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DESCRIPTIVE AND ILLUSTRATED CATALOGUE

OF

THE PHYSIOLOGICAL SERIES

OF

COMPARATIVE ANATOMY

CONTAINED IN

THE MUSEUM

OF

THE ROYAL COLLEGE OF SURGEONS IN LONDON.

Vol. I.

INCLUDING THE ORGANS OF MOTION AND DIGESTION.

LONDON:
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1833.

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Age potius gratias pro his quæ accepisti. Reliqua expecta et nondum plenum te esse gaude. Inter voluptates est superesse, quod speres.—Seneca de Ira, lib. iii. cap. 31.

$\frac{34}{20}$

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PREFACE.

THE surviving friends of Mr. Hunter well remember how deeply the latter period of his life was imbittered by reflections on the imperfect condition of the records and catalogues so essential to the value and utility of his Collection.

It appears, indeed, to have been too much a habit throughout the whole period of its formation, to trust the history of the specimens to memory; and the absence of any adequate system of notation or reference by which they could be recognised was severely felt, when the powers of that mind which had called them into existence began to be shaken by the reiterated attacks of a severe and ultimately fatal disorder. To remedy this deficiency became, therefore, the predominant object of Mr. Hunter's latter years*, and every moment that could be spared from other labours was devoted to the accumulation and arrangement of the materials necessary for the exposition of those vast treasures in every branch of Natural History, in the acquisition of which the greater part of a life of unremitting industry had been spent.

Mr. Hunter's exposition of his Museum would have embraced the anatomy of the whole animal kingdom, so far as it had been investigated by him; and there is ample testimony that few of the forms of animated nature had escaped his scrutiny. It would have contained the summary of his views on the nature of animal life, and his

* He died October 16th, 1793.

opinions on the uses and relations of the several systems of organs, especially of those parts which relate more immediately to the renovation of the individual being, and the reproduction of the race.

The importance which Mr. Hunter attached to a knowledge of the laws of the development of organic bodies, is evinced by the large proportion of the physiological part of his Collection devoted to the illustration of that subject; and the unrivalled Series of Drawings* which he had accumulated for the same purpose, manifests his determination that this portion of his great work should be worthy of a subject the most abstruse and important in physiological science.

The aberrations from the laws of organic formation had no less attracted his attention. His collection of Monstrosities had enabled him to commence a classification of them; and it appears from a manuscript note, in the remaining Hunterian records, that he had advanced to the enunciation of at least one of the laws which regulate these productions†.

The application of his anatomical knowledge was not, however, confined to the elucidation of the œconomy of the individual, or of the relations of particular systems of the animal body; but he had ever in view the affinities subsisting between species, as indicated by the

* The following remarkable passage occurs in the Introduction to the Description of the Drawings relating to Incubation. "If we were capable of following the progress of increase of the number of the parts of the most perfect animal, as they first formed in succession, from the very first, to its state of full perfection, we should probably be able to compare it with some one of the incomplete animals themselves, of every order of animals in the creation, being at no stage different from some of those inferior orders; or, in other words, if we were to take a series of animals from the more imperfect to the perfect, we should probably find an imperfect animal corresponding with some stage of the most perfect."—*Hunterian MSS.*

† "I should imagine that monsters were formed monsters at the very first formation, for this reason, that all supernumerary parts are joined by their similar parts, viz. a head to a head, &c. &c."—*Hunterian MSS.*

totality of their vital instruments, grouping together under expressive terms animals so allied to each other, and thus laying the foundations of a natural system of arrangement*.

Neither were living species and their phænomena the exclusive objects of Mr. Hunter's study. His attention was also directed to the extinct races of the Animal Creation; and although the investigation of their remains was among the latest of his labours, his collection of Fossils, at the period of his decease, was the largest and most select of any in this country, and his posthumous Paper in the *Philosophical Transactions*, and the "Introduction" to the MS. Catalogue of this part of the Collection, prove how fully he estimated their importance.

As a considerable portion of Mr. Hunter's Collection consisted of specimens of diseased parts, the symptoms attending the formation of which he had, for the most part, himself witnessed, it may be inferred that the practical utility of his Exposition of the Collection would not have been inferior to its scientific excellence. The histories of these specimens, without which it is difficult to assign to them their importance, would have come forth enriched with all the physiological and therapeutic deductions which the matured reason and enlarged experience of the Founder must have suggested; and perhaps his peculiar and greatest merit consists in his constant endeavour practically to apply the extensive and varied knowledge which he possessed to the improvement of the noblest of sciences, to the amelioration of the condition, and the relief of the sufferings of his fellow-creatures.

That this is no exaggerated outline of the great Work which Mr. Hunter had commenced, is manifested both by the materials in order to its completion which still remain in the Collection, and by the list of other MSS. which were known to have existed at the period of his decease. It would now be of little utility to enter upon the causes of

* See p. 134, Plates IV. V. VI. Anatomy of the "*Soft-shelled*" Mollusks of Mr. Hunter, or the *Tunicata* of Lamarck.

the long delay that has occurred in the application of these materials to their original purpose ; but the principal difficulty at the outset arose undoubtedly from the absence of the necessary references in the MSS. to the respective specimens, and the consequent necessity of a patient comparison of the latter with existing descriptions, and, in the case of the specimens of comparative anatomy, with the results of repeated dissections.

So far as the present volume of the Catalogue extends, this desirable labour has been completed: the original manuscripts that remain have been scrupulously applied to the elucidation of this department of the Collection ; and in addition to these records, passages from Mr. Hunter's published writings have been added wherever they tend to render more intelligible the descriptions of individual preparations or the subjects of the series. The same system will be adhered to throughout the whole of the present exposition, which will thus become as nearly as possible the work of Mr. Hunter himself. His principles of arrangement will continue to be adopted wherever they are laid down, and when not expressly indicated, the preparations will be so disposed as to accord with his general physiological doctrines.

The materials for the formation of this Catalogue consist,—first, of MS. Lectures, and Notes of Dissections of Animals by Mr. Hunter, partly copied by the Conservator of the Museum from the original MSS., prior to their passing into the hands of Sir Everard Home, and partly from such other Hunterian MSS. as, since the decease of Sir Everard, have been for that purpose temporarily entrusted to the College:—secondly, of a small Catalogue by Mr. William Bell*, of about six hundred preparations of Comparative Anatomy, entered

* An excellent anatomist and accomplished draughtsman who lived fourteen years in Mr. Hunter's house, principally occupied in making anatomical preparations and drawings. He is the author of the papers on the Double-horned Rhinoceros, and the

successively as they were made :—thirdly, of a later Catalogue, consisting of several fasciculi in quarto, also principally in the handwriting of Mr. Bell, but revised and corrected by Mr. Hunter.

The peculiar value of the last-named Catalogue consists in the Introductory Observations to the several Series of Preparations explanatory of the Founder's physiological doctrines, and of the arrangement intended to have been adopted in illustration thereof. The special descriptions generally include but a small proportion of each series, and vary as to minuteness and extent, but for the most part clearly indicate the main object and most interesting feature in the preparation.

Another aid to the identification of the preparations of Comparative Anatomy is a Catalogue of a Series of Drawings * chiefly taken from them, and intended to illustrate their exposition. The arrangement and descriptions of these drawings formed the last of Mr. Hunter's labours ; and while they afford the most satisfactory elucidations of the preparations delineated, they serve as a guide to the general distribution of the whole.

Such, then, are the means of identifying the specimens from genuine and original Hunterian documents.

In their application to this purpose the manuscripts are found chiefly defective in the names of the animals from which the preparations

Chætodon (*Platax*) *arthriticus*, published in the 83rd volume of the *Philosophical Transactions* (1793). He died at Sumatra, in the service of the East India Company, in the year 1792.

* The greater number of the drawings were made by Mr. William Bell ; those of an earlier date are by John Van Rymsdyk, the artist employed by Dr. William Hunter in his great Work on the Gravid Uterus.

It is the intention of the College that a selection from these drawings shall be engraved to illustrate the present Catalogue. To those which accompany this volume are appended the original descriptions by Mr. Hunter, and such additional observations as the present state of science seems to require.

have been taken ; the absence of which information is, and must continue to be, the principal source of difficulty and delay.

In the Vertebrate classes a generic or ordinal term is, with the exception of the domesticated species, for the most part the sole guide to the attainment of this essential particular in the description of the preparation : but with respect to the Invertebrata, which have afforded a very large proportion of the preparations in the Gallery, the indications of the species dissected by Mr. Hunter are still more vague and uncertain. Nor can Mr. Hunter be justly blamed for the want of this kind of information : many of the animals he dissected were unknown to naturalists at that period, and, consequently, were without cognizable or scientific denominations. Linnæus's method, the true *filum Ariadnes* in threading the labyrinth of organic nature, and determining its component elements—the species, was but just beginning to diffuse its salutary influence over Natural History, and its practical application was known to very few in this country. Even on the Continent, at the period of Mr. Hunter's death, the illustrious Pallas presented almost the sole example of a combination of the exactness of the new zoological science with the pursuit of Comparative Anatomy.

During the preparation of the Catalogue of undissected Animals, a collection of works on Natural History was indispensable ; and the determination of those specimens became a necessary preliminary to the descriptions of the preparations in the Physiological Series, which are frequently found to be dissections of the same species.

The excellent Library in this College, in part provided for that purpose, affords therefore the greatest assistance in identifying the more entire specimens of the dissected animals. But the greater number being more or less mutilated in parts of the body from which the zoological characters are derived, the points of comparison are necessarily limited, and a satisfactory identification from books sometimes entirely precluded. The assistance derivable from the same source in ascertaining the species to which the unnamed specimens of detached organs belong, is still more casual and uncertain ; so that in their elucidation it is necessary to consult the book of Nature.

More than two hundred dissections have been made with this view, especially of such animals, as, from any indication in the MSS. it appeared probable had afforded a doubtful specimen ; and many which were before unknown have been in this way identified. Until lately, the means of instituting these comparisons, were few, and depended on the casual acquisition of animals from uncertain sources. But since the institution of the Zoological Society of London, a more ample scope for the investigation of Comparative Anatomy has been opened, and the College is deeply indebted to the Council of that Body for the liberality with which they have afforded those desirable materials for the progressive inquiries.

By these aids the difficulties which have been encountered in the prosecution of this Work have been in a great measure overcome ; and it is confidently expected that few of the preparations will ultimately be found deficient in that part of their history which is most essential to their utility.

The department of the Hunterian Collection to which the present Catalogue relates, is devoted to the illustration of the highest branch of Natural History—the science of life itself.

It consists of dissections of plants and animals in which the structures subservient to the different functions are skilfully and intelligibly displayed.

These structures are taken from every class of organized matter, and are arranged in Series, according to the function, in the order of their complexity, beginning with the simplest form, and exhibiting the successive gradations of organization to the most complex.

The Series are disposed in two divisions,—first, those illustrative of the functions which minister to the necessities of the individual; and secondly, those which provide for the continuance of the species.

The first Division commences with a few examples of the component structures of organic bodies, and then extends into a Series embracing the active and passive apparatus for progressive motion. It is succeeded by analogous Series, illustrative of the functions of digestion, nutrition, circulation, respiration, and excretion,—or the functions immediately connected with the internal œconomy of an organic being. Then follow the organs which bring the individual into relation with the external world, viz. the nervous system and organs of sense, which are the peculiar characteristics of the animal kingdom. After these come the parts which complete the system of an organic body, as respects itself, such as the connecting and adipose tissues, and the various modifications of external covering; and lastly, those instruments which, not being immediately related to any of the vital or animal functions, constitute peculiarities in the œconomy of particular species.

The second Division commences with Series of the generative organs of plants and animals, in the passive and unimpregnated state,—first, of such as complete the function of generation by the simplest kind of hermaphroditism; second, of those in which a necessity for reciprocal impregnation co-exists with the possession of both the sexual systems in the same body; and lastly, of the male and female organs as they are exhibited separately in distinct individuals. The next Subdivision contains the female organs in a state of fructification or impregnation; it exhibits the generated organism in its different stages towards mature development, together with the various temporary structures destined for its support during fœtal existence: and lastly, the organs in the parent which supply the young with food, or afford it shelter, during the helpless period of its existence.

The Collection, of the scope of which the above is a brief summary, includes 3745 anatomical specimens of that kind which require the utmost skill and science in their preparation, and the greatest care and expense in their preservation.

That Mr. Hunter, however, regarded it but as an approximation to an adequate display of the general plan which pervades organic nature, is to be inferred, from the earnest assiduity with which, to the last day of his existence, he laboured towards its perfection.

Some deficiencies he has himself noted, and occasionally has indicated the animal in which would probably be found the intermediate gradation of structure necessary to complete a series. The additions, therefore, have been prepared in exact accordance with those indications, and always, it is hoped, in harmony with the Founder's original design.

As it is important to the history of physiology, and just to the memory of Mr. Hunter, to maintain the integrity of his Collection, these additions are so marked that they are at once readily distinguished from the Hunterian specimens, and the original condition and connexion of the latter left undisturbed. They bear the same numbers (but in a different colour,) as the Hunterian specimens which they respectively follow, and are further distinguished by an added letter.

These additions include, among other interesting specimens, parts of those remarkable animals which have been discovered, and the anatomy of which has been recorded in the *Philosophical Transactions*, since the decease of Mr. Hunter, as, *e. g.*, the *Ornithorhynchus*, *Echidna*, *Dugong*, *Squalus maximus*, &c.; and the names of the individuals to whom science is indebted for these preparations are subjoined to their respective descriptions.

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CATALOGUE.

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Division I.

ORGANS IN PLANTS AND ANIMALS FOR THE SPECIAL PURPOSES OF THE INDIVIDUAL.

Subdivision I.

ORGANS OF MOTION.

Series I. Component Parts of Vegetables and Animals.

" *On Physiology.*

" BEFORE we give any idea on this subject, we should consider the matter of which an animal consists, otherwise we should confound common matter with animal matter, though they are widely different from each other.

" It is merely from our senses that we come at the knowledge of matter, and also it is by matter alone that we come at the knowledge of our senses; for the senses might exist, and yet a man not be sensible of matter, if no impression was suffered to be made upon his senses.

" Matter, of itself, is an abstract idea; for it is not the matter itself that makes the impression on our senses, but the effects of matter. Thus, when we look at a man, it is not the matter of the man which makes the impression on our senses, but the different shades of light that are reflected on our retina. Also, when we hear a drum beaten, our sensations are not excited by the drum, but by the vibrations of air produced by the strokes on the instrument.

"The properties of matter also act upon our senses. The sensation of sweet and sour are not the effects of matter, but of the properties of matter upon the tongue. Touch arises from resistance in matter.

"Animal and vegetable matter are only different modifications of common matter. Common matter has no power of action within itself; but animal and vegetable matter, besides possessing the properties of common matter in general, have a power of acting and performing many changes and operations within themselves, and of producing or generating matter of their own kind from themselves. But though they both have a power of performing operations within themselves, and of generating from themselves, in other respects they greatly differ.

"The operations of both animals and vegetables are attended with waste of their component parts. This waste is recruited by a supply of common matter: but common matter cannot be immediately converted* into animal substance: the decay of animal substance cannot be supplied from common matter until it has by certain changes been altered into animal or vegetable matter. Vegetables can immediately convert common matter into their own substance, and be supplied from it, but animals cannot; which proves that animal matter is still further removed from common matter than the vegetable."

John Hunter, MS. Lectures on Surgery, Lect. II.

Sub-series 1. Vegetable Matter.

No.

1. A cutting from a currant-bush, which exhibits at one view the cuticle and bark, the radicles and the stem, the leaf and leaf-stalk, buds, &c.

* "The circumstance of worms, &c. which feed upon earth would seem to afford an exception to this position: it is likely, however, that the earth they take in is only useful so far as it contains animal and vegetable matter. In order to determine this, we should combine an alkaline salt with earth which will destroy any animal or vegetable matter it contains: then wash it thoroughly, and try if a worm will live upon it."

2. Animal Matter.

2. Blood as it coagulates after extravasation.

3. Muscle. [From an ostrich.]

4. Tendon. [From the leg of an ostrich.]

5. Elastic Ligament. [The ligamentum nuchæ of a calf.]

6. Cartilage. [The thyroid cartilage of a turtle (Chelonia Mydas, *Brongn.*)]

7. Bone. [Lumbar vertebræ and os sacrum of a quadruped.]

8. Gland. [The kidney of a lion.]

9. Brain. [Of the Lemur Mongoz.]

10. Nerve.

11. Cellular or connecting membrane. [Portion of the human scrotum.]

12. Investing membrane. [Portion of the human testis, surrounded by the tunica vaginalis.]

13. Cuticle. [From the hand of a child.]

14. Calcareous earth. [The camp olive (Oliva porphyria, *Lam.*)]

15. Oil. [Portion of the skin and fat of a porpesse (Phocæna communis, *Cuv.*)]

Series II. Sap and Blood; their different kinds.

16. Sap of the willow (Salix capræa) coagulated naturally, or inspissated.

17. Sap of the willow coagulated chemically, or precipitated, by means of the super-acetate of lead used in the form of Goulard's extract.

18. Sap of the willow similarly treated.

19. Sap of the willow similarly treated.

20. Sap of the onion (Allium Cepa) coagulated.

21. Sap of the onion, showing the same circumstance.

22. Blood of the lobster (Astacus marinus, *Fab.*) coagulated; as an example of limpid or colourless blood.

"The red part of the blood I choose to consider last, although it has been more the object of attention than the other two, because I believe it to be the least important; for it is not an universal ingredient in the blood of animals, like the coagulating lymph, and the serum, neither is it to be found in every part of those animals who have it in the general mass of their blood.—The blood of the insect tribe is free from any red parts, as is probably that of most animals below them, yet it has been asserted, and supposed, that their blood contains globules, although not red. I have examined the blood of the silk-worm, lobster, &c. and with considerable magnifying powers, but never could discover any thing but an uniform transparent mass." *Hunter, On the Blood,* 4to, p. 40.

23. Blood of a turtle coagulated; as an example of red blood from a cold-blooded animal.

23 A. Human blood coagulated after extravasation. *Prepared in* 1831.

23 B. A portion of a coagulum of human venous blood, which has been immersed in red size injection, and in that state put under the receiver of an air-pump. The section of the coagulum shows the extent to which it has been penetrated by the injection, which is supposed to occupy canals made by the escape of bubbles of carbonic acid gas during the action of the air-pump. The preparation has been dried and preserved in oil of turpentine. See *Philos. Trans.* cviii. pp. 189—190. pl. xi. fig. 1—2. *Donor,* Sir Everard Home, Bart. V.P.R.S. &c. &c.

23 C. A portion of a coagulum of human venous blood, similarly treated. *Donor,* Sir E. Home, Bart.

23 D. A portion of a coagulum of human arterial blood, similarly treated; but preserved in spirit of wine. *Donor,* Sir E. Home, Bart.

24. Serum of human blood, coagulated by heat.

25. Fibrin or coagulated lymph of human blood, from the left auricle and pulmonary veins.

26. Coagulated lymph from the pulmonary artery.

27. Coagulated lymph from the pulmonary artery.

Series III. Parts of Vegetables having evident Motions.

Of Motion in Vegetables.

All plants are not endowed with evident motion, many being perfectly at rest, having no actions going on in them but those of simple growth, which is the most simple state in which we can conceive life to exist.

Some, however, have motions produced in parts of them, from particular causes, as the rising or setting of the sun, &c. Others are affected by the touch, so as to be immediately put into motion. Some have diurnal motions going on regularly and uninterruptedly, but so exceedingly slowly, as to be with difficulty perceived: others, again, have constant motions, at least through the day, going on so quickly as to be easily detected by the eye.

On what circumstances these motions immediately depend,—whether they arise from the action of structures formed for this purpose, or from a series of contiguous structures so conjoined as to produce the effect by their successive motions, we are at present ignorant. It is probable, however, that the power is analogous to the irritability of animals.

28. One of the ternate leaves of Erythrina corallodendron, to show the part between the leaflet and petiole in which the motion of the leaflets takes place after sunset.

"There is an action in plants which appears to be the contrary of expansion; it may be considered as a relaxation, or an action of those parts antagonizing the others which acted through the day, or at other periods, and it takes place at the time these other parts cease to act.

"This action has hitherto been considered as analogous to sleep in animals; whereas, sleep is a total loss of the sensitive principle, and all the actions dependent on volition for the time; and, therefore, can only take place in animals endowed with sensation. It is rather a defect in the animal, than an action, or the exertion of a principle."

John Hunter, MS. Croonian Lectures, No. I.

[The various actions that take place in plants at the close of day, are described by Linnæus in *Amœnitates Academicæ*, iv. p. 333, under the title *Somnus Plantarum.*]

29. A branch of Mimosa pudica, with two leaves; one of them is in the expanded state; the other contracted, but erect.

[Although one only of the pinnules be touched, the contractile movement is quickly propagated along the other three: it consists of an approximation of the upper surfaces of the opposite subleaflets to each other, with an overlapping of those of the same side.]

30. A portion of a branch of Mimosa pudica, with the leaf bent down, in consequence of the action that takes place at the intumescent part of the joint. The leaf-stalks at the middle and lower part of the preparation appear to have been in the act of recovering their erect position when the branch was removed. The intumescence at the joints, in which the motive power resides, is well seen in this specimen.

"To see if the actions of plants were affected by a continuation of stimulus similar to those of animals, I made the following experiments. As I took for granted that the analogy would go no further than the actions produced by external stimuli, my experiments were only such as had a tendency to these."

——"For the purpose of making my experiments, I took three sensitive plants, having several others for any comparative experiments which might be thought necessary. I first pitched upon one leaf in each plant which was capable of the greatest motion of collapsing and erection; and behind each of these leaves a board was placed, on which was marked the greatest extent of the two motions; so that the leaf was like the index or radius of an arc.

"To have the greatest part of the day before me, I began my experiments at eight in the morning, while the leaves were in full expansion; and I continued them till four in the afternoon; as longer than this would not have been just, for they begin to collapse of themselves between five and six o'clock."

[The leaves were stimulated to act five times during that period; and the point to which each leaf fell, the time it took to rise, and the point to which it rose, were carefully registered.]

" From these experiments we may draw the following conclusions :—

" That there is no fixed time for any of the leaves of the plants to move through its course.

" That they are less affected as they become accustomed to the stimulus; but the power of collapsing is increased (although not in the same degree), so that they do not move through the same arc.

" That they require a stronger or quicker stimulus to produce motion after being some time accustomed to it; which was evidently seen in comparing these with others which had not been stimulated.

" It may also be observed, that when these plants collapse in the evening, they have nearly the same quantity of flexion as when roughly touched at noon: but if touched after they have collapsed from the effect of the evening, they become much more bent than by the same [degree of] touch at noon. This would seem to arise from a disposition to collapse in the evening, and a power of increasing that disposition and action when stimulated.

" Their collapsing more in the day, and erecting themselves less after a repetition of such actions, may assist in explaining the principle on which this depends." *John Hunter, MS. Croonian Lectures, No. I.*

Subsequent experiments on this subject have been made by Mr. Lindsay (Paper read before the Royal Society, A.D. 1790.), by Dr. Dutrochet (*Journ. de Phys.* xcv. p. 474.), and by Professors Mayo and Burnett (*Outlines of Physiology*, p. 11. 2nd ed. and *Quarterly Journal of Science*, xxv. p. 434.), which prove, "that the tuber at the articulation of each leaf with the stalk is formed by antagonist elastic springs, the superior serving to depress, the inferior to elevate the leaf; for, if the upper part of the intumescence be cut through, the leaf rises more than natural, and no irritation however violent can cause it to collapse; that if the under part be divided, the leaf falls, and by no extent of rest will it again be enabled to rise; also the lateral parts being cut, a lateral flexion is caused towards the wounded side. Similarly acting organs exist at the articulations of the pinnules, and of the leaflets; only in the one case they are placed laterally, and in the other diametrically opposite to their position on the leaf-stalk: their motions are in accordance with this change of place, and by similar operations may be interrupted." *Journal of Science*, p. 435.

30 A. Two leaves of Dionæa Muscipula, in one of which the terminal lobes are expanded, in the other closed. These appendages are armed with long spines on their edges, and have sharp points on the middle of the upper surface, from which a fluid substance attractive to flies is secreted; but the moment an insect alights on this part, the lobes close, and destroy by pressure and impalement the stimulating cause.

Donor, Sir E. Home, Bart.

31. Leaves of Hedysarum gyrans, in which the small lateral leaflets have a power of moving up and down, with a varying degree of velocity, and without any mutual uniformity or co-operation. These motions take place independent of external stimulus.

32. A branch of Hedysarum gyrans, with tendrils of Passiflora winding round it.

Series IV. Structure of Muscles.

"The most simple mode of investigating an animal body, is, first to consider the matter of which it is composed. In this inquiry we shall find it more than probable that there is but one species of matter which is peculiar to animals, and therefore I shall call it animal matter.

"The blood appears to be the most simple modification of this matter. It is the material out of which all the solids are composed.

"The next modification, or what may be called the simplest organization, is a certain arrangement of this matter, so as to produce some action. This may be of two kinds; first, such an arrangement as may take place in any kind of matter, of which elasticity is one: the second is such as is capable of producing a motion in itself, without the cause being mechanical as in elasticity; this is the composing of a muscular fibre.

"A muscular fibre is one of the simplest constructions of an active solid; and it is these fibres which compose almost the whole of many animals." *John Hunter, MS. Croonian Lectures, No. IV.*

1. *Muscular Fibre.*

33. A portion of muscle from the neck of a Bull, which has been boiled, and the connecting cellular membrane, vessels, and nerves, removed from the lower part, and the simple muscular fibres there unravelled.

34. The biceps flexor cubiti muscles from the arms of a Negro. That of the right side is in its natural state, the other shortened one half of its length, in consequence of the os humeri of that arm having been fractured obliquely, and having become united with the fractured ends of the bone riding on one another. After the union of the bone, the biceps (together with the other muscles of the arm) became shortened by the interstitial absorption, so as to correspond with the diminished length of the bone, and the arm regained its natural action.

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The following history of the case is given by Sir Everard Home, in his *Lectures on Comparative Anatomy*, 4to. 1814. p. 41.

"A Negro about thirty years of age, having had his arm broken above the elbow-joint, the two portions of the os humeri were unfortunately not reduced into their places, but remained in the state in which they were left by the accident, till the bony union had taken place: so that when the man recovered, the injured bone, from the position in which the fractured parts were left, was shortened almost one half of its length. From this circumstance, the biceps flexor cubiti muscle, which bends the fore-arm, was so much longer than the distance between its origin and insertion, that in the most contracted state it could scarcely bring itself into a straight line; this muscle however, in time, as the arm recovered strength, adapted itself to the change of circumstances by becoming shorter, so as to correspond to the diminished length of the bone; and by acquiring a new contraction in this shortened state, it was enabled to bend the fore-arm.

"Some years after this accident the person died, and the circumstance above mentioned being known, the parts were examined with particular attention: the biceps muscles of both arms were carefully dissected out, and being measured, the one was found to be eleven inches long, the other only five, so that the muscle of the fractured arm had lost six inches, which is more than half its original length: and is distinctly seen in the preparation."

See also *Mr. Hunter's Lectures, delivered by Mr. Home,* 1794-5, MS. p. 156.

35. A portion of the gastrocnemius muscle, injected, dried, and put into oil of turpentine to show its vascularity, on which depends its red colour.

" A muscle, in all animals, is in itself white; and its red colour, found in living animals, and also immediately after death, arises from the blood; for if a red muscle be steeped in water, it will become white; or if the arteries of a part which has red blood be injected with water till it returns by the veins, the muscles soon become white. A red muscle exposed to the air, loses the Modena red, becoming florid."

John Hunter, MS. Croonian Lectures, No. II.

36. Portions of muscle from a Cod-fish (Gadus Morrhua, *Linn.*) which have been steeped in an acid, and reflect iridescent colours in some lights.

2. *Disposition of Muscular Fibre.*

" Muscles are more or less complex, arising generally from the different dispositions of their fibres, which difference is owing to the manner of their arising and being inserted, more particularly the former; and hence we say muscles are straight, broad, radiated, half-penniform, complete-penniform, and complex.

" The most simple muscle would be one whose fibres are in the direction of its body, or in a straight line between the two resisting points, and should be called rectilineal; but there is not in the human body a muscle truly rectilineal; and from what has been observed of the disposition of the muscles and their tendons, and also of their origins, it is hardly possible to have one.

" The straight muscles have fewer fibres, in proportion to their size, than the oblique; therefore their powers are less: some are round, or nearly so; others are flat and broad; some of these last are radiated.

"The half-penniform muscle, although nearly as simple as any in the body, appears to be the first stage towards combination: it is composed of a series of fibres arising from a bone, tendon, or fascia, but more commonly a tendon, of which the insertion runs nearly parallel to the origin, representing a quill with the feathers of one side taken off. This disposition of fibres, from the mode of origin or general disposition of the bones and fascia above described, is almost as common as any in the body.

"The complete-penniform muscle is two half-penniform muscles joined together.

"The complex muscle is several complete-penniform muscles united into one.

"There are many half-penniform and complex muscles in the human body, but hardly one instance of a distinct complete-penniform muscle.

"In proportion to their combination their fibres are shorter, and a greater number in a given size, which must make them proportionally stronger." *John Hunter, MS. Croonian Lectures, No. IV.*

37. A portion of the diaphragm of a Child, injected, dried, and put into oil of turpentine, to show the radiating disposition of the muscular fibres.

37 A. A portion of the sartorius muscle of the human subject, to show the parallel straight direction of the muscular fibres.

