone as passing between the crura of the stapes, from one side of the fenestra ovalis to the other, in the mole, and marmot (in which last animal it is of considerable size). (*Léçons d'Anat. comp.* p. 489, tom. 2). Mr. CARLISLE has represented this part in the marmot, and he states its existence likewise in the guinea pig. (*Philos. Transf.* 1805, pt. 2).

CUVIER has also found that the stapes is nearly solid in the cetacea ; and that there is no perforation in the walrus. This peculiarity of structure seems to belong to such mammalia as live in water ; for the seal has it in a smaller degree. *Léçons d'Anat. comp.* tom. 2, p. 505. CARLISLE, *loc. citat.* gives drawings of the stapes in these animals.

The second ossiculum of the ornithorhynchus approaches very much in its form to the single bone of birds. (CARLISLE, *loc. cit.*).



(D) The membranous canals and vestibulum of the amphibia and fishes, are much smaller than the bony or cartilaginous cavities, in which they reside. Hence these parts can be discerned and demonstrated much more easily in these animals than in mammalia and birds, where they are closely surrounded by the bone.



## CHAPTER XXI.

## ON THE EYE.

§ 272. A SENSIBILITY to the impressions of light is common to all those animals, which in a natural state are exposed to this element : it appears at least very evidently to exist in some of the most simple zoophytes, as the armed polypes (*hydra*) : but the power of perceiving the images of external objects is confined to those who are provided with eyes for their reception. Nature has bestowed on some species even of red-blooded animals, a kind of rudiment of eyes, which have not the power of perceiving light : as if in compliance with some general model for the bodily structure of such animals. This circumstance at least has been asserted of the blind rat (*marmota typhlus*) among mammalia ; and of the *myxine glutinosa* among fishes.

§ 273. Since the eye<sup>1</sup> is a very complicated organ,

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<sup>1</sup> See BIDLOO *de Oculis et Visu variorum Animalium*, Lugd. Bat. 1715-4. ZINN *de Differentiâ Fabricæ Oculi Humani et Brutorum*, in the *Comment. Societ. Reg. Scient. Gotting.* tom. 4, 1754, p. 191 ; and in the *Comment. an.* 1778, p. 47.



organ, particularly in the red-blooded animals, we shall first speak of those peculiarities, which affect the globe itself, its membranes and humours: and afterwards consider the surrounding parts, as the eye-lids, lacrymal passages, &c. For some general observations on the situation and formation of the eye-balls, &c. see note (A) at the end of the chapter.

(A) MAMMALIA.

§ 274. It has been long known<sup>2</sup> that the sclerotica, in several quadrupeds of this class, as in the human subject, is not throughout of equal strength; but that its posterior is much thicker than its anterior part. It has also been conjectured, that this structure might influence what are called the *internal changes of the eye*: by which the form of the eyeball, consequently the length of its axis, and the respective situation of the lens, are adjusted according to the proximity or remoteness of the object, or in reference to any other relations. I flatter myself, that I have ascertained the truth of this con-  
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W. PORTERFIELD *on the Eye*, Edinb. 1759, 2 vol. 8vo.

HALLER in the *Opera minora*, tom. 3, p. 218. J. L. ANGELY *de Oculis, Organis que Lacrymalibus, Ratione Ætatis, Sexus, Gentis, et variorum Animalium*, Erlang. 1803, 8vo.

<sup>2</sup> ZINN in the *Comment. Soc. Reg. Scient. Gotting.* tom. 4, p. 192.

ture,



ture, by discovering the admirable structure of the sclerotica in warm-blooded quadrupeds, which have not only the power of seeing at various distances, but also in two media of such different density as air and water. In the eye of the Greenland seal, where I first noticed the lact<sup>3</sup>, the cornea was thin and yielding; the anterior segment of the sclerotica, or that which is immediately behind the latter membrane, was thick and firm; its middle circle thin and flexible; and lastly, the posterior part very thick, and almost cartilaginous. The whole eyeball is surrounded with very strong muscles; and we can easily understand how their action, varied according to circumstances, produces the requisite changes; how the axis of the eye is shortened, when the animal sees in air, by bringing the lens nearer to the back of the globe, in order to obviate the strong refraction, which the rays of light experience in passing from the thin medium of air into the thicker one of the eyes, and vice versa.

The sclerotica of the cetacea is distinguished by the great thickness of its posterior part; when the

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<sup>3</sup> *Comment. Soc. Reg.* vol. 7, an. 1784. Dr. Albers has discovered the same circumstances in the eye of the Walrus (*trichecus rosmarus*); and has refuted those objections, which have been made to the assigned object of this structure, from the observation of some slight resemblance to it in the eyes of certain land animals, as the horse, &c. See the *Göttingen Literary Notices*, 1803, p. 601.



eye-ball equals an orange in size, the back of this membrane is an inch thick; so that, although the globe be spherical, the space containing the vitreous humor is of a different form. As the sclerotica approaches to the cornea, it becomes thinner. Its posterior part presents a very singular structure, consisting of very firm tendinous threads and laminæ, most closely interwoven, and of more than cartilaginous hardness<sup>4</sup> towards the sides.

The extent of the cornea, when compared to that of the sclerotica, varies in the different species of mammalia. It seems to be greatest in the porcupine (*hystrix cristata*), where the cornea extends over half the globe.

§ 275. A peculiar structure, which appears hitherto to be unique, has been lately discovered in the eye of the East-Indian rhinoceros. Four tendinous fasciculi arise from the back of the sclerotica, and expand anteriorly, so as to join and form a kind of muscular membrane, which is lost in the choroid at the broadest diameter of the globe<sup>5</sup>. This is

<sup>4</sup> RUYSCH, *Thesaur. Anatom.* 2, tab. 1, fig. 1, 2, 6.

LODER, *Tabulæ Anatomice*, vol. 1, tab. 56, fig. 8.

On the eye of the whale in general, see ALBINI, *Index Supelletilis*, J. J. RAVII, p. 36: Also his *Annot. Acad. lib.* 7, p. 40, and *Supellex Anatomica*, p. 132.

*Musei Gaubiani Pars complectens preparata Anatomica*, p. 14.

<sup>5</sup> THOMAS in the *Philos. Transf.* 1801, pt. 1, p. 149, tab. 10; and VOIGT's *new Magazine*, vol. 4, p. 240, tab. 4.



probably connected with the internal changes of the organ.

The choroid coat consists more plainly in the cetacea, than in any other mammalia, of two distinct laminæ; of which the internal (*membrana ruyschiana*) is covered with a dull tapetum.

§ 276. The inner surface of the choroid coat possesses, towards the back of the eye, in several general of this class, particularly in those carnivorous animals, which prey by night, and even in the bifulca, the most brilliant yellow-green and sapphire-blue colours; forming what is called the *tapetum lucidum*<sup>6</sup>. The coloured portion of the choroid is only partial, and the rest of the membrane is covered with pigmentum nigrum, as usual<sup>7</sup>.

In

<sup>6</sup> LINN, *loco citato*, p. 196.

H. F. ELSÆSSER, *de Pigmento Oculi nigro, deque Tapeto*, Tubing. 1800, 8vo.

<sup>7</sup> It is well known that this pigment is entirely, or for the greatest part deficient in the eye of the *albinos* or *chacrelas*: which strange variety occurs, not infrequently, in the human race, and in several other mammalia and birds. I know, however, no instance of an albino among cold-blooded animals. This anomalous deficiency is always congenital, and is connected with a want of the colouring principle of the skin, and of the hair and feathers. It is hereditary in some mammalia, so as to form a constant breed of white animals: viz. in the rabbit, mouse, and horse (which latter are those called *glass-eyed*). I cannot believe that any whole species of  
warm-



In consequence of this structure, less light will be absorbed; and it must, on the contrary, be reflected from the tapetum against the retina, which lies in front of that membrane. (See note (B) at the end of the chapter.)

§ 277. The *retina* exhibits in some quadrupeds, viz. the hare and rabbit, very distinct and elegant fibres or *striæ* of medullary substance, taking for the most part a transverse direction<sup>8</sup>. The remarkable *foramen centrale*, which SÖMMERRING discovered in the human retina, has been since demonstrated in the eyes of several quadrumana, where these organs are directed forwards, and have their axes parallel<sup>9</sup>.

§ 278.

warm-blooded animals should originally want this pigment, and therefore I consider the ferret (*mustela furo*) to have descended from the polecat (*m. putorius*). I have treated at greater length on the want of this pigment, which is so essential a part in the natural structure of the eye, in the *Comment. Soc. Reg. Scient.* vol. 7, p. 29; and in the third edition of my work, *de Generis Humani Varietate Nativâ*, p. 272.

<sup>8</sup> ZINN, *loco citat.* tab. 8, fig. 3. FONTANA *sur le Vénin de la Vipère*, vol. 2, tab. 5, fig. 12.

<sup>9</sup> I have found it, for instance, very plain in the eye of the common Barbary ape (*simia sylvanus*). The entrance of the optic nerve formed a small *yellow circle* on the retina: near this a larger *grey fold* appeared, with the *foramen centrale* in its middle.

In demonstrating lately this opening in the eye of a *simia cyno-*



§ 278. The iris, an organ of very peculiar structure, exhibits in the different genera and species of mammalia more numerous and interesting varieties than any other part of the eye. The colours of its anterior surface, which are peculiar to the different genera, vary in the races and varieties of domestic animals, although less strikingly than in the human subject. These variations are connected, as in the latter instance, with the colour of the hair; so that in spotted dogs, rabbits, &c. a mixture of colours will be seen in the iris.

The substance of the part varies in thickness in the different genera. In no instance have I hitherto been able to discover true muscular fibres; the examination of the part in the elephant and whale having afforded in this respect the same result, as

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*cynomolgus*, I advanced the following conjecture as to its use. Man, and such animals as have the two eyes placed with their axes parallel, thereby gain the advantage of seeing objects with both eyes at once, and therefore more acutely. But at the same time they are exposed to this inconvenience that in a strong light both eyes become dazzled at once; and this happens so much the sooner because the light falls on the corresponding principal focuses of both eyes at once; the organ not possessing a *membrana nictitans*. This inconvenience seems to be obviated by the *foramen centrale*; since that part which forms the principal focus of the eye, opens in a dazzling light, so as to form a kind of small pupil, through which the concentrated rays pass, and fall on the choroid, where they are absorbed by the black pigment.



the tender and almost transparent iris of the white rabbit.

In the eye of the seal the ciliary vessels are not distributed in the substance of the iris; but lie on its anterior surface, and form a considerable plexus, which is visible without any injection<sup>10</sup>.

The pupil in the bifulca, solidungula, cetacea, &c. is transverse; in animals of the cat kind, particularly in a clear light, it is oblong: not to mention other trivial peculiarities, as the small villous appendix, covered with pigmentum nigrum<sup>11</sup>, which is sometimes seen on the middle of the superior margin of the pupil, particularly in the horse<sup>12</sup>. (See note (C) at the end of the chapter.)

§ 279. The corpus ciliare, and particularly the folds of its internal surface, with their numerous and elegantly arranged blood-vessels, constitutes one of the most wonderful parts of the eye, although its

<sup>10</sup> *Comment. Soc. Reg. Scient. Goetting. loco citato, fig. 2, 3.*

<sup>11</sup> This part has a brown colour, in the eye of a white horse, which is in my collection; while the other parts of the same eye, which in horses in general are black, have only a slight greyish brown tinge.

<sup>12</sup> SWAMMERDAM, in speaking of the remarkable curtain of the pupil, which is found in the skate, says he has discovered a similar part in the horse. If he does not allude to any unusual formation, but merely to such appendices as I have mentioned, the comparison is certainly too far fetched. *Biblia Naturæ, p. 881.*

functions,



functions, which must undoubtedly be of the highest importance, are hitherto involved in mystery. Its more minute differences in the genera, which have been hitherto examined, are too numerous to be recounted; and they could not be understood without delineations<sup>13</sup>. Among other instances, those of the elephant and horse may be mentioned, on account of the remarkable beauty and delicacy of their structure.

§ 280. The size of the *crystalline lens* varies in proportion to that of the *vitreous humor*; and some times very considerably. I have found the largest lens in this point of view in the comparatively small eye of the opossum (*didelphis marsupialis*); the whale has the smallest. No mammalia have it so slightly convex on the surface as the adult man. In the cat, hare, the bisulca, the horse, opossum, and seal, it becomes more and more convex according to the series, in which I have named these animals. Lastly, in the cetacea it is nearly spherical<sup>14</sup>. (See note (D)).

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<sup>13</sup> Much information may be gained on this subject from JAC. HOVIUS *de Circulari Humorum Motu in Oculis*. ed. 2, Lugd. Bat. 1716, 8vo. This work, however, is in some parts unintelligible, and not to be depended on; and must, therefore, be consulted with caution.

<sup>14</sup> F. P. DU PETIT in the *Mem. de l'Acad. des Sciences*, 1730. The memoir is translated in FRORUP'S *Bibliotheca for comparative Anatomy*, in German, vol. 1, p. 209.



It is curious to observe the regularity, with which, in some species, the lens divides into certain segments commencing from its centre, in consequence of being dried or immersed in acids <sup>15</sup>.

§ 281. A *lacrymal gland* <sup>16</sup> exists in all animals of this class. Several quadrupeds have, indeed, an additional one, besides that which is found in the human subject. Some have no *puncta lacrymalia*; and the elephant has neither *lacrymal bag* nor *os unguis* <sup>17</sup>. (See note (E).

§ 282. The *nictitating membrane* (*membrana nictitans, palpebra tertia, seu interna, periophthalmium*), of which only a rudiment exists in the quadrumana, and the human subject, is very large and moveable in some quadrupeds <sup>18</sup>. This is the case in animals of the cat kind, in the opossum, the seal, and particularly in the elephant.

<sup>15</sup> LEEWENHOECK, *Arcana Naturæ detecta*. p. 73.

PERRAULT, *Histoire des Animaux*, pt. 1, tab. 30.

YOUNG in the *Philos. Transf.* 1793, tab. 20. HOSACK *Philos. Transf.* 1794, tab. 17. J. C. REIL *de Lentis Crystallinae Structura Fibrosa*. Halle, 1794, 8vo.

<sup>16</sup> BERTIN in the *Mem. de l'Acad. des Sciences*, 1766, p. 281.

<sup>17</sup> CAMPER, *Œuvres*, tom. 2, p. 138, where he also states that this animal has no lacrymal gland, nor passage for the tears into the nose.

<sup>18</sup> TABARRANI in the *Transactions of the Academy at Siena*, tom. 3, p. 115.



§ 283. The relative magnitude of the true eye-lids varies considerably in animals of this class. The lower, which is very large in the elephant, is equally small in the horse. In the latter animal, as well as in most quadrupeds, it has no cilia; while in the quadrumana, the elephant, the giraffe, and others, both eye-lids possess eye-lashes.

(B) BIRDS.

§ 284. The eyes are very large in this class of animals<sup>19</sup>, and consequently the bony orbits are of great magnitude in proportion to the skull.

In the birds of prey they have a peculiar form, which is similar to that of the chalice, or cup used in the communion service: the cornea, which is very convex, forms the bottom of the cup; and the the posterior segment of the sclerotica resembles its cover<sup>20</sup>.

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<sup>19</sup> Besides the works, which have been referred to above, (§ 273) see the memoirs of PETIT on this subject in the *Mem. de l'Acad. des Sciences*, an. 1726, 1735, and 1736. HOME in the *Philos. Transf.* 1796, which is translated into German, in REIL's *Archives*, vol. 2, pt. 2. ALBERS's *Contributions*, vol. 1, p. 69.

<sup>20</sup> SEVERINI, *Zootomia Democritea*, p. 336.  
EM. KÖNIG in the *Ephem. Natur. Curios.* Dec. 2, an. 4, obs. 34.



§ 285. This peculiar form arises from the curvature and length of the bony plates, which, as in all other birds<sup>1</sup>, occupy the front of the sclerotica; lying close together, and overlapping each other. These bony plates form in general a flat, or slightly convex ring; being long and curved in the accipitres, they form a concave ring, which gives the whole eye-ball the above-mentioned form<sup>2</sup>.

§ 286. The distinction between certain parts of the eye, where the membranes have been supposed to be continuous, appears more plainly in some birds, than in any other animals. Thus I have found the boundaries of the choroid coat and iris very clearly defined in the horned owl (*Strix bubo*): and those of the margin of the retina, and the posterior border of the ciliary body very distinct in the toucan (*Ramphastos tucanus*). (See note (F).

§ 287. A great peculiarity in the eye of birds consists in the *marfupium*<sup>3</sup> (*pecten plicatum*, in French,

<sup>1</sup> COITER, *Miscell. Observ. Anat. Chirurg.* p. 130.

<sup>2</sup> PIERCE SMITH in the *Philos. Transf.* 1795, pt. 2, p. 263.

<sup>3</sup> DR. ALBERS observes that the orbit is very imperfect in birds; and that this bony ring may supply the deficiency, *loco citato*.

<sup>3</sup> See a neat delineation of the internal parts of the eye in the osprey (*Falco ossifragus*) by D. G. KIESER, *de Anamorphose*



French, *la bourse, le peigne*), the use of which has not been hitherto very clearly ascertained. It arises in the back of the eye, proceeding apparently through a slit in the retina; it passes obliquely into the vitreous humor, and terminates in that part, reaching in some species to the capsule of the lens. The figure of its circumference is a truncated quadrangle. Numerous blood-vessels run in the folds of membrane which compose it; and the black pigment by which it is covered, suggests an idea that it is chiefly destined for the absorption of the rays of light, when they are too strong or dazzling.

§ 288. Birds have large lacrymal passages, which terminate on the surface of the palate<sup>4</sup>.

Their nictitating membrane<sup>5</sup> is furnished with two very manifest muscles<sup>6</sup>. (See note (G).

In some species, as the common fowl, the turkey, goose, and duck, the lower eye-lid, which contains

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*phosi Oculi*, Goetting, 1804, 4to, tab. 2, fig. 1. The whole dissertation contains much instructive matter on this subject.