38. A section of a muscle, consisting of a single series of oblique fibres, constituting the half-penniform muscle.

39. A section of a muscle, consisting of a double series of oblique fibres, constituting the complete-penniform muscle.

40. A section of a penniform muscle.

41. A section of a penniform muscle.

42. A section of a muscle, in which the fibres are disposed obliquely in several double series, with tendon intervening; constituting the complex muscle.

43. A longitudinal section of a complex or multi-penniform muscle.

44. A transverse section of a complex muscle, to show the intermixture of the carneous and tendinous fibres.

45. A transverse section of a complex muscle.

46. A section of a hollow muscle:—example a gizzard. A transverse section of the two muscular bellies and their uniting tendons. This specimen is from the Negro Fowl (Gallus Morio, *Temm.*).

3. *Tendon.*

—— "There are also parts called tendons, which are the medium of union between the different parts of the machine and the powers. They have hitherto been considered as belonging to the powers, but I shall rather consider them as a part of the machine itself.

"A tendon is a peculiar substance placed between some muscles or powers, and the parts of the machine to be acted upon by such powers. It is composed of white fibres placed parallel to each other, forming a chord which is extremely flexible, has no sensible elasticity, and is much smaller than the power to which it is attached. Its figure is in general a little rounded; sometimes, however, rather flattened, and in many situations it is broad and thin. In all cases it is extended between the body to be moved and the power. It is sometimes spread out in breadth, and is then called Fascia: this form answers various purposes: its fibres in some situations run pretty parallel, but in general they are interwoven. It has flexibility, strength, and convenience in size. The application of this substance is extremely extensive, complicated, and various."

John Hunter, MS. Croonian Lectures.

47. Portions of tendons from the leg of an Ostrich (Struthio Camelus, *Linn.*), which have in this animal an unusually brilliant lustre.

48. The gizzard of the Negro Fowl, in which the whole of the skin and periosteum are of a violet black colour. The tendons are covered by a similar pigment, which still remains, and indicates the extent of the lateral tendon on one side of this preparation; but has been partially removed from the opposite side, to show the ordinary glistening appearance of the tendon beneath.

49. A tendon from the leg of a Calf, injected, dried, and put into oil of turpentine, to show its small degree of vascularity.

49 A. The tendo Achillis, injected, with part of the gastrocnemius muscle, to show by contrast the difference in the vascularity of these parts.

Donor, Sir William Blizard.

Series V. Application of Muscles.

In the most imperfect [or simplest] animals it is very probable that there is no difference in the structure of parts [of the body]; no fixed parts, so as to divide and determine the motion of the animal to those parts, similar to bones in others; but that the whole is principally muscular, like the urinary bladder, or an intestine. But where animals become more complicated, and have various motions, especially progressive, then the motions become more divided, more partial; for which purpose it is necessary that there should be parts, whose firmness of structure and mode of attachment should divide these motions and determine them to the particular parts.

This structure is different, in different animals: in the caterpillar, the earthworm, the nereis, this structure is the skin: it is divided into rings, all of which have motion on each other, and into each are muscles inserted, so that a variety of motions are produced. If the whole act, the animal is shortened; if the whole from end to end act only on one side, the animal is bent; but if a succession of motions from one end to the other takes place, then progressive motion is produced.

In the insect, when arrived at its perfect state; in the lobster, spider, &c., whose parts are still more complicated, and answering a greater variety of purposes, we find this substance still firmer, and of different texture: thus in the flying insect and spider, it is horn; in the lobster, &c. it is bone. In them, too, it makes the covering of the animal; but besides these, there are processes going inwards for the attachment of muscles.

In amphibia, lizards, snakes, &c., there is another, or internal apparatus for motion, besides the external; so that they have both the external [skeleton] which we have described, and another internal [one].

In the more perfect animals these external parts are almost entirely wanting, and make hardly an external part of the animal for motion, so that the muscles and their attachments change sides: this is peculiar to fishes, birds, and quadrupeds.

50. A transverse section of the valves of an Oyster (Ostrea edulis, *Linn.*), showing the adductor muscle, and the disposition of its fibres at right angles to the shell.

51. The lower flattened valve of an Oyster, showing by a transverse section the extent and shape of the adductor muscle.

52. The valves of a Cockle (Cardium edule, *Linn.*), divaricated to show the application of the fibres of the two adductor muscles.

53. A fresh-water Muscle (Anodon cygneus, *Sowerby*), of which part of the mantle-valve is removed, and the mantle dissected away, to show a pair of muscles going obliquely from the body of the animal to their points of insertion in the valves. A bristle is placed between them.

54. The calcareous tube of an Acorn-shell (Balanus sulcatus, *Lam.*), laid open to show the attachments of the muscles to the moveable opercular valves.

55. Part of the margin of a large Medusa (Rhizostoma cerulea, *Cuv.*), on the inferior edge of which, the membrane is disposed in numerous minute plicæ, running in the direction of the circumference, and giving to it a fibrous or muscular appearance.

56. A Holothuria (Holothuria tubulosa), laid open to show fasciculi of muscular fibres disposed in pairs and traversing the body longitudinally; being attached along the whole of their exterior surface to the thick coriaceous integument. In the intervals there are transverse fibres.

57. A Leech (Hirudo medicinalis, *Linn.*), having part of its external tegument dissected off to show its longitudinal subcutaneous muscles.

58. Portion of a Nereis (Lycoris foliosa, *Catal. Nat. Hist. No.*254.), showing two

series of muscles, which extend along the dorsal aspect from one end of the animal to the other: these are intersected at regular distances, corresponding to the breadth of the segments, so as to determine the action of the animal to such parts.

59. A section of the larva of a large North American Moth (Bombyx regalis, *Fabr.*), showing two lateral series of muscles, which extend along the dorsal and ventral aspects, through the whole length of the body. These are intersected at determinate distances, corresponding to the several segments to which they are to give motion.

60. A section of the claw of a Lobster, showing the fibres of the penniform muscle arising from the manus and inserted into the tendon of the pollex or moveable claw.

61. A section of the pollex and manus of the claw of a Lobster, showing the attachment of the penniform adductor in another point of view.

62. The stem of the Eared Barnacle (Otion Cuvieri, *Leach.*), deprived of its external theca to show two series of oblique muscular fibres which arise from a central line or tendon on one side of the stem, and, winding spirally round, are inserted into a similar line on the opposite side of the stem. Beneath these oblique fibres, whose office is to compress the peduncle, others may be observed which are longitudinal, for the purpose of shortening the peduncle.

63. A transverse section of one of the arms of a large Cuttle-fish (Onychoteuthis, *Lichtenstein*, *Isis von Oken*, A.D. 1818, tab. xix. See also Loligo Banksii, No. 166 D. *Catal. Nat. Hist.* p. 33.), showing the complex arrangement of the muscular fibres.

64. A portion of the upper part of the œsophagus of a Lion, showing the disposition of the muscular fibres; those of the outer layer running obliquely, but in different directions, like the fibres of a penniform muscle; the fibres of the inner layer also running obliquely, but in directions the reverse of the outer fibres.

Series VI. Application of Elastic Powers.

1. *As an Antagonist to Muscle.*

"Where constant action is not necessary, muscles alone are employed, as in the greater number of moving parts in most animals; and where any position is required to be constant, and the motion only occasional from being seldom wanted, there elasticity is alone employed for the purpose of constant position, and muscles for the occasional action.

"Some bivalves (as the oyster,) have a strong muscle passing between the shells, for closing them occasionally; but for opening them, no muscles are made use of, as this is performed by an elastic ligament in the joint of the two shells, which is squeezed, when shut, by the contraction of the muscle; and when the muscle ceases to contract, the elasticity of the ligament expands it, so that the shell is opened."

Hunter, On the Blood, 4to. 1794. p. 111.

65. A longitudinal section of the valves of an Oyster, to show the adductor muscle, and its antagonist the elastic ligament at the hinge, above described.

66. A transverse section of the connecting ligament of the valves of a fresh-water Muscle, showing that its structure is fibrous, the fibres being perpendicular to the plane of the shell, and converging towards the centre; so that when the shell is closed, these fibres are in a state of compression, and consequently have a constant tendency to antagonize the adductor muscle, open the shell, and retain it in that state, independent of any muscular action.

67. A longitudinal section of the same ligament, made by dividing the valves from one another.

68. A section of the stem of the Eared Barnacle, showing the semitransparent elastic external theca, which has a constant tendency to rectify the position of the peduncle, when it is inflected by any action of the muscular fibres which it incloses.

69. An Eared Barnacle, with the elastic theca removed from one side, and the longitudinal and oblique muscles turned down from the stem. The tentacula and the muscles which move them are also exposed.

2. *In aid of Muscular Action.*

Animals which have long necks, more especially those whose necks stand in some degree horizontal, or at least project beyond the body, have elastic ligaments placed on the upper side to support the head and neck; so that the muscles have less power to exert in the motion of the head and neck, these ligaments keeping them in a kind of equilibrium. In birds these ligaments are placed between what may be called the roots of the spinal processes, viz. as far towards the posterior surface of the vertebra as possible, so as to be behind the centre of motion of each vertebra: but in quadrupeds, whose necks are much deeper or broader, and whose spinal processes of the back rise high, so as to give origin to muscles, &c., these ligaments rise principally from the tips of these processes along the back, and extending forwards towards the neck, pass along its upper edge. In this course they send broad processes into the posterior surfaces of the vertebræ, and are at last fixed in the posterior process of the os occipitis.

This long sweep which the ligament takes in the bend of the neck, is owing to the short ones bending (it) in that direction. The camel is perhaps one of the best instances of this, probably the camelopard, from its having a long neck. The long sweep of ligament is double, but the processes sent down from them are single.

Hunterian MS. Catalogue. See also *Hunter, On the Blood,* 4to. p. 111.

70. Three vertebræ from the neck of an Ostrich (Struthio Camelus), showing the elastic ligaments which pass between the spinous processes, close to the vertebræ.

71. A single cervical vertebra of an Ostrich, showing the attachment of one of these ligaments to the root of the spinous process.

72. Three dorsal vertebræ of an Ostrich, longitudinally bisected, to show a similar

disposition of elastic ligament between the spinous processes of this part of the vertebral column.

73. A portion of ligamentum nuchæ from a Bull.

73 A. A portion of the ligamentum nuchæ of the Alpaca (Camelus Pacos, *Linn.*), in which animal it consists of two parallel rounded chords, and the processes sent off to the spines of the cervical vertebræ remain distinct from each other to their insertion. *Donor*, Mr. Owen.

74. A portion of the elastic ligamentous substance from the belly of an Elephant.

"On the abdomen of most quadrupeds are to be found elastic ligaments, especially on that of the elephant, which is a constant support to the parts in their horizontal position; and even the cellular membrane of the elephant has a degree of clasticity much above what is generally met with in cellular membranes. Hence there is less expense of muscular contraction in such parts." *Hunter, On the Blood,* 4to. p. 111.

75. A longitudinal section of a portion of the aorta of a Horse, in which elasticity and muscular contraction are combined.

Series VII. The different Substances of which the Skeleton is composed.

76. Gelatinous membrane. [The exterior transparent covering of a Salpa laid open; which is the only firm part of the animal for sustaining and protecting its very delicate organs.]

77. Horn. [The feather-shaped substance from the back of the Calamary (Loligo vulgaris, *Lam.*)]

78. Cartilage and gelatinous substance. [A portion of the spine of a Sturgeon (Acipenser Sturio, *Linn.*)]

79. Cartilage combined with calcareous earth. [Phosphate of lime, but only in a very small proportion. The specimen is a portion of the jaw of a Shark.]

80. Membrane and calcareous earth. [Phosphate of lime in a larger proportion,

as bone. The speeimen is the femur of a Negro Fowl, deprived of its dark-eoloured periosteum, and bleaehed white.]

81. Membrane and ealeareous earth. [Carbonate of lime. The substanee ealled Cuttle-bone, from the baek of the Cuttle-fish (Sepia offieinalis, *Linn.*)]

82. Caleareous earth. [The shell of a Cowry (Cypræa Tigris, *Linn.*), consisting almost entirely of earbonate of lime.]

Series VIII. Structure and Growth of Shell.

Shell is a substanee made use of ehiefly as a defenee from external aeeidents; serving the purpose of a retreat, as in univalves, bivalves, and so on; but in some Inseeta, it not only answers this purpose of external eovering, but serves as levers on which the museles may aet so as to bring about progressive motion, and makes an instrument analogous in some measure to a hand, or to teeth; as, for example, in the elaw of the lobster, where it is eonstrueted so as to lay hold of and pineh whatever molests it. *Hunterian MS. Catalogue.*

1. *In Zoophytes.*

82 A. A Madrepore (Meandrina areolata, *Lam.*), the lower part of whieh has been steeped in dilute muriatie aeid, and partially dissolved. The traees of animal matter are hardly to be pereeived. *Prepared in* 1831.

82 B. A Madrepore (Caryophyllia Cyathus, *Lam.*), the upper part of whieh has been similarly treated. *Prepared in* 1831.

82 C. A portion of Caryophyllia sinuosa, *Lam.*, whieh has been similarly treated, and exhibits the animal eonstituent suffieiently organized to preserve the membranaceous form, and in some degree the foliated eharaeter of the Madrepore. *Prepared in* 1831.

82 D. A Madrepore (Oeulina hirtella, *Lam.*), similarly treated, and exhibiting a greater proportion of animal matter; probably, however, from having been inerusted with some sponge. *Prepared in* 1831.

82 E. A Coralline (Diehotomaria, *Lam.*), the terminal joints of whieh have been subjeeted to the action of dilute muriatic aeid, and redueed to their

membranaceous constituent, which retains perfectly the configuration of the entire joints. *Prepared in* 1831.

83. A small mass of red Organ-pipe Coralline (Tubipora musica, *Linn.*), showing the natural colour and disposition of the tubes.

84. A portion of Tubipora musica, which has been steeped in an acid, and thereby deprived of its colour and earthy material. Many of the small polypes may be seen situated at the open mouths of the tubes; and the membrane reflected from them, down the interior of the tubes, may also be traced in a few places.

85. A few of the tubes of the same Zoophyte similarly treated, showing the transverse septa that connect the tubes at intervals of about ten lines.

"The universal and only hardening principle of these madrepores and millepores was proved to be carbonate of lime, with the single exception of *Millepora polymorpha*, which also appears to be differently constructed from other *Milleporæ.* With this single exception, carbonate of lime seems to be the only hardening substance in these bodies; and when every circumstance is considered, an exact similarity is to be found between the substance forming the various shells, and that which forms the *Madreporæ* and *Milleporæ;* and the nature of these bodies is so completely the same, that the changes or gradations of the one are to be found in the other. For the chemical characters which distinguish the porcellaneous shells are in a great measure approached by those of *Madrepora virginea;* and those which were noticed in the *Patellæ* correspond precisely with the Madrepores and Millepores which afford a gelatinous substance; and lastly, the characters of the membranaceous part, exhibited by the shells formed of nacre or mother-of-pearl, are in like manner to be found among some of the Madrepores and Millepores, such as *Madrepora ramea, Millepora fascialis, Millepora truncata;* for these, like the *Turbo olearius* and *Haliotis Iris,* are composed of a fibrous membrane, hardened by carbonate of lime.

"It appears, therefore, that the Madrepores and Millepores, like the various shells, are formed of a gelatinous or membranaceous substance, hardened by carbonate of lime; and the only difference is the mode according to which these materials have been employed.

"The experiments on *Tubipora musica* proved, that in composition it resembled the foregoing substances."

Mr. Hatchett, Experiments on Zoophytes, &c. Philos. Trans. xc. 1800. p. 361.

85 A. A thick stem of jointed coral (Melitæa ochracea, *Lam.*), the lower part of which has been subjected to the action of dilute muriatic acid, to show the reticular disposition of the flattened gristly substance that is interposed between the portions of earthy coralline material.

Prepared in 1831.

85 B. Smaller branches of Melitæa ochracea; one of which has been similarly treated with dilute muriatic acid, so as to show the form of the interarticular substances. *Prepared in* 1831.

85 C. Another portion of Melitæa ochracea, the terminal branches of which have been similarly treated, and exhibit the external membranaceous covering that surrounds the coralline part, and extends from joint to joint. There is scarcely a trace of this membrane to be observed on the larger branches.

Prepared in 1831.

85 D. A branch of Melitæa coccinea, *Lam.*, the terminal divisions of which have been steeped in dilute muriatic acid, to show the gristly nature of the joints, which resist the action of the acid in this, as in the preceding species. *Prepared in* 1831.

85 E. A portion of jointed Coral (Isis Hippuris, *Linn.*), which has been partially steeped in dilute muriatic acid, and there become semi-transparent from the removal of the earthy material. The joints in this coral are of a horny nature, and smaller than the intervening calcareous parts.

85 F. Another portion of Isis Hippuris, the lower part of which has been longer subjected to the action of the acid, and almost reduced to its membranaceous constituent. The terminal branches are covered by the cortical animal part. *Prepared in* 1831.

"Two species of Isis were next examined, namely, Isis ochracea and Isis Hippuris: both of these were proved to be formed of regularly organised membranaceous, cartilaginous, and horny substances, hardened in the last-mentioned species merely by carbonate of lime; but in the Isis ochracea, with the addition of a very small portion of phosphate of lime." *Hatchett, On Zoophytes, ut supra*, p. 362.

85 G. A portion of the axis of Antipathes politum, reduced to its membranaceous constituent by long maceration in acid. A transverse section is suspended, which exhibits the concentric disposition of the membranes.

Prepared in 1831.

" Another species of *Gorgonia* was next examined, the stem of which is from one quarter to nearly half of an inch in diameter in the thickest parts; of a black colour, and a high polish, like black sealing-wax; it has probably been considered as a variety of *Gorgonia Antipathes*.

"This, by immersion during twenty-eight days in dilute nitric acid, gradually became semi-transparent, and of a bright brownish yellow. In this softened state, it was steeped two days in water, and was then opened longitudinally. By this, the whole structure became apparent, and consisted of thin coats or tubes of a beautiful transparent membrane, which, beginning from a central point, progressively became larger, according to the order by which they receded from the centre.

"These membranes were so delicate, that the fibrous texture could scarcely be discerned.

" The acid in which this species had been steeped was tinged with very pale yellow. Ammoniac being added, changed it to a deep yellow or orange colour; but the transparency of the liquor was not disturbed by this or any of the other precipitants which had been employed in the former experiments.

" When this *Gorgonia* was exposed to a red heat, it crackled and emitted a thick smoke, with the smell of burned horn. The shape was soon destroyed, and a compact coal remained. By continuing the red heat, a very small portion of white matter was obtained, which, as far as the quantity would allow, was proved to be muriate of soda, with some carbonate of the same." *Hatchett, On Zoophytes, ut supra*, p. 349.

86. A specimen of Gorgonia.

87. A portion of Gorgonia verrucosa, *Lam.*, the axis of which is only partially covered with the cortical part.

" The results of the experiments on certain *Gorgoniæ* such as *cerato-phyta, Flabellum, suberosa, pectinata,* and *setosa,* were not a little remark-able; for when the two parts which compose these *Gorgoniæ* (namely the horny stem and the cortical substance by which it is coated) were separately examined, it was proved,

" 1st. That the stems of these *Gorgoniæ* consist of a substance analo-gous to horn; and that by long maceration in dilute nitric acid, this horny substance becomes soft and transparent, so as to resemble a carti-laginous or tendinous body; moreover, the stems of these *Gorgoniæ* afford a quantity of phosphate of lime, but scarcely any trace of car-bonate.

" 2. That the cortical part, on the contrary, consists principally of carbonate of lime, with very little or none of the phosphate; and the carbonate of lime is deposited in and upon a soft, flexible, membrana-ceous substance, which seems much to approach the nature of cuticle."

Hatchett, On Zoophytes, ut supra, p. 363.

88. The red Sea-pen (Pennatula phosphorea, *Linn.*), laid open to expose the slender cylindrical internal axis, or bony stem.

89. The kidney-shaped Sea-pen (Renilla violacea, *Quoy & Gaimard,*), one half of which has been subjected to the action of dilute muriatic acid, which has removed the colour; but from the small proportion of calcareous matter in this species, has not visibly diminished the bulk or altered the form of that part.

90. A longitudinal section of the finger-shaped Sea-pen (Veretillum cynomo-rion, *Lam.*). In this species the central axis is almost wholly reduced to a ligamentous structure. Bristles are placed in apparently natural canals, that extend in the direction of the longitudinal axis of the body, and terminate in more expanded cavities within the lesser obtuse ex-tremity.

91. A portion of Lobularia digitata, *Lam.*, of which a section has been made near the base. In this species the firm parts are mere calcareous spicula dispersed throughout the general mass.

92. A similar specimen.

93. A section of a Sponge (Spongia officinalis, *Linn.*), to show its reticular structure. In the sponges, as in the preceding, the hard parts consist of siliceous or calcareous spicula.

——"The various sponges which were afterwards subjected to experiment were proved to be completely formed by the same membranaceous or horny substance, which became varied by the modifications of a more delicate construction, rather than by any essential difference in composition." *Hatchett, on Zoophytes, ut supra,* p. 364.

2. *In Testaceous Animals.*

"In the porcellaneous shells, such as *Cypreæ*, &c., this substance [the animal matter] was proved to be much less in quantity than those which were afterwards mentioned; and although of a quality which (like a cement or gluten) served to bind and connect the particles of carbonate of lime firmly together, so small was the degree of natural inspissation, and so little advanced was the degree of organization, that when the carbonate of lime was dissolved, even by very feeble acids, little or no vestige of jelly, membrane, or cartilage could be perceived; nor indeed could any be detected, but by the small portion of animal coal which was formed when these shells had been exposed for a short time to a low red heat.

"But, proceeding from shells of this description to others tending to the nature of nacre or mother-of-pearl (such as some of the *Patellæ*), a substance was left *untouched by the acids,* which had the appearance of a yellowish transparent jelly*: so that the substance which served merely as a gluten in the porcellaneous shells, was not only more abundant in these *Patellæ,* but being more inspissated was become immediately visible and palpable.

"In the common oyster these qualities were more strongly marked; and in the river muscle, and in the shells composed of the true nacre or mother-of-pearl, this substance was found not only to constitute a large

* "The term jelly is here employed only to denote the degree of consistency of this substance, which in its nature is very different from the varieties of animal jelly called Gelatin."

part of the shell, but even to be more dense, so as no longer to appear gelatinous; and in addition to these, strong and visible marks of organization were stamped on every part, and a perfect membranaceous body remained, composed of fibres arranged parallel to each other, according to the configuration of the shells."

Hatchett, On Zoophytes, ut supra, p. 358.

93 A. A porcellaneous shell (Cypræa Tigris), with the soft parts. One of the lobes of the mantle, the secreting organ of the shell, is protruded.

Prepared in 1831.

94. One of the valves of the common Muscle (Mytilus edulis, *Linn.*), which has been steeped in an acid to dissolve and separate the earthy part (carbonate of lime), and show the animal part retaining the membranaceous form.

94 A. One of the valves of the fresh-water Muscle (Anodon cygneus), which has been similarly treated, and exhibits similar results.

Donor, Charles Hatchett, Esq. 1802.

The following is the process employed by that gentleman in investigating the nature of shell, and of which this and subsequent donations from him are the results:—

"When shells were examined, they were immersed in acetous acid, or nitric acid diluted, according to circumstances, with four, five, six, or more parts of distilled water; and the solution was always made without heat.

"The carbonate of lime was precipitated by carbonate of ammonia or of potash; and phosphate of lime (if present) was previously precipitated by pure or caustic ammoniac.

"If any other phosphate, like that of soda, was suspected, it was discovered by solution of acetite of lead.

"Bones and teeth were also subjected to the action of the acetous or diluted nitric and muriatic acids.

"The dissolved portion was examined by the above-mentioned precipitants; and in experiments where the quantity of the substance would permit, the phosphoric acid was also separated by nitric or sulphuric acid. The phosphoric acid thus obtained, was proved, after concentration, by experiments which, being usually employed for such purposes, are too well known to require description.

"It is necessary moreover to observe, that as the substances examined were very numerous, and my principal object was to discover the most prominent characters in them, I did not, for the present, attempt in general to ascertain minutely the proportions, so much as the number and quality of their respective ingredients.

"The greater part, if not all, of marine shells, appear to be of two descriptions, in respect to the substance of which they are composed. Those which will be first noticed have a porcellaneous aspect, with an enamelled surface, and when broken are often in a slight degree of a fibrous texture.

"The shells of the other division have generally, if not always, a strong epidermis, under which is the shell, principally or entirely composed of the substance called *nacre* or mother-of-pearl.

"Of the porcellaneous shells, various species of Voluta, Cypræa, and others of a similar nature, were examined.

"Of the shells composed of *nacre*, or mother-of-pearl, I selected the Oyster, the river Muscle, the *Haliotis Iris*, and the *Turbo olearius*."

Hatchett, Experiments on Shell and Bone, Philos. Trans. lxxxix. 1799, p. 315.

95. The shell of an Oyster (Ostrea edulis) similarly treated, showing the succession of laminæ of animal membrane, in and upon which the earthy matter is deposited. The flattened valve is suspended:—the concave valve contains the animal.

96. The shell of a common Snail (Helix hortensis) similarly treated. Nothing but the animal part remains, which still retains in some measure the form of the shell.

97. A specimen of an English fresh-water shell (Lymnæa auricularia, *Lam.*). It has been subjected very little, if at all, to the action of acid, but seems rather intended to show how the shell protects the soft parts of the animal.

97 A. Two species of fresh-water shell [of the genus Neritina, *Lam.*:—the lower suspended specimen is Neritina fasciata, *Lam.*]. They have been treated with an acid, as in the preceding examples, but in different degrees. In the specimen which lies at the bottom of the glass, very little of the earthy part of the shell remains.

Donor, Charles Hatchett, Esq.

98. Portions of an Ear-shell (Haliotis), which have been similarly treated.

98 A. Portions of an Ear-shell (Haliotis Iris), which have been more completely deprived of the earthy material. *Donor*, Charles Hatchett, Esq.

98 B. The shell of Haliotis tuberculata, *Linn.*, part of which only has been steeped in an acid, to show that the animal matter retains the characteristic marks of the shell, after the earthy part has been removed. Below this is suspended a portion of mother-of-pearl, probably part of a valve of Meleagrina margaritifera, *Lam.*, which has been treated in the same way. *Donor*, Charles Hatchett, Esq.

98 C. The membranaceous part of a piece of mother-of-pearl.

Donor, Charles Hatchett, Esq.

98 D. Numerous small pearls, which have been immersed in acetous acid, and thus reduced to their membranaceous constituent.

[It was in this state that they were swallowed by the luxurious ancients; the earthy part only being dissolved.]

Donor, Charles Hatchett, Esq.

"The same experiments were made on pearls, which proved to be similar in composition to the mother-of-pearl; and, so far as their size would enable me to discern, they appeared to be formed by concentric coats of membrane and carbonate of lime: by this structure they much resemble the globular calcareous concretions, found at Carlsbad and other places, called Pisolithes.

"The wavy appearance and iridescency of mother-of-pearl, and of pearl, are evidently the effect of their lamellated structure and semi-transparency; in which, in some degree, they are resembled by the lamellated stone called Adularia."

Hatchett, On Shell and Bone, ut supra, p. 320.

99. The shell of a Wreath (Turbo pica), with the operculum, which has been partially submitted to the action of an acid.

100. Portions of the shell of a Turbo, which have been submitted for a longer time to the action of an acid, so as to leave little else but the animal matter.

100 A. A turbinated shell, which has been similarly treated, showing the strong outer epidermis, and the bright nacre, or mother-of-pearl substance, of which the shell is chiefly composed.

100 B. Portions of the animal substance of a turbinated shell.

101. The soft parts of a Turbo, with the operculum attached. Also the detached operculum of another specimen, in the same bottle.

In this species the operculum is calcareous, of a spiral structure, convex externally, flattened, and with a corneous surface where it adheres to the foot of the animal.

102. The soft parts, and shell, of Purpura patula, *Lam.* The operculum has been detached from the foot of the animal: from its small size and horny nature it can be retracted some way within the shell.

103. Portion of a Teredo navalis, showing the opercular valves which close the external entrance of the shelly tube. Bristles are placed in the syphons.

103 A. Portions of the tube of Teredo gigantea, which have been submitted to the action of an acid, as in the preceding specimens, showing the proportion of animal matter in this shell. *Donor,* W. T. Brande, Esq.

103 B. Portions of the tube of a marine animal, similarly treated.
Donor, W. T. Brande, Esq.

3. *In the Cuttle-fish.*

"Some experiments which I have lately made upon the Cuttle-bone of the shops, have proved that the term *bone* is here misapplied, if the presence of phosphate of lime is to be regarded as the characteristic of bone; for this substance, in composition, is exactly similar to shell, and consists of various membranes, hardened by carbonate of lime, without the smallest mixture of phosphate."

Hatchett, On Shell and Bone, ut supra, p. 321.

Similar experiments, with respect to the proportion of animal and earthy material in this substance, were made by Mr. Hunter (many years antecedent), of which the following specimens are the results. The menstruum employed was dilute muriatic acid.

104. An oblique section of the dorsal plate of a Cuttle-fish (Sepia officinalis), to show its laminated structure.

105. A longitudinal section of the dorsal plate of a Cuttle-fish, showing the laminated structure in another point of view.

106. A corresponding section of another specimen of the dorsal plate of a Cuttle-fish, which has been steeped in dilute muriatic acid and deprived of its earthy part, to show that the proportion of animal matter that remains is sufficiently well organized and abundant to preserve the form and structure which is exhibited in the preceding preparation.

107. The outer lamina of the dorsal plate of a Cuttle-fish, entirely deprived of its earth and dried. In the preceding section, which is the counterpart of this preparation, it is seen *in situ*.

108. The membranaceous constituent of the dorsal plate of a Cuttle-fish.

109. A large portion of the membranaceous constituent of the same substance, which shows very distinctly its laminated structure.