<sup>4</sup> MONRO, *Observations Anatomical and Physiological*. Edinb. 1758, 8vo. Albers, *loco citato*. fig. 1, 2.

<sup>5</sup> It is called by the emperor FREDERIC II. *pellicula palpebrarum*.

<sup>6</sup> PETIT in the *Mem. de l'Acad. des Sciences*, 1735, and 1736.



a peculiar small lamina of cartilage, is the most moveable; in others on the contrary, as in the parrots, and ostrich, the upper has the most extensive motion.

Very few birds have cilia in both eye-lids: they are found in the ostrich, the *falco serpentarius*, the razor-billed blackbird (*crotophaga ani*) and in some parrots. (See note (G).

(C) AMPHIBIA.

§ 289. Little is hitherto known concerning the peculiarities in the structure of the eye of this class<sup>7</sup>.

In some reptiles and serpents of this country, the common integuments form, instead of eye-lids, a kind of firm window, behind which the eye-ball has a free motion.

In the green turtle<sup>8</sup> (*testudo mydas*) the sclerotic has a bony ring at its anterior part, composed like that of birds, of thin osseous plates. These animals possess very large lacrymal glands, and a very moveable membrana nictitans; in which circumstance the frog resembles them<sup>9</sup>. (See note (H).

<sup>7</sup> PETIT in the *Mem. de l'Acad. des Sciences*, 1737 p. 142.

<sup>8</sup> DR. ALBERS intends to publish an accurate account of the anatomy of the eye in this animal.

<sup>9</sup> CALDESI, *Observations concerning the Turtle*, tab. 8, fig. II.



## (D) FISHES.

§ 290. The peculiarities in the eye of fishes<sup>10</sup>, which belong either to the whole class, or to most of the genera and species, consist in the division of their choroid coat and retina into several manifestly distinct laminæ; and in the existence of two small organs within the eye, which belong exclusively to this class.

§ 291. The choroid coat, which in man is a simple membrane, and in some other warm-blooded animals, particularly in the cetacea, a double one, consists in fishes of three distinct laminæ. The inner layer forms a true *tunica ruyschiana*; the middle one (*membrana vasculosa* of HALLER), is perfectly distinct both from the former, and from the exterior coat; which latter must be compared with the proper choroid of all red-blooded animals. Even this last is continued anteriorly into the iris, and possesses in many species the well known brilliant gold and silver colours.

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<sup>10</sup> Good delineations of the internal structure of the eye of fishes are still wanting. The best, which I know of, are by GUENELLON, of the cod's eye; but they are contained in a book, where one should not much expect to find them, viz. in BAYLE'S *Nouvelles de la Republique des Lettres*, March, 1686, p. 326.



The retina is easily separable into two laminæ; of which the external is medullary, and the internal consists of a fibrous texture.

§ 292. The two other peculiarities belong exclusively to the eye of fishes; and are common at least to the whole bony division of these animals. A body, generally resembling in shape a horse-shoe, lies between the internal and middle layers of the choroid; some have thought it muscular, and others glandular. The tunica ruyfchiana gives origin to a vascular membrane, resembling in its form a bell (*campanula* of HALLER). This goes towards the lens, and has, therefore, some resemblance to the marsupium of birds.

No true ciliary body is found, at least in the bony fishes.

§ 293. The crystalline lens of most fishes is very large in comparison with the size of the eye-ball, and nearly or entirely spherical. The *vitreous humour* on the contrary is small, and the *aqueus* in many cases is hardly discernible.

§ 294. The following may be enumerated as instances of remarkable peculiarities in the eyes of particular genera and species of fishes. The firm transparent laminæ of common integuments, behind which the eye-balls move, as in some amphibia



phibia<sup>12</sup> (§ 289); the articulation of the globe on a stalk of cartilage in the skate, and shark<sup>13</sup>: the curtain (*operculum pupillare*) in the eye of the skate<sup>14</sup>, which can be let down so as to cover the pupil: and the unique structure of the *lobitis anableps*, where the cornea is divided into two portions, and there is a double pupil with a single lens<sup>15</sup>. (See note (I).

### (E) INSECTS.

§ 295. Two kinds of eyes, very dissimilar in their structure, are found in this class<sup>16</sup>. One sort is small and simple (*stemmata*): the others, which are large, seem to consist of an aggregation of smaller eyes<sup>17</sup>; for their general convexity is divided into an immense number of small hexagonal convex surfaces, which may be considered as so

<sup>12</sup> *Delineations of Objects in Natural History*, pt. 6, where the part is represented in the *ostracion bicuspis*.

<sup>13</sup> STENONIS, *Specimen Elementor. Myologiae*, tab. 5, fig. 1.

GOYEAU in the *Mercure de France*, Dec. 1757, p. 130.

<sup>14</sup> STENONIS *de Musculis et Glandulis*, p. 68. CAMPER in the *Mémoires présentés à l'Acad. des Sciences des Paris*, tom. 6, tab. 3, fig. 1.

<sup>15</sup> SEEA *Thesaur. Rer. Natural*, tom. 3, tab. 34.

CAMPER in the German translation of MONRO's *Physiol. of Fishes*, p. 165.

LACEPEDE in the *Mem. de l'Institut National*, tom. 2, p. 372.

<sup>16</sup> LEHMANN and SCHELVER, *locis citatis*.

<sup>17</sup> HOOKE's *Micrographia Restaurata*, tab. 20, 21.



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quired in order to shew how these eyes enable the insect to see; and to determine the distinctions between two such very different organs <sup>20</sup>.

(F) VERMES.

§ 298. The cuttlefish only, of this whole class <sup>1</sup>, has been hitherto shewn to possess true eyes; the nature of which cannot be disputed. They resemble on the whole those of red-blooded animals, particularly fishes; they are at least incomparably more like them than the eyes of any known insects; yet they are distinguished by several extraordinary peculiarities <sup>2</sup>. The front of the eye-ball is covered with loose membranes instead of a cornea; the iris is composed of a firm substance, which seems like a continuation of the sclerotica; and a process pro-

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<sup>20</sup> I have given, on a former occasion, the reasons, which led me to think it probable, in opposition to the general opinion formerly maintained; that the polyedrous eyes are adapted for distant objects, and the simple ones for such as are more near. This is confirmed by observing, that butterflies, which, in their perfect or winged state, have the large compound eyes, have only the myopic organs while larvæ.

Yet there are still some doubts respecting the uses of these two kinds of eyes; for some complete *animalia subterranea*, as the *gryllus gryllotalpa* have both kinds.

<sup>1</sup> LEHMANN and SCHELVER, *loc. citat.*

<sup>2</sup> SWAMMERDAM, tab. 52, fig. 2.



jects from the upper margin of the pupil, which gives that membrane a femilunar form.

The corpus ciliare is very completely formed.

In all other vermes the eyes are entirely wanting, or their existence is very doubtful. Whether the black points, at the extremities of what are called the horns of the common snail<sup>3</sup>, are organs which really possess the power of vision, is still problematical<sup>4</sup>.

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*Additional Notes to the Twenty-first Chapter.*

(A) Large animals have small eye-balls in proportion to their size: this is very remarkably the case with the whales. Those which are much under ground have the globe also very small; as the mole and shrew: in the former of these instances its existence has been altogether denied; and it is not in fact larger than a pin's head.

The eyes of man and the simiæ are directed forwards: in the latter animals indeed they are placed nearer to each other than in the human subject. The *lemur tarsius* has them more closely approxi-

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<sup>3</sup> Ibid. tab. 4, fig. 7, 8.

<sup>4</sup> LEHMANN, p. 44.

SLEVOGT in VOIGT'S *Magazine*, vol. 6, p. 466.



mated than any other animal. All other mammalia have these organs separated by a considerable interval, and directed laterally. The same circumstance obtains in birds with the exception of the owl, who looks straight forwards. They are placed laterally in all reptiles: Their situation varies much in fishes: they look upwards in the uranoscopus: they are both on the same side of the body in the pleuronectes: but in general their direction is lateral.

The form of the globe varies according to the medium, in which the organ is to be exerted. In man and the mammalia, it deviates very little from the spherical figure. In fishes it is flattened on its anterior part; in birds it is remarkably convex in front, the cornea being sometimes absolutely hemispherical. The convexity of the crystalline is in an inverse ratio to that of the cornea. Thus in fishes it is nearly spherical, and projects through the iris, so as to leave little or no room for aqueous humor: the cetacea, and those quadrupeds and birds, which are much under water, have this part of the same form. The aqueous humor being of the same density with the medium in which these animals are placed, would have no power of refracting rays of light, which come through that medium: its place is supplied by an increased sphericity of the lens. In birds these circumstances are reversed: they inhabit generally a somewhat elevated region of the  
atmo-



atmosphere; and the rays, which pass through this thin medium are refracted by the aqueous humor, which exists in great abundance. Man and the mammalia, which live on the surface of the earth, hold a middle place between these two extremes.

(B) The tapetum occupies the temporal side of the bottom of the eye-ball; i. e. it is placed exteriorly to the entrance of the optic nerve. It exists in the carnivorous and ruminating animals; in the foliata, pachydermata, and cetacea. In the dog, wolf, and badger, it is of a pure white, bordered by blue.

(C) The figure of the pupil is transversely oblong in the ruminating animals, and the horse: it is heart-shaped in the dolphin.

(D) The crystalline is smaller in the eye of man than in any animal, and it is largest in the fishes.

The following numbers give the proportions of the three humours, measured on the axis of the eye, after it had been frozen.

	Aqueus Humor.	Crystalline.	Vitreous Humor.
Man,	$\frac{5}{21}$	$\frac{4}{21}$	$\frac{15}{21}$
Dog,	$\frac{5}{17}$	$\frac{8}{17}$	$\frac{8}{17}$
Cow,	$\frac{5}{37}$	$\frac{14}{37}$	$\frac{18}{37}$
Sheep,	$\frac{4}{17}$	$\frac{11}{17}$	$\frac{12}{17}$
Horse,	$\frac{9}{43}$	$\frac{16}{43}$	$\frac{18}{43}$
Owl,	$\frac{8}{17}$	$\frac{11}{17}$	$\frac{8}{17}$
Herring,	$\frac{1}{7}$	$\frac{3}{7}$	$\frac{1}{7}$

The



The greater convexity, which the author ascribes to the seal and whales, arises from their inhabiting the water; so that they require an organ of vision like that of fishes.

(E) In addition to the lacrymal gland, several mammalia have another body, called the *glandula Harderi*. This is situated nearer to the nose, and pours out a thick whitish fluid near the third eyelid. It joins the proper lacrymal gland in the hare and rabbit; but is distinguished by its whiter colour. The ruminantia, carnivora, and pachydermata, have it likewise.

The ducts of the lacrymal gland admit of very easy demonstration in the larger quadrupeds, where they open to the number of sixteen or more, by orifices that will admit a large bristle.

The hare and rabbit have, instead of puncta lacrymalia, a slit opening into the lacrymal canal.

The cetacea want the lacrymal apparatus entirely, as their eyes are preserved in a moist state by the element in which they live.

The muscles of the eye-ball are the same in number in the simiæ as in man: but other mammalia possess an additional one, termed the *suspensorius oculi*.

This muscle is of a conical form. Its origin, which takes place from the margin of the optic foramen, represents the apex of the cone; and its insertion



insertion into the posterior half of the sclerotica, constitutes the basis. It fills up therefore the interval left between the four recti, and surrounds completely the optic nerve. In several of the carnivora, and the cetacea, it is divided into four portions; so that these animals may be said to have eight straight muscles. It must enable the animals which possess it to draw the globe back into the orbit; and hence it has sometimes been called the *retractor* of the eye.

A remarkable peculiarity occurs in the conjunctiva of the zemni (*mus typhlus*). It is covered with hair as in other parts of the body, so that the eye, which is, indeed, exceedingly small, seems to be completely useless. A similar structure is also found in two fishes, the murena cecilia, and myxine glutinosa (*Gastrobranchus cæcus*, CUVIER). *Léçons d'Anat. comp.* tom. 2, p. 394.

(F) The ciliary processes of birds are not very prominent: they consist rather of striæ, than of loose folds. They are always closely connected to the crystalline capsule. There is no tapetum in this class.

The colour of the iris varies in the different species of birds; and in many instances possesses great brilliancy. It has a power of voluntary motion in the parrot.

The



The retina passes obliquely through the sclerotica, in a sheath of the latter membrane.

(G) Birds possess both a lacrymal gland, and glandula Harderi. The latter is considerably the largest; and is usually placed between the elevator and adductor muscles of the globe. It furnishes a thick yellow fluid, which is poured from a single duct, opening on the inner surface of third eye-lid.

The eye-lids are closed in most birds by the elevation of the inferior palpebra, which is the largest. This eye-lid has a peculiar depressor muscle arising from the bottom of the orbit. The owl, and the goatfucker are among the few in which the upper eye-lid descends.

The third eye-lid, or *membrana nictitans* is a thin semitransparent fold of the conjunctiva; which, in the state of rest, lies in the inner corner of the eye, with its loose edge nearly vertical, but can be drawn out so as to cover the whole front of the globe. By this, according to COUVIER, the eagle is enabled to look at the sun.

It is capable of being expanded over the globe of the eye by the combined action of two very singular muscles, which are attached towards the back of the sclerotica. One of these, which is called from its shape the *quadratus*, arises from the upper and back part of the sclerotica; its fibres



descend in a parallel course towards the optic nerve, and terminate in a semicircular margin, formed by a tendon of a very singular construction : for it has no insertion, but constitutes a cylindrical canal. The second muscle, which is called the *pyramidalis*, arises from the lower and back part of the sclerotica towards the nose. It gives rise to a long tendinous chord, which runs through the canal of the quadratus, as in a pulley. Having thus arrived at the exterior part of the eye-ball, it runs in a cellular sheath of the sclerotica along the under part of the eye, to the lower portion of the loose edge of the *membrana nictitans*, in which it is inserted.

By the united action of these two muscles, the third eye-lid will be drawn towards the outer angle of the eye, so as to cover the front of the globe ; and its own elasticity will restore it to its former situation.

(H) The ciliary processes are hardly perceptible in the turtle ; but they leave an elegant impression on the surface of the vitreous humor. They are distinct and long in the crocodile. The blood-vessels are visible on the surface of the iris ; where they form a distinct plexus in the crocodile.

The optic nerve forms a tubercle within the sclerotica ; from which the retina commences.

The number, &c. of the eye-lids varies considerably



ably in this class. Serpents have none. The turtle and crocodile have three like those of birds. The frog and toad have three; of which the third is much the largest and most moveable.

The turtle has a very large lobulated lacrymal gland. Serpents have nothing of this kind.

(I) The continuation of the conjunctiva over the cornea admits of being demonstrated in the eel. For it comes off some times with the rest of the skin of the head in stripping off the integuments of this animal.



## CHAPTER XXII.

## ON THE MUSCLES.

§ 299. **T**HE heart and other muscular viscera have been already treated of. We have only to speak here of the proper muscles, which are destined to the performance of the voluntary motions. As the details of myology do not come within the plan of this work, the present chapter will include only a few remarks on the peculiarities in the muscular structure of the different classes, and of some particularly remarkable species<sup>1</sup>.

## (A) MAMMALIA.

§ 300. The degree of resemblance between the muscles of the mammalia<sup>2</sup>, and those of the human subject,

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<sup>1</sup> It can be hardly necessary for me to state that the 1st vol. of CUVIER's excellent work contains by far the most complete account, that we hitherto possess, of comparative myology in general: and that numerous remarks on the subject may be found in BORELLI *de Motu Animalium*, and in BARTHEZ *Nouvelle Méchanique des Mouvements de l'Homme et des Animaux*. Carcassone, 1798, 4to.

<sup>2</sup> We have excellent accounts of the myology of particular species of this class: as for instance, of the chimpanzé (*Simia troglo-*



subject, may be inferred, in any particular instance, by comparing the skeleton of the animal with that of man. The similitude is greatest, on the whole, in the quadrumana. Yet these are distinguished by the smallness of their buttock and calf of the leg; the strength and convexity of which parts constitute peculiar beauties in the human form<sup>3</sup>. (See note (A) at the end of the chapter.)

§ 301. Of the muscles which do not exist in man, nor as far as we hitherto know, in the quadrumana; but which on the contrary are found at least in the greatest number of quadrupeds<sup>4</sup>; the cutaneous expansion of the trunk (*panniculus carnosus, expansio carnea, musculus subcutaneus*), and the *suf-*

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*troglydytes*) by TYSON: of the dog, by DOUGLAS, in his *Specimen Myographiæ comparatæ*; and by GARENGEOT, in the *Myotomie Humaine et Canine*. Paris, 1724, 8vo: of the horse, by STUBBS, in his unrivalled "*Anatomy of the Horse*": of the cow, by VITET *Medecine Veterinaire*, vol. 1.

<sup>3</sup> ARISTOTLE *de Partibus Animalium*, 4, 10.

<sup>4</sup> It does not exist in the pig; but is of extraordinary strength in such animals, as have the power of rolling themselves up; as the tatu, (armadillo) manis, porcupine, hedgehog, &c. See the excellent monograph of HIMLY, *on the rolling up of the hedgehog*. Brunswick, 1801, 4to.

The tendinous fibres of this cutaneous expansion may be split into threads of a hundred feet or more in length in the cetacea; and the inhabitants of the Aleutian islands prepare in this way a very delicate kind of thread.



*penforius oculi*<sup>5</sup> deserve particular mention. (For the particular description of the latter muscle, see the chapter on the eye.)

§ 302. Among such, on the contrary, as are found only in particular genera and species, the most remarkable are the extremely numerous muscles of the prehensile tails of some cercopithecii (sapajous, belonging to the *simiæ* of LINNÆUS), and other South American and Australasian mammalia<sup>6</sup>; those which we have already described in the trunk of the elephant<sup>7</sup>; and that which belongs to the epiglottis of several mammalia (*cerato-epiglottidæus*)<sup>8</sup>.

§ 303. Other muscles, which are common to most orders of the class, are distinguished in some

<sup>5</sup> ZINN in *Comment. Soc. Reg. Scient.* Gotting. tom. 1, p. 48.