4. *In Crustaceous Animals.*

"There is reason to conclude (therefore), that phosphate of lime, mingled with the carbonate, is a chemical characteristic which distinguishes the crustaceous from the testaceous substances; and that the principal difference in the qualities of each, when complete, is caused by the proportion of the hardening substances, relative to the gluten by which they are cemented; or by the abundance and consistency of the gelatinous, membranaceous, or cartilaginous substance, in and on which the carbonate of lime, or the mixture of carbonate and phosphate of lime, has been secreted and deposited. Moreover, as the presence of phosphate of lime, mingled with carbonate, appears to be a chemical character of crustaceous marine animals, there is every reason to conclude that Linnæus did right not to place the Echini among the testaceous ones."

Hatchett, On Shell and Bone, ut supra, p. 324.

110. The outer crust of an Echinus (Siderites Hystrix, *Lam.*), from which the earthy constituent has been partially removed by the action of an acid.

111. A section of the crustaceous covering of the claw of a Lobster, which has been similarly treated, and has become soft and elastic, of a yellowish white colour, but still retaining its original figure.

Series IX. Structure and Growth of Bone.

Bone is a compound of animal substance and calcareous earth, and serves to support the other parts of the machine, so as to allow of the different parts being kept at a certain distance from each other, and to be acted upon by the muscles or moving powers of the body.

These (the Bones) are of different shapes in almost every class of animals, varying as it is necessary for defence from external accidents, strength, velocity, or convenient attachment of muscles.

In some they are similar to shell, serving as a house for the animal, as in the turtle; and in the more perfect animals they serve the same purpose for particular parts.

They are of different consistence in fishes and quadrupeds; in the first, being chiefly animal substance; in the latter, containing a considerable quantity of earth.

In quadrupeds, in some they are very cellular, thin, and spongy; in others, very hard, solid, and compact, according as strength is required.

Hunterian M.S. Catalogue.

1. *Component Parts of Bone.*

a. *In Fishes.*

112. The vomer of a Cod-fish (Gadus morrhua), which has been steeped in an acid, in order to remove the calcareous earth, and show the proportion of animal substance, which in this species is very considerable.

113. Part of the lower jaw (Os dentale, *Cuv.*) of a Cod-fish, which has been prepared in the same manner, to show the same circumstances.

114. Part of the osseous apparatus of the pectoral fin (Os humerale, *Cuv.* Os claviculare, *Geoffroy*, *Meckel.*) of a Cod-fish, prepared in the same manner.

115. The cubitus, radius, and carpal bones of a Cod-fish, similarly treated.

"The bones of fish, such as those of mackarel, brill, and skate, afforded phosphate of lime; and the only difference was, that the bones of these fish appeared in general to contain more of the cartilaginous substance, relative to the phosphate of lime, than is commonly found in the bones of quadrupeds, &c.

"The different bones also of the same fish were various in this respect; and the bones about the head of the skate only differed from cartilage, by containing a moderate proportion of phosphate of lime."

Hatchett, On Shell and Bone, ut supra, p. 326.

b. *In Mammalia.*

116. A section of the tympanum of a whale-bone Whale (Balæna Mysticetus, *Linn.*), similarly treated.

117. A section of the solid part of a human femur, which has been steeped in an acid, dried, and preserved in oil of turpentine, to show the animal part.

"It is scarcely necessary for me to mention the usual effects of acids on bones steeped in them, as they are known to every physiologist and anatomist.

"In every operation of this nature, the ossifying substance, which is principally phosphate of lime, is dissolved, and a cartilage or membrane of the figure of the original bone remains.

—— "It is also known that the nature of bone is more influenced by the greater or less predominance of the membranaceous or cartilaginous part, than by any other cause. It is not, therefore, for me to add any thing to this part; and in respect to the substance which is the cause of ossification, little also requires to be mentioned, for this (as has been already observed) is known principally to consist of phosphate of lime."

Hatchett, On Shell and Bone, ut supra, p. 325.

c. *In Fossil Bones.*

The following preparations are specimens of bones in a fossil state, which have had the earthy part removed by means of dilute muriatic acid; showing that, under favourable circumstances, bones will retain their animal matter for an immense length of time.

118. A glossopetra, or shark's tooth in a fossil state, which has been steeped in an acid. The external lamina, or what appears to be analogous to enamel, has separated from the central portion of the tooth, and has sufficient animal matter remaining to preserve its form. The central portion, or body of the tooth, still remains in a completely fossil state.

119. The external lamina of a glossopetra, separated by means of an acid; showing nearly the same circumstances as the preceding specimen, of which it appears to have formed a part.

"In the shark's tooth, or glossopetra, the enamel is composed of animal substance and calcareous earth, and is nearly in the same quantity as in the recent; but the central part of the tooth has its animal substance in the state of mucus interspersed in the calcareous matter.

Observations on some Fossil Bones, by the late John Hunter, Esq. F.R.S., Philos. Trans. lxxxiv. 1794, p. 415.

120. A small portion of fossil bone deprived of its earth.

121. A larger portion of fossil bone, prepared in a similar manner.

122. A portion of fossil bone from an animal belonging to the genus Bos, prepared in a similar way.

123. The animal part of a portion of a Deer's horn (Cervus giganteus, *Goldfuss.*), from Ireland, in a fossil state.

124. The animal part of some small portions of the cranium of the Ursus spelæus or Bear of the Caverns, from Bayreuth in Germany.—The paper by Mr. Hunter above quoted is on the subject of the fossil bones found in these caverns.

125. A molar tooth of one of the same fossil bears, which has been treated with acid in the same manner as the preceding preparation, and shows that it has retained a very large proportion of its animal matter.

126. The animal part of a section of a tusk of the same species of Bear, dried and varnished.

127. A portion of a tusk of the same animal, in spirit, showing the very large proportion of animal matter which remains after the phosphate of lime has been removed by means of acid.

"In incrusted bones, the quantity of animal substance is very different in different bones. Those from Germany, especially the harder bones and teeth, seem to contain all the animal substance natural to them; they differ, however, among themselves in this respect."

John Hunter, On Fossil Bones, ut supra, p. 416.

128. A small section from the anterior part of a molar tooth of the Mammoth (Mastodon giganteum, *Cuv.*), from the banks of the River Ohio in North America; which has been treated with acid, dried, and varnished, to show the proportion of animal matter.

129. A larger portion of the same molaris, preserved in spirit, showing the same circumstances as the preceding preparation.

130. A still larger portion of the same molaris, prepared in a similar manner. [The remaining part of the tooth is preserved among the fossil teeth of quadrupeds.]

"In the fossil bones of land animals, and those which inhabit the waters, as the sea-horse, otter, crocodile, and turtle, the animal part is in considerable quantity. In the stag's horns dug up in Great Britain and Ireland, when the earth is dissolved, the animal part is in considerable quantity and very firm. The same observations apply to the fossil bones of the elephant found in England, Siberia, and other parts of the globe; also those of the ox kind; but more particularly to their teeth, especially those from the lakes of America, in which the animal part has suffered very little."—"The state of preservation will vary according to the substance in which they have been preserved; in peat and clay I think the most; however, there appears in general a species of dissolution; for the animal substance, although tolerably firm, in a heat a little above 100° becomes a thickish mucus, like dissolved gum, while a portion from the external surface is reduced to the state of wet dust."

John Hunter, On Fossil Bones, ut supra, p. 415.

2. *Formation of Bone.*

a. *In Membrane.*

131. The carapace or dorsal shell of a very young Turtle (Chelonia Mydas), showing the state of ossification, which is continued from the margins of the ribs, at this period quite distinct from each other, until they meet and become joined by indented sutures similar to those of the cranium.

132. The cranium of a Fœtus (at about six months), showing the several places of commencement or centres of ossification, and the ossific matter deposited in fine bony fibres radiating therefrom.

b. *In Cartilage.*

132 A. The vertebral column of a Fœtus of the sixth month, injected, showing the commencement of ossification in the bodies and rings of the vertebræ. *Donor*, William Lawrence, Esq. F.R.S.

132 B. The sternum of a Fœtus of the sixth month, injected, exhibiting the commencement of ossification by four separate points or centres: that of the manubrium, or first bone, has been removed from the cavity in which it was imbedded. *Mus. Heaviside, No.* 90.

133. The sternum and sternal extremities of the true ribs of a mature Fœtus. Four separate points of ossification may be observed in the sternum.

133 A. The pelvis of a (female) mature Fœtus, showing the radiating disposition of the ossific fibres in the ilium, and the separate points of ossification in the sacrum, ischium, and pubes. The coccyx is still wholly cartilaginous. *Donor*, Mr. Clift.

133 B. The femur of a mature Fœtus, showing the cartilaginous epiphyses; the superior of which comprehends the great and little trochanter. *Donor*, Mr. Clift.

133 C. The tibia of a mature Fœtus, showing the cartilaginous epiphyses. *Donor*, Mr. Clift.

133 D. A section of the foot of a mature Fœtus, injected, showing the cartilaginous condition of the bones of the tarsus, with the commencement of ossification in the os calcis and astragalus. *Prepared in* 1831.

The following preparations have been injected, dried, and preserved in oil of turpentine, to show the vascularity of temporary cartilage during the progress of ossification therein.

134. The sternum of a Child at an early period of life, showing vessels from the internal mammary arteries, ramifying on the several separate ossifications.

135. The upper extremity of the tibia of a Child, having the patella attached. The arteries of the cartilaginous patella are injected, but ossification had not yet begun.

136. The patella of a Child more advanced in age, in which ossification has begun in the centre, and has extended along the coats of the arteries, making them appear like bony ramifications.

137. A series of three human patellæ of different periods of growth, to show the progress of ossification. This preparation also shows that the cartilage is not in fact extruded, but removed by the absorbents as ossification advances; and consequently that the increase in size of the whole patella is not in the ratio of the increase of the ossific deposition; as is exemplified in the lowest of the three patellæ.

138. A metatarsal cartilage of a Calf, injected. The points of the arteries in several parts are of a whitish colour, from a deposit of calcareous earth.

139. A section of the epiphysis of a metacarpal bone of the same animal, showing ossification beginning in several parts of the cartilage.

140. A similar preparation.

141. Another section, to show further progress of the ossification.

142. A section of the epiphysis of the shank-bone of a Calf, in which ossification is chiefly advancing from the centre.

143. A section of the epiphysis of a metacarpal bone of the same animal, injected; with a more distinct centre of ossification.

144. Another section, with the ossification more advanced.

145. The cartilage of an epiphysis, with the central ossification well injected, showing that it is much more vascular than the surrounding cartilage.

146. A similar preparation.

147. A similar preparation, with the ossification in its centre more advanced.

148. A section of temporary cartilage. The large vessel which traverses the preparation probably lies in the interspace of two adjoining epiphyses.

The following preparations have been injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of growing bone.

> " Parts whose use in the machine may be said to be passive, as tendon, cellular membrane, ligaments, investing membrane, bone, and cartilage, which last is probably the most passive, have all small vessels, and of course but few that are visible. As bone, however, is composed of two parts, viz. animal substance and earth, it is probable that there may be more action required to form the latter than either tendon or cartilage, and therefore there will be more vessels.
>
> " As a further proof that this is a general principle, we find that all growing parts are much more vascular than those that are come to their full growth; because growth is an operation beyond the simple support of the part: and this is the reason why young animals are more vascular than those that are full grown."—" This is known by injections, when parts are in the growing state, or are just grown, and for some time after." *Hunter*, *On the Blood*, 4to. 1794. p. 156.

149. A transverse section of the epiphysis of a cylindrical bone, which exhibits the progress of the vessels from the circumference towards the centre.

150. A transverse section of an epiphysis [probably from the leg of a fœtal Calf], the ossification of which is nearly completed.

151. A similar preparation.

152. A section of the metacarpal bone of a Calf.

153. A similar section of the metacarpal bone of a Calf.

154. A longitudinal section of the metatarsal bones of a Calf. Along the middle of this preparation may be observed the progress of the ossification, which afterwards produces a complete anchylosis, and reduces the two to a single cannon-bone.

155. A similar preparation; apparently a section of the preceding specimen.

156. The exterior section of the same bones. The vessels in the cartilaginous extremity are particularly distinct.

157. The two middle metatarsal bones of a Pig, sawed down. The vascularity is greatest at the spongy extremities.

158. A small section of bone, while in a growing state; apparently the outer crust of a tibia.

159. A similar preparation.

160. A longitudinal section of the tibia of a Calf.

161. A transverse section of the tibia of a young Man, exhibiting a much less degree of vascularity.

162. A section of the lower part of a human tibia, in which the degrees of vascularity of the epiphysis, the cancellous extremity, and denser part of the shaft of the bone may be compared with each other.

3. *Formation of Bone, exemplified in the Growth of the Horns of Deer.*

All the examples are from the Fallow Deer (Cervus Dama, *Linn.*).

163. A transverse section of part of the palm of the horn, while in a growing state, injected. The parts which invest the horn at this period are, a vascular membrane similar to periosteum and continued from the pericranium, cutis and cuticle continued from the integuments of the head, and a particular kind of short downy hair, which gives it a velvet appearance.

164. The extremity of the palm of the horn, while in a growing state, injected.

165. A transverse section of part of the palm of the horn, while in a growing state, injected; from which the outer velvet-like tegument has been removed, to show the vascular periosteal membrane, part of which is turned back.

166. A transverse section of part of the palm of the horn, while in a growing state, injected, to show its delicate cancellated structure, its vascularity at this period, and its periosteum, part of which is reflected from the bony substance.

167. A horizontal section of part of the palm of the horn, while in a growing

state, injected, and showing the same circumstances as the preceding preparation.

168. The outer layer of bone and the periosteal covering of part of the palm, and of one of the antlers of the growing horn, highly injected, and deprived of the earthy material by being steeped in acid, so that the ramifications of the vessels in the substance of the bone are more clearly shown. One of the external vessels of the periosteum derived from branches of the external carotid is also exposed.

"We find it a common principle in the animal machine, that every part increases in some degree according to the action required. Thus we find muscles increase in size when much exercised; vessels become larger in proportion to the necessity of supply, as for instance in the gravid uterus; the external carotids in the stag, also, when his horns are growing, are much larger than at any other time: and I have observed, that in inflammation the vessels become larger, more blood passes, and there appear to be more actions taking place; but the nerves do not seem to undergo any change. The nerves of the gravid uterus are the same as when it is in the natural state; neither do the branches of the fifth and seventh pair of nerves in the stag become larger."

Hunter, On the Blood, 4to. 1794, p. 288.

169. A section of an antler and part of the palm, injected, stripped of its periosteum, and steeped in an acid, to show the high degree of vascularity in the substance of the bone at this period of its growth.

170. The other section, or counterpart, of the preceding specimen.

171. A small portion of the palm taken from the same horn as the preceding specimen, and prepared in the same manner. It is extremely vascular.

The following seven preparations have been minutely injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of the substance of the growing horn.

172. A longitudinal section of an antler, in which the longitudinal disposition of the fibres may also be observed.

173. A similar specimen.

174. A similar specimen.

175. A transverse section of the palm of the horn, which gives to the internal structure a reticular appearance ; in which part it may also be observed, that the blood-vessels are exceedingly minute, there being no large branches as on the external surface. See No. 168.

176. A similar specimen.

177. A small portion of the cancellated structure of the palm, cut in the direction of the fibres.

178. A section of the outer compact substance of the palm.

179. A section of part of the os frontis and of the base of a Deer's horn, of which the growth was nearly completed. It shows the horn to be a continuation of bone from the outer table of the skull, and the velvet-like covering of the horn to be equally continuous with the integuments of the head. It shows also the burr or pearl which has been formed round the base of the horn, and illustrates the effects of this part on the growth of the horn.

In the formation of the burr, which is the last part of the process, and takes place rapidly, the osseous tubercles of which it is composed are projected outwards, and, by their pressure, induce absorption of the vascular external covering, and increasing at the same time laterally, they inclose and compress the blood-vessels ; thus in a short space of time the circulation is entirely obstructed, and consequently the whole of that once very vascular and sensible tegument loses its vitality, dries, shrinks, and peels off, leaving the horn a naked insensible weapon.

In one of the branches (the brow antler) in this preparation, the whole of the vessels appear to have been thus obliterated: in the other, a slight degree of vascularity remains, and one of the large external arterial branches is still uncompressed.

180. A section of part of the os frontis and base of the horn, which has been completely formed and divested of its external tegument, or burnished, as it is technically termed. This specimen has been injected, and steeped in an acid.

181. A section of part of the os frontis and base of the horn, injected and steeped in an acid, to show the connection of the horn with the skull the loose spongy texture in the centre of the bone, and the outer, compact, last-formed layer.

182. A slice of the same parts as the preceding preparation, showing the same circumstances.

183. A transverse section of the beam of the same horn as No. 181, injected and steeped in acid, "showing the two stages of growth, and its becoming cellular in the centre." [This is the original description in the manuscript Catalogue; but Mr. Hunter, unfortunately, has not left any commentary or further explanation of his ideas respecting this specimen.]

184. A similar preparation.

185. A similar preparation.

186. A section of part of the skull and base of the horn, a short time previous to its being shed; injected and steeped in an acid. It shows the commencement of the interstitial absorption at the root of the horn, which renders that part soft and yielding; and also the separation of the outer, last-formed, compact layer of bone from the internal spongy part.

187. A slice of the same parts as the preceding preparation, which exhibits more clearly the progress of the interstitial absorption at the base of the horn.

4. *Growth of Bone.*

188. The left tarsus of the domestic Fowl, upon which the following experiment was performed:—Two small holes were made by cauterization near the extremities of the bone; the length of the bone at that time being two inches and ten lines, and the distance between the holes one inch and eight lines. After a certain period the animal was killed, and the length of the bone was found to be three inches seven lines, while the space between the apertures was one inch and eleven lines; the increase of the bone beyond the points of cauterization being more than double that

of the space included between them. [The original note of the experiment is preserved in the bottle.]

189. The right tarsus of the domestic Fowl, longitudinally bisected, to show the results of the following experiment.—When the animal was young, the bone was perforated near each extremity, and a small leaden shot was introduced into each hole. After a certain period the animal was killed, and the length of the bone was found to have been increased to three inches and ten lines; but the distance between the shots, which had now reached the medullary cavity, was exactly the same as when first introduced. [The original note of the experiment is preserved in the bottle.]

—— "And here I must observe, that a bone does not grow in all its parts, that is, it does not grow by addition of new particles among those already arranged, or in their interstices, but by the addition of parts lengthways or sideways of the bone. This I proved by exposing the bones of young animals, and boring holes in them, which were prevented from being obliterated by fixing pieces of leaden shot in them: these bones were examined a considerable time after, when, although the bones had considerably grown, the holes were exactly at the same distance from each other." *John Hunter, MS. Lectures.*

The following preparations are from the common Hog (Sus domesticus), and are the results of experiments made by feeding that animal on the root of madder (Rubia tinctorum), but they have lost much of their original brightness of colour.

190. The skull of a young Pig, slightly tinged.

191. A larger skull, more strongly coloured.

192. The right side of the lower jaw, in which the ivory of the teeth has retained more perfectly the red colour, whilst the enamel is of its ordinary whiteness: [a circumstance which was remarked by Mr. Belchier, the discoverer of this property of madder.

See *Philos. Trans.* xxxix. 1736. p. 287.]

193. A longitudinal section of the humerus. [The counterpart is preserved dry. No. 748. *Osteological Catalogue.*] The madder appears to have been

remitted a short time before death, as there is a thin layer of uncoloured bone deposited on the external surface.

194. A longitudinal section of the ulna, probably from the same animal as the preceding.

195. A longitudinal section of a metacarpal bone, in which an external layer of uncoloured bone may be observed, as in No. 193, being probably part of the same animal.

196. The os innominatum, in which a very slight tinge remains.

197. A longitudinal section of the femur of the same Hog as No. 193.

In this preparation may be observed a very thin layer of uncoloured bone deposited on the exterior of the shaft after the madder was remitted, and also some of the original uncoloured bone which had not been absorbed from the interior of the shaft when the animal was killed.

[The counterpart of this preparation is preserved dry, No. 748. *Osteological Catalogue.*]

198. A longitudinal section of the femur of an older Hog, in which the layers of bone deposited before, during, and after the administration of madder are more distinctly observable. [This preparation is figured in an original drawing by Wm. Bell, Mr. Hunter's Assistant. *Cube* ii. *Drawer* i. No. 5.]

199. A longitudinal section of the femur of an older Hog, in which the coloured bone, deposited while the animal was under the influence of the madder, may be observed in some places to have reached the medullary cavity; the whole of the *originally exterior* uncoloured bone having been entirely absorbed at those parts.

200. A longitudinal section of the tibia of the same Hog as No. 193, [the counterpart of which is preserved dry, No. 748. *Osteological Catalogue*]. It exhibits the same circumstances as are described in Nos. 193 and 197.

201. A longitudinal section of the tibia of a younger Pig, with a thin exterior layer of coloured bone.

By comparing this specimen with, and observing the size of the medullary cavity in, the preceding, the extent of the absorbing process will appear manifest; since the cavity is rendered sufficiently large to contain the entire bone of the earlier period of growth.

"In the formation of a bone, ossification begins in a spot, and gradually increases. By feeding an animal on madder, it is shown, that while bony matter is deposited on the outside of the bone, the absorbents are removing it from the inner side, otherwise the bone would become heavy and clumsy, and unfit for motion; therefore as the bony matter which was deposited becomes useless, nature removes it by the absorbents."

John Hunter, MS. Lectures.

See also "Experiments and Observations on the Growth of Bone, *from the Papers of the late Mr. Hunter*, by Everard Home, Esq. F.R.S.," in the *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, ii. p. 277. Read Oct. 4, 1798.

5. *Texture of Bones.*

a. *In Mammalia.*

202. A section of the bone of the tympanum of a Whale-bone Whale (Balæna mysticetus), which has been subjected to the action of an acid, and deprived of its earthy constituent. It exhibits a concentric laminated structure, and uniform solidity; the first formed central part not having undergone any change from the action of the absorbents, and no part exhibiting a trace of fibres, cancelli, or vessels.

203. Another section of the same bone, similarly treated, and exhibiting more distinctly the laminated texture.

"The bony part of the organ (of hearing) is very hard and brittle, rendering it even difficult to be cut with a saw, without its chipping into pieces. That part which contains the immediate organ is by much the hardest, and has a very small portion of animal substance in it; for when steeped in an acid, what remains is very soft, almost like a jelly, and laminated. The bone is not only harder in its substance, but there is on the whole more solid bone than in the corresponding parts of quadrupeds, it being thick and massy."

John Hunter, On the Structure and Œconomy of Whales, Philos. Trans. lxxvii. 1787. p. 432.

204. A section of the proximal extremity of the humerus of a young person, showing the reticular cancellous structure of the epiphysis, and of the extremity of the diaphysis of the bone.

205. The counterpart of the preceding preparation.

206. A section of the astragalus of a young person, exhibiting the reticular cancellous structure of the whole bone, the cancelli being largest in the centre.

207. The counterpart of the preceding preparation.

208. The os naviculare of a young person, longitudinally bisected, to show the cancellous structure nearly uniform throughout the bone.

209. The os cuneiforme internum of a young person, longitudinally bisected, and showing a similar structure.

209 A. A section of the diaphysis of a human tibia, injected; exposing the medullary cavity, and the secreting vessel of the marrow (Arteria medullaris), ramifying on the lining membrane of the cavity.

Donor, William Lawrence, Esq. F.R.S.

b. *In Birds.*

Showing the cavities of the bones which contain air.

210. The os humeri of an Owl (Strix ——— ? *Linn.*), which shows the cavity free from marrow, and cellular only at the extremities, and therefore a good receptacle for air. Near to the joint of the shoulder may be observed the aperture by which the air passes into the cavity.

"In most birds, I believe in all that fly, these axillary cells communicate with the cavity of the os humeri, by means of small openings in the hollow surface near the head of that bone: in some they are continued down the wing, communicating with the ulna and radius; in others they reach even as far as the pinions. The ostrich, however, is an exception:" [*i. e.* has no air even in the humerus.]

Hunter, On the Animal Œconomy, 4to. p. 92.

211. A longitudinal section of the ulna of the same bird as the preceding spe-

cimen, into which the air-cells are not continued, and which therefore exhibits the character of a cavity containing medullary matter.

212. A longitudinal section of the femur of the same bird, which has also had no connection with the air-cells, but contains medullary matter, and exhibits the difference between such bones and those which contain air.

[The bird from which the three preceding specimens were taken has evidently been injected, although the traces of vascularity in the humerus are extremely slight.]

"The bones which receive air are of two kinds; some, as the sternum, ribs, and vertebræ, have their internal substance divided into innumerable cells; whilst others, as the os humeri and the os femoris, are hollowed out into one large canal, sometimes with a few bony columns running across at the extremities. Bones of this kind may be distinguished from those that do not receive air, by several marks: 1st, by their less specific gravity; 2ndly, by being less vascular than the others, and therefore whiter; 3rdly, by their containing little or no oil, and consequently being more easily cleaned, and appearing much whiter when cleaned than common bones; 4thly, by having no marrow, nor a bloody pulpy substance, even in their cells; 5thly, by their not being, in general, so hard and firm as other bones; those of some birds are so soft, that they can be squeezed together with the finger and thumb; however, the bones of the extremities have very solid sides: 6thly, the passage by which the air gets into the bones can be easily perceived, even in cleaned bones. Generally there are several holes placed together near the end of the bone which is next the trunk of the bird; and distinguishable by having their external edges rounded off, which is not the case with those holes through which either nerves or blood-vessels pass into the substance of the bone."

An Account of certain Receptacles of Air in Birds, by John Hunter, F.R.S. Philos. Trans. lxiv. 1774. p. 205.

213. The os humeri of a Silk-fowl (Gallus lanatus, *Temm.*) longitudinally bisected, to show the cavity for containing air, and the passage by which it enters, which is indicated by a bristle.

"In the common fowl no air appears to enter any bone except the os humeri." *Hunter, On certain Receptacles of Air in Birds, ut supra,* p. 210.

214. A longitudinal section of two anterior dorsal vertebræ of an Ostrich (Struthio Camelus), showing the delicate reticular structure of the entire substance of these bones for receiving air, which enters by apertures near the roots of the transverse processes.

215. A section of the upper extremity of the femur of an Ostrich, showing its cellular structure for containing air. A bristle is passed through the aperture by which the air enters.

216. A section of the upper extremity of the femur of a young Ostrich, showing its cellular structure, and the aperture by which the air enters the cavity of the bone.

217. A section of the lower extremity of the femur of a young Ostrich, showing its cellular structure for containing air.

218. A section of the upper extremity of the tibia of a young Ostrich, showing the more compact cellular structure, containing medullary matter; and the epiphysis.

219. A section of the lower extremity of the tibia of a young Ostrich, showing the more compact cellular structure, and the medullary cavity.

6. *Ossification by Excretion**.

220. A section of the tusk and part of the jaw of a Boar, exposing the pulp, upon and from which the tooth is formed. The parts have been steeped in an acid, so as to remove the enamel and earthy constituent of the tooth.

* This Title is made to precede No. 220 $\left(\frac{1}{5\,a}\right)$ in the original MS. Catalogue, but without any comment or further explanation. Mr. Hunter's opinions respecting the Growth of Teeth are, however, fully set forth in his work on the Teeth, and there are numerous preparations in illustration thereof in the series appropriated to the subject. The preparation of the Boar's tooth appears to have been placed here chiefly to show the difference between Ivory and Bone, in Structure and Mode of Growth.

"*Of the Bony Part of a Tooth.*

"The other substance of which a tooth is composed is bony, but much harder than the most compact part of bones in general. This substance makes the interior part of the body, the neck, and the whole of the root of a tooth. It is a mixture of two substances, viz. calcareous earth and an animal substance, which we might suppose to be organized and vascular. The earth is in very considerable quantity; it remains in the same shape after calcination, so that it is in some measure kept together by cohesion, and it is capable of being extracted by steeping in the muriatic and some other acids. The animal substance, when deprived of the earthy part, by steeping in an acid, is more compact than the same substance in other bones, but still is soft and flexible."

Hunter, On the Teeth, 4to. 1778, p. 36.

Series X. Situation of the Skeleton.

1. *External.*

221. The shell of a Limpet (Patella deaurata, *Lam.*).

2. *Internal.*

222. The calcareous plate of a Cuttle-fish (Sepia officinalis) [See also Nos. 105, 106.]

3. *Mixed.*

223. A section of the claw of a Lobster (Astacus marinus), where part of the skeleton is thrown inwards for the insertion of muscles. [See also Nos. 60, 61.]

224. A section of the Hercules Beetle (Dynastes Hercules, *Macleay*), showing the processes which are sent inwards from the external integument.

[The principal processes given off from the upper part of the trunk or *Thorax*, are the *prophragma*, the *mesophragma*, and the *metaphragma*, from which the muscles of the wings arise, and others that move the segments of the body. Of those given off from the under part of the body or Pectus, are the *antifurca*, *medifurca*, and *postfurca*, which serve as points of attachment to the muscles that move the legs.

See *Kirby and Spence, Introd. to Entomology*, iii. p. 581.]

Series XI. Composition of the Skeleton.

1. *Skeleton composed of One Piece.*

225. The horny elongated plate of Loligo vulgaris, *in situ*.

226. A section of the calcareous plate of Sepia officinalis.

2. *Skeleton composed of Several Pieces unattached.*

227. A Sea-pen (Pennatula grisea, *Bohadsch.*), laid open along the anterior aspect to expose the single bony stem running along the whole centre; and the spines going off laterally, but not attached to the central stem.

228. A longitudinal section of Pennatula grisea, exhibiting the structure of the central stem.

229. A longitudinal and transverse section of Pennatula grisea, exposing the central stem and its membranous theca, and also the origins of the lateral spines.