<sup>6</sup> MERY reckoned no less than 280 muscles in the prehensile tail of a cercopithecus. DU HAMEL, *Hist. Acad. Reg. Scient.* p. 276.

<sup>7</sup> See the interesting observations of CUVIER on the organization of the elephant's trunk, in the seventh part of the *Menagerie du Museum National*. He designs to explain the wonderful structure of this completely unique organ, in a separate work, with twelve plates. Some remarks on the subject may be found in the valuable *Description Anatomique d'un Elephant male*, par P. CAMPER, publié par son Fils, A. G. CAMPER, Paris, 1802, folio.

<sup>8</sup> J. G. RUNGE *de Voce ejusque Organis*, Lugd. Bat. 1753, 4to,



species by remarkable strength, which adapts them for peculiar kinds of motion. This is the case with the *gluteus medius*<sup>9</sup> of the horse; which, in connection with some others, particularly the *gemellus*<sup>10</sup>, enables the animal to kick out backwards with such astonishing force; with the immensely strong flexors of the beaver's tail, &c. (See note (B)).

### (B) BIRDS.

§ 304. The muscles in this class are distinguished by possessing a comparatively weak irritable power, which is soon lost after death; and by their tendons becoming ossified, as the animal grows old, particularly in the extremities, but sometimes also in the trunk. I have observed this to a very remarkable degree, in the crane<sup>11</sup>.

§ 305. The most remarkable circumstances in the myology of this class<sup>12</sup> have been incidentally  
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<sup>9</sup> STUBBS *Muscles*, tab. 2, q, r, s, t; and tab. 3, a, b, c, d.

<sup>10</sup> Ibid. tab. 3, 60—64.

<sup>11</sup> This appearance led several physiologists of the 17th century to the erroneous conclusion, that the bones in general, at least for the most part, are formed from tendons. See STENONIS *de Musculis et Glandulis*, p. 26. CASP. BARTHOLIN *Specimen Historiæ Anatomicae Partium Corporis Humani*, p. 185.

<sup>12</sup> On the myology of birds the reader may consult STE-



mentioned in previous parts of the work. For instance, muscles which are peculiar to birds; as those of the *membrana nictitans*\*; or such as are deficient, as the diaphragm; or distinguished by their remarkable size and peculiar form, as the pectoral muscles †.

### (C) AMPHIBIA.

§ 306. The two chief divisions of this class are distinguished from each other by a remarkable difference in their muscular structure, which arises from a corresponding diversity in the skeleton. In the reptiles, for instance, and particularly in the turtles<sup>13</sup> and frogs, where the trunk of the skeleton possesses but little mobility, the muscles are very few in number. Not only the diaphragm, but also the

MONIS in the *At. Havniens*, 1673, p. 6; and VALENTINI *Amphitheat. Zootom.* pt. 2, p. 8.

Also VICQ-D'AZYR in the *Mem. de l'Acad. des Sciences de Paris*, 1772. MERREM'S *Miscellaneous Tracts in Natural History*, p. 144.

And WIEDEMANN'S *Archives*, vol. 2, p. 68.

\* These muscles are described in the chapter, which treats on the eye.

† For a more particular description of these muscles, see note (C) at the end of the chapter: and for the mechanism by which birds are supported in roosting, note (D).

<sup>13</sup> For the myology of this animal see WIEDEMANN'S *Archives*, vol. 3, pt. 2, p. 78.

muscles



muscles of the abdomen and chest are wanting in the genus testudo. The other muscles are, however, of vast strength in this genus. In the serpents on the contrary, they are more uniform and thin; and more numerous beyond all comparison, in consequence of the vast number of vertebræ and ribs, and the want of all external organs of motion.

### (D) FISHES.

§ 307. The muscles of this class<sup>14</sup> are distinguished from those of animals which breathe by means of lungs, not only by receiving a smaller supply of blood, and consequently being of a paler colour; but also by their disposition in layers, and by the uniformity<sup>15</sup> of their substance, which in general is destitute of tendinous fibres. This structure, together with the number and bulk of their muscles, is well calculated to support that great expenditure of strength and exertion, which is a necessary consequence of the peculiar abode, and whole economy of these animals<sup>16</sup>.

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<sup>14</sup> LACEPEDE, *Hist. Naturelle des Poissons*, tom. 1, *Discours*, p. 47.

<sup>15</sup> KIELMEYER *on the Relation of the Organic Powers to each other*, p. 22, 8vo, 1793, Stutgard.

<sup>16</sup> DR. BLANK'S *Lecture on Muscular Motion*, p. 54.



## (E) INSECTS.

§ 308. The observations which have just been made concerning the uniformity, number, and strength of the muscles of fishes, will hold equally good, on the whole, of insects; but under other modifications, and generally in a more striking degree<sup>17</sup>. In the few, which have been hitherto investigated with a view to this subject, some differences have been observed. The immensely strong muscles of the claw in the crab and lobster<sup>18</sup>, bear considerable analogy to those in some organs of red-blooded animals: while the muscles of other insects, as may be seen in the larvæ, are distinguished by a peculiar bluish white colour, and flattened form. Their great number concurs also with these characters in distinguishing them from those of the former classes. LYONET<sup>19</sup> reckoned 4061 in the larva of the *coffus*<sup>20</sup>: and 2186 of these belong to the alimentary canal.

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<sup>17</sup> KIELMEYER, *loco citato*.

<sup>18</sup> STENONIS *Specimen Elementorum Myologiæ*, p. 55.

PERRAULT *Essais de Physique*, tom. 3, tab. 4, fig. 3.

<sup>19</sup> Tab. 6, 7, 8, 15, 16, 17; and tab. 5, fig. 7, 8.

<sup>20</sup> This number includes about ten times as many as belong to the human body.

## (F) VER-



## (F) VERMES.

§ 309. The arrangement of the muscular system of the mollusca<sup>1</sup> has considerable analogy, on the whole, to that of the larvæ of insects. Those which inhabit shells, have, moreover, peculiar muscles connecting them to their testaceous covering, and enabling them to move it. Thus the snail has large muscular fasciculi running along the abdomen, attaching it to the upper turn of the shell, and enabling the animal to withdraw itself into the cavity. The bivalves have powerful adductor muscles to close their shells<sup>2</sup>. In several of the *mollusca nuda* there is a considerable apparatus of cutaneous fibres, by which a very remarkable shortening of the body can be produced. A similar and very astonishing contractile power resides in the gelatinous parenchyma of the zoophytes, and animals which inhabit corals; in whose structure nothing like muscular fibres can be distinguished.

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<sup>1</sup> See an account of the muscles of the *Aphrodite aculeata*, in PALLAS's *Miscellanea Zoologica*, tab. 7, fig. 13.

Of the *Tritonia*, *Aplysia*, &c. by CUVIER, in the *Annales du Muséum National d'Hist. Nat.* tom. 1 and 2.

Of the snail (*helix pomatia*) by SWAMMERDAM, tab. 6, fig. 2, of numerous bivalves and multivalves in several figures of POLI's work.

<sup>2</sup> HUNTER *on the Blood*, p. 111. POLI, vol. 1, *Introduction*, p. 59.



*Additional Notes to the Twenty-second Chapter.*

(A) The differences which we discern in the muscles of the lower extremity between man and the other mammalia, arise out of that characteristic feature, which so strikingly distinguishes man from all other animals : viz. his erect stature. The most minute investigation of this subject will shew us that the erect position belongs to man only ; and thereby confirms the elegant observation of the Roman poet :

Pronaque cum spectent animalia cetera terram,  
Os homini sublime dedit ; cœlumque tueri  
Jussit ; et erectos ad sidera tollere vultus.

In order to enable any animal to preserve the erect position, the following conditions are required. First, That the parts of the body should be so disposed, as to admit of being maintained with ease in a state of equilibrium ; 2dly, That the muscles should have sufficient power to correct the deviations from this state ; 3dly, That the centre of gravity of the whole body should fall within the space occupied by the feet ; and lastly, That the feet themselves should have a broad surface resting firmly on the ground, and should admit of being  
in



in a manner fixed to the earth. All these circumstances are united in the necessary degree in man only.

The broader the surface included by the feet, the more securely will the line of gravity rest within that surface. The feet of man are much broader than those of any animal, and admit of being separated more widely from each other. The sources of the latter prerogative reside in the superior breadth of the human pelvis, and in the length and obliquity of the neck of the femur, which by throwing the body of the bone outwards, disengage it from the hip-joint.

The whole tarsus, metatarsus, and toes, rest on the ground in the human subject, but not in other animals. The simiæ, and the bear, have the end of the os calcis raised from the surface; while on the contrary it projects in man, and its prominent portion has a most important share in supporting the back of the foot. The exterior margin of the foot rests chiefly on the ground in the simiæ; which circumstance leaves them a freer use of their thumb and long toes in seizing the branches of trees, &c.; and renders the organ so much the less adapted to support the body on level ground.

The *plantaris* muscle, instead of terminating in the os calcis, expands into the plantar fascia in the simiæ; and in other quadrupeds it holds the place of the *flexor brevis* or *perforatus digitorum pedis*,  
passing



passing over the os calcis in such a direction that its tendon would be compressed, and its action impeded if the heel rested on the ground.

The extensors of the ankle joint, and chiefly those, which from the calf of the leg, are very small in the mammalia, even in the genus simia. The peculiar mode of progression of the human subject sufficiently accounts for their vastly superior magnitude in man. By elevating the os calcis they raise the whole body in the act of progression; and, by extending the leg on the foot, they counteract that tendency, which the weight of the body has to bend the leg in standing.

The thigh is placed in the same line with the trunk in man; it always forms an angle with the spine in animals; and this is often even an acute one. The extensors of the knee are much stronger in the human subject than in other mammalia, as their double effect of extending the leg on the thigh, and of bringing the thigh forwards on the leg forms a very essential part in the human mode of progression.

The flexors of the knee are, on the contrary, stronger in animals; and are inserted so much lower down in the tibia (even in the simiæ), than in the human subject, that the support of the body on the hind legs must be very insecure; as the thigh and leg form an angle, instead of continuing in a straight line.



The *gluteus maximus*, which is the largest muscle of the human body, is so small and insignificant in animals, that it may almost be said not to exist. This muscle, which forms the great bulk of the human buttock, extends the pelvis on the thighs in standing; and, assisted by the other two *glutei*, maintains that part in a state of equilibrium on the lower extremity, which rests on the ground, while the other is carried forwards, in progression. The true office of these important muscles does not therefore consist, as it is usually represented, in the common anatomical works, in moving the thigh on the pelvis, but in that of fixing the pelvis on the thighs, and of maintaining it in the erect position.

Such then are the supports, by which the trunk of the human body is firmly maintained in the erect position. The properties of the trunk, which contribute to the same end, do not so immediately belong to the present part of the work; but may be slightly mentioned to complete the view of the subject. The breadth of the human pelvis affords a firm basis on which all the superior parts rest securely; the same part is so narrow in other animals, that the trunk represents an inverted pyramid; and there must consequently be great difficulty in maintaining it in a state of equilibrium, if it were possible for the animal to assume the erect position. In those instances, where the pelvis is broader,



broader, the other conditions of the upright stature are absent: the bear, however, forms an exception to this observation, and consequently admits of being taught to stand and walk erect, although the posture is manifestly inconvenient and irksome to the animal.

The perpendicular position of the vertebral column under the centre of the basis cranii, and the direction of the eyes and mouth forwards would be as inconvenient to man, if he went on all-fours; as they are well adapted to his erect stature. In the former case he would not be able to look before him; and the great weight of the head, with the comparative weakness of the extensor muscles, and the want of ligamentum nuchæ would render the elevation of that organ almost impossible.

When quadrupeds endeavour to support themselves on the hind extremities, as, for instance, for the purpose of seizing any objects with the fore-feet, they rather sit down than assume the erect position. For they rest on the thighs as well as on the feet, and this can only be done where the fore-part of the body is small, as in the simiæ, the squirrel, &c.: in other cases, the animal is obliged also to support itself by the fore-feet, as in the dog, cat, &c. The large and strong tail in some instances forms as it were a third foot, and thereby increases the surface for supporting the body; as in the kangaroo and the jerboa.

Various



Various gradations may be observed in the mammalia, connecting man to those animals which are strictly quadrupeds. The *fimixæ*, which are by no means calculated for the erect position, are not, on the other hand, destined like the proper quadrupeds to go on all-fours. They live in trees, where their front and hind extremities are both employed in climbing, &c.

The true quadrupeds have the front of the trunk supported by the anterior extremities, which are consequently much larger and stronger than in man; as the hind-feet of the same animals yield in these respects to those of the human subject. The chest is in a manner suspended between the *scapulæ*, and the *ferrati magni* muscles which support it in this position are consequently of great bulk and strength. When viewed together they represent a kind of girth surrounding the chest.

(B) The *pectoralis major*, *latissimus dorsi*, and *teres major*, are of vast size in the mole; and enable the animal to dig its way under ground, and to throw up the earth.

(C) Birds possess three pectoral muscles, arising chiefly from their enormous sternum, and acting on the head of the humerus. The first, or *great pectoral*, weighs, of itself, more than all the other muscles of  
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the bird together. The keel of the sternum, the fork, and the last ribs, give origin to it; and it is inserted in a rough projecting line of the humerus. By depressing that bone, it produces the strong and violent motions of the wing, which carry the body forwards in flying. The *middle pectoral* lies under this; and sends its tendon over the junction of the fork, with the clavicle and scapula, as in a pulley, to be inserted in the upper part of the humerus; which bone it elevates. By this contrivance of the pulley, the elevator of the wing is placed at the under surface of the body. The third, or *lesser pectoral* muscle, has the same effect with the great pectoral, in depressing the wing.

(D) One of the flexor tendons of the toes of birds, (produced from a muscle which comes from the pubis) runs in front of the knee; and all these tendons go behind the heel: hence the flexion of the knee and heel produces mechanically a bent state of the toes, which may be seen in the dead bird; and it is by means of this structure that the bird is supported, when roosting, without any muscular action.

“ This circumstance of the flexion of the toes accompanying that of the other joints of the lower extremity of birds, was long ago observed by BORELLI, and attributed by him to the connexion, which the flexors of the toes have with the upper parts



parts of the limb, by which they are mechanically stretched, when the knee is bent. This explanation has been controverted by VICQ D'AZYR, and others, who have referred the effect to the irritability of the muscles. The opinion of BORELLI appears, notwithstanding, to be well founded; for not only the tendon of the accessory flexor passing round the knee, but the course of the flexor tendons over the heel, and along the metatarsus, must necessarily cause the contraction of the toes, when either of these joints is bent; and if the phenomenon was not produced on mechanic principles, it would be impossible for birds to exhibit it during sleep, which they do, or to prove the effect on the limb of a dead bird, than which nothing is more easy. The utility of this contrivance is great in all birds, but particularly so in the rapacious tribe, which by this means grasp their prey in the very act of pouncing on it; and it is still more necessary to those birds which perch or roost during their sleep, as they could not otherwise preserve their position, when all their voluntary powers are suspended."

REES'S *Cyclopaedia*, art. BIRDS.







CHAPTER XXIII  
ON THE THEORY OF  
GENERATIVE FUNCTIONS.

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GENERATIVE FUNCTIONS.



GENERATIVE FUNCTIONS.

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## CHAPTER XXIII.\*

## ON THE MALE ORGANS OF GENERATION.

§ 310. **I**N considering the comparative anatomy of the sexual functions, we must confine ourselves to those animals, which possess male organs destined for the purpose of impregnation, and female parts for that of conception.

To the former belong chiefly the testes, vesiculæ seminales, prostate and penis. Yet the three last mentioned parts, and particularly the vesiculæ and prostate are by no means constantly found even in red-blooded animals.

§ 311. The testes, and sometimes the vesiculæ seminales and prostate vary most remarkably in their magnitude in such animals, as have a regular rutting season. They are very diminutive at other periods of the year; but swell at that particular time to a comparatively vast magnitude. This change is particularly observable in the testes of the mole, sparrow, and frog<sup>1</sup>.

§ 312.

\* For a general account of this subject, see note (A) at the end of the chapter.

<sup>1</sup> In animals, which have lost the testes by the operation



§ 312. It is necessary to mention here, in a cursory and general manner, the peculiar organs possessed by the males of some species, for the purpose of holding the female during the act of copulation. Of this kind are, the spur on the hind-feet of the male ornithorhynchus; the rough black tubercle formed in the spring season on the thumb of the common frog; the two members, formed of bones articulated to each other, near the genitals of the male torpedo and other cartilaginous fishes<sup>2</sup>; the forceps on the abdomen of the male dragon-fly, &c.

(A) MAMMALIA.

§ 313. A *scrotum*, or bag, in which the testes hang on the outside of the abdominal cavity exists only in the mammalia; but is not by any means common to all the genera. It is not found, and that for very obvious reasons, in the aquatic animals of this class; nor in the perfect *subterranea* (those

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of castration, a similar circumstance may be observed in some of the remaining organs; as in the *vesiculæ feminales* of the gelding. BOURGELAT, *Elémens de l'Art Veterinaire*. Paris, 1769, 8vo. p. 359.

<sup>2</sup> RAY, KLEIN, BATTARRA and others, considered these parts as real organs of generation: and the same mistake was committed by MENZ and KRÜGER concerning the tubercles on the thumb of the frog.

which



which live under ground), as the mole; nor in such as roll themselves up on the approach of danger, as the hedgehog. These which may be called true *testiconda* (i. e. animals having their testes concealed) must be distinguished from such, as have the power of withdrawing these glands from the abdomen, and retracting them into the cavity according to circumstances; as the hamster<sup>3</sup> (*marmota cricetus*) and Canadian musk-rat<sup>4</sup> (*mus zibethicus*).

In those *testiconda*, which have the penis much concealed by the integuments in its unerected state, as the hare, rabbit, elephant, &c. it is difficult some times to distinguish the sexes on the first view, particularly at an early age. (For further particulars respecting the position of the testes, &c. see note (B) at the end of the chapter.)