3. *Elastic Joints.*

Joints are the different configurations given to the ends of those substances, whatever they may be, on which the animal is to have motions produced, and the adaptation of those surfaces together so as to allow of easy motion. These will always vary according to the strength or quantity of motion required in the joint; and as the two are incompatible with each other, preference must always be given to one or the other according to circumstances. *Hunterian MS. Catalogue.*

230. A portion of the spine of the glutinous Myxine or Hag (Gastrobranchus cæcus, *Bloch.*], in which all distinction of the bodies of the vertebræ is lost, and the whole spine is composed of a fibrous capsule surrounding a single cylindrical gelatinous or soft cartilaginous body.

230 A. A portion of the River Lamprey (Petromyzon fluviatilis, *Linn.*), in which is exposed the cylindrical gelatinous mass occupying the situation of the bodies of the vertebræ. *Prepared in* 1831.

230 B. A portion of the spine, with the head, of a River Lamprey, showing the cartilaginous part which surrounds the spinal chord, and in which the vertebral rings are indicated. In the transverse sections may be observed the relative situations of the cartilaginous and gelatinous parts of the spine. *Prepared in* 1831.

230 C. A portion of the spine of a Sea Lamprey (Petromyzon marinus, *Linn.*), showing the cartilaginous and gelatinous parts, and their mode of connection with the head: the latter substance is connected by gomphosis with the occipital cartilage. *Prepared in* 1831.

231. A transverse section of the spine of a Sturgeon (Acipenser Sturio, *Linn.*), showing the cylindrical fibrous capsule inclosing the gelatinous body analogous to the spines of the Myxine and Lamprey, and the external investing cartilaginous substance in which the vertebral rings are slightly indicated, and the spinous processes and rudiments of the transverse processes are distinctly developed.

232. A portion of the internal gelatinous substance from the spine of a Sturgeon. A longitudinal section has been made on one side, which exposes some small cavities in the centre.

233. A longitudinal section of a part of the same substance, exposing a larger central cavity.

234. A transverse section of the spine of a Sturgeon, showing the internal gelatinous and membranous substance, and the external cartilaginous parts; also the circular canal above the bodies of the vertebra, which contains the spinal chord, and the transverse canal beneath, for the passage of the large blood-vessels. There may be also observed a space above the canal of the spinal chord, formed by the divarication of the cartilaginous pieces which constitute the summits of the spinous processes of the vertebræ. This is filled by fibro-cartilaginous substance connecting the processes in question.

235. A longitudinal section of the spine of a Sturgeon, which shows the indistinct character of the division of the vertebral pieces. The whole spine being composed of very elastic materials, renders the existence of joints almost unnecessary.

236. A vertical section of the spine of a Sturgeon, showing the ligamentous connection of two portions thereof.

237. A portion of the spine of a Shark (a small species), longitudinally bisected, to show the external cartilaginous part of a firmer texture than in the sturgeon, and divided into distinct vertebræ, which are joined to each other by elastic ligamentous capsules, attached to the base of hollow cones formed in the bodies of contiguous vertebræ.

237 A. A longitudinal section of part of the spine, from near the middle of the abdomen, of the Basking Shark (Squalus maximus, *Linn.*), exhibiting the cavities of two intervertebral capsules. These are tensely filled, in the living state, with a transparent fluid resembling lymph, which, from the elasticity of the surrounding capsule, is thrown out to a considerable distance when the cavity is opened. The internal projection of the capsule is partly owing to the infiltration of fluid between the laminæ of which it is composed, and partly occasioned by the superincumbent weight of the vertebræ before the parts had been sufficiently hardened in spirit. *Prepared by Mr. Clift. Presented by Sir E. Home, Bart.*

237 B. A longitudinal section of part of the spine of the Basking Shark, made after sufficient maceration in spirit, and in which, consequently, the natural form of the intervertebral cavity is better preserved.
Prepared by Mr. Clift. Presented by Sir E. Home, Bart.

238. A longitudinal section of five vertebræ of a Cod-fish (Gadus morrhua), exhibiting intervertebral cavities of the same form as in the shark, but which are filled, as in all osseous fishes, with a more consistent gelatinous substance.

239. The counterpart of the preceding preparation.

4. *Joints, with Ligamentous Fibres attached to the whole of the Articular Surface.*

240. A section of the ligamentous substance which unites the lower jaw to the cranium in the Whale.

"The articulation of the lower jaw is not by simple contact either single or double, joined by a capsular ligament, as in the quadruped; but by a very thick intermediate substance of the ligamentous kind, so interwoven that its parts move on each other, in the interstices of which is an oil. This thick matted substance may answer the same purpose as the double joint in the quadruped."

Hunter, On the Structure and Œconomy of Whales, Philos. Trans. lxxvii. 1787, p. 384.

240 A. The left ramus of the lower jaw, and part of the cranium of a Porpesse (Phocæna communis). A section has been made through the joint, to show the fibrous connecting substance *in situ*. *Prepared in* 1831.

241. A longitudinal section of two caudal vertebræ of a Horse, and their connecting concentric ligaments, the fibres of which are seen passing between the whole of the articular surfaces in a direction perpendicular to the planes of those surfaces.

242. The corresponding section or counterpart of the preceding preparation. These vertebræ form a remarkable contrast to those of fishes, as they present to each other convex, instead of concave, surfaces.

243. A single vertebra from the tail of a Horse, exhibiting a transverse section of the intervertebral substance, the ligamentous fibres of which are disposed in concentric circles, which recede from each other as they approach the centre, and have a glairy fluid in the interspaces.

244. A transverse section of the intervertebral substance of the caudal vertebra of a Horse.

245. A transverse section of the intervertebral substance of the Bottle-nose Whale (Delphinus Dalei, *Fred. Cuvier*). *Hunter, On the Whale, Philos. Trans.* lxxvii. 1787. *tab.* xix. *Catalogue, Osteological Division, No.* 1145.

It is six inches in diameter: the external half inch appears of uniform consistency, and exhibits very little of the fibrous character. The rest of the substance, to within an inch of the centre, is composed of ligamentous fibres arranged in concentric circles, and at nearly equal distances: the remaining central part appears to be wholly occupied by coagulated glairy matter.

246. A longitudinal and vertical section of two vertebræ of a Siren (Siren lacertina, *Linn.*). The articular surfaces of the bodies of the vertebræ are hollowed out as in fish, but the cavities are occupied by ligamentous fibres disposed in concentric circles: the oblique processes are joined by capsular and synovial membranes.

247. *The vertebral column of a mature Fœtus, from which the ligamentum commune anterius has been removed, to show the intervertebral substances, which are composed of concentric ligamentous fibres, passing between and connecting the whole of the articular surfaces of the bodies of the vertebræ, as is exhibited in the preceding specimens. The oblique processes are connected by another mode of articulation [see the following sub-series], where opposed cartilaginous articular surfaces are simply in contact, being connected to each other by a capsular ligament and synovial membrane.

247 A. The vertebral column of a Child, showing the same circumstances as the preceding preparations. The capsule connecting the atlas and dentata is preserved and laid open on the right side, showing its laxity, so as to allow of the rotatory motions between these vertebræ.

248. A longitudinal and vertical section of the cervical vertebræ of a Turtle (Chelonia Mydas), the bodies of which (with the exception of the first three) are connected by ligamentous substance passing between the whole of their articular surfaces. These surfaces, in the second, third, and fourth vertebræ, are convex at the anterior part, and concave at the posterior; in the fifth they are concave at both aspects; the anterior

* This and the preceding preparation formed a distinct groupe, in the original Catalogue, with the title, "Articulation with Broad Surfaces and Capsular Ligaments," in allusion to the two kinds of joints, viz. between the bodies and the oblique processes of the vertebræ.

surface of the sixth is concave, the posterior plane; both surfaces are plane in the seventh; but the posterior surface of the eighth vertebra is convex.

5. *Joints with Synovia and Capsular Ligaments.*

249. A longitudinal and vertical section of the cervical vertebræ of a Tortoise, in which the motions of the neck are much freer than in the Turtle; the articular surfaces of the bodies of the vertebræ being covered by cartilage, and surrounded by synovial membrane. The anterior surfaces of the first three vertebræ are convex, the posterior concave. The fourth vertebra, which is the principal centre of motion in the neck, has both the articular surfaces convex. Of the remainder the anterior surfaces are concave, the posterior convex. The canal of the spinal chord may be observed to be the widest, where the motion in this part of the spine is most extensive.

250. A longitudinal and vertical section of the vertebral column of an Alligator (Crocodilus lucius, *Cuv.*). The vertebræ are for the most part united by a species of enarthrosis, or ball-and-socket joint; the anterior surface being concave, the posterior convex. The exceptions occur in the atlas and dentata; in the sacral vertebræ, which are articulated together by plane surfaces; and in the first caudal vertebra, which has both its articular surfaces convex.

250 A. A longitudinal and vertical section of the anterior part of the vertebral column of a large Serpent (Python Tigris, *Daudin.*). The bodies of the vertebræ are joined by a very regular and complete enarthrosis; the posterior part of each vertebra presenting a smooth hemispherical tubercle, which is received into a corresponding cavity in the anterior part of the vertebra that succeeds it. *Prepared in* 1831.

250 B. The counterpart of the preceding preparation. *Prepared in* 1831.

250 C. A longitudinal and transverse section of the bodies of the vertebræ of a large Serpent (Python Tigris, *Daudin.*), exhibiting the forms of their articular surfaces. *Prepared in* 1831.

251. A longitudinal section of two cervical vertebræ of an Ostrich, exposing the cavity of the ball-and-socket joint which unites these vertebræ; but here, the anterior surface is convex, the posterior concave.

252. A longitudinal section of two anterior dorsal vertebræ of the Ostrich, the bodies of which are articulated by a capsular ligament, as in the preceding specimen, but the articular surfaces approach nearer to a ginglymoid joint.

The canal for the passage of the medulla spinalis is enlarged near the articulation, to prevent its being compressed in the motions of that part of the spine.

253. A dorsal vertebra, and the vertebral extremity of a rib of an Ostrich, showing that the latter is articulated by distinct capsular ligaments to two different points of the vertebra; viz. the anterior part of the body, and the transverse process. The orifice for the admission of air into the rib may be observed in the angle of the neck and tubercle.

254. A portion of the sternum and the sternal extremity of the rib of an Ostrich, showing that this part is also articulated by distinct capsules to two points of the sternum. The sternal and vertebral portions of the rib are also articulated by a synovial capsule.

255. The parts constituting the left human shoulder-joint. The capsular ligament is laid open to expose the head of the humerus, and the tendon of the long head of the biceps muscle passing along the upper part of the articular cavity, and attached to the marginal ligament of the glenoid cavity of the scapula. The section of the capsular ligament shows its relative thickness at the upper and lower part.

255 A. The os innominatum and femur of a large Tortoise (Testudo Indica, *Vosmaer.*). The hip-joint is laid open to show that the ligamentum teres is deficient. This simple form of joint obtains at the hip in all the Chelonian reptiles. *Prepared and Presented by Mr. Clift.*

255 B. The left os innominatum and femur of a Seal (Phoca vitulina, *Linn.*). The capsule of the hip-joint is partly removed, and the head of the thigh-bone turned out of the cotyloid cavity, showing it to be quite smooth,

without any depression for a ligamentum teres, which is deficient in this animal*: the cotyloid cavity has, however, the usual notch and depression, the latter being filled with the fatty membranous substance called *Gland of Havers*. *Prepared in* 1831.

255 C. The right os innominatum, os marsupiale, and posterior extremity, with a section of the lumbar, sacral, and part of the caudal vertebræ of the Ornithorhynchus Paradoxus. The anterior part of the capsule of the hip-joint is turned down, to expose the head of the thigh-bone, and the cotyloid cavity, and to show that the ligamentum teres is deficient also in this species. *Prepared in* 1831.

255 D. The right os innominatum, os marsupiale, and femur, of the Echidna Hystrix. The capsule of the hip-joint is turned down, and the head of the femur turned out of the cotyloid cavity, to show a similar deficiency of the ligamentum teres. There are two slight depressions in the middle of the cartilage covering the head of the femur, which may have been produced by pressure against the sides of the foramen at the back part of the cotyloid cavity, which is deficient at that part, as it is in birds. *Prepared in* 1831.

255 E. The head of the right femur of an Elephant (Elephas Indicus, *Cuv.*), three years old. The cartilaginous articular surface is uniformly smooth, having no depression for the insertion of the ligamentum teres, which is deficient in the hip-joint of this species also. *The animal purchased.*

255 F. The head of the left femur of the same animal. *The animal purchased.*

255 G. The right os innominatum and femur of the three-toed Sloth (Bradypus tridactylus, *Linn.*). The hip-joint is laid open to show a similar deficiency of the ligamentum teres. *Prepared in* 1831.

255 H. The right os innominatum and femur of the two-toed Sloth (Bradypus didactylus, *Linn.*). The hip-joint is laid open to show a similar deficiency of the ligamentum teres. *Prepared in* 1831.

* On examining the head of the thigh-bone in another species of Seal, and in the Walrus, no depression for ligamentum teres was found, and most probably it is deficient in all this tribe.

255 I. The left os innominatum and upper part of the femur, with a section of the lumbar, sacral, and coccygeal vertebræ of an Orang Utan (Simia Satyrus, *Linn.*). The hip-joint is laid open, and the head of the thigh-bone dislocated and turned forwards, to show its smooth and uniform spherical articular surface, having no depression for a ligamentum teres, which is deficient also in this species.

[The Simia Satyrus exhibits but little agility while in captivity, and is seldom observed to go on all fours after the manner of quadrupeds, or the inferior Simiæ; but in using its long arms in progressive motion on the ground, it supports itself on the bent fingers as on a pair of crutches, and swings the body forward between them. The diminutive lower extremities appear to be especially destined for the actions of grasping and climbing, and are by no means calculated to support the body erect. The flexor muscles of the fingers of the hinder hands have also some peculiar modifications in their origins and insertions, which well adapt them for grasping objects: thus, the muscle analogous to the Flexor longus pollicis pedis has its origin extended above the knee-joint to the outer condyle of the femur, in the same manner as the Flexor sublimis of the upper extremity passes over the elbow-joint and arises from the humerus: like it also, the above-named muscle in the lower extremity sends no tendon whatever to the thumb, but is inserted exclusively into the fingers, being limited however to the third and fourth, which are the longest fingers of the hinder hand. This disposition of the flexor muscles of the fingers, together with the simplicity of the hip-joint, add considerably to the analogy between the upper and lower extremities in this quadrumanous animal.] *Prepared in* 1831.

6. *Joints with Capsular and Interarticular Ligaments.*

255 K. The right anterior extremity of a large Frog (Rana ——? *Laurenti*). The shoulder-joint is laid open, and the capsule turned back, to show an interarticular ligament, passing from a depression in the head of the humerus to a depression in the centre of the glenoid cavity, and attached also to the inferior margin of that cavity. A bristle is passed behind this

ligament: a small synovial bag projects into this joint just above the insertion of the ligament.

This additional security against dislocation of the shoulder-joint appears to be necessary in the frog, to obviate the effects of the shock, or impulse, which the anterior extremities receive when the animal alights from a leap. *Prepared in* 1831.

256. The parts constituting the human hip-joint of the right side. The anterior part of the capsular ligament is turned back to show the extent to which the synovial membrane is reflected over the anterior part of the neck of the thigh-bone; the thickness of the ligamentous part of the capsule is also shown by the section.

In the cotyloid cavity may be observed the ligamentum teres, round which a bristle is tied, and the depression containing the fatty and synovial substance commonly called the Gland of Havers.

257. A dorsal vertebra, and the articular extremities of four ribs of a Horse. These are attached by capsular ligaments to the angles of the body of the vertebra; they have also a strong transverse ligament which passes from the head of one rib, behind the intervertebral substance, to the head of the opposite rib; thus connecting them firmly to each other, and to the vertebra.

7. *Joints with Capsular Ligaments, and Interarticular Substances for the adaptation of the different parts of the Joint to one another.*

258. A vertical and longitudinal section of part of the lower jaw and temporal bone of a young Lion, exhibiting the interarticular substance extending through the whole of the joint, and dividing it into two synovial cavities.

259. The corresponding section of the same parts, showing the same circumstances.

260. A vertical and transverse section of part of the lower jaw and temporal bone of a Lion, showing the extent of the joint in that direction and the form of the interarticular substance, convex from side to side above, concave below.

261. A section through the temporal bone and condyle of the lower jaw of a Beaver (Castor Fiber, *Linn.*), giving a posterior view of the double articular cavity and intermediate substance; and showing that the capsular ligament between the interarticular substance and glenoid cavity is longer than that between the interarticular substance and condyle of the lower jaw; both of which, therefore, in extensive motions of the jaw backwards and forwards, must move together upon the temporal bone.

262. The interarticular ligamentous substance from the joint of the lower jaw of the Elephant. The surface adapted to the temporal bone is concave in the lesser and convex in the larger diameter: the opposite or lower surface presents a deep, oval excavation for the reception of the condyle of the jaw.

263. A vertical section of the interarticular substance from the joint of the lower jaw of a younger Elephant, showing the degree of concavity on each side, so well calculated for adapting two convex surfaces to each other. A bristle is placed in an orifice leading out of the lower cavity, which is probably the duct of a gland.

264. The counterpart of the preceding preparation, divided horizontally, and exhibiting a disposition of the outer ligamentous fibres in concentric circles, similar to the intervertebral substances of the spine.

265. A vertical section of part of the temporal bone and ramus of the lower jaw of a human subject, exhibiting the forms of the temporal and condyloid articular cavities, and of the intermediate fibrous cartilage.

"Just under the beginning of the zygomatic process of each temporal bone, before the external meatus auditorius, an oblong cavity may be observed; in direction, length, and breadth, in some measure corresponding with the condyle of the lower-jaw. Before, and adjoining to, this cavity, there is an oblong eminence placed in the same direction, convex upon the top in the direction of its shorter axis, which runs from behind forwards; and a little concave in the direction of its longer axis, which runs from within outwards. It is a little broader at its outer extremity, as the outer corresponding end of the condyle describes a larger circle in its motion than the inner. The surface of the cavity and eminence is covered with one continued smooth cartilaginous crust, which is somewhat ligamentous, for by putrefaction it peels off, like a membrane, with the common periosteum. Both the cavity and eminence serve for the motion of the condyle of the lower-jaw. The surface of the cavity is directed downward; that of the eminence downward and backward, in such a manner, that a transverse section of both would represent the italic letter *ſ*. Though the eminence may, on a first view of it, appear to project considerably below the cavity, yet a line drawn from the bottom of the cavity to the most depending part of the eminence is almost horizontal, and therefore nearly parallel with the line made by the grinding surfaces of the teeth in the upper-jaw; and when we consider the articulation farther, we shall find that these two lines are so nearly parallel, that the condyle moves almost directly forwards in passing from the cavity to the eminence; and the parallelism of the motion is also preserved by the shape of an intermediate cartilage.

"In this joint there is a moveable cartilage, which, though common to both condyle and cavity, ought to be considered rather as an appendage of the former than of the latter, being more closely connected with it, so as to accompany it in its motion along the common surface of both the cavity and eminence. This cartilage is nearly of the same dimensions with the condyle, which it covers; is hollowed on its inferior surface to receive the condyle: on its upper surface it is more unequal, being moulded to the cavity and eminence of the articulating surface of the temporal bone, though it is considerably less, and is therefore capable of being moved with the condyle from one part of that surface to another. Its texture is ligamento-cartilagineous. This moveable cartilage is connected with both the condyle of the jaw and the articulating surface of the temporal bone, by distinct ligaments, arising from its edges all round. That by which it is attached to the temporal bone, is the most free and loose; though both ligaments will allow an easy motion, or sliding of the cartilage on the respective surfaces of the condyle and temporal bone. These attachments of the cartilage are strengthened, and the whole articulation secured, by an external ligament, which is common to both, and which is fixed to the temporal bone, and to the neck of the condyle. On the inner surface of the ligament, which attaches the cartilage to the temporal bone, and backwards, in the cavity, is placed what is commonly called the gland of the joint; at least, the ligament is there much more vascular than at any other part."

Hunter, On the Teeth, 4to. 1st edit. 1771. p. 9.

8. *Joints with Capsular and Interarticular Ligaments, and Interarticular Substances.*

265 A. The parts constituting the human knee-joint. The patella and part of the capsule are turned down to show the ligamentum adiposum within the joint and the anterior crucial ligament; the extent of the synovial membrane and the line of its reflection upon the condyles of the femur: the capsule is removed from the posterior part of the joint to show the interarticular semilunar cartilages and the posterior crucial ligament. The lateral ligaments and part of the tendon of the popliteus are also shown. *Prepared in* 1831.

266. The interarticular semilunar cartilages from the human knee-joint, injected; showing their transverse connecting ligaments, and the different character of the upper and lower parts for adapting a convex to a flat surface.

267. A portion of the lower articulating extremity of a human femur, showing the fibrous structure of the articular cartilage, and the direction of the fibres perpendicular to the surface from which they arise.

268. Another section of the same bone and cartilage, showing the same circumstances.

"An articulating cartilage is an elastic substance, uniformly compact, of a white colour, and somewhat diaphanous, having a smooth polished surface covered with a membrane; harder and more brittle than a ligament, softer and more pliable than a bone.

"When an articulating cartilage is well prepared, it feels soft, yields to the touch, but restores itself to its former equality of surface when the pressure is taken off. This surface when viewed through a (magnifying) glass, appears like a piece of velvet. If we endeavour to peel the cartilage off in *lamellæ*, we find it impracticable; but if we use a certain degree of force, it separates from the bone in small parcels, and we never find the edge of the remaining part oblique, but always perpendicular to the subjacent surface of the bone. If we view this edge through a glass, it appears like the edge of velvet; a mass of short and nearly parallel fibres rising from the bone, and terminating at the external surface of the cartilage; and the bone itself is planned out into small circular dimples, where the little bundles of the cartilaginous fibres were fixed. Thus we may compare the texture of a cartilage to the pile of velvet, its fibres rising up from the bone as the silky threads of that rise from the woven cloth or *basis*. In both substances the short threads sink and bend in waves upon being compressed; but by the power of elasticity, recover their perpendicular bearing as soon as they are no longer subjected to a compressing force. If another comparison were necessary, we might instance the flower of any corymbiferous plant where the *flosculi* and *stamina* represent the little bundles of cartilaginous fibres; and the calyx upon which they are planted bears analogy to the bone.

"Now these perpendicular fibres make the greatest part of the cartilaginous substance; but without doubt there are likewise transverse fibrils which connect them, and make the whole a solid body, though these last are not easily seen, because being very tender, they are destroyed in preparing the cartilage.

"We are told by anatomists, that cartilages are covered with a membrane named *Perichondrium.* If they mean the cartilages of the ribs, *larynx*, ear, &c. there indeed such a membrane is very conspicuous; but the *perichondrium* of the smooth articulating cartilages is so fine, and firmly braced upon the surface, that there is room to doubt whether it has been often demonstrated or rightly understood.

"This membrane, however, I have raised in pretty large pieces after macerating, and find it to be a continuation of that fine smooth membrane that lines the capsular ligament, folded over the end of the bone from where that ligament is inserted. On the neck of the bone, or between the insertion of the ligament and border of the cartilage, it is very conspicuous, and may be pulled up with a pair of pincers; but where it covers the cartilage, it coheres to it so closely, that it is not to be traced in the recent subject without great care and delicacy. In this particular it resembles that membrane which is common to the eye-lids and the fore part of the eye-ball, and which is loosely connected with the *Albuginea,* but strongly attached to the *Cornea.*

" From this description it is plain that every joint is invested with a membrane which forms a complete bag, and gives a covering to everything within the articulation, in the same manner as the *Peritonæum* invests not only the *Parietes* but the contents of the *Abdomen.*"

" *On the Structure and Diseases of Articulating Cartilages, by William Hunter, Surgeon*" (afterwards M.D.). *Philos. Trans.* xlii. 1742—3, *page* 514.

269. The parts constituting the knee-joint of a Calf. The patella is turned down, to expose the anterior part of the joint; and on the opposite side the capsular ligament is removed, to show the intervening semilunar cartilages and crucial ligaments. This joint has in this animal a septum extending across it (apparently a greater developement of what is called Ligamentum adiposum in the human subject), which divides it into an anterior and posterior cavity.

270. A vertical section of the parts constituting the knee-joint of the same animal, showing the intermediate substance which unites the femur and tibia, producing a distinct anterior cavity between the patella and condyle of the femur, and a posterior one between the condyle and head of the tibia.

271. The counterpart of the preceding preparation.

271 A. The parts constituting the knee-joint of the Ornithorhynchus paradoxus. The articular cavity is divided into two compartments by a continuation and extension of the ligamentum adiposum from the back of the patella to the crucial ligaments; there being one synovial cavity common to the patella and anterior part of the femur, with the internal condyle and tibia, containing the internal semilunar cartilage; and a second common

to the external condyle of the femur and tibia, with the head of the fibula, in which is contained the external semilunar cartilage.

Prepared in 1831.

272. The parts constituting the knee-joint of an Ostrich, injected. A section has been made through the patella, and the anterior part of the joint is laid open to show the crucial ligaments, and a very large tendon passing through the joint to be attached to the front of the external condyle: also a tendon passing through a synovial sheath in the ligament of the patella, in an oblique direction from the femur to the tibia. Posteriorly, the capsular ligament is removed, to show the semilunar cartilages and the ligament connecting the external one to the head of the fibula, which in this class of animals is articulated with the external condyle of the femur, and forms part of the knee-joint.

The blood-vessels upon the inner condyle are successfully filled, and exhibit numerous mutual anastomoses as they approach the articular cartilage, forming what Dr. Hunter termed "the *Circulus Articuli vasculosus;* the vascular border of the joint."

Series XII. Mechanical Contrivances by which the Powers of the Muscles are augmented.

"In the formation of many parts of the body, neatness is a principal object, as is visible not only in the external form of the limb, but in the parts constructed for motion; as in the formation of the bones and their situation with respect to one another, and the mode of removing the inserted tendon (when too close to the centre of motion to produce a sufficient effect) a little further off, by means of little moveable bones called Patellæ, or Sesamoid bones, as in the knee, first joints of the thumb, and great toe: and where this construction would be clumsy and inconvenient, as in the fingers and lesser toes, the two tendons which are obliged to pass along these parts to their insertions at the second and third joints, are so disposed in their course, that the profundus, or one nearest to the bone, acts as a patella to the other, keeping it at a distance from the centre of motion equal to its own thickness; and the sublimis, or upper one, is obliged to split into two, near its termination, before it can be inserted into the second bone. The advantage gained by this construction is, that the tendon of the muscle employed in the greatest action is removed further from the centre of motion than it otherwise could be, and from which the other sustains no disadvantage."

John Hunter, MS. Croonian Lectures.

1. *By the Mode of Insertion.*

273. A vertical section of the articular extremities of the human humerus and ulna, showing the trochlea of the former bone to which the articular cavity of the latter is adapted, and the mode in which the power of the triceps brachii is increased by the projection of the olecranon, its point of insertion, beyond the centre of motion.

273 A. A vertical section of the foot of a child, showing the insertion of the tendo Achillis at the inferior part of the os calcis, a bursa mucosa being interposed as it passes over the back part of the same bone.

Prepared in 1831.

2. *By the Interposition of Tendons and Ligaments.*

273 B. The middle finger and a longitudinal section of the fore finger of the human subject. In the former the flexor tendons are exposed, to show the perforans tendon acting as a patella to the perforatus as it passes over the first joint of the finger, and being itself removed from the centre of motion by the interposition of the perforatus tendon at the second joint. In the section of the index finger may be observed an additional contrivance for the same purpose, viz. the interposition of a ligamentous substance at the second and third joints, between the flexor tendons and the centres of motion. *Prepared in* 1831.

274. Portions of tendons from an Ostrich, showing two passing through a sheath formed by a third; which, intervening between them and the

centre of motion, acts as a patella to them, in the manner exhibited in the preceding preparation.

275. The parts constituting the tarsal joint of an Ostrich. The flexor tendons of the toes pass through a sheath in the extensor tendon of the tarsus, which is considerably thickened at that part; and while it securely retains them in their proper situation, removes them further from the centre of motion at that joint, and augments the lever of the moving power.

276. A vertical section of the metatarsal bone and phalanges of the greater toe of an Ostrich, and of their flexor tendons. Each bone has its proper tendon inserted into it, which forms a sheath for the tendon of the succeeding phalanx: and on the plantar aspect of each joint is situated a ligamentous substance (analogous to those in the human finger), forming part of that joint, and playing on an articular surface in the lower extremity of the superior bone. These act like patellæ, removing the flexor tendons further from the centres of motion of their respective joints, and forming so many elastic cushions to protect the joints, and obviate the effects, by diffusing the forces of pressure and percussion.

276 A. The hinder extremity of a large Frog (Rana ——— ? *Laurenti*), showing that the muscles which flex the tarsus arise from the front part of the condyle of the femur, and pass over the knee-joint. A large bristle is placed under the tendon of the tibialis anticus. These tendons serve, in some degree, to remove the extensor tendon of the leg from the centre of motion, for it contains neither a patella nor sesamoid bone in this order of animals. *Prepared in* 1831.

276 B. The anterior extremity of the same animal as the preceding, showing that the tendon of the extensor cubiti is thickened as it passes over the elbow-joint; that it plays on a convexity at the lower and back part of the humerus, and acts as a substitute for the olecranon. *Prepared in* 1831.

3. *By means of Sesamoid Bones.*

276 C. The anterior extremity of a Surinam Toad (Rana Pipa, *Linn.*), showing

a sesamoid bone interposed like a patella between the tendon of the extensor cubiti and the elbow-joint. *Prepared in* 1831.