§ 314. In several quadrupeds, as the dog, horse, ram and others, there is a body, composed of condensed cellular substance, lying according to the axis of the testicle near the epididymis, and known by the name of *corpus Highmori*. This is not a canal, nor does it possess that artificial structure which has been described and delineated

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<sup>3</sup> SULZER, p. 38, 67.

<sup>4</sup> SARRAZIN in the *Mem. de l'Acad. des Sciences de Paris*; 1725.



by several anatomists of the seventeenth century<sup>5</sup>.  
(See note (C)).

§ 315. Most species of mammalia, and, with the exception of the cetacea<sup>6</sup>, some out of every other order in the class, possess *vesiculæ seminales*. They swell to a vast size in the rutting season in many animals, as some of the fimiæ, and most particularly in the hedgehog<sup>7</sup>.

Among the species, in which these parts do not exist, are the dog and cat-kind, the bears, the opossums, sea-otter, seals, and ornithorhynchus. (For further particulars on this subject, see note (D)).

<sup>5</sup> DE GRAAF *de Viror. Organis Generat. inservient.* tab. 3, fig. 4, in the dog.

See also the excellent delineations by A. MONRO, junior, *de Testibus*, Edinb. 1755, 8vo. tab. 4, fig. 5, in the dog; fig. 8, in the horse; tab. 3, fig. 5, in the pig, &c.

<sup>6</sup> Mr. HUNTER at least expressly asserts, that these parts are not found in the cetacea (*Philos. Transf.* vol. 77, p. 442). I am, indeed, aware of the common opinion, which supposes the first discovery of these important parts to have been made in the dolphin, by that excellent zootomist RONDELET, to whose labours the science is so much indebted. But the passage quoted for this purpose from his classical work *de Piscibus Marinis*, p. 461, seems to me to be quite as inadequate to prove that point, as the observation of RAY on the male organs of the porpoise. (*Philos. Transf.* vol. 6.) which has also been applied by HALLER to the *vesiculæ seminales*.

<sup>7</sup> DAUBENTON, vol. 8, tab. 7 and 8.



§ 316. The possession of a prostate (in some instances simple, but generally divided into two parts) is peculiar to the mammalia; and seems to take place in every species of the whole class. In many animals, at least, where its existence has been denied, as in the goat and ram, considerable glandular bodies are found, which bear a greater resemblance to the prostate, than to COWPER'S glands<sup>8</sup>.

§ 317. In many species the penis consists of a single *corpus cavernosum*, without any septum. The pig and the cetacea furnish examples of this structure; and in the latter animals there are numerous tendinous layers crossing it<sup>9</sup>.

In some species, where the act of copulation requires a longer portion of time, as in the dog, badger, &c. the corpus spongiosum of the glans, and of the posterior part of the penis, swells during the act much more considerably than the rest of the organ, and thus the male and female are held together during a sufficient space of time for the discharge of the seminal fluid<sup>10</sup>. (See note (E).

<sup>8</sup> HALLER in *Comment. Soc. Reg. Scient. Gotting.* tom. 1, tab. 1.

<sup>9</sup> RUYSCH, *Epist. Problemat.* 15, tab. 19, fig. 5.

<sup>10</sup> DAUBENTON, tom. 5, tab. 47; and WALTER, *Mémoire sur le Blaireau* in the *Mem. de l'Acad. de Berlin*, 1792, p. 20.



§ 318. Several species of mammalia, both among those, which possess no vesiculæ feminales, and thereby require a longer time for completing the act of copulation, and in such as are not distinguished by this peculiarity<sup>11</sup>, possess a peculiar bone in the penis, generally of a cylindrical form, but sometimes grooved<sup>12</sup>. This the case with some of the simiæ, most of the bat-kind, the hamster and several others of the mouse-kind, the dog, bear, badger, weasel, seal, walrus, &c<sup>13</sup>.

§ 319. In most of the male animals of this class the urethra runs on to the end of the glans, and forms a common passage for the urine, prostatic liquor and semen. In some few species, the passage which conducts the two former fluids, is distinct from that of the seminal liquor. The bifid fork-like glans of the opossum<sup>14</sup> has three openings,

<sup>11</sup> A *Simia Cynomolgus*, which I lately dissected, had a small *os penis*, with large vesiculæ feminales.

<sup>12</sup> Delineations of this bone in several species of animals may be seen in REDI *de Viventibus intra Viventia*, tab. 26, and in the works of MEYER and DAUBENTON.

<sup>13</sup> It is somewhat remarkable that this bone should not be found in all the species of the same genus. Thus it is wanting in several simiæ, in some bats, and in the hyena of the dog-kind. See J. F. HERMANN, *Observat. ex Osteol. comparat.* Argent, 1792, p. 13.

<sup>14</sup> COWPER in the *Philos. Transf.* vol. 24, p. 1583, fig. 2-5. Among other peculiarities of this singular animal, it may be mentioned, that the penis lies behind the scrotum.



one at the point of bifurcation for transmitting the urine; and two for the seminal fluid at the two extremities of the glans. The short urethra of the *ornithorhynchus paradoxus* opens directly into the cloaca, and the large penis of the animal serves merely to conduct the seminal fluid. It divides into two parts at its extremity, and each of these is furnished with sharp papillæ, which are perforated for the passage of the semen<sup>15</sup>. A similar structure obtains in the *ornith. bystrix*; where the penis divides into four glandes<sup>16</sup>.

§ 320. In some species of the cat-kind the glans is covered with retroverted papillæ, which, as these animals have no vesiculæ feminales, may enable the male to hold the female longer in his embraces<sup>17</sup>.

§ 321. Lastly, it deserves to be mentioned, that in some species of this class, the male penis, while unerecled, is turned backwards; so that the urine is voided in the male, in the same direction

<sup>15</sup> HOME in the *Philos. Transf.* 1802, tab. 4, fig. 1.

<sup>16</sup> Ibid. tab. 12, fig. 1.

<sup>17</sup> In a collection at Hanover there is a penis, which must have belonged to a tiger, or some similar species; where the lower part of the glans is furnished with two strong horny processes divided each into three points, which are turned backwards.



as in the female. The hare, lion, and camel, afford instances of this structure. But the statement which has been so often repeated since the time of ARISTOTLE<sup>18</sup>, that these *retromingentia* copulate backwards, is erroneous.

(B) BIRDS.

§ 322. The testes, which lie near the kidneys, and the *ductus deferentes*, are the only male organs which are constantly found in the whole class<sup>19</sup>. (See note (F)).

In a very few instances, as in the cock, the last mentioned canals terminate in a dilated part, which has been considered analogous to the *vesiculæ seminales*. Instead of a penis, most birds have in the cloaca two small papillæ, on which the seminal ducts terminate. This is the case in the cock<sup>20</sup>, turkey, and pigeon.

Some few species have a simple penis of considerable length, which is ordinarily concealed and retracted within the cloaca; but remains visible externally for some time after copulation. It forms

<sup>18</sup> *Historia Animalium*, II. 1, V. 2, and *de Partibus Animal*, IV. 10.

<sup>19</sup> G. G. TANNENBERG, *Spicilegium Observationum circa Partes Genitales Masculas Avium*. Gœtting. 1789-4.

<sup>20</sup> DE GRAAF, *de Mulierum Organis*, tab. 17. TANNENBERG, tab. 1 and 2.



a long worm-shaped tube in the drake<sup>1</sup>; and constitutes a groove in the ostrich, which is visible when the animal discharges its urine<sup>2</sup>.

(C) AMPHIBIA.

§ 323. The kidney, testes, and epididymis, lie close together in the testudines; but each of the three organs may be distinguished by its peculiar colour and structure on the first view. They appear to have no vesiculæ feminales<sup>3</sup>; I could at least discover none in a *testudo græca*, which I lately dissected. The penis on the contrary is very large; and retracted within the cloaca in its ordinary state. Instead of an urethra, this part contains a groove; whose margins approach to each other, when the

<sup>1</sup> Ibid. tab. 2 and 3; also HOME, *loc. citat.* tab. 12, fig. 2.

<sup>2</sup> CUVIER in the first part of the *Ménagerie du Muséum National*.

<sup>3</sup> I should not express myself with uncertainty on this subject, if Lieberkuhn had not ascribed vesiculæ feminales to the turtle; (he does not mention the species); G. E. HAMBURGER, *Physiol. Med.* p. 712.

There is much obscurity in the different descriptions of the male organs of generation of the turtle and tortoise. The various observations on this subject are collected by SCHNEIDER in his *Natural History of the Genus Testudo*, p. 129. See also GILIBERT, *Medecin Naturaliste*, 1st series. Lyons, 1800-8, p. 290.



part is erected, so as to form a closed canal <sup>4</sup>. The glans terminates in an obtuse hook-like point, somewhat resembling the end of the elephant's trunk.

§ 324. Frogs <sup>5</sup> have large vesiculæ feminales; and a small papilla in the cloaca, instead of a penis. Both these parts are wanting in the toad <sup>6</sup>.

§ 325. Crocodiles have a simple penis; while the lizards of this country have two; and the water-newt, which does not copulate, has no organ of the kind.

§ 326. Serpents have long slender testicles; no vesiculæ feminales; but a double penis, each of which has a bifid point covered with sharp papillæ <sup>7</sup>.

#### (D) FISHES.

§ 327. The male organs of generation possess

<sup>4</sup> This may be compared with the groove-like continuation of the œsophagus, which goes into the third stomach of ruminating animals. (See § 90 and 91).

<sup>5</sup> RÖSEL, tab. 5, fig. 1, 2, and 3, tab. 6, fig. 1.

<sup>6</sup> Ibid. tab. 21, fig. 25 and 26.

<sup>7</sup> TYSON in the *Philos. Transf.* vol. 13, tab. 1, fig. 2, in the rattlesnake, and fig. 3, in the viper.



very different structures<sup>8</sup> in the different orders of this class. We shall take two species as examples; the torpedo for the cartilaginous, and the carp for the bony fishes.

In the former instance there are manifest testicles, consisting partly of innumerable glandular and granular bodies, and partly of a substance like the soft roe of bony fishes. We find also *vasa deferentia*, and a *vesicula seminalis* which opens into the rectum by means of a small papilla<sup>9</sup>.

The soft roe supplies the place of testes in the carp<sup>10</sup>, and most other bony fishes. It forms two elongated flat viscera of a white colour, and irregular tuberculated surface; placed at the sides of the intestines and swimming bladder, so that the left encloses the rectum in a kind of groove. Through the middle of each soft roe passes a *ductus deferens*, which opens behind into a kind of *vesicula seminalis*, and this terminates in the cloaca<sup>11</sup>.

§ 328.

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<sup>8</sup> PH. CAVOLINI *on the Generative Process in Fishes and Crabs*; with Remarks by E. A. W. ZIMMERMANN. Berlin, 1792, 8vo. in German.

DE GRAAF, *Partium Genitalium Desensio*, pag. 253.

<sup>9</sup> LORENZINI, tab. 4, fig. 4. See also MONRO's *Physiology of Fishes*, tab. 11, 12.

<sup>10</sup> PETIT in the *Mem. de l'Acad. des Sc.* 1733, tab. 17.

<sup>11</sup> It is a curious circumstance, that hermaphrodites, possessing the complete organs of both sexes, are found very frequently



## (E) INSECTS.

§ 328. The animals of this class exhibit such numerous varieties of structure in the different orders, genera, and species<sup>12</sup>, that we shall be contented with choosing two of the latter as examples. These are, the moth of the silk-worm (*bomleyx mori*), which is chosen because its genital organs resemble those of some of the more perfect red blooded animals; and a species of locust (*gryllus*) on account of the external resemblance between the male and female organs.

In the latter (*gryllus verrucivorus*) the large testicles with their convoluted fasciculi of vessels bear

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quently in this species: much oftener than among other fishes. See ALISCHER in the *Breslau Collections*, 14 vers. p. 645. SCHWALBE in the *Commerc. Lit. Noric.* 1734, p. 305. and MORAND in the *Hist. de l'Acad. des Sc.* 1737, p. 51.

I possess the whole viscera of two such individuals, that were sent to me within a short time of each other in the last year.

According to BONNET fishes have sometimes no sexual distinctions: *Ouvrés*, vol. 3, p. 506.

<sup>12</sup> See a representation of these parts in the *scarabaus nassicornis*, by SWAMMERDAM, tab. 30, in a large water-beetle, tab. 22; in the *nepa cinerea*, tab. 3; in the *papilio urticae*, tab. 36; in the *ephemera horaria*, tab. 14; in the drone, tab. 21 and 22; in the *musca cameleon*, tab. 42; in the *musca putris*, 43.

In a cicada MALPIGHI de *Bombyce*, tab. 11, fig. 2.

In a crab, CAVOLINI, tab. 2, fig. 10, 11. In the *cancer*

Bern-



bear a very close resemblance to the ovaries, in which the ova are collected into similar bundles <sup>13</sup>.

In the moth of the silk-worm we distinguish, besides the testes, long *vasa deferentia*, even a kind of *vesiculæ feminales*, and a very considerable penis, with a hook-shaped glans <sup>14</sup>.

(F) VERMES.

§ 329. From this class we shall select two instances <sup>15</sup>. The one is an intestinal worm (*ascaris lumbricoides*), and derives, therefore, some interest from its connection with nosology. The cuttle-fish, of the class mollusca, forms the other, and is selected on account of the remarkable peculiarities in its male organs.

The *ascaris* has one testis, occupying nearly the middle of the animal's body, and consisting of

*Bernhardus*, SWAMMERDAM, tab. 11. In the crawfish, RÖSEL, vol. 3, tab. 60.

<sup>13</sup> RÖSEL, vol. 2, tab. 9, of the locusts.

<sup>14</sup> MALPIGHI, tab. 10, fig. 1. SWAMMERDAM, tab. 28, fig. 3.

<sup>15</sup> For the male organs of such vermes, as have the generative parts of both sexes combined in each individual. See SWAMMERDAM, tab. 8, fig. 9, where they are represented in the slug.

For those of the *aplysia*, *elio borealis*, and *tritonis*. See CUVIER, *loco citato*.

Of the *lepas balanus*, POLI, vol. 1, tab. 4, fig. 13.

Of the *helix pomatia*, SWAMMERDAM, tab. 5, fig. 10.



a single vessel convoluted into a long bundle, but admitting of being unravelled with facility; when it appears to be about three feet in length. Towards the posterior part of the worm it forms a larger tube, which nearly equals a crow's quill in size, and becomes connected to the penis, which lies concealed near the tail, and is probably projected at the time of copulation<sup>16</sup>. (See note (G).

The male organs of the cuttle-fish (*Sepialoligo*) have excited particular attention, from the remarkable, and, indeed, somewhat heightened description which TURBERVILLE NEEDHAM<sup>17</sup> gave of them, and which formed the basis of BUFFON's theory of generation<sup>18</sup>.

The part, which corresponds to the soft roe of bony fishes, contains at the spawning season several hundred small tubular seminal receptacles (about four lines in length): these are placed in bundles towards the vas deferens, and are contained in a thick fluid. These tubes are expelled from the body in an entire state; when a spiral vessel, which they contain, together with the semen, as in a sheath, bursts their thin anterior extremity, from which the semen escapes and impregnates the spawn of the female.

<sup>16</sup> TYSON in the *Philos. Transf.* vol. 13, p. 161, fig. 1.

<sup>17</sup> *Nouvelles Observations Microscopiques*, tab. 3 and 4.

<sup>18</sup> *Histoire Naturelle*, tom. 2, p. 230.



*Additional Notes to the Twenty-third Chapter.*

(A) I have inserted the following general view of the subject of generation from the 5th vol. of the *Léçons d'Anatomie comparée*, as it affords a comparative statement of the manner, in which that function is executed in the different classes; although the remarks may be considered by some as too much of a physiological nature to admit of insertion in a merely anatomical work.

“ The nature of *generation*, which is the greatest mystery in the economy of living bodies, is still involved in impenetrable obscurity. The *creation* of a living body, that is, its formation by the union of particles suddenly brought together, has not hitherto been proved by any direct observation. The comparison of this process to that of crystallization is founded in a false analogy: crystals are formed of similar particles attracting each other indifferently, and agglutinated by their surfaces, which determine the order of their arrangement: living bodies, on the contrary, consist of numerous fibres or laminæ of heterogeneous composition, and various figures, each of which has its peculiar situation in relation to the other fibres and laminæ. Moreover, from the instant in which a living body can be said to exist, however small it may be, it possesses all its parts; it does not grow by the addition



tion of any new laminæ, but by the uniform or irregular development of parts which existed before any sensible growth.

“ The only circumstance common to all generation, and consequently the only essential part of the process, is, that every living body is attached at first to a larger body of the same species with itself. It constitutes a part of this larger body, and derives nourishment, for a certain time, from its juices. The subsequent separation constitutes *birth*; and may be the simple result of the life of the larger body, and of the consequent development of the smaller, without the addition of any occasional action.

“ Thus the essence of *generation* consists in the appearance of a small organised body in or upon some part of a larger one; from which it is separated at a certain period in order to assume an independent existence.

“ All the processes and organs, which co-operate in the business of generation in certain classes, are only accessory to this primary function.

“ When the function is thus reduced to its most simple state, it constitutes the *gemmaiparous*, or *generation by shoots*. In this way the buds of trees are developed into branches, from which other trees may be formed. The polypes (*hydra*) and the sea anemones (*actinia*) multiply in this manner; some worms are propagated by a division of their body, and must therefore be arranged in the same division.



division. This mode of generation requires no distinction of sex, no copulation, nor any particular organ.

“ Other modes of generation are accomplished in appropriate organs: the germs appear in a definite situation in the body, and the assistance of certain operations is required for their further development. These operations constitute *fecundation*, and suppose the existence of *sexual parts*; which may either be separate, or united in the same individual.

“ The office of the male sex is that of furnishing the *fecundating* or *seminal fluid*: but the manner, in which that contributes to the development of the germ, is not yet settled by physiologists. Some, forming their opinions from the human subject and the mammalia, where the germs are imperceptible before fecundation, suppose that these are created by the mixture of the male fluid with that which they suppose to exist in the female; or that they pre-exist in the male semen, and that the female only furnishes them with an abode. Others consult the analogy of the other classes of animals, and of plants. In several instances, particularly in the frog, the *germ* may be clearly recognised in the *ovum*, before fecundation; its pre-existence may be concluded in other cases, from the manner in which it is connected to the ovum when it first becomes visible; for it is agreed on all sides that the ovum exists in the female before fecundation,



since virgin hens lay eggs, &c. From such considerations these physiologists conclude, that the germ pre-exists in all females; and that the fecundating liquor is a stimulus which bestows on it an independent life, by awakening it, in a manner, from the species of lethargy, in which it would otherwise have constantly remained.

“ The origin of the germs, and the mode of their existence in the female; whether they are formed anew by the action of life, or are pre-existent, and inclosed within each other; or whether they are disseminated, and require a concurrence of circumstances to bring them into a situation favourable for their development; are questions, which, in the present state of our knowledge, it is utterly impossible for us to decide. These points have for a long time been agitated by physiologists; but the discussion seems now to be abandoned by universal consent.

“ The combination of the sexes, and the mode of fecundation are subject to great variety. In some instances they are united in the same individual, and the animal impregnates itself. The acephalous mollusca, and the echinus exemplify this structure. In others, although the sexes are united in each individual, an act of copulation is required, in which they both fecundate, and are fecundated. This is the case with the gasteropodous mollusca, and several worms. In the remainder of the animal



animal kingdom the sexes belong to different individuals.

“ The fecundating liquor is always applied upon, or about the germs. In many cases the ova are laid before they are touched by the semen ; as in some fishes of the bony division, and the cephalopodous mollusca. Here, therefore, impregnation is effected out of the body ; as it is also in the frog and toad. But in the latter instances the male embraces the female, and discharges his semen in proportion as she voids the eggs. In most animals the seminal liquor is introduced into the body of the female, and the ova are fecundated before they are discharged. This is the case in the mammalia, birds, most reptiles, and some fishes ; in the hermaphrodite gasteropodous mollusca, in the crustacea, and insects. The act by which this is accomplished, is termed *copulation*.

“ In all the last mentioned orders ova may be discharged without previous copulation, as in the preceding ones. But they receive no further development ; nor can they be fecundated when thus voided.

“ The effect of a single copulation varies in its degree ; it usually fecundates one generation only ; but sometimes, as in poultry, several eggs are fecundated ; still, however, they only form one generation.

“ In a very few instances one act of copulation



fecundates several generations, which can propagate their species without the aid of the male. In the plant-louse (*aphis*) this has been repeated eight times; and in some *monoculi* twelve or fifteen times.

“ When the germ is detached from the ovary, its mode of existence may be more or less complete. In most animals it is connected, by means of vessels, to an organised mass, the absorption of which nourishes and develops it until the period of its birth. It derives nothing, therefore, from the body of the mother, from which it is separated by coverings varying in number and solidity. The germ, together with its mass of nourishment, and the surrounding membranes, constitutes an egg, or *ovum*; and the animals which produce their young in this state, are denominated *oviparous*.

“ In most of these the germ contained in the egg is not developed until that part has quitted the body of the mother, or has been *laid*; whether it be necessary that it should be afterwards fecundated, as in many fishes; or require only the application of artificial heat for its incubation, as in birds; or that the natural heat of the climate is sufficient, as in reptiles, insects, &c. These are strictly *oviparous* animals.

“ The ovum, after being fecundated, and detached from the ovarium, remains in some animals within the body of the mother, until the contained



germ be developed and hatched. These are *false viviparous* animals ; or *ovo-viviparous*. The viper, and some fishes afford instances of this process.

“ Mammalia alone are truly viviparous animals. Their germ possesses no provision of nourishment, but grows by what it derives from the juices of the mother. For this purpose it is attached to the internal surface of the uterus, and sometimes, by accident, to other parts, by a kind of root, or infinite ramification of vessels, called a *placenta*. It is not, therefore, completely separated from the mother by its coverings. It does not come into the world until it can enjoy an independent organic existence. The mammalia cannot, therefore, be said to possess an *ovum* in the sense which we have assigned to that term.

“ From the above view of the subject, generation may be said to consist of four functions, differing in their importance, and in the number of animals, to which they belong.

“ 1st, The *production of the germ*, which is a constant circumstance ; 2dly, *fecundation*, which belongs only to the sexual generation ; 3dly, *copulation*, which is confined to those sexual generations, in which fecundation is accomplished within the body :

“ Lastly, *uterogestation*, which belongs exclusively to viviparous generation.” *Léçon 29, pag. 2, and seq.*



(B) A scrotum exists in all the quadrumana, and in most of the carnivora; in animals of the opossum kind, which have it in front of the pelvis; in the hare, and gerboa; in most of the ruminating genera, and in the solidungula.

The testes are placed under the skin of the perineum in the pachydermata and the civet; or under that of the groin, as in the camel and otter. They pass from the abdomen into one or the other of these situations, particularly at the rutting season, in the bats, the mole, shrew, and hedge-hog; and in several rodentia, as the rat, guinea-pig, porcupine, beaver, squirrel, &c. They remain constantly in the abdomen in the ornithorhynchus paradoxus, and hystrix, in the elephant, hyrax, the amphibious mammalia, and the cetacea.

The *tunica vaginalis* exists constantly in the mammalia. As the horizontal position of the body obviates the danger of herniæ, the cavity of this covering always communicates by means of a narrow canal with the abdomen, in such animals as have the testes remaining constantly in the scrotum. Where these glands occasionally pass out of the abdomen, and return again, the communication is very broad and free.

(C) The seminal tubes are collected in some animals into large fasciculi; as in the baboons,  
most



most of the large carnivora, the wild boar, and the rhinoceros. It is the union of the septa, which divide these fasciculi, that constitutes the corpus HIGHMORI. In most of the rodentia, and particularly in the rat, these tubes are large and parallel, and very easily separable.

The vasa deferentia are usually enlarged in size, and assume a cellular structure for some short distance previous to their termination. The structure of this part is the most remarkable in the horse; where "the vas deferens, in passing over the bladder, enlarges to the size of the human thumb; this amplification extends from its entrance into the urethra to the distance of five or six inches from that point, where it again becomes of its ordinary diameter.

"The inside of this enlargement is composed of cells, and somewhat resembles in construction the cells of the corpus cavernosum penis, passing in a transverse direction across the tube. In the centre of this enlargement passes the small canal of the vas deferens; each cell communicates by one, two, or more small pores with the canal of the vas deferens, and the cells diminish as they approach the neck of the bladder, till they are lost in a smooth passage entering the urethra.

"What the purpose of this structure is, does not appear; it must retard the passage of the semen, and probably adds some fluid to it, secreted from  
the



the cells themselves." Mr. CLARK in REES'S *Cyclopædia*, art. ANATOMY OF THE HORSE.

The cells of this part contain a thick white fluid, which flows out in abundance on compression.

An analogous structure is met with in the ram.

(D) The following animals have no vesiculæ feminales according to CUVIER: the plantigrada, except the racoon and hedge-hog; all the carnivora, and marsupial animals; the ruminantia, the seals, the cetacea, and the two species of ornithorhynchus. Their existence or absence does not seem to follow any general law.

Their form and structure vary almost infinitely in the different mammalia, where they often terminate in the urethra by a separate opening from that of the vas deferens. This circumstance, together with the fact of their containing generally a fluid of different appearance and properties from those of the semen, and the glandular structure which their coats possess in many instances, militates strongly against the opinion, which considers these vesicles as reservoirs of the semen, and inclines us to suppose with Mr. HUNTER, that they add a peculiar secretion of their own to the fluid which comes from the testes.

See Mr. HUNTER'S remarks on the vesiculæ feminales, in his *Observations on certain Parts of the Animal Economy*, p. 27. and seq.



In the hedge-hog these parts are of a vast size, much exceeding the volume of the testes. They form four or five bodies on each side, consisting of a small and infinitely convoluted tube, and open separately into the urethra. The rodentia are generally distinguished by the great size of their vesicles. These parts in the guinea-pig are long, uniform, cylindrical cavities, containing generally a firm cheesy matter. In the boar they are very large, and of a lobulated structure; a common excretory duct receives the branches from the lobes. In the horse, they form two large and simple membranous bags, opening near the vasa deferentia, but separately.

(F.) In the quadrumana and bats the penis hangs loose from the pubis as in man. In most of the other mammalia it is contained in a sheath of the integuments, which extends nearly to the navel. This sheath has an adductor and a retractor muscle. The penis is generally folded when drawn within the sheath, on account of its length. In some animals it turns back, when it has reached the front of the pubis, and passes out near the anus; this is the case with the guinea-pig, marmot, and squirrel. It goes directly backwards from the beginning in the hare, rat, dormouse and opossum, where the prepuce is found close to the anus.

The corpora cavernosa form a cylindrical ring  
in



in the kangaroo; and the urethra passes in the centre.

Mr. B. CLARK has given us the following interesting observations on the penis of the horse, in his description of the anatomy of that animal in the 2nd vol. of REES'S *Cyclopaedia*, art. ANATOMY OF THE HORSE.

“ We have remarked that the penis of the horse possesses a voluntary power of erection, not known to the human, nor perhaps to most other animals. This power is exerted on making water, and though the erection is not very considerable, it is yet sufficient to bring the penis from its sheath, which is effected apparently by its increased gravity from blood accumulating in the cavernous cells of this part. After stating this semi-erection of the penis subsides, and it is again retracted within the sheath. This operation, though occurring daily to the sight of every one, has not, it is apprehended, been noticed by any veterinary writer.

“ The urethra of the horse is muscular from one extremity to the other, being formed on the outside of strong transverse fleshy fibres, and supported by a strong ligament.

“ In the glans of the penis, immediately over the opening of the urethra, externally, there is a large cell or cavity, smooth on the inside, and lined with a membrane which secretes a brown unctuous substance for the lubrication of the penis, and defend-  
ing



ing it from the corrosive effects of the urine; another cell of a similar description with the former is observable, on the side of the urethra, and nearly surrounding it; it is separated from the former by a membranous partition.

“ The apparently unctuous secretion above described is miscible with water; it burns, however, in the fire like an oily substance, and is not soluble in spirits of wine or nitrous acid, nor does it dry on exposure to the air during several weeks.

“ There is nothing resembling a frenum to the penis of the horse.

“ The cavernous body has no longitudinal septum.

“ Another singularity in the genital parts of this animal is, that there is an immense congeries of veins, lying on the back of the penis, which are filled during copulation, forming an elevation nearly as large as the penis itself; these veins communicate with both the cavernous and spongy bodies.”

(F) The testes of birds consist of a congeries of seminal tubes analogous to those of the mammalia.

(G) Dr. HOOPER states that he has never found any distinction of sex in these worms; but that they all possess the parts described as belonging to the female.

See



See the account compiled by him in the *Mem. of the Lond. Med. Soc.* vol. 5, p. 237. Yet Dr. BAILLIE has given a figure of the male worm, similar to that of TYSON; but it is copied from WERNER. *Fascic.* 4, pl. 9, fig. 2 and 4. The representation of CUVIER agrees with that of Dr. HOOPER. *Léçons d'Anat. comp.* tom. 5, p. 187.



## CHAPTER XXIV.

## ON THE FEMALE ORGANS OF GENERATION.

§ 330. AN ovarium\* is the most essential and universal of all the female parts of generation. In addition to this, those animals which breathe by means of lungs, as well as some fishes, and several white-blooded animals, have also *oviducts*, (Fallopian tubes, &c.) or canals leading from the ovarium to the uterus: and lastly, those, at least, which are impregnated by a real copulation, possess a *vagina*, or canal connecting the uterus to the external organs of generation.

In birds, all the parts, which we have just mentioned, are single. Some cartilaginous fishes have two oviducts; beginning, however, by a common opening, and terminating in a simple uterus. The human female, as well as that of many other mammalia, has two ovaria, with an oviduct belonging to each; a simple uterus, and vagina. The females of this class, in several other instances, possess an *uterus bicornis*: and in some cases the generative or-

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See note (A) at the end of the chapter.



gans are double throughout ; that is, there are two uteri, and, at least for some extent, a double vagina.

(A) MAMMALIA.

§ 331. Of the external female sexual organs in this class, the clitoris is found most universally and invariably<sup>1</sup>; for it exists even in the whales<sup>2</sup>, and probably is wanting in no other instance than the ornithorynchus<sup>3</sup>.

As this organ, in its general structure, bears considerable resemblance to the male penis, it contains a small bone in several species of mammalia, as the *marmota citillus*, the racoon (*ursus lotor*), the lionsess, the sea-otter, &c. In the opossum it possesses a bifid glans, like that of the penis. The analogy between the two organs is carried so far in the lori (*lemur tardigradus*), that the urethra runs through

<sup>1</sup> LINNEUS considered this organ to be a peculiar mark of distinction between the human female, and that of the simiæ : whereas in the latter animals it is generally remarkably large. I found it of very considerable magnitude in a mandrill (*Papio maimon*), which I lately dissected.

<sup>2</sup> TYSON'S *Anat. of a Porpesse*, tab. 2, fig. 3.

In a *balæna boops* of fifty-two feet in length, this part was very large, even in proportion to the monstrous size of the animal.

<sup>3</sup> HOME in the *Philos. Transf.* 1802, p. 81.



the organ, and terminates on its anterior extremity<sup>4</sup>. In the rat, the domestic mouse, the hamster, &c. the clitoris and the orifice of the urethra are placed at some distance from the vagina, and in front of that part. This structure has sometimes been mistaken for a preternatural hermaphrodite formation<sup>5</sup>. (See note (B).

§ 332. A true *hymen*, or one at least, which in form and situation resembles that of the human subject, has been observed in no other animal. The well-known membranous valve, covering the orifice of the meatus urinarius in the vagina of the mare, can by no means be considered as a hymen<sup>6</sup>. (See note (C).

<sup>4</sup> AUDEBERT *Hist. Nat. des Singes*, tab. 2, fig. 8, of the anatomical figures.

<sup>5</sup> J. J. DÖBEL, in *Nov. Literar. Maris Baltici*, 1698, p. 238.

JO. FABER, in his remarks on F. HERNANDEZ, *Plantar. &c. Mexicanar. Hist.* p. 547.

<sup>6</sup> RUINI, p. 164. DAUBENTON, tom. 4, tab. 4, fig. 2; and tab. 8.

BOURGELAT, *loco citato*, p. 383.

BRUGNONE, *Mem. de l'Acad. des Sc. de Turin*, tom. 4, p. 405.

The description of a similar part in the manati of Kamtschatka (*trichechus manatus*) may be seen in the *Nov. Comment. Acad. Petropolit.* tom. 2, p. 308.



§ 333. The vagina of quadrupeds is distinguished from that of the human subject by two chief characters: its direction, and the structure of its internal surface. In consequence of the form and position of the pelvis, this canal lies in the same axis with the uterus, or at least with the neck of that organ. The glandular membrane, which constitutes its internal coat, forms none of those extremely elegant transverse plaits, which distinguish it in the human female, but is merely folded longitudinally. If transverse folds exist in any instance, they are either confined to the immediate neighbourhood of the external opening, as in the mare; or, if they extend farther, as in the *simiæ*, they do not possess that regular arrangement, or beautiful formation, which are displayed in the human female<sup>7</sup>.

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<sup>7</sup> A representation of the vagina of the mare laid open, may be seen in DAUBENTON, tom. 4, tab. 4, fig. 2.

That of the cow, in NIC. HOBOKEN, *Anat. Secundinæ Vitulinae*, Ultraject. 1675, 8vo, fig. 3; and in J. G. EBERHARD, *over het verlossen der Koeijeu*, Amsterdam, 1793, 8vo, tab. 1.

Of the ewe, FAB. AB AQUAPENDENTE, *de formato Fœtu*, tab. 17, fig. 35, and 36; and DE GRAAF, *de Mulierum Organis*, tab. 20.

Of the hind, DAUBENTON, tom. 6, tab. 17.

Of the rat, *ibid.* tom. 7, tab. 38, fig. 3.

Of the genet, (*viverra genetta*) *ibid.* tom. 9, tab. 37, fig. 2.

Of the panther, *ibid.* tab. 16.



§ 334. The structure and form of the uterus vary very considerably in this class. In no instance does it possess that thickness, nor has its parenchyma that density and toughness, which are observed in the human female<sup>8</sup>. Of those which I have dissected, the *simia sylvanus* had comparatively the firmest uterus. The two-toed ant-eater came the next in order in this respect. But in the greater number of mammalia, this organ is thin in its coats, resembling an intestine in appearance, and provided with a true muscular covering.

§ 335. The variations in form of the impregnated uterus may be reduced to the following heads :

1. The simple uterus without horns (*uterus simplex*), which is generally of a pyramidal or oval figure. This is exemplified in those animals, where we have stated that it possesses thick coats. Its circumference in some simiæ presents a more triangular form than in the woman: and towards the upper part, in the neighbourhood of the fallopian

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<sup>8</sup> "The human uterus, says HALLER, is different from that of all animals which I have dissected. In quadrupeds this organ is a true muscle, something like the œsophagus. It is thicker in man, than in any animal." *Element. Physiol.* tom. 7, pt. 2, p. 56.



tubes, there is an obscure division into two blind sacs<sup>9</sup>, (as in the gibbon, or long-armed ape): this distinction is more strongly expressed in the lori, (*lemur tardigradus*), so as to form a manifest approach to the *uterus bicornis*<sup>10</sup>.

2. A simple uterus with straight or convoluted horns (*uterus bicornis*). They are straight in the bitch<sup>11</sup>, in the bats of this country, in the sea-otter, seal, &c.<sup>12</sup>: somewhat convoluted in the cetacea<sup>13</sup>, mare<sup>14</sup>, and hedge-hog, and still more tortuous in the bifulca<sup>15</sup>.

3. A double uterus, having the appearance of two horns, which open separately into the vagina: this is seen in the hare<sup>16</sup> and rabbit<sup>17</sup>, (*uterus duplex*).

4. A double uterus, with extraordinary lateral

<sup>9</sup> DAUBENTON, tom. 14, tab. 5, fig. 2.

<sup>10</sup> Ibid. tab. 31, fig. 4.