277. A vertical section of the human tibia and patella, and of the tendon of the extensors of the leg, showing the distance to which the tendon is removed from the centre of motion by the interposition of the latter bone.

278. The corresponding section of the same parts. These sections also show the mode of attachment of tendons to bone; not immediately into the substance of the bone, but into the periosteum.

279. A vertical section of the fore foot of a Horse, in which are illustrated all the preceding contrivances for augmenting the moving powers, and diffusing the concentrated forces of pressure and percussion. To attain the first of these purposes, the posterior projecting process of the small pastern bone, like an olecranon, affords a more advantageous insertion to the flexor perforatus, the tendon of which acts also as a patella to the tendon which passes behind it; and this again has the sesamoid or nut-bone (os naviculare) interposed between it and the last joint, before it is ultimately inserted into the coffin-bone or terminal phalanx :—for the second purpose may be observed the interposition of that peculiar substance called the *fatty frog;* and the disposition of the fibres of the hoof, like those of articulating cartilage, perpendicular to the direction of the compressing forces.

Series XIII. The various Organs for Progressive Motion.

—— " I may be allowed to observe, previous to entering upon the mechanical motions produced by the muscles in an animal body, that, without resistance, the progressive motions of animals could not take place; for although a muscle has the power of contracting in itself, and is capable of moving all its different parts upon itself, it cannot, however, move any other part without having a fixed point to move from, which must be the greatest point of resistance. There is a fixed point, therefore, in every animal, from which the parts of the body take their principal motions. This point, in the human body, seems to be the joints of the thigh bones; which point, being in the middle of the body, must be common to the extremities. We see, therefore, that the body either moves upon the legs, or the legs move on the body or trunk: besides this there are many other fixed points: so that the body is to be looked upon as a chain of joints, whose general centre of motion is in the joints of the thigh; but each particular one has its fulcrum, or centre of motion, which is always on that side next to the first or general centre of motion of the whole: by which means the smaller moves upon the greater, as the toe upon the foot, the leg upon the thigh, and the thigh upon the body. The same also in the arms, the wings of birds, the tails of fishes, the oars of a boat, &c.

"These motions can be, and often are, inverted; as the thigh moving upon the leg, the body upon the thigh; or in birds, the body upon the wing, &c.: but then the smaller must be made the fixed point, which cannot happen without external resistance.

"It is the inverted motions, then, which produce the progressive; but it is necessary, for the production of a succession of them, to bring in also the motion of smaller parts upon greater; the two kinds of motion are therefore acting alternately whenever the progressive motion is carried beyond the first action.

"All animals which move upon the surface of the earth have that surface for their point of resistance: birds are supported and propelled in their flight by the air; and fishes, as also boats, by the resistance of the water." *John Hunter, MS. Croonian Lectures.*

1. *Progressive Motion in Water.*

a. *Fins of Fishes.*

279 A. The sterno-clavicular cartilage, scapulæ, and other cartilages of the pectoral fins of a Piked Dog-fish (Spinax Acanthias, *Cuv.*). On the right side are preserved some of the transparent horny filaments or bristle-like appendages that support the extreme edges of the membrane of the fin.

Donor, Mr. Clift.

279 B. The pelvic cartilages of the Piked Dog-fish. *Donor*, Mr. Clift.

279 C. The vertebræ and spinous processes which support the caudal fin of the Piked Dog-fish. *Donor*, Mr. Clift.

279 D. A similar preparation, showing in addition the transparent horny filaments which support the extreme edges of the membrane of the fin. The tail is the chief locomotive organ in fish, which impel themselves forwards by giving sudden and powerful lateral strokes to the water, bending the tail in two different directions: the other fins act chiefly as librators. *Donor*, Mr. Clift.

b. *Webbed Feet.*

280. The fore and hind foot of the American Bull-Frog (Rana pipiens, *Linn.*). Between the toes of the hind foot a membrane or web is extended to the last phalanx: this is employed in swimming, after the manner of an oar, striking the water by a broad extended surface.

281. The webbed feet of the Red-breasted Goosander (Mergus Serrator, *Linn.*). The hinder toe is provided, on the inner side, with a fin-like process of integument.

281 A. The fore-foot of the Ornithorhynchus paradoxus, in which the natatorial membrane is continued for some distance beyond the extremities of the toes, and is gathered into folds at each toe, which folds are concave towards the palm, and are supported behind by the strong elongated claws; a form of surface admirably adapted for striking the water with effect. *Prepared in* 1831.

2. *Progressive Motion in Air.*

282. A Flying-fish (Exocœtus volitans, *Linn.*). The pectoral fin on one side is partially expanded, showing its great extent of surface, which enables the animal to support itself in air for a short time after the body has received the impulse for motion at leaving the water.

282 A. A specimen of the Flying Lizard (Draco viridis, *Daudin*), in which a considerable fold of integument is produced laterally from the sides of the body, forming a parachute which supports the animal in the

air, and enables it to leap to a considerable distance from bough to bough. The membrane is supported by five elongated spurious ribs on each side; the first of which has a muscle extending and attached to its whole length, which draws it forward, when the rest follow, and the membrane is expanded. A bristle is placed beneath this muscle.

Prepared in 1831.

282 B. A specimen of the Horse-shoe Bat (Rhinolophus bihastatus, *Geoff.*), with the left wing expanded. This, as in the preceding specimen, is formed by a fold of the common integument, but is supported by the bones of the anterior extremity; the metacarpal bones and phalanges being remarkably elongated for that purpose. The pectoralis muscle and biceps flexor cubiti are dissected. A bristle is placed beneath the former.

Prepared in 1831.

282 C. A Humming-bird (Trochilus), with the wings extended, and the pectoralis muscle of one side exposed, which in this genus is remarkably powerful, and the keel of the sternum proportionately deep. As in all birds of great powers of flight, the first primary or digital quill-feather is the longest.

Prepared in 1831.

3. *Progressive Motion on Land.*

a. *Structures for Creeping.*

282 D. A portion of the vertebral column, with the ribs attached, of a large Serpent (Python Tigris, *Daud.*). The ribs are articulated to the transverse processes of the vertebræ by shallow ginglymoid joints, which admit of their being moved forwards and backwards on an axis passing perpendicularly through the joint. The ligaments, independent of the articular capsule, are so disposed as to limit the motions of the ribs to these directions: they are two in number,—one situated below the joint, which passes from the head of the rib to the transverse process, and thence is continued to the capsule of the intervertebral articulation; the other strengthens the upper part of the joint, and connects the neck of the rib to the transverse process.

The influence of the ribs in the progressive motion of serpents appears first to have been observed by Sir Joseph Banks, who, in a large Coluber, saw them brought forward in succession, like the feet of a Centipede, as it moved along the floor of the room, and the motions could be distinctly felt in their extremities when the hand was laid flat under the belly of the animal.

The muscles which produce these motions in the ribs were in consequence examined in a Boa Constrictor, or Python, and are described by Sir Everard Home, and figured in the Philosophical Transactions, cii. 1812. p. 163. In the two following preparations they are shown in another genus of Serpent. *Prepared by Mr. Owen.*

282 E. A portion of the body of the Hooded Snake (Naja tripudians, *Merrem*), in which the muscles moving the vertebræ and ribs are dissected and exposed. The muscular columns on each side of the spine are analogous to those deeper seated muscles of the back, which appear after removing the Cucullaris and Latissimus dorsi in the higher animals that possess extremities for locomotion.

The mesial column (*Semispinalis et Spinalis dorsi*) arises by two series of origins; one series from the roots of the spinous processes, the other by short tendons from the transverse processes: the fibres pass forwards, coalesce after the manner of a penniform muscle, and terminate in long tendons which are attached to the summits of the spines. Two bristles are interposed between this muscle and the spines of the vertebra on the right side of the preparation. The column external to the preceding (*Longissimus dorsi*) arises by a series of fleshy origins from the transverse processes; the fibres pass forwards and outwards, are attached to the spinous processes by the medium of the fascia covering the preceding muscle, and ultimately are inserted into the occiput.

The third column originates from the fascia separating it from the preceding, and detaches, from its outer edge, long and delicate tendons which run forwards to be inserted into the ribs about half an inch from their vertebral extremities, presenting a striking analogy to the *Sacro-lumbalis.* This is shown more distinctly on the left side of the preparation, the fleshy column being raised by a bristle.

On removing the Semi-spinalis dorsi (which has been done on the left side of the spine), muscles are seen running obliquely between the transverse and spinous processes, and filling up the interspace between them, like the *Multifidus spinæ*; and beneath these, *Musculi Interspinales et Intertransversales* are situated.

External to the Multifidus spinæ is a series of short and strong oblique muscles, which, like the *Levatores costarum breviores*, arise from the transverse processes, and are respectively inserted into the rib attached to the succeeding vertebra. Where these are inserted, longer muscles (*Prætrahentes costarum*) arise, which run more obliquely backwards, each of which terminates in the eighth rib beyond that from which it arose; but is also inserted into all the intermediate ribs, and is closely connected to the intercostales. There is an appearance of a division of these long muscles into an upper and a lower portion by a middle transverse line, and these divisions are described as distinct muscles by Sir Everard Home in a large Coluber, but the two portions are strictly continuous in this species. The *intercostales*, which are hardly distinct from the preceding, have their direction downwards and backwards, and are continued to the extremities of the ribs.

In this preparation are also preserved portions of the two series of muscles which connect the integument to the ribs. Those of the upper series arise from the ribs, where the Levatores costarum are inserted, pass obliquely backwards, and are inserted at a little distance above the scuta: the lower muscles arise from the extremities of the ribs, and pass forwards to be inserted into the base of each scutum.

The actions of these several muscles are sufficiently obvious on inspecting the preparation. *Prepared by Mr. Owen.*

282 F. A portion of the body of the Hooded Snake, in which the internal muscles of the vertebræ and ribs are dissected and exposed. The muscles on the inferior surface of the spine are peculiarly developed; they arise from the transverse processes, and converge forwards to be inserted into the inferior spinous processes of the vertebræ. External to these are situated the *Retrahentes costarum*, which arise from the lower part of

the transverse processes, and after passing obliquely forward over three ribs, are respectively inserted into the fourth. Where these muscles are inserted, the *Transversalis abdominis* takes its serrated origin: its fibres descend obliquely forwards and terminate with those of the opposite side, in a common middle tendon, which closely adheres to the middle of the scuta.

On removing the Retrahentes costarum, there appears a stratum of short muscles which arise respectively from the head of one rib, and run obliquely backwards to be inserted into the next rib.

On removing the Transversalis abdominis, there appears a stratum of flat and broad muscles analogous to those which Winslow has termed *Sub-costales* in the human subject: they arise from the ribs where the Retrahentes costarum are inserted; pass obliquely downwards and forwards over one rib, to be respectively inserted in the next.

The cutaneous muscles seen in this preparation pass from the middle aponeurotic line to the scuta. *Prepared by Mr. Owen.*

4. *Structures for Burrowing.*

282 G. The anterior half of the body of a Mole (Talpa Europæa, *Linn.*), in which the diaphragm and principal muscles of the right extremity are dissected and exposed. *Prepared in* 1831.

282 H. The right tibia and fibula of the Koala (Phascolarctos fuscus, *Desm.*), with the interosseous muscle. *Donor,* Sir Everard Home.

" Among the extraordinary animals from New South Wales, the Wombat is met with, which is formed for burrowing; and another species of the same genus, the Koala, which exactly resembles it in its internal structure, is a climber, and lives on the tops of the highest trees; but in the night descends to the ground, and burrows in search of roots. These animals are the most perfectly adapted for burrowing of any we know; since their hind legs are formed in a different manner from those of any other species of quadruped, having a close resemblance to the human fore-arm, and this structure evidently for the purpose of burrowing. As this is a new fact in comparative anatomy, I shall mention this structure more in detail.

"There is no patella, but the tendon of the extensor muscles of the leg, where that bone is usually situated, is much thickened. The fibula is proportionally larger than in most animals. At the upper extremity it is broad, and has two distinct articulating surfaces; the anterior of which is articulated to the tibia, and the posterior to a small bone of a pyramidal shape, which is connected to the tendon of the external head of the gastrocnemius muscle, like a sesamoid bone. The lower extremity of the fibula is large, and forms about half of the articulating surface for receiving the tarsus at the ankle. An inter-articular cartilage is here interposed between the tibia and the fibula, and another between the fibula and the tarsus.

"The fibula has a slight degree of motion on the tibia on its upper end, and a half rotatory motion on it at its lower end. Between the two bones is a strong muscle, which passes from the one to the other throughout their whole length; their fibres have their origin from the inner edge of the fibula, and pass obliquely inward and downward to be inserted into the opposite surface of the tibia. When this muscle contracts, it pulls the fibula forwards, and produces a degree of rotation on the tibia which turns the toes inwards. The anterior surface of the muscle is covered by a thin fascia or interosseous ligament; and there is another fascia less complete on its posterior surface. The muscle of the leg corresponding to the biceps flexor of the human body is inserted into the posterior part of the fibula, and is an antagonist to the muscle just described. Its action brings the toes back to a straight line, but does not turn them outwards.

"The use of this mechanism appears to be for throwing back the earth while the animal is burrowing. There is nothing at all similar to it in the hind legs of other burrowing animals, and it may therefore be adapted to particular soils." *Home, Lectures on Compar. Anat.* i. p. 133.

282 I. The left anterior extremity of the Echidna Hystrix, which exhibits in a marked degree all the peculiarities connected with fossorial habits; viz.

a broad extended palm, and strong trowel-like nails, powerfully developed muscles of the extremity, especially those of the hand, and a peculiar form of the humerus to afford them advantageous and extensive attachments; the condyles in this instance being so far produced in the lateral direction that the breadth of the bone at this part equals its length.

Prepared in 1831.

5. *Structures for Climbing.*

282 K. A Chameleon (Chamæleo planiceps, *Merrem*), exhibiting a form of the extremities adapted for grasping the twigs and smaller branches of trees, the three outer toes being directly opposed to the two inner; the tail has also the prehensile character. *Prepared in* 1831.

282 L. A Parrakeet (Psittacus Taïtianus, *Gmel.*), in which the foot has a similar disposition of the toes for grasping, and a form of beak well adapted for assisting in the climbing actions. *Prepared in* 1831.

282 M. The hinder extremities and tail of the two-toed Ant-eater (Myrmecophaga didactyla, *Linn.*). In the feet may be observed the peculiar inflected state of the toes, the heel serving as a fulcrum in the act of grasping. The tail is also prehensile, and devoid of hair and rugous along the lower part of the terminal half. *Prepared in* 1831.

6. *Structures for Leaping.*

283. The right hind-foot of a young Kangaroo (Macropus giganteus, *Shaw*), is an example of a part formed advantageously for springing. The second toe is broad, and produced far forwards, carrying the fulcrum of the lever to a considerable distance from the point of resistance, while the projection of the os calcis behind affords an advantageous attachment to the power. The two inner toes are very minute, and connate, except at the extreme point, where each of them has its own proper claw.

7. *Extremities formed with Parts for Progressive Motion only.*

284. A section of the hoof of a Horse, exhibiting externally the parts usually denominated the quarters and the coronet of the hoof; the bars of the

hoof and the frog on the lower part behind the sole; and the horny laminæ on the inner surface of the walls and bars.

285. The foot of an Ass, injected, from which the hoof has been removed to show the vascularity of the secreting organ of the hoof, and the laminæ on the exterior surface, called the sensible laminæ, to which the horny laminæ are adapted and firmly attached.

285 A. A section of the terminal phalanx, or coffin-bone of the Horse, with one of the lateral ligamentous cartilages attached.

Donor, Strickland Freeman, Esq.

285 B. A similar section of the coffin-bone of a Horse, with the lateral ligamentous cartilage, and part of the elastic ligamentous substance which is interposed between the flexor tendon and the horny frog, commonly called the soft or fatty frog. *Donor*, Strickland Freeman, Esq.

286. The bisulcate foot of a Calf, injected. The nail or hoof is removed from one of the toes, to show the vascular and sensible laminæ, similar to those in the horse, but much smaller.

8. *Extremities provided with Structures for seizing and tearing Objects of Prey.*

287. A toe from the right fore-foot of a Lion, with the last phalanx retracted on the ulnar (which from the prone state of the foot is the outer) side of the second phalanx. This state of retraction is constantly maintained, except when overcome by an extending force, by means of elastic ligaments, two of which have bristles placed beneath them in the preparation. The principal one arises from the outer side and distal extremity of the second phalanx, and is inserted into the superior angle of the last phalanx; a second arises from the outer side and proximal end of the second phalanx, and passes obliquely to be inserted at the inner side of the base of the last phalanx. A third, which arises from the inner side and proximal extremity of the second phalanx, is inserted at the same point as the preceding. The tendon of the flexor profundus perforans, which is the antagonist of the ligaments, has been divided.

287 A. A toe from the left fore-foot of a young Lioness, with the last phalanx drawn out, as in the action of the flexor profundus. The same ligaments are shown as in the preceding preparation, together with the insertion of the flexor and extensor tendons.

In order to produce the full effect of drawing out the claw, a corresponding action of the extensor muscle is necessary, to support and fix the second phalanx; by its ultimate insertion in the terminal phalanx, it serves also to restrain and regulate the actions of the flexor muscle. A bristle is placed beneath that part of the extensor tendon which passes under one of the elastic ligaments to be inserted into the base of the last phalanx immediately above the articulation.

In both preparations, lateral processes of tendon may be observed going to the under part of the base of the phalanx, which are partly inserted there, and partly lost in the integument: they are given off from the extensor tendon as it passes over the proximal phalanx, and are joined by ligamentous fibres from the sides of the same phalanx.

Prepared in 1831.

288. A toe from the right hind-foot of a Lion, with the last phalanx drawn out, and the elastic ligaments put on the stretch. As the phalanges of the hind-foot are retracted in a different direction to those of the fore foot, *i. e.* directly upon, and not by the side of the second phalanx, the elastic ligaments are differently disposed, as may be seen by comparing this with the preceding preparation. The outer ligament is of a flattened triangular form; it arises from the whole outer side of the middle phalanx, is strongest at the anterior margin, and is inserted at the superior angle of the last phalanx: the inner ligament is of a rounded form, arises from the inner side and distal end of the second phalanx, and is also inserted at the superior angle of the last phalanx, which is necessarily drawn back in the diagonal of the elastic forces.

288 A. The innermost toe, or pollex, of the right fore-foot of a young Lioness, exhibiting a disposition of the elastic ligaments, and mode of retraction, similar to the toes of the hind-foot; but here the inner ligament is of the flattened triangular form, and the outer one rounded. The latter

passes between a division in the extensor tendon, one part of which is inserted in the base of the last phalanx, just above the articulation ; the other part into the outer side of the base of the phalanx, and into the integument.

It seems scarcely necessary to allude to the final intention of these beautiful structures, which are, with some slight modifications, common to the genus Felis. The claws being thus retracted within folds of the integument, are preserved constantly sharp, and ready for their destined functions, not being blunted and worn away in the ordinary progressive motions of the animal; while at the same time, as soft parts only are brought in contact with the ground, this circumstance contributes to the noiseless tread of the feline tribe. *Prepared in* 1831.

Subdivision II.

ORGANS OF DIGESTION.

Series I. Structure and Growth of Teeth.

On Teeth.

As the stomach is the digesting organ of the food of animals,—is in common a containing part in the form of a bag or bags,—and as it is generally placed on the inside of the animal, there must be an external communication to that cavity: and as the food is either passive, as vegetables, or active in contradiction to that process, as most animal food, there must be a mode of collecting, catching, adapting, and conveying that food to, and through that communication to the stomach.

Various are the means of doing all these operations; and this variety of modes arises from the nature of the food which the animal lives upon, different modes of digestion (as the difference between a ruminant and a horse), also a great variety of circumstances attending that food, the nature of which when caught may be often similar. The first of which (circumstances) I shall reckon fluidity, as honey, the juices of plants, such as what many insects live upon, &c. Secondly, being alive, therefore a mode of catching and killing, which requires a greater extension of parts, and then to separate parts from the whole. Thirdly, collecting parts of growing vegetables; all of which have parts formed and adapted for such purposes. Most of these operations are performed by the mouth, or beginning of this communication in some animals; and in many others by the mouth with its other apparatus, as teeth; but it has often still more exterior assistance, as hands, claws, feet, &c.

These operations may be divided into three, although all the three are not necessary in every animal. The catching and collecting is the first: the fitting some food for digestion, and adapting most for deglutition, is the second: and the conveyance of that so collected and adapted into the stomach, is the third.

The mouth, which is the principal actor in these operations, is, in many, formed alone for these operations; and these formations are according to the nature of the food, and circumstances attending that food, viz. the natural situation of that food; as honey, which requires an apparatus to get to it, which is a mode of many of the winged insects; the lips, as in some fish, as the sturgeon; the tongue, as in the ant-bear, &c.

The parts of an animal immediately preparatory to deglutition and digestion are divided, in those that live on solids, into two kinds, viz. bills or beaks, and teeth: to which, probably, may be added a third, viz. those (parts) of insects which are exterior to the mouth. A mixed kind may, also, probably be added, viz. those that may be classed either with the teeth or with the bill, such as the dividers of some reptiles, as the snail, leech, &c. The bills are exterior, and are placed on, or surrounding, the mouth of the animal: they are of the same shape with the mouth, making a case for it; and as the mouth is made up of two parts opposing one another, commonly called upper and lower jaw, the bill is also composed of two parts, or a pair.

That class of parts of an animal preparatory to deglutition and digestion called teeth is so extensive, and of such various forms and uses, that it is uncertain in some cases what parts ought to be classed among the teeth and what not; and in those where they are evidently for this purpose, it becomes difficult to class them either according to their various uses or their forms*.

* Further on in the MS. Catalogue appears the following passage, through which the pen had afterwards been drawn. "Teeth are parts which cannot in any respect be classed according to the other

In some animals there are teeth for deglutition and others for digestion, as the nippers (*mandibulæ et maxillæ*) of a crab or lobster, while those for digestion are in the stomach: and where teeth were not necessary for digestion, they are wholly for deglutition, as the grinders in a lion, cat, &c.

The teeth are always placed between what may be called the brim or margin of the mouth, and the first intestine; viz. (in the) mouth, œsophagus, and stomach. Those subservient to deglutition are always placed in the mouth, viz. between the margin of the mouth and the œsophagus, having at the mouth a border of soft parts surrounding them, called lips, which is much more in some animals than in others, and which is the beginning of the mouth.

The mouth is the most frequent situation of the teeth, at least in those animals we are most acquainted with, viz. quadrupeds, amphibia, fish. In some reptiles they are placed in the œsophagus, as in the —— and ——*; and in some animals they are placed in the stomach, as in the water-insect or crab, &c.

Those in the mouth may be divided into two situations:—First, all those forming two rows in each jaw (i. e. one row in the right, and another in the left jaw), and opposed by similar rows in the opposite jaws; Secondly, where the teeth are placed on other parts, as the tongue. The first situation admits of divisions, as where those rows are single, as in the quadruped and amphibia: in others they are double, triple, &c. rows, as in many fish,

organs of the animal, but must be considered entirely with the food, as the only thing to which they belong: but as the food is always adapted to the organs of digestion, so far the teeth and those organs will always coincide.

"The teeth are adapted to the dividing, and masticating or grinding the food proper for the animal; but besides all this, are adapted to the catching of it, as in many fish and wild animals. Teeth also are in many a defence from enemies, and seem entirely given for this purpose, as in the tusk of the elephant. Teeth, besides these general uses, serve many secondary purposes in different animals.

They may be classed in this way:

Prensores simple.
——— with Laniarii.
——— ———— and Molares.

Incisores simple.
——— and Molares.
———— Laniarii.
——— Molares and Laniarii.
in the lower jaw only
formed like chisels."

* Quere, Myxine, Nereis? The term Reptiles is commonly applied by Mr. Hunter to the *Vermes* of Linnæus; whilst the *Reptilia* of the modern zoologists he usually denominates Amphibia or Tricoilia.

where the four rows mentioned are composed of a vast number of rows of teeth.

They may be classed according to their uses, which I shall at present reckon four, viz. holders or retainers, which may be called killers; dividers, crackers, and grinders, the two last of which may be thought the same.

The dividers are always more external than the grinders. Some dividers are always external, others are some way within, some more, as in the—(nereis?); some less, as in the snail. Some of the grinders are as far forwards as the dividers will allow them, as in those who have mouths filled with both kinds, as in most of the more perfect animals; but in many, those grinders are placed in the stomach, but then those have their dividers wholly external. Teeth are commonly fixed in or upon some bone, which (bones) are commonly the jaws of the animal; but this is not always the case, as in the lamprey, where there is no jaw-bone.

Some teeth grow to a given size, and then become stationary, as in most animals, viz. the human, &c.; some of which teeth last through life; others, of the same animal, are thrown off at given ages, called shedding of the teeth, and are again supplied by others, which last through life. In some other animals there is a regular succession of teeth, by the falling off or destruction of the teeth, and new ones continually growing and gradually coming into use; the new teeth being always a proportional size longer than the old: the jaws of which (animals) follow the same course, so that there is a regular succession of jaw and teeth growing. This is the case in many fish, as in all the ray-kind. In others there is a succession of young teeth growing at the basis of the old, or rather within the old, so that the old (tooth) drops out like a conical case, and the young one is uncovered. Probably the young tooth grows on the same pulp, so that these teeth never draw towards a point at the base, but always keep open or conical, yet do not always continue to grow, as the tusks.

Some teeth are wholly composed of bony substance, which is a mixture of two different substances, viz. a mixture of animal substance and calcareous earth: such are those of the ray-kind, alligator; as also some peculiar teeth of some animals whose teeth in general are not so simple, such as the elephant's tusk, boar's tusk, &c. The teeth of many animals are composed of the two abovementioned substances, but in one degree in a different manner, viz. one part being composed of bony substance, the other of calcareous earth alone.

Hunterian MS. Catalogue.

Sub-series 1. *Parts analogous to Teeth in Invertebrate Animals.*

a. *The Food being fluid.*

289. An intestinal Worm (Echinorhynchus porrigens, *Rudolphi*) attached to a portion of the intestine of the Piked Whale (Balæna Boops, *Linn.*, Bal. rostrata, *Fab.: Hunter, Philos. Trans.* lxxvii. *tab.* xx.). The worm has perforated the intestine, and has formed in its parietes a tortuous passage; the head having penetrated the mucous and muscular coats, and returned again through the latter, into the intervening cellular coat. The sides of the canal are composed of thickened and condensed cellular membrane, and in the enlarged cavity which contains the head there is a quantity of curdled matter, which appears to be lymph thrown out in consequence of the irritation. The proboscis of the animal is protruded from its funnel-shaped receptacle; it is about a line in length, including the sheath that surrounds its base, and is armed with numerous minute recurved hooks, visible by the aid of a lens. A bristle is placed behind the neck of the Echinorhynchus in a dilated part of the canal.

290. A specimen of Echinorhynchus porrigens similarly attached to a portion of the intestine of the Piked Whale. In this instance the cyst containing the head of the animal is situated between the muscular and peritoneal coats of the intestine, forming a projection or tumour in the latter. In the course of the canal, and communicating with it, there has been formed another rounded cavity, in which the head of the animal was probably lodged at some previous period, the canal beyond being more closely contracted round the neck of the specimen. There is a similar appearance in the preceding preparation, which would indicate that the passage of the worm through the coats of the intestine is not regularly progressive, but that there are intermissions of rest, during which that part of the canal in which the head is lodged becomes permanently dilated by the condensation of the surrounding cellular membrane.

291. A specimen of Echinorhynchus porrigens similarly attached to a portion of

the intestine of the Piked Whale, but having penetrated the mucous coat only.

292. A portion of the intestine of the Piked Whale, with the canal and cyst laid open of an Echinorhynchus porrigens. The head of the animal still remains in the cyst, which is situated beneath the peritoneal coat of the intestine.

293. A portion of cellular substance from the intestine of the Piked Whale, containing a similar cyst, of which a section has been made, showing the thickness of its parietes, and the extent of the adhesive inflammation induced by the irritation of the foreign body.

294. The head and neck of an Echinorhynchus porrigens, probably taken from the preceding cyst. A section has been made of the funnel-shaped receptacle into which the proboscis is retracted.

295. An intestinal Worm (Echinorhynchus glandiceps, *Catal. Nat. Hist.* No. 191.) from the intestines of a 'different species of Whale.' A much larger portion of the head is armed with hooks in this than in the preceding species, and their disposition may be more easily observed.

295 A. A Leech prepared to show its piercers or teeth. These are three in number, of a cartilaginous structure, and of a rounded form, with sharp cutting edges: they rest on small eminences in the œsophagus, and are retained in their situation by a circular ligament. *Prepared in* 1832.

296. Four heads of a large species of Cicada, exhibiting the *promuscis* or suctorious organ. This consists of a long jointed sheath (*vagina*), the base of which is covered by a long, slender and pointed process (*labrum*), above which issue four slender but rigid styles or lancets (*scalpella*), which are supposed to represent the mandibles and maxillæ of the mandibulate insects. By the union of these pieces a suetorious tube is formed, which the animal inserts into the substance the juices of which form its nutriment.

The lowest of the specimens exhibits the *vagina* and *labrum*, the next exhibits the filiform *scalpella*, and the succeeding one displays all the *trophi*.

297. A Black Humble-bee (Bombus lapidaria, *Latr.*), with the *trophi* or oral organs displayed.

298. Two heads of Humble-bees, with the *trophi* displayed on a slip of ivory. These are composed of the usual parts, viz. *mandibulæ, maxillæ, labium, palpi labiales, palpi maxillares,* and *lingua:* the latter is the organ principally concerned in collecting the nectar of flowers, being for that purpose of an elongated form, and fringed with hair on each side.

299. Two heads of a larger, and two of a smaller species of Bee, with the *trophi* displayed on a slip of ivory. The tongue may be readily distinguished by its incurvated and elongated form, and by its hirsute character.

b. *The Food being solid.*

300. The head of a Locust (Acrida viridissima, *Kirby*), with the *trophi* or oral organs displayed. The jaws, which in insects have a horizontal motion, are divaricated; the upper pair are very strong, of a hard horny texture, notched, and of a black colour at the cutting margin, and are termed the *mandibulæ;* the lower pair are much smaller, are terminated by three minute black horny teeth, and are termed the *maxillæ*. The mouth is closed above by a moveable part analogous to an upper lip, and called the *labrum*, below by another moveable organ termed the *labium*, to which and to the maxillæ are articulated slender jointed moveable organs, probably analogous in function to the cirri of the cod, or the labial bristles of the cat, and termed respectively *Palpi labiales* and *palpi maxillares*.

301. The large Shell-snail (Helix Pomatia, *Linn.*), showing the form of the mouth and the part which performs the office of teeth. This is a dentated horny substance, of a dark colour and arched form, situated transversely above the aperture of the mouth, and forming, as it were, the margin of the upper lip; the lower lip is divided by a vertical fissure.

302. The head of a Shell-snail, showing the same structure of mouth.

303. A Slug (Limax ater, *Linn.*) prepared to show its horny tooth.

304. The muscular parietes of the mouth, with the lips, jaws, and part of the

œsophagus, of a Tritonia (Trit. Hombergii, *Cuv.*). The lips have been separated in order to expose the jaws, which are of a horny nature, and of a very remarkable form: they consist of two curved laminæ, moving upon an elastic articulation which connects their lower extremities: their margins are capable of overlapping each other, and are extremely sharp, so that both in their form and mode of action they resemble a pair of curved scissors. The food, after being divided by the action of these jaws, is directed by the recurved horny papillæ of the tongue to the œsophagus, through which, in the preparation, a bristle is passed.

305. The head and arms of a Cuttle-fish (Sepia officinalis), showing the situation and form of the mouth. The jaws or mandibles are composed of a dark brown horny substance, and are almost concealed in the preparation by the lips. These consist of three circular folds of membrane: the exterior lip large, and loosely surrounding the mouth; the middle one more closely embracing it; and the third projecting beyond the former, and beset with numerous elongated papillæ. The form of the jaws is better seen in the following preparation.

306. The horny jaws or mandibles of the Cuttle-fish. These are two in number, having a vertical motion, and are of a hooked shape, not unlike the beak of a parrot, but placed in the reverse position; the inferior being that which is most curved, and which extends beyond and overlaps the other. They consist of an external and internal lamina, and are incased upon a muscular substance, to which they owe their motions.

307. A section of the lips and muscular apparatus of the mouth of a Cuttle-fish, with the tongue and part of the œsophagus.

308. A vertical section of the mouth of a large Calamary (Loligo), showing the inner lip, the disposition of the mandibles, their mode of attachment to the muscular apparatus of the mouth, and also the structure of the tongue. This part is sheathed at its extremity with a horny substance, furrowed in the vertical direction, and capable of acting as a molar tooth by being opposed to the mandibles. The upper surface of the tongue is traversed longitudinally by a deep sulcus, the sides of which are beset with horny

prickles directed backwards, and which in the motions of the tongue successively seize the divided portions of the aliment, and direct them to the œsophagus.

2. *Bills of Birds.*

309. The head of the King of the Vultures (Vultur Papa, *Linn.*), showing a beak fitted by its strength, sharpness, and hooked form, to tear the flesh of animals.

310. The head of the Wattle-bird of New Holland (Glaucopis cinerea, *Forster*), for the form of its beak.

Both these species are remarkable for fleshy appendages connected with the beak, the use of which is not known. In Vultur Papa the appendage is above the beak, carunculated and notched like the comb of a cock: in Glaucopis the appendages are of a circular form, and are continued pendent from the angles of the mouth, like the wattles of the same bird.

311. The head of a Woodpecker, showing a depressed conical and pointed form of beak, adapted for penetrating the bark of trees.

312. The head of the Blue Honey-bird (Nectarinia cœrulea, *Illiger*), showing an elongated slender bill, like that of the humming-bird, adapted for guarding the long tongue which they insinuate into the nectary of flowers.

313. The head of the Grouse (Lagopus scoticus, *Cuv.*), for the form of the beak peculiar to the gallinaceous tribe.

314. The lower mandible of the Spoon-bill injected. A large artery runs down the centre, and divides about two inches from the dilated extremity of the bill, forming a vascular network around the margin.

315. The head of the Coulterneb (Alca arctica, *Linn.*), showing a peculiarly compressed and vertically extended beak.

316. The head of the Sea-Crow (Rhyncops nigra, *Linn.*), showing a still more extraordinary form of beak. The mandibles are compressed into the form of simple laminæ, and the lower one is produced beyond the other; so

that they can procure their food only by lifting it from the water as they skim along the surface.

317. The head of the Muscovy Duck (Anas moschata, *Linn.*), showing the serrated character of the margins of the mandibles, and the peculiar tuberosity at the base of the beak.

318. The head of the Red-breasted Goosander (Mergus Serrator, *Linn.*). Each mandible is armed along the margins with small pointed teeth, directed backwards, like those of a saw.

3. *Structure and Growth of Whalebone.*

"The mouths of animals are the first parts to be considered respecting nourishment or food, and are so much connected with everything relative to it, as not only to give good hints whether the food is vegetable or animal, but also respecting the particular kind of either, especially of animal food. The mouth not only receives the food, but is the immediate instrument for catching it. As it is a compound instrument in many animals, having parts of various constructions belonging to it, I shall at present consider it in this tribe no further than as connected with their mode of catching the food, and adapting and disposing it for being swallowed. It is probable that these animals do not require either a division of the food or a mastication of it in the mouth, but swallow whatever they catch whole; for we do not find any of them furnished with parts capable of producing either effect. The mouth in most of this tribe is well adapted for catching the food; the jaws spread as they go back, making the mouth proportionally wider than in many other animals.—Some catch their food by means of teeth, which are in both jaws, as the Porpoise and Grampus: in others they are only in one jaw, as in the Spermaceti Whale; and in the large Bottle-nosed Whale, described by Dale, there are only two small teeth in the anterior part of the lower jaw. In the Narwhale only two tusks* in the fore part of the upper jaw; while in some others there are none at all . . . . .

* I call these tusks, to distinguish them from common teeth. A tusk is that kind of tooth which has no bounds set to its growth, excepting by abrasion, as the tusk of the elephant, boar, sea-horse, manatee, &c.

" Some genera of this tribe have another mode of catching their food, and retaining it till swallowed, which is by means of the substance called whalebone. Of this there are two kinds known : one very large, probably from the largest Whale yet discovered; the other from a smaller species. This whalebone, which is placed on the inside of the mouth, and attached to the upper jaw, is one of the most singular circumstances belonging to this species, as they have most other parts in common with quadrupeds. It is a substance I believe peculiar to the Whale, and of the same nature as horn, which I shall use as a term to express what constitutes hair, nails, claws, feathers, &c. It is wholly composed of animal substance, and extremely elastic.*

" Whalebone consists of thin plates of some breadth, and in some of very considerable length, their breadth and length in some degree corresponding to one another; and when longest they are commonly the broadest, but not always so.

" These plates are very different in size in different parts of the same mouth, more especially in the large Whalebone-Whale, whose upper jaw does not pass parallel upon the under, but makes an arch, the semidiameter of which is about one-fourth of the length of the jaw. The head in my possession is nineteen feet long, the semidiameter not quite five feet: if this proportion is preserved, those Whales which have whalebone fifteen feet long must be of an immense size.

" These plates are placed in several rows (see No. 323.), encompassing the outer skirts of the upper jaw, similar to teeth in other animals. They stand parallel to each other, having one edge towards the circumference of the mouth, the other towards the centre or cavity. They are placed near together in the Piked Whale, not being a quarter of an inch asunder where at the greatest distance, yet differing in this respect in different parts of the same mouth; but in the great Whale the distances are more considerable. The outer row is composed of the longest plates; and these are in proportion to the different distances between the two jaws, some being fourteen or fifteen feet long, and twelve or fifteen inches

* From this it must appear that the term bone is an improper one.

broad; but towards the anterior and posterior part of the mouth they are very short, they rise for half a foot or more, nearly of equal breadths, and afterwards shelve off from their inner side until they come near to a point at the outer: the exterior of the inner rows are the longest, corresponding to the termination of the declivity of the outer, and become shorter and shorter till they hardly rise above the gum.

"The inner rows are closer than the outer, and rise almost perpendicularly from the gum, being longitudinally straight, and have less of the declivity than the outer. The plates of the outer row laterally are not quite flat, but make a serpentine line; more especially in the Piked Whale the outer edge is thicker than the inner. All round the line made by their outer edges runs a small white bead, which is formed along with the whalebone, and wears down with it. The smaller plates are nearly of an equal thickness upon both edges. In all of them the termination is in a kind of hair, as if the plate was split into innumerable small parts, the exterior being the longest and strongest.

"The two sides of the mouth composed of these rows meet nearly in a point at the tip of the jaw, and spread or recede laterally from each other as they pass back; and at their posterior ends, in the Piked Whale, they make a sweep inwards, and come very near each other, just before the opening of the œsophagus. In the Piked Whale there were above three hundred in the outer rows on each side of the mouth. Each layer terminates in an oblique surface, which obliquity inclines to the roof of the mouth, answering to the gradual diminution of their length; so that the whole surface, composed of these terminations, forms one plane, rising gradually from the roof of the mouth: from this obliquity of the edge of the outer row we may in some measure judge of the extent of the whole base, but not exactly, as it makes a hollow curve, which increases the base. The whole surface resembles the skin of an animal covered with strong hair, under which surface the tongue must immediately lie, when the mouth is shut; it is of a light brown colour in the Piked Whale, and is darker in the large Whale.

"In the Piked Whale, when the mouth is shut, the projecting whalebone remains entirely on the inside of the lower jaw, the two jaws meeting everywhere along their surface; but how this is effected in the large Whale I do not certainly know, the horizontal plane made by the lower jaw being straight, as in the Piked Whale; but the upper jaw being an arch cannot be hid by the lower. I suppose, therefore, that a broad upper lip, meeting as low as the lower jaw, covers the whole of the outer edges of the exterior rows.

"The whalebone is continually wearing down, and renewing in the same proportion, except when the animal is growing it is renewed faster, and in proportion to the growth.

"The formation of the whalebone is extremely curious, being in one respect similar to that of hair, horns, spurs, &c.; but it has, besides, another mode of growth and decay equally singular.

"These plates form upon a thin vascular substance, not immediately adhering to the lower jaw-bone, but having a more dense substance between, which is also vascular. This substance, which may be called the nidus of the whalebone, sends out (the above) thin broad processes, answering to each plate, on which the plate is formed, as the cock's spur or the bull's horn, on the bony core, or a tooth on its pulp; so that each plate is necessarily hollow at its growing end, the first part of the growth taking place on the inside of this hollow.

"Besides this mode of growth, which is common to all such substances, it receives additional layers on the outside, which are formed from the above-mentioned vascular substance extended along the surface of the jaw. This part also forms upon it a semihorny substance between each plate, which is very white, rises with the whalebone, and becomes even with the outer edge of the jaw, and the termination of its outer part forms the bead above mentioned. This intermediate substance fills up the spaces between the plates as high as the jaws, acts as abutments to the whalebone, or is similar to the alveolar processes of the teeth, keeping them firm in their places.

"As both the whalebone and intermediate substance are constantly growing, and as we must suppose a determined length necessary, a regular mode of decay must be established, not depending entirely on chance, or the use it is put to.

"In its growth, three parts appear to be formed; one from the rising cone, which is the centre; a second on the outside; and a third being the intermediate substance. These appear to have three stages of duration; for that which forms on the core, I believe, makes the hair, and that on the outside makes principally the plate of whalebone; this, when got a certain length, breaks off, leaving the hair projecting, becoming at the termination very brittle; and the third or intermediate substance, by the time it rises as high as the edge of the skin of the jaw, decays and softens away like the old cuticle of the sole of the foot when steeped in water. The use of whalebone, I should believe, is principally for the retention of the food till swallowed; and do suppose the fish they catch are small* when compared with the size of the mouth."

J. Hunter, On the Structure and Œconomy of Whales. Philos. Trans. lxxvii. 1787. p. 397.

319. A transverse section of several plates of whalebone, with the vascular basis or gum, from the upper jaw of the Piked Whale (Balæna Boops, *Linn.*). The side view of the preparation shows the part of the plate which is sunk in the gum, and the part which projects beyond it, and terminates in the rigid hairs. At the margins of the plate, where it is sunk in the gum, may be seen the white horny substance which surrounds the whalebone, passing between the plates, and forming the ridge or bead, observable along their outer margins; exterior to which is the vascular basis or nidus, which Mr. Hunter calls the gum. (See *Philos. Trans.* lxxvii. pl. xii.) The cut surfaces show the relative thickness of the plates at different parts, and their wavy disposition, the concavity of the plates being principally towards the throat.

320. A perpendicular section of several plates of whalebone from the jaw of the Piked Whale (Balæna Boops, *Linn.*), in their natural situation in the gum. The section having removed the inner or inclined margins of the plates, the cut edges are seen from the inside of the mouth. The lower part shows the rough surface formed by the hairy termination of each

* See No. 323 A, which remarkably verifies this ingenious conjecture.

plate of whalebone: the middle part shows the distance at which the plates of whalebone stand from each other: and the upper part the white substance in which they are fixed, and also the vascular bases from which they grow.

321. A perpendicular section of a single plate of whalebone from the Piked Whale; showing the mode of growth of the plates, and of the intermediate white substance. The middle layer of the plate is formed on a conical pulp that may be seen passing up the centre of the plate: the termination of this layer forms the hair. Portions of the intermediate white substance have been successively detached, showing that laminæ are continued from that substance along the sides of the middle layer, and that these laminæ form the firm outer layer of the whalebone.

322. A perpendicular section of a single plate of whalebone, near the root, with part of the outer layer turned back, to show the inner layer, composed of detached fibres from the very commencement of the plate; which fibres being inclosed between the more compact outer layers, form, where these cease to extend, the free fringed extremity of the whalebone.

323. A perpendicular section of several plates of whalebone, with the intermediate substance and vascular nidus, from the upper jaw of a young specimen of the Great Whale (Balæna Mysticetus, *Linn.*). The latter part has been reflected from the plates, and the pulps which secrete the fibres of the fringe have been drawn out from their cavities at the roots of the plates. A white bristle is introduced into one of these cavities, and black bristles into vessels which are ramifying in the vascular nidus of the whalebone. This preparation also shows the disposition and relative proportions of the plates of whalebone, as described in the introductory paragraph; from which disposition it results that only the fringed extremities of the whalebone plates are visible from the inside of the mouth of the Whale; the whole concavity of the palate appearing to be beset with coarse rigid hairs or bristles, which explains a long-contested passage in Aristotle, who, speaking of the Great Whale (μυστικητος), says, " δε και ὁ μυστικητος ὀδοντας μην ἐν τῳ στόματι ουκ ἔχει, τριχας δε ὁμοιας

ύεαις. Mysticctus etiam pilos in ore intus habet vice dentium, quibus omnino caret, suillis sctis similes." *Hist. Anim.* lib. iii. cap. xii.

323 A. Numerous specimens of Clio borcalis, or Whale's-food of the Greenland fishermen. This is a small molluscous animal that exists in sufficient abundance in the Northern Ocean to constitute the chief support of the Great Whale-bone Whale. The structure and disposition of the whale-bone plates explain how these, or any other small species of animal, are retained in the capacious mouth of their devourer, while the water, taken in along with them, drains through the interstices of the plates.

Donor, Capt. Sir W. E. Parry.

4. *Formation of Teeth.*

"We may call everything *teeth* fitted for the purposes before mentioned (see Introductory Observations to this Series) which is composcd of an animal substance, and calcareous earth, called Bone: how far horny substance may be so shaped as to deserve the name of tecth, I do not *yet* know." *Hunterian MS. Catalogue.*

A. *Whose growth is limited.*

This class I divide into two *Genera,*—one, where they are wholly composed of bone,—the other wherc they are composed of bone and enamel. The first belongs to the alligator, lizard, snake, porpesse, spermaceti whale, sea-lion, and, I believe, the seal. The second, viz. of thosc composed of bone and enamel, belongs to man, the cat, the hare, the horse, ruminating animals, &c.*

The bony part of both genera are formed upon and by a pulpy substance; thereforc the whole of the first genus is formed by this pulp, but only the bony part of the second; the enamel is formed by an opposite pulp, which makes it more complicated. *Hunterian MS. Catalogue.*

* The two latter examples are, in the present arrangement, comprehended with the elephant under a third genus or subdivision, as having teeth composed of three substances; to wit, bone or ivory, enamel, and crusta petrosa or cæmentum.

a. Teeth composed of horny Substance.

323 B. The lower mandible and jaw, with the tongue, larynx, &c. of the Ornithorhynchus paradoxus.

There is on each side between the coronoid process and the plicated membrane of the jaw, a horny substance in the form of a molar tooth; that on the right side has been removed to show the vascular substance on which it is based, the elevations of which exactly correspond with those on the surface of the tooth. Anterior to these there are two other narrower and more elongated horny ridges, which may be also considered as teeth. *Donor*, Sir E. Home, Bart.

b. Teeth composed of Bone only.

324. A section from the middle of the lower jaw of a young Porpesse. The jaw is cut down along the inner sides of the teeth to expose their roots or fangs inclosed in the jaw.

325. A section of the lower jaw of a young Porpesse, with the teeth exposed in a similar manner. The last-formed tooth is formed in the gum, upon the edge of the jaw, not in a cavity in the substance of the bone.

325 A. A section of the upper jaw of a young Porpesse similarly prepared, and showing the same circumstance with respect to the new-formed teeth.

Prepared in 1832.

326. A transverse section from the upper jaw of a Porpesse, exhibiting the oblique direction of the fangs of the teeth at the back part of the jaw.

327. A transverse section of the lower jaw, with three teeth, of the small Bottle-nose Whale of Mr. Hunter (Delphinus Tursio, *Fabr.*). At one end of this section the tooth has been split down to show that it is hollow, and formed from the inside *stratum inter stratum.* At the other end of this preparation, the outer part of the jaw and socket has been removed, showing one tooth in its socket, and the other tooth split down similar to the first, so as to expose its cavity, and also the pulp upon which the tooth was forming.

328. Another section of the same jaw. At one end of the section is seen a tooth split down to expose its cavity, the pulp being turned down. From the outer part of the jaw a portion has also been removed, which exposes

one tooth in its socket, another split down with the pulp *in situ,* and the third tooth altogether removed, but the pulp is left standing.

"In those whales which have teeth in both jaws, the number in each varies considerably: the small Bottle-nose had forty-six in the upper, and fifty in the lower, and in the jaws of others there are only five or six in each.

"The teeth are not divisible into different classes, as in quadrupeds, but are all pointed teeth, and are commonly a good deal similar. Each tooth is a double cone, one point being fastened in the gum, the other projecting: they are, however, not all exactly of this shape. In some species of porpoise the fang is flattened, and thin at its extremity. In the Spermaceti Whale, the body of the tooth is a little curved towards the back part of the mouth; this is also the case in some others. The teeth are composed of animal substance and earth, similar to the bony part of the teeth in quadrupeds. The upper teeth are commonly worn down upon the inside, the lower on the outside;—this arises from the upper jaw being in general the largest.

"The situation of the teeth, when first formed, and their progress afterwards, as far as I have been able to observe, is very different in common from those of the quadruped. In the quadruped, the teeth are formed in the jaw, almost surrounded by the alveoli, or sockets, and rise in the jaw as they increase in length, the covering of the alveoli being absorbed. The alveoli afterwards rise with the teeth, covering the whole fang; but in this tribe the teeth appear to form in the gum, upon the edge of the jaw, and they either sink in the jaw as they lengthen, or the alveoli rise to inclose them; this last is most probable, since the depth of the jaw is also increased, so that the teeth appear to sink deeper and deeper in the jaw. This formation is readily discovered in jaws not full grown; for the teeth increase in number as the jaw lengthens, as in other animals. The posterior part of the jaw becoming longer, the number of teeth in that part increases, the sockets becoming shallower and shallower, and at last being only a slight depression.

"It would appear that they do not shed their teeth, nor have they new ones formed similar to the old, as is the case with most other quadrupeds, and also with the Alligator. I have never been able to detect young teeth under the roots of the old ones; and indeed the situation in which they are first formed makes it in some degree impossible, if the young teeth follow the same rule in growing with the original ones, as they probably do in most animals.

"If it is true that the Whale tribe do not shed their teeth, in what way are they supplied with new ones, corresponding in size with the increased size of the jaw? It would appear, that the jaw, as it increases posteriorly, decays at the symphysis; and while the growth is going on, there is a constant succession of new teeth, by which means the new-formed teeth are proportioned to the jaw. The same mode of growth is evident in the Elephant, and in some degree in many fish; but in these last the absorption of the jaw is from the whole of the outside along where the teeth are placed. The depth of the alveoli seems to prove this, being shallow at the back part of the jaw, and becoming deeper towards the middle, where they are the deepest, the teeth there having come to the full size. From this forwards they are again becoming shallower, the teeth being smaller, the sockets wasting, and at the symphysis there are hardly any sockets at all. This will make the exact number of teeth in any species uncertain." *J. Hunter, on Whales, ut supra,* p. 398.

c. *Teeth composed of Bone and Enamel.*

329. The anterior part of the right *ramus* of the lower jaw of a young Lion, showing the teeth, together with the gums in which they are imbedded, and the border of soft parts, or lip, with which they are surrounded. In this specimen the teeth are not, as in the preceding preparations, of an uniform character, but vary in form; the three anterior being termed *incisores*, or incisor teeth; the succeeding large tooth *cuspidatus*, or laniary; and the remaining teeth *molares*, grinding teeth, or molaries.

330 The anterior part of the upper jaw of a young Lion injected, in which the body of the second or permanent laniary (*cuspidatus*) is pretty completely formed, and the fang forming. The laniary is cut down in the direction of its axis to expose the cavity containing the pulp on which it

was forming. There is one of the molaries in the act of being shed, and the adult or permanent tooth is pushing into the gum.

331. The counterpart or opposite section of the above laniary.

332. The laniary of the jaw of the opposite side of the same Lion, showing the whole of the pulp on which it was forming.

d. *Teeth composed of Ivory, Enamel, and Cæmentum*.*

a. With a single cavity in the fang, but a double one in the body of the tooth. The enamel principally external.

333. The pulp of the incisor of a Horse, which is forked or split at its unattached end, forming the two cavities in the body of the tooth. Between the two forks is the loose end of the pulp which forms the enamel.

334. The incisor of the Horse at an early period of its formation. A portion has been removed from both sides in the direction of its axis, which shows the cavity in the centre of the cutting surface, and the forked appearance of the tooth, which results from this treatment. The end of the pulp appears also forked on which the bony part is formed. The pulp of the enamel may be seen in the interspace of the bifurcation.

335. A section of the anterior part of the jaw of a Colt, exposing the pulps of two incisors, the sockets being laid open and the teeth being removed. At one side is the pulp of the tooth, pulled out of the socket, exhibiting its bifurcation, at the top of which socket is the pulp of the enamel. At the other side of the preparation is the loose or unattached end of the pulp of the other tooth, in the cavity of which a bristle is placed to open it.

336. A section of the anterior part of the jaw of a Colt, with one of the shedding incisors drawn, and the socket in which the permanent tooth was forming laid open, and that part of the tooth that was formed taken away, so as to show the pulps, viz. the bone-forming pulp, and the enamel-forming pulp.

337. A similar section from the other side of the same jaw as the preceding,

* Cortical osseux, *Tenon.* Crusta petrosa, *Blake.* Cement, *Cuvier.*

with the shedding incisor also drawn out; but the permanent incisor has been cut through in the socket, so as to show its forked cavity filled with the bone-forming pulp, which arises from the bottom of the socket, and the interspace of the bifurcation filled by the enamel-forming pulp, which originates from the upper part of the socket.

β. With double cavities in both body and fang. The enamel mixed internally with the bony part.

338. The anterior part of the left ramus of the lower jaw of a Foal, of which the outer plate has been removed, to expose the sockets and the growing teeth. At the end of the jaw (the upper part of the preparation) the *capsula dentis* of the first incisor has been removed to show the tooth: it is left on the second. It has been reflected from the first and third grinders, but is left on what remains of the intermediate grinder, part of which has been removed.

339. A section of the lower jaw of a Foal, including a molar tooth which had not yet pierced the gum: it is exposed by removing a part of the jaw. The internal periosteum of the socket, or capsule of the tooth, has been reflected from one part to expose the tooth: on the other part of the same tooth it is left. A bristle is placed behind the attachment of the capsule and pulp to the jaw, through which attachment the vessels and nerves do pass.

340. The grinder of a Horse, at the beginning of its formation. It is suspended by a part of the capsule. One portion of the bony part has been removed to show the two pulps upon and from which it was formed: below, the other two bony portions of the tooth remain with the pulps in them.

341. The capsule and pulps of the grinder of a Horse, at an early period of its formation.

342. Part of the pulp of a Horse's tooth.

343. The bone-forming pulp of a Horse's grinder, attached at its basis to the lining of the socket, and terminating at the other end in numerous

divisions like turrets, which were drawn out of as many cavities in the body of the tooth.

344. A similar preparation. The divisions of the bony pulp, exceeding four in number in both these preparations, show that they have been taken from grinders of the under jaw.

345. A tooth of incomplete growth removed out of its socket, split in the direction of its axis, and suspended by the root, so as to exhibit the processes of the bone-forming pulp passing down, as it were, in grooves, and part of the enamel-forming pulp hanging down, attached to the gum which covers the extremity of the tooth.

346. A transverse section of the upper jaw of a Horse, in which are two grinders of incomplete growth, one of which is much further advanced than the other, having pierced the gum. The external part of the jaw has been removed to expose these teeth. From the most advanced tooth, the outer capsule and external lamella of the tooth have been removed to expose the bone-forming pulp, which adheres to the bottom of the socket, and as it passes into the cavity of the tooth, divides as those cavities divide. In the other tooth, the forked bone-forming pulp is turned up, and another lamella of the tooth removed to expose the enamel-forming pulp attached at its base to the gum, the two pulps, as it were, interdigitating.

347. A horizontal section of the upper jaw, with the two first grinders, of a Horse. The bases of the sockets are removed, to show the hollow growing roots of the teeth, of which the bone-forming pulps have been pulled out, and hang down, attached at their bases to the bottom of the socket.

348. A horizontal section of the jaw of a Colt, which includes the apertures of the sockets of two grinders that had not yet advanced through the gum. The teeth have been removed, leaving the enamel-forming pulp in its situation, attached at its base to the inside of the gum, and loose where it was situated between the interstices of the bony part.

349. A Horse's grinder which has been steeped in an acid; a section removed from the side, and from the grinding surface, and the tooth, as it were,

unfolded, the *cæmentum* being drawn out from the interstices of the ivory portion, and the intervening enamel wholly dissolved.

γ. With many cavities in both body and fang. The ivory, enamel, and cæmentum regularly alternating.

On the Teeth of the Elephant.

They have but one tooth on each side of each jaw when the animal is fully grown. They shed their teeth at least twice, for in the young animal, which has shed its teeth once, we find a third tooth approaching; and most probably they shed them much oftener: even that third tooth is much smaller than what we find in the old elephants.

The reason why they should shed their teeth more than once, and therefore oftener than what is done in other animals, is very evident, and arises entirely from their having only one complete tooth at a time on each side of each jaw. In those animals that have more teeth than one, each tooth is to be considered when in use as only a part of a whole, each tooth being much smaller than if the whole, as is the case with the Elephant, were united into one.

Those animals that have more teeth than one, shed a certain number which is equivalent to the shedding of the first tooth in the Elephant; but here they stop, and make up the deficiency in another way, while the Elephant goes on in the same course: now let us reconcile this difference.

In the Polydentata, the increase of new teeth, or rather the increase of grinding surface, is from behind, forming in regular succession as the jaw increases, which supersedes in them the necessity of a second change, otherwise another set of proportionally larger teeth must unavoidably have taken place, to fill up the additional growth of the jaw; but in the Elephant there is not this increase of new teeth, therefore nature must take the next expedient, viz., change the tooth while the jaw is increasing. However, even in the Elephant, there is an effect produced, which is somewhat similar to the other, although not so great, viz., the whole tooth in breadth is not formed at the same time, the anterior end being always formed a considerable time before the other, and of course higher in the jaw; so that there is backwards an increased succession of grinding surface produced, similar to new formed teeth in other animals; but as this tooth does not lengthen backwards in proportion to the increase of jaw, it does not keep pace with that increase, therefore a new tooth is formed behind to succeed the other.

These new teeth are not formed under the first tooth, or by the side of it, as in the Polydentata, but entirely behind; and as the posterior end of the first tooth is latest of growing, while the anterior end of the second is by much the earliest, the anterior end of the succeeding tooth comes into use long before the first tooth is fit to be shed, and the length of grinding surface is increased by the whole of one and part of another tooth.

The line of direction is very oblique, similar to the oblique line made by the teeth of different growths backwards in the Polydentata; but in the Elephant, as the tooth rises in the jaw, its anterior end is worn down, so there is an increased surface produced.

The jaws still continuing to grow, the succeeding tooth acts at first only in part, at which time there are two teeth in view and in action; but by the time that this succeeding tooth is considerably exposed, the other is shed, by which means the animal is reduced to one tooth. A repetition of this process goes on while the animal is growing; but when the growth of the jaw is at a stand, then the animal is reduced to a single tooth.