<sup>11</sup> VESALIUS, p. 585, ed. of 1555.

<sup>12</sup> DAUBENTON, tom. 9, tab. 16, of the panther; tab. 33, of the civet; tab. 37, fig. 2, and tab. 38, 39, of the genet; tom. 13, tab. 51, of the seal.

<sup>13</sup> TYSON, tab. 2, fig. 3.

<sup>14</sup> LA FOSSE, tab. 45, 46.

<sup>15</sup> It is represented in the sheep, by DE GRAAF, tab. 20. In the cow, by HOBOKEN, fig. 29, 30; by EBERHARD, tab. 1.

<sup>16</sup> DAUBENTON, tom. 6, tab. 45.

<sup>17</sup> DE GRAAF, tab. 25; DAUBENTON, *loc. cit.* tab. 56.



convolutions, is met with in the opossum and kangaroo<sup>18</sup>, (*uterus anfructuosus*). (See note (D)).

§ 336. These various forms undergo different changes in the pregnant state.

The alteration in the simple uterus is, on the whole, analogous to that which occurs in the human female.

The pregnant *uterus bicornis* suffers a different change in those animals, which bear only one at a time, from that which it undergoes in the *multi-para*. The fetus of the mare is confined in its situation to the proper uterus<sup>19</sup>. In the cow it extends at the same time into one of the horns, which is enlarged for its reception<sup>20</sup>. In those, on the contrary, which bring forth many young at once, as also in the double uterus of the hare and rabbit, both cornua are divided by contracted portions into a number of pouches corresponding to that of the young; and where those horns are straight in the unimpregnated state, as in the bitch, they become convoluted<sup>1</sup>.

The

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<sup>18</sup> HOME, in the *Philos. Transf.* for 1795, tab. 18, fig. 1; tab. 19, fig. 3.

<sup>19</sup> RUINI, pag. 181, et seq. FAB. AB. AQUAPENDENTE, tab. 20, 21.

<sup>20</sup> HOBOKEN, fig. 1, 6, 31; EBERHARD, tab. 9, 10.

<sup>1</sup> FAB. AB. AQUAPENDENTE, tab. 28, of the bitch.



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*corpora lutea*, which have received this name from their colour in the ovaries of the cow, are probably never found in the quadruped, except after impregnation<sup>4</sup>.

### (B) BIRDS.

§ 339. The female organs of generation in this class may be most conveniently arranged under three divisions: The external parts, including the *cloaca*;

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The wild and domesticated races of the same species of animals differ very remarkably in their fertility; which difference furnishes a new and strong argument against the supposed pre-existence of previously formed germs in the female ovary. The domestic sow brings forth commonly two litters in the year, each of which consists, perhaps, of twenty young ones. The wild animal, on the contrary, becomes pregnant only once in the year, and the number of its young never exceeds ten. Both reach about the same age; viz. twenty years.

A similar difference is found to obtain between the tame and wild cats; as also between the domestic dove and the wood-pigeon. How should those domestic animals, which descend from the original wild stock, produce such a remarkably greater number of young ones, if these are merely to be evolved from germs, which have existed since the first creation of things?

<sup>4</sup> I have shewn in the *Comment. Soc. Goetting.* that *corpora lutea* may be formed in the ovaria of virgins, as empty *calices* are sometimes met with in those of birds; and have also pointed out under what circumstances this takes place; tom. 9, p. 109.

the



the *tubus genitalis* (oviduct) resembling an intestine; and lastly, the *ovarium*, which is almost entirely separate from the latter part.

As the general structure of these parts is very uniform in all birds, we may take as an example, the most familiarly known species, the hen<sup>5</sup>.

§ 340. The *external* opening of the genitals consists of a *transverse slit* behind the ossa pubis, which do not form a symphysis: this is larger in the hen than in the cock; and its smaller anterior labium is covered by the larger posterior one (*velabrum*).

This slit leads to the cloaca, in which several organs open, (§ 114). These are the rectum; the two ureters on the prominent margin of that part; the vagina on the left; behind which, and on the upper part of the cloaca, there is the *bursa Fabricii*<sup>6</sup>.

§ 341.

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<sup>5</sup> For the sake of brevity, I refer once for all in this description of the generative organs of birds, to the excellent delineations by ULMUS in ALDROVANDI'S *Ornitholog.* tom. 2, p. 209, ed. of 1637, and by DE GRAAF, tab. 18.

<sup>6</sup> The opinion of the celebrated anatomist, whose name this mysterious organ bears; that it receives and retains the semen of the cock, is refuted by this, among other circumstances; viz. that the part in question is found also in the cock, where it is actually much larger than in the hen: nay,



§ 341. In the *tubus genitalis*, which considerably resembles an intestine, and is really on the whole very uniform in its appearance, we may, however, distinguish three parts. The vagina; the proper *uterus*; and the *oviductus*: the latter part terminates in the *infundibulum*, which is very different in its structure and appearance.

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it is often so small in the latter, that its very existence has lately been denied. This, however, is going too far. For I have never failed in finding it, at least in young hens; although it is sometimes no longer than a barley-corn, and instead of being loose, as in the cock, is closely invested by cellular substance, so that its demonstration requires some care and attention. The opening, by which it may be inflated, is found on the superior surface of the cloaca, behind the termination of the rectum, and on the front edge of a small eminence (*scutellum*), the size and development of which seem to be in an inverse ratio to those of the bursa.

From all the observations, which I have been able to make on this part (which PERRAULT very inappropriately termed *le troisieme cacum*) I am led to conclude, that the function, which forms its final use, must belong to the male, and that it is only to be considered as a mechanical rudiment in the hen, thereby affording another example of the union of the two principles in the *formative impulse*. (See § 37, and the last note but one in that paragraph).

In the present instance the teleological principle is manifested in the bursa of the cock, and the mechanical in that of the hen. In the breasts, on the contrary, the case is reversed: the teleological principle prevails in the female sex, where the final use or purpose of the glands is discerned; and these parts are formed in the male, merely as rudiments in compliance with the mechanical principle.

The



The *vagina* is about one inch and a half long, and very extensile : it follows a tortuous course.

The *uterus* is about the same length, but larger, and thicker in its parietes ; and folded internally. (See note (F)).

The *oviductus* (in French *la portière*) appears like a continuation of the last mentioned part : it is about one foot and a half long, convoluted like an intestine, and, though slightly contracted at intervals, on the whole conical, so that it decreases in diameter to the infundibulum. Its internal coat is covered with innumerable papillæ, which secrete the white of the egg ; and the whole tube is connected above to the spine by a kind of mesentery (*mesometrium* or *meseræon uteri*).

It opens by its small end into the *infundibulum*, which is an expanded part, analogous to the fringed extremity of the Fallopian tube, for receiving the yolk from the ovarium. This infundibulum is formed of a delicate membrane, with a very elegantly folded margin ; which is connected behind to the uterus by means of a round tendinous cord.

§ 342. The *ovarium*, resembling in its appearance a bunch of grapes, lies under the liver, and contains in a young laying hen about five hundred yolks, varying in size from a pin's head, to their perfect magnitude : the largest always occupy the



external circumference of the part. Each yolk is inclosed in a membrane (*calyx*) which is joined to the ovarium by means of a short stalk or pedicle (*petiolus*). A white shining line forms on the calyx, when the yolk has attained its complete magnitude. The membrane bursting in this part, the contained yolk escapes, and is taken up by the infundibulum in a manner, which we cannot easily conceive<sup>7</sup>. It then passes along the oviduct, and acquires in its passage the white and shell. The calyx on the contrary remains connected to the ovarium; but it contracts and diminishes in size, so that in old hens, which have done laying, the whole internal organs of generation nearly disappear.

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<sup>7</sup> WEPFER *Cicuta aquatica Historia et Noxa*. p. 173.

This forms one of the many instances in the animal economy, of remarkable and peculiar motions, which cannot be referred to any of the general vital and motive powers, as contractility, irritability, &c. according to the physiological notions, which have been hitherto affixed to those terms. Hence I have arranged them as specimens of a peculiar principle or *vita propria*, without presuming to give any explanation of the subject. This term will serve to denote and distinguish them until the received opinions on the above-mentioned general vital powers shall have been so far altered or modified, as to include these peculiar cases. I have entered more fully into this subject in my "*Cura iterata de vi vitali sanguini deneganda, vita autem propria solidis quibusdam Corporis Humani partibus adserenda*". Goettingen. 1795, 4to.



## (C) AMPHIBIA.

§ 343. The tortoise has a manifest clitoris, lying in the cloaca. The uterus, oviduct and ovarium have on the whole much analogy with those of birds; but all these parts are double, and have two openings into the cloaca<sup>8</sup>. The two uteri are thick and fleshy, while the oviducts are thin and delicate.

§ 344. The frogs of this country have a large uterus divided by an internal partition into two cavities, from which two long convoluted oviducts arise, and terminate by open orifices at the sides of the heart. The ovaria lie under the liver, so that it is difficult to conceive how the ova get into the above mentioned openings. The uterus opens into the cloaca<sup>9</sup>.

The toads have not the large uterus; but their oviducts terminate by a common tube in the cloaca<sup>10</sup>.

§ 345. The lizards of this country have on

<sup>8</sup> CALDESI, tab. 6, fig. 9, 10.

<sup>9</sup> RÖSEL, tab. 6, fig. 2, tab. 7, 8.

<sup>10</sup> Ibid. tab. 21, fig. 24.

The structure is the same in the *rana pipa* (Surinam toad). See CAMPER'S *Smaller Writings*, vol. 1, pt. 1, tab. 3, fig. 1.



the whole a similar structure to that of the last mentioned animals. Their oviducts are larger, but shorter, and the ovaria contain fewer ova.

§ 346. Female serpents have double external openings of the genitals for the reception of the double organs of the male (see § 346). The oviducts are long and much convoluted. The ovaria resemble rows of beads, composed of yellow vesicles.

#### (D) FISHES.

§ 347. We shall take the torpedo and the carp as examples of the two chief divisions of the class, as we did in speaking of the male organs<sup>11</sup>.

In the former fish<sup>12</sup> there are two uteri, communicating with the cloaca by means of a common vagina. The oviducts form one infundibulum, which receives the ova as they successively arrive at maturity. These are very large in comparison with those of the bony fishes. The yolk, in its passage through the oviduct, acquires its albumen, and shell. The latter is of a horny consistence, and is

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<sup>11</sup> CAVOLINI, *loco citato*.

<sup>12</sup> LORENZINI, tab. 3, fig. 1, 2, also MONRO'S *Physiology of Fishes*, tab. 2 and 13, of the skate.

known



known by the name of the sea-mouse<sup>13</sup>. It has an elongated quadrangular figure, and its four corners are curved and pointed in the skate, while they form horny plaited eminences in the sharks<sup>14</sup>. The secretion of the albumen, and the formation of the shell are performed by the papillous internal surface of the duct; and chiefly by two glandular swellings which appear towards its anterior extremity in the summer months, while the eggs are being laid<sup>15</sup>.

The structure is much more simple in the carp, and probably also in the other oviparous bony fishes. The two roes occupy the same position as the soft roe of the male does (§ 327). They are placed at the side of the intestines, liver, and swimming bladder, as far as the anus. They consist of a delicate membrane inclosing the ova, which are all of one size, and extremely numerous (more than 200,000 in the carp); and terminate by a common opening behind the anus<sup>16</sup>. (See note (G).

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<sup>13</sup> W. G. TILESIIUS, *on the horny Eggs of Fishes, or Sea-mice, as they are commonly called.* Leipzig. 1802, 4to. tab. 4, 5.

<sup>14</sup> J. HERMANN, *Tabula Affinitatum Animalium*, p. 279.

<sup>15</sup> These temporary organs were known to ARISTOTLE, who called them breasts. See also RONDELET *de piscibus marinis*, p. 380. COLLINS, vol. 2, tab. 43. MONRO and TILESIIUS, *loc. citat.*

<sup>16</sup> PETIT, *loc. citat.*



## (E) INSECTS.

§ 348. We shall here notice the two species only, which were mentioned in the former chapter<sup>17</sup>.

Each of the large ovaria of the *gryllus verrucivorus* contains about fifty ova disposed in bundles. The two organs are connected together at their posterior extremities, and open between the two sheaths of a part by which they are discharged from the body<sup>18</sup>.

In the silkworm moth<sup>19</sup> on the contrary, the ovarium resembles four rows of pearls: each row contains about sixty ova, which are laid from the end of the abdomen after passing through a short duct, which has, however, connected with it several vesicular processes of uncertain use.

## (F) VERMES.

§ 349. We shall describe here the female genitals of those two animals only, whose male organs were noticed in the preceding chapter<sup>20</sup>.

<sup>17</sup> In the works quoted in note 12, § 328, delineations of the female organs of generation of the insects there mentioned, will be found.

<sup>18</sup> RÖSEL, *loc. citat.* tab. 9, fig. 3.

<sup>19</sup> MALPIGHI, tab. 12, fig. 1, 2.

<sup>20</sup> For an account of these parts in some other genera, see the works quoted in note 15, § 329.



The opening of the genitals of the female round-worm (*ascaris lumbricoides*) is situated near the middle of the body, and leads to a short canal, which divides into two tubes. These gradually contract into two slender threadlike oviducts; which are very long and variously convoluted<sup>1</sup>. It happens occasionally that the integuments of the worm burst and some turns of the duct protrude: these have been mistaken for young worms, and have given rise to the erroneous notion that the animal is viviparous. (See note (H).)

The structure of the parts is very simple in the cuttle-fish. There are two ovaria, containing ova of various sizes; and a common tube leading to the anus<sup>2</sup>. (For an account of the organs of generation in some others of the lower classes, see note (K).)

<sup>1</sup> TYSON in the *Philos. Transf.* vol. 13, fig. 2, or in his works. London, 4to. 1751.

(The same parts have also been represented by Dr. HOOPER, in the *Memoirs of the London Medical Society*, vol. 5, and by Dr. BAILLIE in his elegant *Fasciculi of Morbid Anatomy*. Fascic. 4, pl. 9, fig. 3 and 5. T.)

<sup>2</sup> TURB. NEEDHAM, *Nouvelles Obs. Microsc.* tab. 2.

Compare with this, the delineations by LISTER, which indeed are somewhat different. *Conchylior. bivalv. exercit. Anat. Tertia.* Lond. 1696, 4to. tab. 1, fig. 10; and by SWAMMERDAM, tab. 52, fig. 10.



*Additional Notes to the Twenty-fourth Chapter.*

(A) *Ovaria* are found in the females of all animals where the male possesses *testicles* : but their structure is in general more simple than that of the latter glands, particularly in the first class. These bodies were formerly called the *female testicles* ; but the term *ovary* is much preferable, as it denotes the function which the parts perform in the animal economy. For, if the office of these bodies be at all dubious, when their structure is considered in man and most of the mammalia ; their organization is so evident in the other classes, that no doubt can be entertained respecting their physiology. It is manifest in all these, that the ovaria serve for the growth and preservation of the germs or ova, which exist in these, bodies, completely formed before the act of copulation. Analogy leads us to conclude that these bodies have the same office in the mammalia ; and thus our explanation and illustration of this most interesting part of physiology are entirely derived from researches in comparative anatomy.

(B) In consequence of the horizontal position of the body of quadrupeds, the clitoris is at the under margin of the orifice of the vagina, instead of the upper one, as in women.



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of its parts, from the same function as observed in the other mammalia, a considerable difference is found in the generative organs: of which, as the subject is a very interesting one, I shall present the reader with a more detailed description, from the paper of Mr. HOME, in the Philosophical Transactions for 1795.

“ The vagina (of the kangaroo) is about an inch and a half in length, beyond which it is divided into two separate canals, and on the ridge, which lies between them, opens the meatus urinarius.

“ These two canals are extremely narrow for about a quarter of an inch in length, and their coats at this part very thick, but afterwards they become more dilated; they diverge in their course, and pass upwards for nearly four inches in length; they then bend towards each other, so as to terminate laterally in the two angles of the fundus of the uterus, of which they appear to be an uniform continuation,

“ The uterus itself is extremely thin and membranous, and its coats infundibular in its shape, and situated in the middle space between these canals; it is largest at its fundus, and becomes smaller and smaller towards the meatus urinarius, where it terminates; the uterus at that part in the virgin state being impervious.

“ The same internal membrane appears to be continued over the inner surface of the uterus and



lateral canals ; it is thrown into several folds, forming longitudinal projecting ridges ; one of these constitutes a middle line, extending the whole length of the uterus, and dividing it into two equal parts.

“ The ovaria, as well as the fimbriæ, both in appearance and situation, resemble those of other quadrupeds ; the fallopian tubes follow nearly the same course to the uterus, but a little way before they reach it they dilate considerably, forming an oval cavity ; the coats of this part are also much thicker than those of the rest of the canal, and they are supplied with an unusual number of blood-vessels, giving these cavities a glandular appearance. The fallopian tubes after having formed these oval enlargements contract again, and pass perpendicularly through the coats of the uterus at its fundus, and terminate in two projecting orifices, one on each side of the ridge formed by a fold of the internal membrane.

“ In the impregnated state, the uterus, and two lateral canals have their cavities very much increased in size ; but that of the uterus is the most enlarged : the communication between these canals and the vagina is completely cut off, by the constricted parts close to the vagina being filled with a thick inspissated mucus ; and in this state of the parts there is an orifice very distinctly to be seen, close to the meatus urinarius, large enough to admit a hog’s bristle, leading directly into the uterus,



rus, where in the virgin state no such passage could be observed.

“Immediately after parturition, the parts are nearly brought back into their original state: the only circumstance deserving of notice is, that the opening leading directly from the uterus to the vagina, which is not met with in the virgin state, after being enlarged by the passage of the fœtus, forms a projecting orifice, and almost wholly conceals the meatus urinarius.