They do not shed their teeth as other animals do that have more than one; for those that have more than one tooth can afford to be for some time without some of their teeth; therefore the young tooth comes up in many nearly in the same place with its predecessor, and some exactly underneath, so that the shedding tooth falls sometime before the succeeding tooth can supply its uses; but this would not have answered in the Elephant, for if the succeeding tooth had formed in the same situation with respect to the first, the animal would have been for some time entirely deprived of a tooth on one side, or at least if it had had one on the same side in the opposite jaw, that one could have been of no use;

and if this process took place in both sides of the same jaw, and in either jaw, the animal would for some time be entirely deprived of any use of the two remaining. *Hunterian MS. Catalogue.*

350. A longitudinal section of the bone-forming pulp of an Elephant's grinder which was in a growing state. These pulps are so many plates or laminæ attached at their bases and edges to the enveloping membrane or periosteum, which might be called *perident.*

351. A longitudinal section of the enamel-forming pulp of the above-mentioned Elephant's tooth. They are so many plates or laminæ attached at their base to the gum, and passing into the interstices of the tooth, interdigitating with the former, first covering the bony parts with the enamel, and afterwards forming bone (*cæmentum*) upon the enamel.

352. A section of the growing tooth of a young Elephant, which has been steeped in an acid so long as to remove entirely the enamel. On the uncut or natural side may be seen the enveloping membrane; and where it covers the two edges, or rather the cutting surface and the base, it gives attachment or origin to the two pulps. On one edge is the bone-forming pulp, and on the opposite edge is the enamel-forming pulp, both of which are seen going into the different interstices of the tooth, as it were, overlapping each other.

353. The opposite section of the same tooth. This and the preceding preparations are from the Indian Elephant.

354. A molar tooth of an African Elephant, which has been steeped in an acid until the whole of the enamel has been dissolved, and the remaining constituents of the tooth so far softened as to bear being cut with a knife. In this way a (longitudinal) vertical section has been removed from the preparation, which thus exhibits the rhomboidal plates of ivory formed by the pulps that arise from the bottom of the sockets, and the bony part (*cæmentum*), which is formed from the pulps attached to the gum; the two kinds of pulps, as it were, interdigitating. In the intervening empty spaces was situated the enamel, formed also from the last-mentioned pulp.

B. *Whose growth is continual.*

Teeth continually growing I have divided into two species: first, the *Dentes scalprarii;* and second, the tusks. The first belongs to Hares, &c.; the second to the Boar tribe; as also to the Narwhal, and probably to many more. *Hunterian MS. Catalogue.*

a. *Incisores.*

355. The right ramus of the lower jaw of a Beaver (Castor Fiber, *Linn.*), in which, by an oblique section, the root of the incisor is exposed, and part of it also removed, so as to exhibit the vascular secreting pulp in the cavity of the tooth, together with the form of the tooth and its great extent within the jaw.

356. The left ramus of the lower jaw of a Porcupine (Hystrix cristata, *Linn.*), in which the outer parietes of the socket of the incisor have been removed to show the form of the tooth and its great extent within the jaw.

357. The right ramus of the same jaw, in which the tooth itself as well as the outer parietes of the socket of the incisor have been removed, so as to exhibit the form and extent of the socket, and the secreting pulp, which is of an elongated pyramidal figure.

357 A. A portion of the left ramus of the lower jaw of a Porcupine, in which the socket of the incisor is laid open, the tooth displaced, and the vascular parts concerned in its formation exposed. The ivory-forming pulp, having been drawn out of the cavity of the tooth, hangs attached by its base to the root of the socket: the enamel-forming membrane is reflected from the socket as far as its attachment to the orifice of that cavity. This membrane is found only on the convex side of the socket, and adheres firmly at its edges to the parietes of the socket; the line of termination may be distinctly seen in the preparation, and corresponds with the limits of the enamel on the tooth. For in these teeth the enamel is confined to the anterior surface, terminating in a well-defined edge on either side; and from this disposition of substances differing in density, results, as a consequence of constant attrition, the sharp cutting anterior edge, and posterior sloping surface like that of a chisel.

And as this resemblance in form arises from a similarity in composition, these teeth were termed *Dentes scalprarii* by Grew, and Mr. Hunter makes use of a modification of the same term (*Scalpris-dentata*) * to signify the animals to which they are peculiar, viz. the *Glires* of Linnæus. *Prepared by Mr. Owen.*

357 B. The right ramus of the same jaw as the preceding, in which the dental canal is laid open, and the nerve displaced, showing the filaments which are given off to the pulps of the teeth, and more particularly that which goes to the pulp of the incisor. This is given off at the middle of the canal, and returns at an acute angle to gain the capsule of the pulp, where it may be seen to ramify. Its course is indicated by portions of bristle. *Prepared by Mr. Owen.*

b. *Laniarii.*

358. Part of the right upper jaw of a Boar (Sus scrofa, *Linn.*), in which the tusk and its socket have been sawed through in the direction of their axes, so as to exhibit the depth of the socket, the cavity in the root of the tusk, and the vascular pulp by which it was secreted. A bristle is placed behind the latter.

359. The corresponding section of the same jaw and tooth, showing the same circumstances.

360. A portion of the left upper jaw of apparently the same Boar, in which the whole of the outer parietes of the socket and outer half of the tusk have been removed so as completely to expose the pulp, which is of a flattened pyramidal figure.

361. A part of the right ramus of the lower jaw of a Boar, in which the inner parietes of the socket of the tusk have been removed to show the form of the tusk and its extent within the jaw; upon the non-exserted part may be observed transverse curved lines, which indicate the different stages of growth.

c. *Growth of Teeth exemplified by Experiments with Madder.*

[All the specimens in this group are from the common Hog (Sus do-

* Zoological Appendix to White's *Journal of a Voyage to New South Wales*, p. 274.

mesticus). The madder was administered at particular periods or intervals, so as to have the teeth tinged *stratum super stratum,* but they have now entirely lost the colour so imparted.]

362. An incisor and a tusk in the growing state, longitudinally bisected to show the different strata of colour.

363. A tusk and a molary, both in the growing state, similarly bisected to show the same circumstances.

364. A transverse section of the lower jaw, containing a molary, from which a portion has been removed on both sides. The stratum of red colour is (stated to have been) seen both in the tooth and in the jaw.

365. A similar section with the permanent molary not so far advanced. The colour is (stated to have been) not so distinct.

366. A similar section.

367. A similar section in which the red colour is (stated to have been) more brilliant.

368. The right ramus of the lower jaw, in which the molaries have been filed down to different extents to exhibit the circular stratum of red in each, but much faded (now entirely gone).

5. *Component parts of Teeth.*

369. The superior maxillary bones of a Woman, injected, and containing the teeth, all of which have been by means of acid deprived of their earthy part, and dried so as to render them transparent, and afterwards preserved in oil of turpentine. The anterior or outer plates of the alveolar processes have been removed, together with the outer moieties of the teeth, so that the extent of the fangs within the jaws, their cavities, and the vascular pulps, may be seen.

370. The outer plate of the alveolar processes of the superior maxillary bones of a Woman, injected, with the outer moieties of the teeth; all of which have been treated in the same manner, and exhibit the same circumstances as the preceding preparation.

371. The outer plate of the lower jaw of a Woman, with the outer moieties of the teeth, which have been steeped in an acid and dried, but are preserved in spirits of wine. This preparation exhibits the dental canals, and the forms and proportions of the sockets and fangs of the teeth.

372. The anterior part of the left ramus of the lower jaw of a young Lion, injected, and, together with the teeth, steeped in an acid, dried, and preserved in oil of turpentine; by which treatment is shown the transparency of the teeth when deprived of their earth, and their non-vascularity.

373. A transverse section of the body of a Horse's grinder, which has been steeped in an acid and consequently deprived of the earthy constituent of the ivory, and the whole of the enamel; so that the situation which the latter substance occupied in the tooth is now indicated by empty spaces.

374. A longitudinal section of a Horse's grinder, which has been similarly treated, and exhibits, in consequence, similar interstices which the enamel had previously occupied.

375. A similar preparation.

375 A. Part of a Horse's grinder, the lower half of which has been subjected to the action of acid, and shows the same circumstances as the preceding preparations. *Donor*, Charles Hatchett, Esq.

"When a tooth coated with enamel is immersed in diluted nitric or muriatic acid, a feeble effervescence takes place, and the enamel is completely dissolved; so also is the bony part, but the cartilage of that part is left, retaining the shape of the tooth. Or, if a tooth in which the enamel is intermixed with the bony substance, is plunged in the acid, the enamel and the bony part are dissolved, in the same manner as before; that is to say, the enamel is completely taken up by the acid*, while the tooth, like other bones, remains in a pulpy or cartilaginous state, having been deprived of the ossifying substance. Consequently those parts which were coated or penetrated by lines of enamel, are diminished in

* This fact had not escaped Mr. Hunter, who, speaking of enamel, says, "When soaked in a gentle acid, there appears no gristly or fleshy part with which the earthy part had been incorporated."
History of the Human Teeth, p. 35.

proportion to the thickness of the enamel which has been thus dissolved; but little or no diminution is observed in the tooth."—"As porcellaneous shell principally differs from mother of pearl only by a relative proportion between the carbonate of lime and the gluten or membrane; in like manner, the enamel appears only to be different from tooth or bone by being destitute of cartilage, and by being principally formed of phosphate of lime cemented by gluten."

Hatchett, Experiments on Shell and Bone,
Philos. Trans. lxxxix. 1799, p. 328.

375. B. A portion of the cæmentum of an Elephant's grinder, which has been steeped in an acid, dried, and preserved in oil of turpentine, for the purpose of showing the proportion of animal matter that it contains.

Donor, Sir E. Home, Bart.

6. *Process of Shedding the Teeth.*

a. *Where only a certain number of the Teeth are shed, viz. those on the fore part of the mouth, and shed but once.*

376. A vertical section of the left ramus of the lower jaw of a young Lion, with the teeth; exhibiting two temporary molaries, with their fangs partially absorbed, preparatory to their being shed; and the permanent molaries beneath almost completely formed.

377. A section of the upper jaw of a young Horse, containing a temporary grinder, and a permanent one forming in a socket at its root. The outer plate of the jaw has been removed, so as to exhibit the effects of the absorbent process on the fangs of the temporary tooth, and the vascular pulps concerned in the formation of the permanent one.

378. A similar section of the upper jaw of a young Horse, containing two temporary and two permanent teeth; the former in the act of being shed, the latter in the act of growth: but both processes are more advanced than in the preceding preparation.

379. A section of the lower jaw of a young Horse, containing two temporary and two permanent teeth. The sockets of the latter have been laid open, and one of them is left surrounded by the external capsule; but from the

other the capsule has been removed, together with part of the substance of the tooth, so as to expose the bone-forming pulp.

b. *Where all the Teeth are shed, and probably continue to be so shed during the life-time of the animal, at least while it continues growing, which is probably through its whole life.*

α. Where there is a succession of Teeth forming on the same pulp.

380. The right ramus of the lower jaw of a young Crocodile (*Crocodilus acutus*, Cuv.), in which the outer wall of the alveolar processes has been removed, together with the outer part of the teeth, so that their cavities are exposed, and the vascular pulps on which these teeth are formed, and on which succeeding teeth form.

β. Where there is a succession of Teeth forming on distinct pulps.

381. A portion of the jaw of the Angler (*Lophius piscatorius*, Linn.), in which fish the jaw is increased by matter added to the outside, and is diminished in a certain proportion by the removal of matter from the inside: the teeth also follow the same order, forming in the new-forming jaw, gradually increasing in density and size as they advance with it inwards, and by the time they are completely formed becoming inner teeth.

The teeth exhibit also another peculiarity in this fish: they are not lodged in sockets, but are supported by ligaments, of a tendinous lustre and of a pyramidal form.

The process of shedding is exemplified in those of the perfect teeth which are situated most anteriorly.

382. A section of the post-mandibular bone of a Shark (*Squalus Carcharias*, Linn.), in which the mode of increase of the bone and the order of the succession of the teeth (viz. from the outside to the inside, as in the preceding example,) are reversed; for the teeth are developed from within, and by the time they are completely formed become the exterior teeth, when they wear away and drop off.

The gradual increase in density, and the filling up of the cavity of the tooth as it advances forward, are shown on one side of this section; and also the change of position of the tooth from the recumbent to the erect state, which takes place when it arrives at the exterior row.

383. A similar preparation.

383 A. A section of the post-mandibular bone of the gray Shark (*Squalus Galeus*, LINN.), showing the manner in which the new-formed teeth are covered by the gum. *Prepared by Mr. Owen.*

384. A section of the post-mandibular bone of a Skate (*Raia Batis*, LINN.), in which the mode of increase of the jaw and of the succession of the teeth are the same as in the Shark, viz. from within outwards ; but the teeth are here much more numerous, covering the jaw like a pavement.

7. *The Situation of the Teeth.*

a. *In the Mouth.*

α. In a single row in each jaw.

385. The head of a Fish (*Julis*, CUV.), exhibiting conical curved teeth in a single series in each jaw.

386. The left superior maxillary bone of an Agama, exhibiting a single series of obtuse teeth.

387. The left ramus of the lower jaw of an Iguana, exhibiting a single series of compressed acuminate and serrate teeth.

388. The right superior maxillary bone of a young Crocodile (*Crocodilus acutus*, CUV.), exhibiting a single row of conical sharp-pointed but irregular teeth.

389. Part of the lower jaw of a young Dolphin (*Delphinus Tursio*, FABR.), exhibiting a single row of regular conical teeth.

390. The lower jaw of a Sloth (*Bradypus didactylus*, LINN.), exhibiting a single row of obtuse cylindrical teeth, which are all molaries.

391. The head and anterior part of the body of the Indian Musk-Shrew (*Sorex myosurus*, PALLAS), with the teeth exposed, which are arranged, as in other mammalia, in a single row, but exhibit all those differences of form known by the names of incisors, laniaries, and molaries.

β. In two or more rows in each jaw.

392. A portion of the jaw of a Shark, exhibiting the teeth disposed in four or five rows, of which the first row is erect, the others recumbent.

393. The anterior part of the lower jaw of an Eel (*Anguilla latirostris*, YARRELL),

exhibiting teeth of a very small size, and disposed in numerous rows on the jaw.

γ. In rows on the jaws, and also on other parts, as the tongue.

394. The lower jaw of a Trout (*Salmo fario*, Linn.), exhibiting teeth on the maxillary, the lingual, and the pharyngeal bones.

395. The head of a Salmo from the South Seas (of the sub-genus *Saurus* of Cuvier), characterized by numerous sharp-pointed teeth on the maxillary and intermaxillary bones, as well as on the palatine, lingual, and pharyngeal bones.

δ. Where the Teeth are scattered.

396. The head of a Lampern (*Petromyzon fluviatilis*), with the mouth expanded, so as to expose the teeth, disposed for the most part in curved lines along the inner membrane of the mouth: there is also a large semicircle of teeth below the tongue, and transverse rows of very small teeth upon the tongue.

396 a. The head of the Lamprey (*Petromyzon marinus*), injected, exhibiting the same disposition of teeth, but on a larger scale.

Donor, Mr. Clift.

397. The tongue and part of the body of the Hag (*Myxine glutinosa*, Linn.), showing the teeth, strong, conical, and sharp-pointed, disposed in four curved rows on the tongue, the two on one side opposing the two on the opposite, like the laterally disposed jaws of the *Insecta* and *Nereidæ*.

ε. Where the Teeth are disposed like a pavement.

398. The pharyngeal bone of a Fish from the South Seas (of the genus *Labrus*, Linn.).

ζ. "This is a very singular class of teeth, where there is no jaw, the motion being in the teeth only."—*Hunterian MS. Catalogue.*

399. A vertical section of an Echinus (*Ech. mammillatus*, Lam.), exposing the triedral and pyramidal calcareous pieces which surround the commencement of the alimentary canal, converging towards the oral aperture of the shell, and supporting on their apices the projecting teeth. The latter are of an elongated prismatic form, pointed at the extremity, and have the inner or central angle so produced as to render them capable of acting

as dividers. The pyramidal supporters are finely grooved in the transverse direction on the sides that are opposed to each other, and may be supposed to act as grinders.

Calcareous processes in the form of arches project into the cavity of the shell at certain distances round the mouth, and serve as fixed points for the attachment of the muscles which act upon the moveable apparatus. In the preparation may also be observed the external lip surrounding the points of the teeth, and the membranous œsophagus continued from the basis of the pyramidal supporters.

b. *In the Pharynx or Œsophagus.*

400. The fauces of a Carp (*Cyprinus Carpio*, Linn.), showing the strong sharp-pointed teeth on the inferior pharyngeal bones, and the hard triangular plate fixed in the *os basilare*, which, like an anvil, supports the food, and fixes it while undergoing comminution from the action of the pharyngeal teeth.

401. A small Annelide (*Polynoë squammata*, Savigny), laid open on the ventral aspect so as to expose the alimentary canal. "In the œsophagus (proboscis) may be observed several teeth like claws." These are of a horny nature, and, in this species, not dentated.

402. The anterior part of a larger Annelide (*Lycoris foliosa*, Owen), laid open on the ventral aspect so as to expose the retracted proboscis and alimentary canal: in the former may be observed the extremities of two black horny maxillæ, which are dentated, falciform and pointed. To the lower part of the œsophagus are connected two elongated follicles probably serving as a salivary apparatus. A small bristle is passed through the orifice, by which the proboscis communicates with the intestinal canal.

It is now satisfactorily ascertained that the muscular tube, in which the horny teeth or jaws of the *Nereidæ* are situated, can be completely and rapidly protruded at the will of the animal; and that it constitutes essentially the mouth, and not the œsophagus or stomach. (In Nos. 256, 254, *Nat. Hist. Series*, they are exhibited in the exserted state in both the above species.)

The present specimen is figured in an original drawing by Mr. Hunter's artist and assistant, Mr. W. Bell, (No. 35. fig. 2. Cube II. dr. 4). In the description of the drawing, Mr. Hunter calls these teeth 'dividers', and says they are "placed a considerable way within the head of the animal; as it were, at the beginning of the stomach: and we must suppose it is capable of projecting or inverting the œsophagus. Or we may suppose it has the power of drawing in the food so far, and then dividing it."

c. *In the Stomach.*

403. A Mollusk (*Bullæa aperta*, Lam.), with bristles introduced into the mouth and anus.

404. The stomach or gizzard of the same species laid open, with the commencement of the intestines. In the former cavity are three calcareous plates, two of which are of an elongated triangular form, and the third rhomboidal.

404 a. Small cartilages from the stomach of the Oyster.

Donor, Sir Anthony Carlisle.

"The stomach" of the Oyster "consists of a sinuous cavity, subdivided by alternate projections and clefts adapted to each other,—and in those spaces I have generally found a detached piece of cartilage, whose office may be that of assisting in the trituration of the food, because the interior of the stomach itself presents similar cartilaginous projections."

Carlisle, Hunterian Oration, 1826, *p.* 17.

405. The gizzard, membranous stomach, intestine and biliary ducts of an orthopterous insect, called by Mr. Hunter the Cape Grasshopper, or large Grasshopper from the Cape of Good Hope. The first cavity or gizzard is muscular, with the internal surface plaited longitudinally and armed with six longitudinal rows of minute teeth. At the point of union of the gizzard with the membranous stomach there are two cæcal appendages. The biliary ducts are numerous and filamentary.

A magnified view of this preparation is preserved in an original drawing by Mr. W. Bell. (No. 36. fig. 1. Cube II. dr. 4.)

406. The stomach of the River Craw-fish (*Astacus fluviatilis*, Fabr.) laid open; exposing a pair of horny 3-dentated processes within, and the rounded, flattened, calcareous masses, commonly called *oculi cancrorum*, attached to the outer membrane of the stomach.

407. The stomach of a Lobster (*Astacus marinus*, Fabr.), showing the bony processes attached to its posterior part near the pylorus. These processes support the teeth observable in the interior of the stomach, and serve as points of attachment to the moving powers, and are therefore analogous to jaws.

408. The stomach of a Lobster laid open, exposing the teeth, which are five in number, situated around the pyloric orifice, in such a manner as to subject the alimentary matters to their action before passing into the intestine.

Two of the teeth are very small, and are armed with three sharp points; the other three are large; and of these, two are lateral and are opposed to each other, and have transverse ridges on the grinding surface; but the third projects over the pyloric orifice in the intervening space, and is curved towards the cavity of the stomach, so as to throw back between the grinders those morsels of food which had not previously undergone sufficient comminution.

408 a. The stomach of a large Crab, from "New South Wales". It is armed with teeth similar to those of the lobster; but the sides of the groove leading to the pyloric aperture are rendered rough by numerous filamentary processes, which may probably serve as a filter or sieve, regulating the size of the particles which are to pass into the intestine.

Donor, Sir E. Home, Bart.

Series II. Structure of the Stomach.

"The apparatus necessary for the simple operation of digestion, is as simple as any thing we can well conceive. It only requires a bag or cavity fit to contain the substance to be digested, joined with the power of furnish-ing the fluid capable of digesting or animalizing the said substance. In such a light, it is only to be considered as a gland with a cavity. But it was necessary that there should be some part added to furnish this bag with materials to be digested; for which purpose there are in some, arms; in others, both arms and teeth, &c.

"Besides the simplicity of the apparatus for the operation of digesting, there is another apparatus added to furnish (fulfil) the intention, which is the system for absorbing the animalized parts for the nourishment of the same bag; and added to this power of secretion and absorption, is the power of throwing out of the bag the indigestible parts, acting as a kind of excretory duct*.

"From this account, nothing can be more simple; however, it completes a whole animal, and nothing more can be necessary for the support of such an animal; but when we come to such stomachs as have parts superadded for other purposes than the above, then we find that this same apparatus for digestion has also parts superadded for the purposes of digesting; so that the parts preparatory and subservient to digestion, become more complicated, and indeed so much so, that there is hardly any system in an animal more complicated in itself; and when we consider the varieties of these complications which take place in the various animals, they appear to be almost without end.

"It is these complications and varieties that we mean to consider, and reduce, as far as they will admit, to their several classes.

"The parts subservient to digestion in the complicated animals bear a great relation to the other properties of the animal†.

"In classing the organs of digestion in the complicated animals, many parts are to be considered which appear from a slight view of the subject to be only secondary, and therefore might be thought necessary to be considered apart: but we shall find that many of these parts have pecu-

* "Nothing more is necessary to complete an animal, than the power of continuing the species, which power is superadded to this bag in many."

† "Animals in general might be tolerably well classed by these organs, most being reducible to a few general classes, which again admit of many subdivisions."

liarities, and these are adapted to the peculiar food and peculiar mode of getting it, and not at all belonging to simple digestion in particular.

"These superadded parts, which have their mechanism adapted to the way of life with respect to digestion, are the powers of mastication,—in some, reservoirs,—the varieties of stomachs,—whether or not a cæcum, and of what kind,—and colon; so that in classing the organs of digestion, we must consider teeth, stomachs, cæcums, and colon.

"In this method of classing, we shall find that the different forms of stomachs have the least share of any, or is less fixed in its properties than either teeth, cæcums, or colon, so that the stomach varies much less than any of the other three.

"One can easily see a reason why the teeth should vary according to the mode of procuring the food, and according to the food; and one can easily conceive why the stomach need not vary much, because it can only be considered as a bag; but why so much dependence is to be had upon the cæcum and colon, is not so easily conceived. In classing stomachs, it might be thought proper to take in all these relative parts; but that method would breed confusion. Therefore I shall class all the different stomachs with their varieties; and in classing of the other parts they must be referred to their respective stomachs. This will appear most natural when we consider that there are many stomachs that have no relative parts, which I shall naturally begin with, as the first class.

"Our first class is the simple stomach with one opening, which I call *Regurgitators*." *Hunterian MS. Catalogue.*

1. *Digestive Cavity simple, or without distinction of Stomach and Intestine, receiving and expelling its contents by the same orifice.*

409. Two specimens of Hydatid (*Cysticercus tenuicollis*, Rud.). This species is most commonly found in the Ruminant tribe, and is always inclosed in a cyst attached to the omentum, or to some of the abdominal viscera. The above specimens were taken alive from the sheep. When removed from the cyst in this state, and placed in warm water, they exhibit remarkable contractile and undulatory motions. The animal consists of a head, a body or neck, and a terminal bag, for the most part of a globular form,

into which the preceding parts can be wholly retracted. The head is provided with four suctorious discs, and a central proboscis (*rostellum*) armed with a double circle of recurved hooks. In both the specimens the head is retracted within the body, leaving a terminal slit-like orifice at the point of retroversion, which might be mistaken for the mouth.

409 A. A large specimen of *Cysticercus tenuicollis*, in which the body, and the commencement of the sac, have been laid open, showing the continuation of their cavities, and the longitudinal retractile muscles of the head and neck. A circular disposition of fibres is remarkably distinct over the whole of the sac. *Prepared by Mr. Owen.*

410. A small *Cysticercus tenuicollis*, attached by its exserted proboscis to the parietes of its cyst, which has been formed in the peritoneal covering of the liver, probably of a sheep.

411. A Hydatid (*Cœnurus cerebralis*, Rud.) from the brain of a Sheep. This species is peculiar to that part of the body, and occasions the vertiginous disease in sheep, called the staggers. The sac, which in the preceding species is appended to a single vermicular body, is here common to many, which are very small, but are severally armed in a similar manner with an uncinated proboscis, and suctorious discs. The vermiculi are capable of wholly retracting themselves in their sac as in the preceding species, and consequently appear in that state to be attached to its inner surface. They may be seen in both states in the preparation: some wholly retracted within the cyst,—others protruding from it externally.

412. A portion of *Cœnurus cerebralis*, with the vermiculi retracted.

413. A longitudinal section of an intestinal Worm (*Echinorhynchus porrigens*, Rud.) showing the exserted proboscis, its retractile muscles and receptacle, and the alimentary tubes: the latter do not appear as membranous canals distinct from the integument, but are merely passages excavated in the parenchyma of the animal, and have no anal outlet.

414. A longitudinal section of *Echinorhynchus porrigens*, showing the alimentary tubes, and parenchyma of the body.

415. A small portion of the intestine of a Whale, to which several specimens of

Echinorhynchus glandiceps are adhering. The alimentary tubes are more distinct from the parenchyma in this, than in the preceding species. (For the head and proboscis of both the above species, see Nos. 294. 295.)

416. A longitudinal section of a Fluke (*Fasciola* (*Distoma*) *ventricosa,* PALLAS), showing its parenchyma full of dark-coloured matter; and the membranous sac which is contained in the clavate extremity. A bristle has been introduced into this sac through the small aperture which is situated at that end of the body.

416 A. Two polypes taken from the stem of an aggregate species of Zoophyte (*Xenia umbellata,* SAVIGNY). The long bi-serrate tentacles which surround the mouth, and collect the nutriment, are displayed on white paper: a fine bristle is introduced through the mouth of the upper specimen into the alimentary canal, which is continued into, and contributes to the support of the common stem from which it has been removed.

Prepared by Mr. Owen.

416 B. Two portions of *Xenia umbellata,* with some of the alimentary tubes continued from the polype-heads, injected with mercury; showing the continuation of the canal into the common stem, where the ova are developed; and also its division near the mouth and extension in the opposite direction along the centre of each of the tentacles. *Prepared by Mr. Owen.*

417. A section of a Zoophyte (*Lobularia digitata,* LAM.). The polypes are, for the most part, retracted: bristles are placed in some of the alimentary tubes.

418. One of the pinnules, and part of the stem, of the gray Sea-pen (*Pennatula grisea,* BOHADSCH). The polypes may be seen projecting near the margin of the pinnule, which is supported by diverging spines. The section shows the cellular parenchyma of the stem, in which the alimentary tubes continued from the polypes terminate.

419. Two specimens of the kidney-shaped Sea-pen (*Renilla Americana,* LAM.). The polypes may be seen projecting in considerable numbers from one of the surfaces of the common base.

419 A. A specimen of *Renilla Americana,* in which the form and structure of

the polypes may be distinctly seen. They are severally provided with eight bi-serrate tentacles, as in *Xenia*. *Prepared by Mr. Owen.*

420. A small portion of the finger-shaped Sea-pen (*Veretillum Cynomorium*, Cuv.), exhibiting one of the polypes retracted in its cell: this is provided, as in the preceding species, with eight bi-serrate tentacles. A bristle is introduced through the orifice surrounded by these tentacles into the stomach, from which some small tortuous intestinal tubes are continued: these terminate as they approach the centre of the stem in slender vessels, which traverse the pulpy substance of the stem, and communicate freely with similar vessels from the other polypes.

421. A few of the tubes of the Organ-pipe Coralline (*Tubipora musica*, Solander & Ellis). At the extremities of the dependent tubes may be observed the polype inhabitant. The tentacles surrounding the mouth may be plainly seen, and also the lining membrane of the calcareous tube continued from them.

422. Transverse and longitudinal sections of the clustered Animal-flower of Ellis (*Actinia sociata*, Philos. Trans. vol. lvii. p. 428. *Zoanthus Ellisii*, Cuv.), exhibiting the orifice of the digestive cavity, and the retracted tentacles which surround it.

423. A cluster of *Zoanthus Ellisii*, one of which has been transversely, and the other longitudinally divided, showing the same circumstances.

424. Sections of a larger species of Animal-flower (*Zoanthus Banksii*, Owen). In the one which is suspended, may be seen the inverted proboscis and tentacles, the alimentary cavity, and the spiral oviducts.

425. A specimen of *Zoanthus Banksii*, with the extremity containing the inverted proboscis removed by a transverse section, so as to show the constriction which separates the funnel-shaped cavity containing that part from the rest of the alimentary cavity.