“Were we to consider the uterus and its appendages in the unimpregnated state, the two lateral canals would appear to be the proper vagina, particularly as they begin at the meatus urinarius, which is commonly placed at the entrance of the proper, or true vagina, and receive the penis in coition, the end of which is pointed to fit it for that purpose; in some species of the opossum the male has a double glans, each of them pointed, and diverging from the other, so as to enter both canals. But when we find these canals in the impregnated state, forming with the uterus one general reservoir of nourishment for the fœtus, and all communication during that period between them and the vagina cut off, we consider them more immediately as appendages to the uterus than the vagina.”

In the opossum (*didelphis marsupialis*), the vagina divides, as it approaches the uterus, into



two tubes : and the meatus urinarius opens at the point of division. From each tube a canal commences, which runs outwards, and then returns in the same course to open into a middle cavity ; from which the cornua uteri arise. The changes which these parts undergo in the impregnated state have not hitherto been ascertained.

(E) The passage of the foetus, in the opossum tribe and the kangaroo, from the cavity of the uterus into the false belly, where it adheres by its mouth to the nipple, presents one of the most singular and interesting phenomena in the whole circle of comparative anatomy. Physiologists have not yet ascertained, whether the embryo possesses, at any period, a connection with the uterus similar to that which is observed in the other mammalia : but it appears very probable, that the processes, which follow the passage of the ovum from the ovarium, are entirely different in these animals, from those which take place in the other mammalia. Neither has the precise period, at which the foetus enters the false belly, been hitherto shewn.

The following statement of the subject, as far as it is at present known, is derived from Mr. HOME'S paper.

The uterus and lateral canals, in their pregnant state, are distended with a very adhesive jelly of a bluish



bluish white colour; which also fills the oval enlargements of the fallopian tubes.

“ In the cavity of the uterus, says Mr. HOME, I detected a substance, which appeared organized; it was enveloped in the gelatinous matter, and so small as to make it difficult to form a judgment respecting it; but when compared with the foetus after it becomes attached to the nipple, it so exactly resembled the backbone with the posterior part of the skull, that it is readily recognized to be the same parts in an earlier stage of their formation.”

This substance is represented in plate 20, fig. 2; but the engraving does not, in my opinion, possess the slightest similitude to the parts mentioned by Mr. HOME.

The size of the foetus at the time it leaves the uterus is not yet ascertained. The smallest, which has been hitherto found in the false belly, weighed twenty-one grains; and was less than an inch in length. In another instance it was “ thirty-one grains in weight, from a mother of fifty-six pounds. In this instance the nipple was so short a way in the mouth, that it readily dropped out, we must therefore conclude that it had been very recently attached to it.

“ The foetus at this period had no navel string, nor any remains of there ever having been one; it could not be said to be perfectly formed, but those  
parts



parts which fit it to lay hold of the nipple were more so than the rest of the body. The mouth was a round hole, just enough to receive the point of the nipple; the two fore-paws, when compared to the rest of the body, were large and strong, the little claws extremely distinct; while the hind-legs, which are afterwards to be so very large, were both shorter and smaller than the fore ones."

"The mode in which the young kangaroo passes from the uterus into the false belly, has been matter of much speculation; and it has even been supposed that there was an internal communication between these cavities; but after the most diligent search, I think I may venture to assert that there is no such passage. This idea took its rise from their being no visible opening between the uterus and vagina, in the unimpregnated state; but such an opening being very apparent, both during pregnancy, and after parturition, overturns this hypothesis; for we cannot suppose that the foetus, when it has reached the vagina, can pass out in any other way than through the external part." This passage will be facilitated by the power which the animal possesses of drawing down the false belly to the vulva, which has naturally a considerable projection.

(F) In speaking of the uterus and vagina of birds, the author does not sufficiently keep up the distinction



distinction which ought to be observed between an *uterus* and an *oviduct*.

The germ, or ovum, passes from the ovarium through a canal, which either conveys it out of the body, (as in the case of the egg) or transmits it into another organ. The latter is a cavity, admitting of enlargement, and having the germ attached to its parietes by means of vessels, which nourish and preserve it, until it has acquired a certain development.

The first mentioned organs are found in all the four classes of vertebral animals: they are called *fallopian tubes* in the mammalia; and *oviducts* in the three other classes. The latter belongs to the mammalia only, and is their *uterus*. We find, however, that the author speaks of the uterus of other classes: the difference in the office of the parts is so striking that they should on no account be confounded together.

(G) The ovaria of fishes generally contain a very large number of ova, so as to account to us satisfactorily for the astonishing multitudes in which some species are formed. In a perch weighing one pound two ounces, there were 69,216 ova in the ovarium: in a mackarel of one pound three ounces, 129,200: in a carp of eighteen inches PETIT found 342,144: and in a sturgeon of one hundred and sixty pounds, there was the enormous number of 1,467,500.

(H) The



(H) The genital tubes of the ascaris contain a milky fluid, which, when examined by the microscope, is found to contain numerous ova.

The *ascaris vernicularis* possesses a genital apparatus of the same appearance with that of the *lumbricoides*. Dr. HOOPER in *Trans. of the Lond. Med. Soc.*

(I) The ova of the cuttle-fish, when discharged from the body, are connected into bunches, exactly resembling grapes, by a tenacious and ductile substance. The similarity is so striking as to have given rise to the term of *sea-grapes*, which is applied to them in common language. In the *sepia octopus* and *loligo* (calmar) they form small masses.

(K) Most of the gasteropodous mollusca are true hermaphrodites, and have the male and female organs of generation united in the same individual: but they copulate, so that each fecundates, and is fecundated. The common slug (*limax*) and snail (*helix*) afford the most familiar examples of this structure. They possess an ovarium, oviduct, testis, vas deferens, and penis. The oviduct and vas deferens open into a cavity situated under the right superior horn; and the penis is contained in the same cavity. The latter part enters the oviduct of the other animal at the time of copulation.



The snail has, in addition to these organs, a very singular one, the use of which is quite obscure. It consists of a cavity with an eminence at bottom; from which a sharp pointed, thin, calcareous body proceeds. This can be thrust forth from the cavity, and is employed by the snails to prick each other before the act of copulation.

In the acephalous mollusca, such as the oyster, muscle, &c. there is no discernible organ of generation, except an ovarium, which varies in size and colour at different periods of gestation.

The same observation holds good also of the *asterias* (star-fish) and *echinus* (sea-urchin). In both these genera the ovaria consist of several distinct masses of ova.

The process of generation in the zoophytes resembles the growth of buds and branches in trees; and therefore these animals contain no generative organs, nor have any distinction of sex. This is the case in the polype (*hydra*) and the sea anemone (*actinia*); where the young shoot out from any part of the surface of the parent. If these animals are cut in two, the divided portions will form perfect animals.



## CHAPTER XXV.

ON THE FŒTUS OF THE MAMMALIA, AND THE  
ORGANS WITH WHICH IT IS CONNECTED<sup>1</sup>.

§ 350. **T**HE first parts which can be discerned in the uterus after impregnation, are the membranes (*involucra*) of the ovum; in which the embryo itself becomes visible after a certain period. By means of the navel-string the fœtus is connected to these membranes, and consequently to the uterus of the mother; from which its nourishment is derived until the time of birth. It will, therefore, be the natural method to pass from the description of the uterus, to that of the membranes, and other parts of the after birth; and to consider in the last place whatever may be worthy of remark concerning the embryo itself.

§ 351. The mode of connection of the pregnant uterus with the membranes of the ovum, and thereby with the embryo itself, displays three chief differences in the various mammalia.

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<sup>1</sup> Much information on the subject of this, and of the last chapter, is contained in Dr. J. F. LOBSTEIN'S *Essai sur la Nutrition du Fœtus*. Straßb. 1802, 4to.



Either the whole external surface of the ovum adheres to the cavity of the uterus; or the connection is effected by means of a simple *placenta*; or by more numerous small *placentæ* (*cotyledons*).

§ 352. The first kind of structure is observed in the sow<sup>2</sup>; and is still more manifest in the mare. In the latter case, the external membrane of the ovum, the chorion, may be said to form a bag-like placenta. Numerous and large branches of the umbilical vessels ramify through it, particularly in the latter half of the period of pregnancy; and its external surface is covered with innumerable flocculent papillæ, which connect it to the inside of the uterus<sup>3</sup>.

§ 353. In those animals of this class, where the embryo is nourished by means of a placenta, remarkable varieties occur in the several species; sometimes in the form and successive changes of the part; sometimes in the structure of the organ as being more simple or complicated.

In most of the digitated mammalia, as well as in the quadrumana, the placenta has a roundish

<sup>2</sup> FAB. AB AQUAPEND. tab. 25 and 26. DAUBENTON, tom. 5, tab. 21, 22.

<sup>3</sup> FAB. AB AQUAPEND. tab. 21, 22; tab 23, fig. 46.

form;



form<sup>4</sup>; yet it consists sometimes of two halves lying near together; and in the dog, cat, martin, &c. it resembles a belt (*cingulum* or *zona*<sup>5</sup>). Its form in the pole-cat holds the middle between these two structures; as there are two round masses joined by an intervening narrower portion<sup>6</sup>.

I have discovered a most remarkable instance of change in the form of this organ, in the hedge-hog. For some weeks after impregnation, the placenta includes nearly the whole circumference of the chorion, and may be compared, in size and form, to a hazel-nut. It is spongy and vascular internally; but on the outer surface firm and tough, and approaching to cartilaginous hardness. It is not, however, of uniform strength throughout; but thinner and more flexible towards the concave side of the cornua uteri, than on the opposite part. As pregnancy advances, this thinner portion increases, and gradually assumes a nearly membranous structure, while the opposite thick part forms a firm

<sup>4</sup> DAUBENTON, tom. 7, tab. 38, fig. 3, 4, of the rat.

Ibid. tab. 40, fig. 7, 8, of the domestic mouse; tom. 8, tab. 13, fig. 6, of the mole.

<sup>5</sup> It is represented in the dog, by EUSTACHIUS, tab. anatom. tab. 14, fig. 7, 8, by FAB. AB. AQUAPEND. tab. 27, 28, and by DAUBENTON, tom. 5, tab. 50.

In the cat, by NEEDHAM, *de Formato Fatu*, tab. 4, fig. 1, and DAUBENTON, tom. 6, tab. 6.

In the martin, *ibid.* tom. 7, tab. 20.

<sup>6</sup> *Ibid.* tom. 7, tab. 27.



and dense placenta of a saddle-like shape with extenuated margins. This lies in the more mature fœtus nearly across the ilia; so that the neighbouring parts are protected from any injury, which might have arisen from accidental pressure. For the final purpose of this singular, and, as far as I know, unique construction, is the preservation of the tender embryo in the abdomen of an animal, which rolls itself up with such force, that without this provision, the pregnant uterus and its contents would be exposed to a most dangerous pressure.

In several species of digitated mammalia the external surface of the placenta is provided with a white and apparently glandular body (*corpus glandulosum* EVERARDI<sup>7</sup>, or *subplacenta*), smaller than the proper placenta, by which it is inclosed<sup>8</sup>. In proportion as the embryo becomes more mature, this part admits of more easy separation from the placenta.

§ 354. The placenta of the *bifulca* is divided

<sup>7</sup> *Cosmopolite Historia Naturalis*, 1686. 12, p. 60.

<sup>8</sup> In the hare it is represented by DAUBENTON, tom. 6, tab. 46.

In the rabbit by NEEDHAM, tab. 3, and DE GRAAF, tab. 26, 27.

In the guinea-pig by FAR. AB. AQUAP. tab. 30, and DAUBENTON, tom. 8, tab. 4, fig. 6.

In the water-rat, *ibid.* tom. 7, tab. 46, fig. 4, 5.



into numerous *cotyledons*; the structure of which is very interesting, as it elucidates the whole physiology of this organ. The parts designated by this appellation are certain fleshy excrescences (*glandulæ uterinæ*), produced from the surface of the impregnated uterus, and having a corresponding number of flocculent fasciculi of blood-vessels (*carunculæ*), which grow from the external surface of the chorion, implanted in them. Thus the *uterine* and *fetal* portions of the placenta are manifestly distinct from each other, and are easily separable as the foetus advances to maturity. The latter only are discharged with the after-birth, while the former, or the cotyledons, gradually disappear from the surface of the uterus after it has parted with its contents. The number and form of these excrescences vary in the different genera and species. In the sheep and cow they sometimes amount to a hundred. In the former animal and the goat, they are, as the name implies, concave eminences<sup>9</sup>; while on the contrary, in the cow, deer, &c. their surface is rounded or convex<sup>10</sup>.

§ 355. The trunks of the veins which pass

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<sup>9</sup> For a view of these parts in the sheep, see FAB. AB. AQUAP. tab. 12, 14, 15.

<sup>10</sup> In the cow, HOBOKEN: particularly fig. 14, to 17. In the goat, DAUBENTON, tom. 6, tab. 17.



from the placenta or carunculæ, and of the arteries which proceed towards these parts, are united in the *umbilical* chord, which is longer in the human embryo <sup>11</sup>, than in any other animal.

In the foal, as in the child, the chord possesses a single umbilical vein <sup>12</sup>; whilst most other quadrupeds have two, which unite, however, into a common trunk near the body of the fœtus, or just within it <sup>13</sup>.

§ 356. The amnion, or innermost of the two membranes of the ovum, which belongs to the pregnant woman, as well as to the mammalia, is distinguished in some of the latter, as for instance in the cow, by its numerous blood-vessels; while on the contrary, in the human subject it possesses no discernible vascular ramification.

§ 357. Between the chorion and amnion there is a part found in most pregnant quadrupeds, and even in the cetacea, which does not belong to the human ovum; viz. the *allantois* or *urinary membrane*. The latter name is derived from the connection, which this part has, by means of the

<sup>11</sup> The pole-cat probably has the shortest chord. DAVENTON, tom. 7, tab. 27, fig. 3.

<sup>12</sup> RUINI, p. 189.

<sup>13</sup> HOBOKEN, fig. 23, 27, in the calf.



*urachus*, with the urinary bladder of the foetus; whence the watery fluid, which it contains, has been regarded as the urine of the animal. The term *allantois* has arisen from the sausage-like form, which the part possesses in the bisulca and the pig<sup>14</sup>; although this shape is not found in several other genera and species. Thus in the hare, rabbit, guinea-pig, &c. it resembles a small flask; and it is oval in the pole-cat. It covers the whole internal surface of the chorion in the *solidungula*, and therefore, incloses the foal with its amnion. It contains most frequently in these animals (although not rarely in the cow), larger or smaller masses of an apparently coagulated sediment in various forms and number, which has been long known by the singular name of the *horse-venom* or *hippomanes*<sup>15</sup>.

Some orders and genera of mammalia resemble the human subject in having no allantois; as the *quadrumana* and the hedge-hog: nay, in the latter animal, the urinary bladder has no trace whatever

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<sup>14</sup> FAB. AB. AQUAP. tab. 13, fig. 29, and tab. 17, fig. 37, in the sheep. J. C. KUHLEMANN has represented this part in an embryo of the 19th day after conception. *Observ. circa Negotium Generationis in Ovibus*. Götting. 1753, 4to. tab. 2, fig. 1, 2.

HOBOKEN, fig. 10 to 13 and 15, in the cow. FABRIC. tab. 25, in the pig.

<sup>15</sup> DAUBENTON, tom. 4, tab. 9, fig. 1, 2, of the horse.

HOBOKEN, fig. 19, 21, and fig. 37, of the cow.



of urachus; which even exists in a certain degree in the human subject; but its fundus is perfectly spherical in the fœtus.

§ 358. There is on the contrary in this animal, as well as in the dog, cat, and others, a peculiar part called the *tunica erythroides*, situated between the chorion and amnion like the allantois, for which it might easily be mistaken on the first view. It contains a watery fluid at the commencement of pregnancy, but is easily distinguished from an allantois, as it is not joined to the fundus of the bladder by the urachus, but is connected by means of the *omphalomesenteric veins* with the mesenteric blood-vessels of the fœtus<sup>16</sup>. This connection constitutes a resemblance on one hand to the yolk-bag of the incubated bird, and on the other side to that remarkable *vesicula umbilicalis*, which is observable in the early months of pregnancy<sup>17</sup>. The *tunica erythroides*, as well as that vesicula are most complete in young embryos, and are, on the contrary, so diminished in subsequent periods, that their functions must be connected with the earlier stages of existence,

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<sup>16</sup> FAB. AB. AQUAP. tab. 1, of the dog.

NEEDHAM, tab. 4, fig. 1, of the cat.

<sup>17</sup> *Comment. Soc. Reg. Scient. Gotting.* vol. 9, p. 128, fig. 1.



§ 359. The first trace of the formation of an embryo cannot be discovered in the different species of this class until a considerable time after conception. The original formation, as in the human subject, is widely distant from the subsequent perfection of the mature foetus<sup>18</sup>: and the growth and formation of the members, instead of proceeding alike in the whole class, are so ordered in particular species, that those external organs, which are most necessary to the young animal, according to its peculiar mode of life, are formed and completed the soonest. Hence arises the great size of the posterior hands of the foetal *quadrumana*, of the feet of the squirrel, of such animals in short as are destined to live in trees; likewise of those of the foal and kid, which are obliged to use their legs immediately after birth<sup>19</sup>, when compared with the corresponding parts of the mature human foetus<sup>20</sup>.

§ 360.

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<sup>18</sup> See delineations of the embryo of different animals in the early periods: viz. of the rabbit in DE GRAAF, tab. 26, fig. 8-10, and in HALLER, *Oper. Minor*, tom. 3, tab. 21, fig. 1-4. Of the sheep in KUHLEMANN, tab. 2.

<sup>19</sup> In the foetal kangaroo, in that state at least, in which it is first found in the false belly, the fore-feet are much larger and stronger than the posterior ones, on account of the use, to which the animal puts them in holding by the nipple. When the animal in a more mature state is in a manner born a second time, and must soon be left to itself, the posterior limbs increase to their well-known enormous magnitude.

<sup>20</sup> The erroneous observation concerning the supposed unshape.



§ 360. The most important points, in which the fœtus of the mammalia differs from that of the human subject, have been already noticed. In other respects their structure seems to correspond<sup>1</sup>; at least, for instance, in the membrana pupillaris<sup>2</sup>, in the thymus, thyroid, and supernatural glands. Some trivial points of distinction are not noticed; such as the meconium resembling hard scybala in the bifulca, and animals of the mouse-kind<sup>3</sup>, &c.

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shapeliness of the fœtus of the bear, which has been so often made since the time of ARISTOTLE, would not require an express refutation in the present day, had it not been repeated by some modern zoologists, whose accuracy in general is much to be relied on. I have completely shewn how unfounded this supposition is, by the representation of a young bear's fœtus in the 4th vol. of the *Delineations of Objects relating to Natural History*, tab. 32; and it appears to be very completely formed.

<sup>1</sup> There is a view of the viscera of a fœtal horse, in RUIX, p. 189, and in DAUBENTON, tom. 4, tab. 7.

Of the sheep in KUHLEMANN, tab. 2, fig. 8.

Of the calf by HOBOKEN, fig. 24-25.

WRISBERG in the *Nov. Comment. Soc. Reg. Scient. Goetting.* tom. 2, p. 207.

<sup>3</sup> FLEMING'S *German Huntsman*, p. 130, and HARVEY *de Generat. Animal*, p. 197.



## CHAPTER XXVI.

ON THE BREASTS AND TEATS OF THE  
MAMMALIA.

§ 361. **T**HE nourishment of the young animal immediately after birth, is derived in this class from the milk of the mother, which is secreted in the *breasts*. This secretion, which is peculiar to the class in question, has given rise to the name *mammalia*, by which LINNEUS has distinguished them. Yet no teats have been hitherto discovered in the *ornithorhynchus*<sup>1</sup>; and they seem also to be wanting in the males of some other species, as the hamster, and *lemur mongoz*; although this sex possesses them in general as well as the female<sup>2</sup>. They are some-

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<sup>1</sup> HOME, in the *Philos. Transf.* 1802, p. 69.

<sup>2</sup> Numerous instances have occurred, in which milk has been secreted in the breasts of male animals, as the goat, ox, dog, cat, and hare, as well as in men. I have treated more particularly of this physiological phenomenon in describing a goat, which it was necessary to milk every other day for the space of a year; in the *Hanoverian Magazine*, 1787, p. 753.

Milk is commonly found in the breasts of newly born children of both sexes; and the same observation holds good in the foal and calf.



times however found in smaller number in the former sex, as in the dog; or in a different situation, as in the horse<sup>3</sup>.

§ 362. The position and number of the teats varies considerably in the different species. Several irregularities occur in the latter point, particularly among the domestic animals<sup>4</sup>. Numerous exceptions must be made in some species, as the domestic sow, the guinea-pig, and others, to the general rule, which assigns to animals twice as many teats as the number of young, which they ordinarily produce.

Their situation is the most singular in the female marsupial animals; where their existence can scarcely be recognized except at the time when the young are actually contained in the abdominal pouch, or false belly<sup>5</sup>. (See note (A) at the end of the chapter.)

§ 363.

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<sup>3</sup> DAUBENTON in FOUREROY'S *Médecine éclairée*, tom. 2, p. 274.

<sup>4</sup> "Naturalists were long at a loss to discover the mammae and teats of this animal; in the male they were at length detected by BUFFON, on the sheath of the penis. Mr. J. HUNTER also made the same remark, without knowing that BUFFON had previously noticed it; these teats are largest in the foetus and young foal." REES'S *Cyclop.* art. *Anatomy of the Horse*.

<sup>4</sup> BUFFON, tom. 10, p. 295.

<sup>5</sup> TYSON, who on all other occasions displays the greatest acute-



§ 363. In the singular animals, which have been just alluded to, as well as in those which live in the water, or under-ground, the mammary glands, for reasons which must be very obvious, lie flat under the skin, and do not project so as to form breasts or udders: neither do the lactiferous ducts possess such dilatations and cavities as are observed in the bifulca, the mare and others<sup>6</sup>. In those animals which have their breasts placed on the chest (*mammæ pectorales*), these organs never possess that form, which so peculiarly distinguishes the human female in the bloom of life. (See note (B) at the end of the chapter.)

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acuteness, could discover no trace of teats in his female opossum. D'ABOVILLE expressly asserts, that they are formed by the suction of the young; that their number, therefore, in animals which are giving suck, exactly corresponds to the number of young at that period; and that they are placed without any symmetry, being formed wherever the young animals may happen to attach themselves on their arrival in the abdominal pouch. See *Voyages du Marq. DE CHASTELLUX dans l'Amérique Septentrionale*, tom. 2, p. 332.

In an opossum which I possessed for several years, and whose ovaria discovered no trace of any previous impregnation, there were three pairs of teats in the false belly, very small indeed and flat, but regularly arranged in a half moon.

<sup>6</sup> DAUBENTON, tom. 5, tab. 12, of a goat which had double teats on each udder.

Addi-



*Additional Notes to the Twenty-sixth Chapter.*

(A) The mammæ and teats of the opossum tribe, kangaroo, and some other animals, are situated in a cavity, formed by the common integuments, at the posterior part of the abdomen. This is generally called the false belly. Its margin contains muscular fibres, which acting like a sphincter muscle, close the opening. It is connected to, and supported by the pair of bones which arise from the pubis, and are described in the chapter on the skeleton.

§ 37. These bones possess muscles which depress, and others which elevate them; and the false belly necessarily follows their motions. The same bones are found in the ornithorhynchus, where no false belly exists, and where the mammæ have not hitherto been discovered.

The passage of the fœtus into this receptacle at a very early period, and its connection to the nipple, have been mentioned in the notes to the twenty-fourth chapter.

It may be further observed, that in the kangaroo, the young animal remains in the false belly, or enters it occasionally, long after it seems capable of providing for itself.

A spe-



A species of toad, (the *rana pipa*, or Surinam toad) has a structure somewhat analogous to the false belly of the marsupial mammalia. There are several cells, amounting in number to 70 or 80, formed by the integuments of the back of the female. The ova are placed in these, and go through their different changes to the formation of the young frog. The integuments, which form these cells, appear to have no peculiarity in their organisation: nor are the cells formed until the time at which they are to receive the ova.

(B) The mammæ of animals are not surrounded with that quantity of fat, which is observed in the human female: hence they are not very apparent except at the period of suckling, when they become distended with milk.

Another remarkable difference occurs in the structure of the nipple. This part in women has about fifteen openings, which are the terminations of as many lactiferous tubes. In the other mammalia it is hollow, and has only one or two orifices. Its cavity communicates with two large reservoirs, in which the lactiferous tubes terminate.



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give, first, a cursory chronological<sup>4</sup> view of the whole process, and then to make a few remarks on some of the most important parts of the subject.

§ 367. A small shining spot of an elongated form, with rounded extremities, but narrowest in the middle, is perceived at the end of the first day, not in nor upon the cicatricula, but very near that part on the yolk-bag, (*nidus pulli*; *colliquamentum*; *areola pellucida*). This may be said to appear before-hand as the abode of the chick which is to follow.

No trace of the latter can be discerned before the beginning of the second day: and then it has an incurvated form, resembling a gelatinous filament with large extremities, very closely surrounded by the amnion, which at first can scarcely be distinguished from it.

ANT. MAITRE-JAN, *Observat. sur la Formation du Poulet*, Par. 1722, 12mo.

C. F. WOLFF, *Theoria Generationis*, Hal. 1759, 4to, tab. 2; also in the *Nov. Comment. Acad. Petropolitan.* tom. 12, 13, and 14.

As the plates of LANGLY and WOLFF represent only the earlier periods, and the others are not executed with that elegance and clearness which they ought to possess; I have given in the 4th and 7th parts of my *Delineations of Objects relating to Natural History*, some neat and accurate representations, taken from two periods, in which the most important phenomena of incubation are most clearly discernible.

<sup>4</sup> The periods of the different changes are set down as I have ascertained them in my own repeated observations.

About



About this time the halones enlarge their circles ; but they soon after disappear entirely, as well as the cicatricula.

§ 368. The first appearance of red blood is discerned on the surface of the yolk-bag, towards the end of the second day. A series of points is observed, which form grooves ; and these, closing, constitute vessels, the trunks of which become connected to the chick. The vascular surface itself is called *figura venosa*, or *arca vasculosa* : and the vessel, by which its margin is defined, *vena terminalis*. The trunk of all the veins joins the *vena portæ* ; while the arteries, which ramify on the yolk-bag, arise from the mesenteric artery of the chick.

§ 369. On the commencement of the third day, the newly-formed heart (the primary organ of the circulating process, which now commences) is discerned by means of its triple pulsation ; and constitutes a threefold *punctum saliens*. Some parts of the incubated chicken are destined to undergo successive alterations in their form ; and this holds good of the heart in particular. In its first formation it resembles a tortuous canal, and consists of three dilatations lying close together, and arranged in a triangle. One of these, which is properly the right, is then the common auricle ; the other is the only ventricle, but afterwards the left ; and the third is the dilated part of the aorta, (*bulbus aortæ*).



About the same time, the spine, which was originally extended in a straight line, becomes incurvated; and the distinction of the vertebræ is very plain. The eyes may be distinguished by their black pigment, and comparatively immense size; and they are afterwards remarkable in consequence of a peculiar slit<sup>5</sup> in the lower part of the iris<sup>6</sup>.

§ 370. From the fourth day, when the chicken has attained the length of four lines, and its most important abdominal viscera, as the stomach, intestines, and liver, are visible, (the gall bladder, however, does not appear till the sixth day), a vascular membrane (*chorion*, or *membrana umbilicalis*) begins to form about the navel; and encreases in the following days with such rapidity, that it covers nearly the whole inner surface of the shell, within the *membrana albuminis*, during the latter half of incubation. This seems to supply the place of the lungs, and to carry on the respiratory process instead of those organs. The lungs themselves begin indeed to be formed on the fifth day; but, as in the foetus of the mammalia, they must be quite incapable of

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<sup>5</sup> I have found an exactly similar slit in the iris of the common lizard (*lacerta agilis*), before it had attained maturity. Thus this structure belongs to such animals as have no *membrana pupillaris*.

<sup>6</sup> MALPIGHI, *de Format. Pulli*, tab. 2. fig. 18—21; and *de Ovo*, tab. 3. fig. 18, 20; tab. 4. fig. 21.

*Delineations of Objects*, &c. pt. 7, tab. 64.

See also HALLER, *sur la Formation du Cœur dans le Poulet*, tom. 1, p. 163—194; tom. 2, p. 160.



performing their functions while the chick is contained in the amnion.

§ 371. Voluntary motion is first observed on the sixth day; when the chick is about seven lines in length.

Ossification commences on the ninth day; when the ossific juice is first secreted, and hardened into bony points (*puncta ossificationis*). (See the note to § 5.) These form the rudiments of the bony ring of the sclerotica, which resembles at that time a circular row of the most delicate pearls<sup>7</sup>.

At the same period, the marks of the elegant yellow vessels (*vasa vitelli lutea*), on the yolk-bag, begin to be visible.

On the fourteenth day, the feathers appear; and the animal is now able to open its mouth for air, if taken out of the egg.

On the nineteenth day it is able to utter sounds; and on the twenty-first to break through its prison, and commence a second life.

§ 372. We shall conclude with one or two remarks on those very singular membranes, the yolk-bag and chorion, which are so essential to the life and preservation of the animal.

The chorion, that most simple yet most perfect temporary substitute for the lungs, if examined in the latter half of incubation in an egg very cautiously opened, presents, without any artificial injection, one

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<sup>7</sup> I have found this part much more elegantly formed than in the hen, in the incubated pea-fowl of the fourteenth and following days.



of the most splendid spectacles that occurs in the whole organic creation. It exhibits a surface covered with numberless ramifications of arterial and venous vessels. The latter are of the bright scarlet colour; as they are carrying oxygenated blood to the chick; the arteries on the contrary are of the deep or livid red, and bring the carbonated blood from the body of the animal<sup>8</sup>. Their trunks are connected with the iliac vessels; and, on account of the thinness of their coats, they afford the best microscopical object for demonstrating the circulation in a warm-blooded animal.

§ 373. The other membrane, the *membrana vitelli*, is also connected to the body of the chick; but by a two-fold union, and in a very different manner from the former. It is joined to the small intestine, by means of the *ductus vitello-intestinalis*<sup>9</sup> (*pedunculus, apophysis*); and also by the blood-vessels, which have been already mentioned (§ 368), with the mesenteric artery and vena portæ.

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<sup>8</sup> Hence, as is well known, the incubated bird perishes if the shell be varnished over; as the respiratory process is thereby suspended.

<sup>9</sup> This is regarded by LEVEILLE merely as a ligament. It is well known that no true yolk is discoverable in the intestine of the incubated chick. Yet sometimes (not indeed always, but under certain circumstances not yet sufficiently understood) air will pass from the intestine through this part into the yolk bag. This fact, which was noticed by HALLER, and after him by MAITREJAN, has occurred also to myself in a duck of the twenty-second day.

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In the course of the incubation the yolk becomes constantly thinner and paler by the admixture of the inner white. At the same time innumerable fringe-like vessels with flocculent extremities, of a most singular and unexampled structure, form on the inner surface of the yolk-bag, opposite to the yellow ramified marks above-mentioned (§ 371); and hang into the yolk. There can be no doubt that they have the office of absorbing the yolk, and conveying it into the veins of the yolk-bag<sup>10</sup>; where it is assimilated to the blood, and applied to the nutrition of the chick. Thus in the chicken, which has just quitted the egg, there is only a remainder of the yolk and its bag to be discovered in the abdomen. These are completely removed in the following weeks, so that the only remaining trace is a kind of cicatrix on the surface of the intestine.

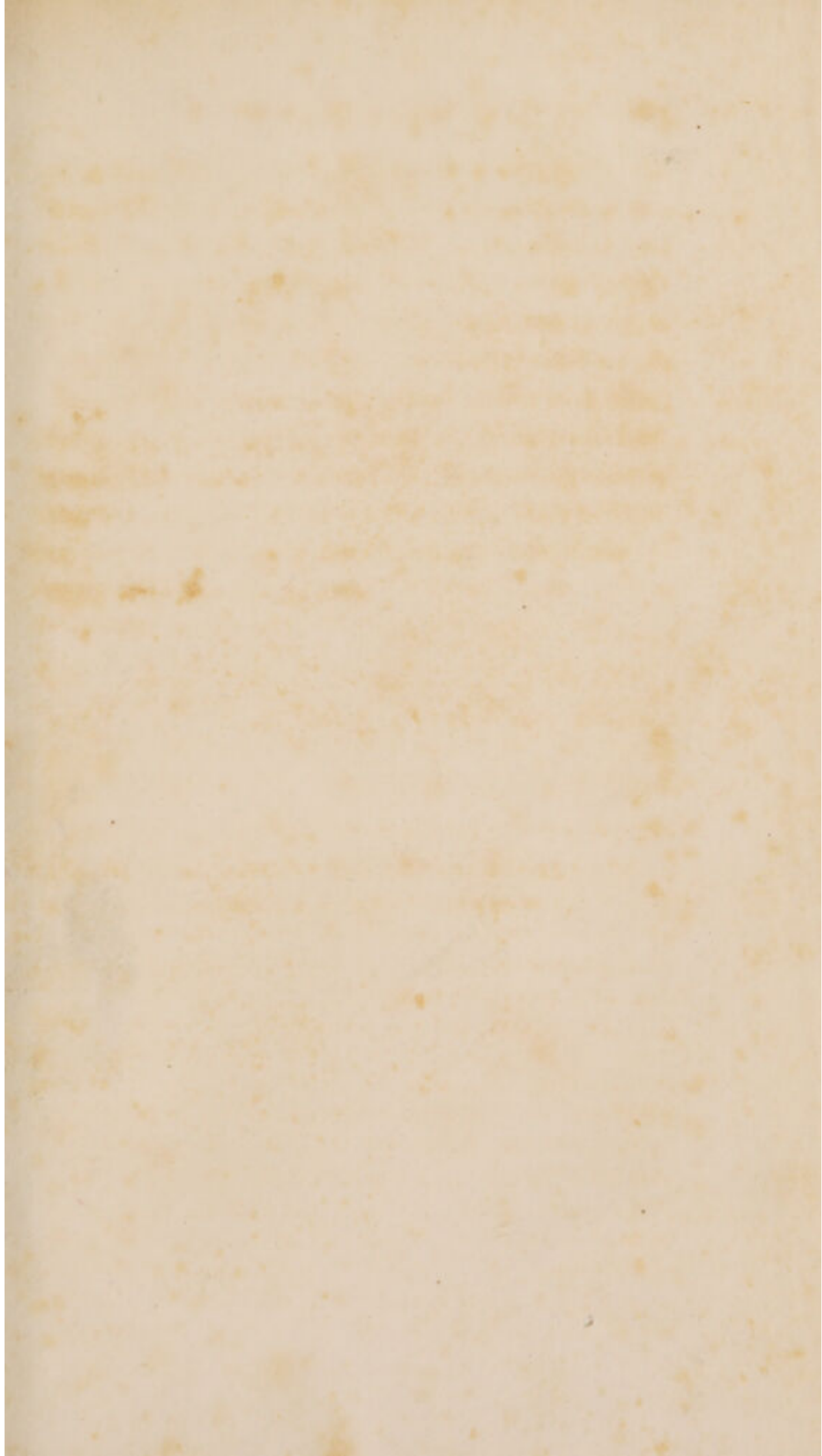
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The analogous umbilical bag of the fetal-shark, (which is found also in several other fishes, and some reptiles) is connected to the small intestine; at least to the *bursa entiana*, which is a peculiar dilatation of the posterior end of the intestine. COLLINS, vol. 2, tab. 33, fig. 2.

<sup>10</sup> In numerous and varied microscopical examinations of the yolk-bag in the latter weeks of incubation, I think I have observed the actual passage of the yolk, from the yellow flocculent vessels of the inner surface of the bag, into the blood-vessels, which go to the chicken. That is, I have seen manifest yellow streaks in the red blood contained in those veins.

THE END.







Faint, illegible text, possibly bleed-through from the reverse side of the page. The text is arranged in several paragraphs, but the characters are too light and blurry to transcribe accurately. There are some darker spots and stains on the paper, particularly on the right side.