425 a. Transverse sections of *Zoanthus Banksii*, showing the constriction above mentioned from below; and also the numerous processes of the alimentary membrane, in the duplicatures of which the tortuous oviducts are situated. *Prepared by Mr. Owen.*

426. An Actinia or Sea-anemone (*Act. crassicornis*, LINN.), showing the single central orifice of the alimentary cavity, its circular lip, and the large conical tentacles which surround it.

427. A vertical section of *Actinia crassicornis*. The general contraction has been such as almost to obliterate the digestive cavity; but the alimentary membrane may be distinguished by its plicated character: external to it are situated the lobules of the liver and ovaries. The space in which the tentacles are retracted is indicated by bristles.

428. An Actinia, in which the digestive cavity is laid open from behind, showing several small bivalves contained therein, which had been swallowed by the animal.

429. A Porpita (*Porp. gigantea*, PERON), exhibiting its central tubular mouth, and the tentacles surrounding it. These are of two kinds, and arise from the whole of the oral surface of the body, the central ones being short, and enlarged at the extremity; while those at the circumference are very long, and are provided with small granular and probably glandular bodies, which are appended, at regular distances, throughout the whole length of the tentacles. The circular form of the body is maintained by a flat transparent substance of a horny texture.

430. A Velella (*Velella limbosa*, LAM.), showing the central orifice of the digestive cavity, surrounded by numerous tentacles, which are also of two kinds, as in the preceding specimen; but the long ones at the circumference are not provided with the granular appendages. The form of the body is maintained by an oval horny disk, from the upper surface of which arises a vertical crest, by means of which, as by a sail, the animal is wafted along.

431. A vertical section of a Medusa (*Æquorea*, PERON & LESEUR), exhibiting the central digestive cavity, excavated, as it were, in the parenchyma of the body, and without any distinct membranous parietes.

432. A Star-fish (*Asterias papposa*, LINK.), exhibiting the central orifice of the digestive cavity. A portion of the integument has been reflected on the opposite side of the body to show the numerous cæcums continued from the digestive cavity.

433. A vertical section of *Asterias papposa,* showing the interior of the digestive cavity.

434. A Star-fish (*Asterias rubens,* LINN.), in which the integument has been removed from the whole of the anterior part of the body, showing the membranous digestive cavity containing some small bivalves.

435. A Star-fish (*Asterias discoidea,* LAM.), from which two rays have been removed; showing the singular and beautifully ramified form of the digestive cavity. The membranous pouches appear to be given off in two series, are sacculated, and strung, as it were, upon a mesentery.

2. *Digestive Cavity, with an orifice for the evacuation of its contents distinct from that by which the food is taken in.*

435 A. The body of a Star-fish (*Alecto glacialis,* LEACH). In this genus, the alimentary canal is continued in a spiral direction from the central orifice or mouth, and terminates by a second distinct orifice, or anus, situated at the extremity of a fleshy tube, which projects forwards by the side of the mouth. *Prepared by Mr. Clift.*

436. A transverse section of a large Echinus (*Ech. esculentus,* LINN.). The section has been made a little on one side of the centre to preserve the attachments of the commencement and termination of the alimentary canal to their respective outlets, viz. mouth and anus. The alimentary canal is suspended by small ligaments around the inner circumference of the cavity of the shell, and, having made one circumvolution, it returns upon itself, and makes a second in the contrary direction before terminating at the anus.

437. A Holothuria (*Hol. vittata,* LAM.), laid open longitudinally so as to expose the alimentary canal, which has an uniform structure, and little variety of diameter, until its termination. Commencing at the mouth, which is in the form of an inverted cone, it is continued down one side of the body to near the opposite extremity, then returns to above the middle of the body, and lastly again descends, and terminates in a dilated cavity or cloaca. In this course, the canal is attached to the sides of the body by a thin membrane or mesentery: a large vascular trunk is con-

tinued along the greater part of its course, and is connected with it by numerous minute branches, probably acting as an absorbent vessel. An elongated glandular body also accompanies the middle fold of the intestine, and is probably the liver;—a bristle is inserted into this body.

438. The alimentary canal of a Holothuria, removed from the body, and displayed on a slip of wood. In this specimen the tentacles which surround the mouth, and the blind processes continued from them within the body are preserved, and their communication with each other shown. The blind processes were considered by Mr. Hunter as analogous to a salivary apparatus. The intestinal canal is filled with sand and calcareous particles. The injected filamentary tubes which open into the cloaca, are the respiratory organs.

338 A. A Sand-worm (*Lumbricus* (*Sipunculus*) *phalloides*, Pallas), laid open longitudinally so as to expose the alimentary canal, which, in simplicity and uniformity of structure, is similar to that of *Holothuria*, but is more complex in disposition. It passes down from the mouth to the opposite end of the body, returns upon itself for about two thirds of its extent, again descends towards the posterior end of the body, and lastly again advances forward, and terminates about two inches and a half from the mouth. The four folds of intestine at the posterior half of the body, are twisted spirally together. In the last fold there is a quantity of fine sand.

The difference in the position of the anus in the above genera is admirably adapted to their different modes of life. *Holothuria* is met with on the beach, in the sea-weed and other refuse left by the retreating tide, and its excrement may without any inconvenience be expelled from that part of the body furthest from the mouth; while *Sipunculus*, dwelling habitually in deep holes in the sand, would in that case either be ultimately expelled from its retreat by the accumulated fæces below it, or be subjected to the alternative of completely quitting its hole in order to evacuate the contents of the alimentary canal. But, by the position of the vent near the anterior extremity of the body, a small part only need be protruded for that purpose, and the retraction of this part is secured by the opposite bulbous extremity remaining in the hole, and becoming a firm point of attachment. The whole of the alimentary canal is retained in its position by filamentary processes passing from it to the muscular parictcs of the body, and probably containing the nutrient vessels. Bristles are placed in the mouth and anus. *Prepared by Mr. Owen.*

439. An intestinal Worm (*Ascaris lumbricoides*, RUD.), laid open longitudinally, to show the alimentary canal, which has been filled with red injection. It is a membranous canal, distinct from the parietes of the body, (compare with No. 413,) and extends the whole length of the body without any convolution. The oviducts are drawn out of the body, and a bristle has been introduced into the vagina.

439 A. An intestinal Worm (*Ascaris Halicoris*, n. sp.), with the alimentary canal exposed. It differs from that in the preceding species chiefly in having a slender cæcum, half an inch in length, continued forwards from it at about the same distance from the mouth. It grows wider towards the lower end of the body, where it has been laid open to show the wavy longitudinal rugæ of the internal membrane. *Prepared by Mr. Owen.*

440. The anterior part of a Sea-worm (*Pleione æolides*, SAVIGNY). The dorsal parietes of the body have been removed to show the alimentary canal, which is laid open at its commencement so as to bring into view the inverted proboscis. This part is longitudinally divided, to show its thick muscular parietes and the horny teeth. The alimentary canal beyond it becomes thin and membranous, and puts on a sacculated appearance at the lower part of the preparation.

441. A Tube-worm (*Sabella pavonina*, SAVIGNY), laid open longitudinally, to show the alimentary canal, continued spirally, and making close turns upon itself, from the mouth to the anus; in the latter orifice is placed a bristle.

3. *Situation of the Stomach.*

442. A Leech (*Hirudo medicinalis*, LINN.), laid open longitudinally, to expose the alimentary canal, the greater part of which is in the form of cells, and may be regarded as stomach. The intestine is situated between the two last long cells, and ends just above the disk that terminates the lower extremity.

442. A. A Sea-mouse (*Aphrodita aculeata*, LINN.), laid open longitudinally, to expose the alimentary canal. The first division of this canal is commonly considered as the stomach; but it is rather a preparatory organ than a true digestive cavity, and is protruded like a proboscis, when the animal takes its food. It is strong and muscular like a gizzard, and communicates with the second portion of the canal by a narrow passage. The true digestive cavity is wide and membranous, and has a series of elongated cæcal appendages passing from it on either side. *Donor*, Sir Anthony Carlisle.

443. A Locust (*Locusta serrata*, KIRBY), with part of the parietes of the thorax and abdomen removed, to expose the alimentary canal. The crop is a capacious cavity, an inch in length; it is preceded by a very short œsophagus, and occupies the region of the thorax. The longitudinal and circular muscular fibres are very evident in its parietes, which have in consequence a reticulate appearance. Beyond this cavity there is a small gizzard, and then a third membranous stomach, to which are connected two pairs of elongated cæcal appendages. The intestine becomes gradually smaller to its termination. Bristles are inserted into the pharynx and anus.

443 A. A Calamary (*Loligo sagittata*, LAM.), laid open longitudinally, to expose the alimentary canal. A bristle is passed from the œsophagus to the muscular stomach or gizzard, which is situated near the bottom of the sac; to this succeeds the laminated cavity, which is laid open; from which the intestine extends forwards to terminate near the base of the funnel.

Prepared by Mr. Clift.

443 B. A Charr (*Salmo alpinus*, LINN.), with part of the abdominal parietes removed, to show the stomach *in situ*. It is situated at the anterior part of the abdomen, and is acutely bent upon itself. A bristle is placed in the œsophagus. *Prepared by Mr. Owen.*

444. A Siren (*Sirena intermedia*, LECONTE), with the parietes of the abdomen removed, to expose the alimentary canal. There is very little difference in structure or diameter between the stomach and intestine; but the former terminates about two inches from the pharynx, as may be seen by the constriction of the pylorus; the intestine, after performing a few convolutions, ends, as is usual among Reptiles, in a dilated rectum.

444 A. A Frog (*Rana temporaria*, LINN.), with the anterior parietes of the abdomen removed, to show its contents, and more especially the situation of the stomach, which is a dilated cavity of a pyriform shape, occupying the left side of the abdomen. *Prepared by Mr. Clift.*

444 B. A Toad (*Bufo vulgaris*, LAURENTI), with the cavity of the abdomen similarly exposed. The stomach occupies an analogous situation, but is more muscular. *Prepared by Mr. Clift.*

444 C. A small Coluber (*Coronella*, LAURENTI), with part of the parietes of the abdomen removed, to show the stomach *in situ*. This viscus is not distinguishable externally from the gullet; its limits are therefore indicated by bristles. It is of a simple elongated form, becoming smaller and more muscular towards the pyloric end, and is situated to the left of the liver, which has been removed. *Prepared by Mr. Owen.*

445. A Lizard (*Lacerta agilis*, LINN.), with the cavity of the abdomen exposed, and greater part of the intestines removed, to show the stomach, an elongated muscular bag, situated on the left side of the abdomen. A bristle is extended between the pylorus and the rectum.

446. The body of a young Crocodile (*Crocodilus acutus*, CUV.), with the anterior parietes removed, to expose the viscera, and especially the stomach, which is stretched transversely across the abdomen, the greater end turned towards the left side. Above the stomach is the heart, lying between the lobes of the lungs and liver. Below the stomach are the intestines.

446 A. A Parrot, with the anterior parietes of the abdomen removed, to expose the stomach, which is situated at the left side of the abdomen, and consists of a membranous preparatory cavity, or proventriculus, and a small fleshy gizzard. The liver and apex of the heart have been removed to obtain a better view of this viscus. *Prepared by Mr. Owen.*

447. A Rat (*Mus decumanus*, LINN.), with the anterior parietes of the abdomen removed, to expose the stomach. It is in the usual situation, viz. the left hypochondriac and epigastric regions, and exhibits a constriction in the middle, and a tendinous and gizzard-like structure at the pyloric end. The

liver and small intestines have been removed; the cæcum hangs out at the lower part of the abdomen.

448. The trunk of a human Fœtus, with the anterior parietes of the abdomen removed, to expose the stomach. The small intestines and liver are also taken away, so that the situation of the cæcum and track of the colon may be seen. A bristle connects the duodenum and ilium.

4. *Structure of the Œsophagus.*

449. A transverse section of the Human œsophagus.

450. A section of the Human œsophagus, dissected. On one side of the preparation may be seen the muscular fibres, disposed in an outer longitudinal and an inner circular layer; on the opposite side the cuticular covering of the inner membrane is turned down.

451. A section of the œsophagus of a Lion. This preparation is taken from near the termination of the tube, and exhibits a disposition of the muscular fibres, and of the inner membrane, different from that at the commencement (*see* No. 64). The muscular fibres are here exhibited, arranged in an outer longitudinal and an inner circular layer. The inner membrane is disposed in small and numerous transverse alternate rugæ.

451 A. A portion of the œsophagus of a Lion, taken from where the transverse rugæ of the inner membrane commence. It has been inverted and dissected, to show a layer of longitudinal fibres superadded to, and more internal than the two above mentioned; which layer adheres closely to the inner membrane, and appears to contribute to the formation of the peculiar transverse folds, as it can only be demonstrated at the part of the œsophagus where they exist. A portion of the circular fibres is shown, which fibres are separated from the internal longitudinal ones by loose cellular membrane. They are more closely connected to the external layer of fibres, part of which has been exposed, to show them passing from the oblique to the longitudinal direction.

Prepared by Mr. Owen.

452. A transverse section of the œsophagus of a Boar, close to its termination in the stomach, showing the contraction of the cardiac orifice.

453. The termination of the œsophagus of a Boar, and the commencement of the stomach, showing the continuation of the cuticular lining of the œsophagus into the stomach.

454. A portion of the œsophagus of the 'Bottle-nose Whale' (*Delphinus Tursio*, Bonnaterre, or else *Hyperoodon bidens*, Lacép.)*. The preparation is apparently taken from near the termination of the œsophagus. A portion of the cuticle has been turned down to show its thickness.

455. A transverse section of the œsophagus of a young Whalebone Whale (*Balæna Mysticetus*, Linn.), showing the small size of the tube, and the closing of the canal by the contraction of the surrounding muscular fibres. In this act they are assisted by the peculiar disposition of the inner membrane, which forms large longitudinal folds, projecting into the cavity, in consequence of a remarkable irregular accumulation of cellular substance between this membrane and the muscular coat. This structure of the gullet is well adapted to insure the deglutition of the small animals (No. 323 a.), which constitute the chief food of the great Whalebone Whale.

456. A transverse section of the œsophagus of the same Whale. The cavity of the tube is laid open, and the rugæ, as it were, unfolded. The cuticular lining has been partially removed, showing the irregular surface of the rugæ.

457. A longitudinal section of the œsophagus of the same Whale, showing the appearance of the longitudinal rugæ, apparently after having been stretched transversely. Only a small part of the cuticular lining remains. The thickness of the muscular coat is well shown in this preparation.

458. A portion of the œsophagus of an Ostrich, inverted, to show the villous internal surface.

458 a. A portion of the œsophagus of a Gannet (*Sula Bassana*, Brisson). The deep longitudinal rugæ, into which the inner membrane is thrown, show it to be capable of considerable dilatation. It is said to regurgitate the fish it has swallowed when attacked by the Frigate-bird.

Prepared by Mr. Clift.

* Mr. Hunter, in his paper on Whales, (Philos. Trans. 1787,) calls both these species 'Bottle-nose,' distinguishing them as *great* and *little*.

459. A portion of the œsophagus of a large Tortoise (*Testudo Indica,* Vosm.), in which the inner membrane is thrown into longitudinal rugæ, and has a fine reticular and porous appearance.

460. A portion of the œsophagus of a Turtle (*Chelonia Mydas,* Brogn.), showing the peculiar pointed processes with which its whole inner surface is beset. From their direction, pointing down towards the stomach, they serve to insure the deglutition of the slippery fuci, and other marine vegetable productions, which constitute the natural food of this animal.

461. The termination of the œsophagus and commencement of the stomach of a Turtle, injected, showing the different degrees of vascularity in the lining membrane of the two parts. The cuticular layer of the gullet does not end abruptly, but appears to pass insensibly into the vascular membrane of the stomach.

461 A. The termination of the œsophagus and commencement of the stomach of a Turtle, injected, and the cuticular lining of the œsophagus reflected.

Prepared by Mr. Clift.

462. A transverse section of the œsophagus of a Torpedo (*Raia Torpedo,* Linn.), taken near the cardia and inverted, showing a peculiar substance interposed between the muscular and inner coats, at that part; which substance is indicated by bristles.

463. A portion of the œsophagus of a Sturgeon (*Acipenser Sturio,* Linn.), showing the circular distribution of the outer layer of muscular fibres, and the broad but short obtuse processes which project from the inner surface, analogous to those of the turtle.

464. The termination of the œsophagus, and commencement of the stomach, of the Piked Dog-fish (*Spinax Acanthias,* Cuv.). In this species the gullet is provided with more numerous pyramidal processes, analogous to those in the turtle; but they are here jagged and fringed at the extremity.

464 A. The termination of the œsophagus of the Basking Shark (*Squalus maximus,* Linn.), inverted, showing a number of ramified processes attached to the inner surface, at the termination of the tube, and surrounding the

cardia, forming a valve at the entry of the stomach, and preventing the return of ingesta from that cavity. *Prepared by Mr. Clift.*

464 B. A longitudinal section of the termination of the gullet and commencement of the stomach of the same Shark, showing the same structure. *Prepared by Mr. Clift.*

464 C. A portion of the gum of *Squalus maximus*, showing the smallness of the teeth, which renders it probable that many fish are swallowed alive and uninjured, and may therefore render the above valvular contrivance at the cardia the more necessary. *Prepared by Mr. Clift.*

5. *Stomachs of Annulosa*.*

465. A Sea-mouse (*Aphrodita aculeata*, LINN.), with the ventral parietes of the body removed, to show the alimentary canal. The inverted proboscis, or preparatory cavity, is laid open, showing the thickness of its muscular parietes: it is lined by a thin cartilaginous membrane, delicately furrowed in the transverse direction, excepting at the termination, where there are a few longitudinal plicæ. The intestinal canal is also laid open, exhibiting the orifices of the lateral cæcums.

466. A longitudinal section of a Leech, that has been hardened in alcohol, after having gorged itself with blood. The coagula have been removed from some of the middle cells of the stomach.

467. A longitudinal section of a Leech, similarly prepared. A bristle has been passed into the intestine.

468. The ventral moiety of a Leech that has been divided longitudinally, showing the transverse partitions which divide the stomach into so many cells, and the central orifice by which they communicate together.

469. The dorsal moiety of the same Leech, showing that the transverse partitions

* Animals whose nervous system is composed of ganglions, arranged in a regular series, and brought into communication by a double chord, viz. Worms with red blood, Insects, Crustaceans and Cirripeds. See Catal. Nat. Hist. p. 61.

separate into two laminæ, near the central orifices, so as to form a middle series of cellules, distinct from the lateral. The lateral series are further partially subdivided by processes of membrane projecting into them from the parietes of the body. This structure, while it increases the surface for digestion and absorption, is at the same time admirably adapted for resisting the pressure of contained fluid.

470. An Earth-worm (*Lumbricus terrestris*, LINN.), laid open longitudinally, to expose the alimentary canal. The mouth consists of two labia, without tentacles or armature of any description; but the superior is elongated and proboscidiform. The œsophagus, a wide membranous canal, is continued straight down for half an inch, and ends in a dilated bag, or reservoir; to this succeeds a muscular stomach, or gizzard, disposed in the form of a ring. The intestine is constricted at each segment of the animal by a series of ligaments or partitions, connecting it to the parietes of the body, and swells out in the intermediate spaces, when distended by the particles of earth.

471. The anterior part of a Silk-worm (Larva of *Bombyx Mori*, FABR.), laid open, to show the stomach.

472. The larva of a Capricorn Beetle (called the *Sawdust Beetle* in the Old Catalogue), laid open longitudinally, to expose the alimentary canal. The stomach is a muscular tube, about eight lines in length, and nearly a line in diameter: the intestine that succeeds is much narrower; the fæces appear to be separated in the last turn of the intestine.

473. The stomach and intestine of an Orthopterous Insect, probably *Acrida viridissima*, KIRBY. The plaited cavity, or gizzard, is laid open, exhibiting its longitudinal folds, which are armed with serrations, or teeth. The intestine contains earthy particles.

474. A specimen of Locust (*Acrida viridissima*, KIRBY), with the anterior parietes of the abdomen and thorax removed, to show the alimentary canal.

A bristle is inserted at the œsophagus. The crop, the gizzard, the two cæcums—one anterior the other posterior, the intestine, and filamentary hepatic tubes which open into it, are well displayed.

475. The stomach and intestine of an Orthopterous Insect, probably of the tribe *Locustina*, Kirby. The gizzard is partially laid open; beyond which there are cæcal appendages, as in *Acrida viridissima:* at a little distance below these appendages, numerous hepatic filamentary ducts communicate with the intestine, which is a dilated canal, marked externally with narrow spiral white lines.

476. Two Humble-bees (*Bombus terrestris*, Latr.), with the anterior parietes of the abdomen removed, to show the alimentary canal.

477. The digestive organs of a Hive-bee (*Apis mellifica*), similarly displayed.

" *Of the parts concerned in the nourishment of the Bee.*

" Animals who only swallow food for themselves, or whose alimentary organs are fitted wholly for their own nourishment, have them adapted to that use only; but in many, these organs are common for more purposes, as in the pigeon, and likewise in the bee. In this last, some of the parts are used as a temporary reservoir, holding both that which is for the immediate nourishment of the animal, and also that which is to be preserved for a future day, in the cells formerly described: this last portion is therefore thrown up again, or regurgitated. As it is the labourers alone in the common bee that are so employed, we might conceive this reservoir would belong only to them; but both the queen and males, both in the common and humble bee, have it, as also, I believe, every one of the bee tribe. As the bee is a remarkable instance of regurgitation, it is necessary the structure of the parts concerned in this operation, and which are also connected with digestion, should be well considered. Ruminating animals may be reckoned regurgitating animals, but in them it is for the purpose of digestion entirely in themselves. But many birds may be called regurgitating animals, and in them it is for the purpose of feeding their young. Crows fill their fauces, making a kind of craw out of which they throw back the food when they feed their young; but the most remarkable is the dove tribe, who first fill their craw, and then throw it up into the beak of their young. The bee has this power to a remarkable degree,—not however for the purpose of feeding the young, but it is the mode of depositing their store, when brought home.

"In none of the above-mentioned regurgitating animals, are the reservoirs containing the food, the immediate organ of digestion; nor does the reservoir for the honey in the bee appear to be its stomach.

—"The œsophagus, in all of this tribe of insects, begins just at the root of the tongue, as in other animals, covered anteriorly by a horny scale which terminates the head, and which may be called the upper lip, or the roof of the mouth. It passes down through the neck and thorax, and when got into the abdomen, it immediately dilates into a fine transparent bag, which is the immediate receiver of whatever is swallowed. From this the food (whatever it be,) is either carried further on into the stomach, to be digested, or is regurgitated for other purposes. To ascertain this in some degree, in living bees, I caught them going out early in the morning, and found this bag quite empty: some time after I caught others returning home, and found the bag quite full of honey, and some of it had got into the stomach. Now I suppose that which was in the craw, was for the purpose of regurgitation; and as probably they had fasted during the night, part had gone on further for digestion. Whatever time the contents of this reservoir may be retained, we never find them altered so as to give the idea of digestion having taken place: it is pure honey. From this bag the contents can be moved either way; either downwards to the stomach, for the immediate use of the animal itself; or back again, to be thrown out as store for future aliment.

"The stomach arises from the lower end, and a little on the right side of this bag. It does not gradually contract into a stomach, nor is the outlet a passage directly out, but in the centre of a projection which enters some way into the reservoir, being rather an inverted pylorus, thickest at its most projecting part, with a very small opening in the centre, of a peculiar construction*. This inward projecting part is

* See the lower specimen in No. 476.

easily seen through the coats of the reservoir, especially if full of honey.

"The stomach begins immediately on the outside of the reservoir; and the same part which projects into the reservoir is continued some way into the stomach, but appears to have no particular construction at this end; and therefore it is only fitted to prevent regurgitation into the reservoir, as such would spoil the honey. This construction of parts is well adapted for the purpose; for the end projecting into the reservoir prevents any honey from getting into the stomach, because it acts there as a valve; therefore whatever is taken in, must be an action of this vascular part. The stomach has a good deal the appearance of a gut, especially as it seems to come out from a bag. It passes almost directly downwards in the middle of the abdomen. Its inner surface is very much increased by having either circular valves, somewhat like the *valvulæ conniventes* in the human *jejunum*, or spiral folds, as in the intestine of the shark, &c.; these may be seen through the external coats. In this part the food undergoes the change. Where the stomach terminates, is not exactly to be ascertained; but it soon begins to throw itself into convolutions, and becomes smaller.

"The intestine makes two or three twists upon itself, in which part it is enveloped in the ducts constituting the liver, and probably the pancreas, and at last passes on straight to the termination of the abdomen. Here it is capable of becoming very large, to serve upon occasion as a reservoir containing a large quantity of excrement: it then contracts a little, and opens under the posterior edge of the last scale of the back, above the sting in the female and labourers, and the penis in the male." *John Hunter, Observations on Bees, Philos. Trans.* lxxxii. 1792. p. 176.

478. A specimen of the Vitreous Barnacle (*Pentalasmis vitrea*, Leach, *Lepas fascicularis*, Ellis), with the lateral valves of one side removed, together with the outer investing membrane or mantle, so as to expose the contained viscera. A black bristle is inserted at the mouth, which is situated on the ventral aspect of the body, immediately above the tentacles (the position in which the animal is suspended being considered the natural one). The stomach is a dilated cavity with a sacculated exterior,

and has two cæcums opening into it, also sacculated and granular, and considered by Mr. Hunter to be the liver; the intestine which succeeds, winds round to the dorsal aspect of the body, and runs down between the seminal tubes (one of which is obvious by its tortuous course in the preparation), and terminates at the base of the lowest pair of tentacles. A white bristle is inserted at the anus.

479. The stomach and liver of the Vitreous Barnacle removed from the body, and laid open, showing the cellular structure.

6. *Stomachs of Mollusca.*

479 A. An Orbicula, in which the upper valve has been removed, and the corresponding lobe of the mantle turned down, to show the stomach, which is a slightly dilated canal extending straight down the middle of the body. The liver which surrounded it has been dissected off. A bristle is inserted at the anus. *Prepared by Mr. Owen.*

480. A Salpa (*Salpa gibbosa,* Quoy & Gaimard), with the transparent cartilaginous outer covering, or shell, laid open to expose the contained parts.

At the upper part is exposed an oval mass, which is the alimentary canal; bristles are inserted at the oral and anal orifices, and into the mouths of cæcal appendages connected with the canal. The white body to the right of the alimentary canal is probably the liver. The long narrow ribbon-like body which hangs loose from the other side of the alimentary canal, is the branchia: it is delicately striated or puckered in the transverse direction: the lower end has been detached from its natural connexions with the parietes of the cavity. An irregular granular body which is situated behind the alimentary canal is most probably the ovary. The water enters at the wide aperture at the lower or posterior end of the body, and in the preparation may be observed the valve that prevents its return, which is a large fold of membrane projecting into the cavity. The water is propelled forwards by the contraction of the surrounding parietes, and ejected by the opposite aperture; traversing the parietes of the branchia, and causing a retrograde motion of the animal: and whilst this current contributes to the respiration and locomotion of the animal, it is no less essential to its nutrition, the particles of matter being thus introduced which constitute its food.

This specimen is figured in an original drawing (No. 19. pl. i. ii. iii. Cube II. dr. 3.) with the following description by Mr. Hunter.

" *Of the Sun-fish**.

"This animal is composed first of a bag, which may be supposed to answer in some measure some of the purposes of a shell. It is open at both ends, one of which may be called the mouth of the bag, the other the bottom; having two long hollow processes like ears at that end which I call the mouth†, the cavities of which (processes) communicate with the general bag. The texture of this bag is uniform like cartilage, but not near so solid; it is semi-transparent. The bag is flattened, and on one edge there are ridges, like an imitation of ribs, which pass transversely: whether this is the back or fore part I cannot say, but shall call it the back."—See *Home's Comp. Anat.* ii. *pl.* lxxi. *fig.* 2, 3, which are engravings of the above drawings, where the animal is called the '*Dagyza strumosa*' ‡ of Sir Joseph Banks.

481. The membrane which lines the outer shell of the Salpa.

482. *Salpa infundibuliformis*, Quoy & Gaimard, *Salpa Tilesii*, Cuv., to show the situation of the alimentary canal and the thickened verrucose projection of the shell which protects it.

See original drawing (No. 22. pl. iv. Cube II. dr. 3.), with the following description by Mr. Hunter.

* Probably so called from the brilliant lustre these animals present when floating on the waves and exposed to the rays of the sun.

† This is considered by some authors (Chamisso, Quoy and Gaimard,) as the posterior aperture of the body; but M. Cuvier is of opinion that it is more properly the anterior opening; and that the orifice of the intestinal canal next to it is the mouth.

‡ The animals of the genus *Salpa*, Cuv. were termed by Dr. Solander, *Dagyza*. The species figured by Parkinson, and engraved in the plate in Home's Comparative Anatomy, cited above, evidently ranks under the fifth division of the genus, and not the seventh as indicated by Cuvier (*Règne Animal*, iii. p. 165. nouv. edit.). On comparing it with the descriptions given of the species with a bi-appendiculated extremity by MM. Quoy and Gaimard, in their Zoology of the Circumnavigatory Expedition of Capt. Freycinet, it appears from the warty projections on the sac, and the disproportionate length of one of the labia of the inferior aperture, to be of the species called by these naturalists '*gibbosa*,' and taken by them at the Society Isles.

"Plate iv. may be reckoned a species of the Soft-shell* called the Sunfish, although it differs in many respects. It has a gelatinous transparent soft shell, which is very much of the consistence of the crystalline humour of animals. It is oblong, with an opening at each end, one of which is the general cavity opening at once, being there but little contracted; the other is at one corner, which is elongated: in the opposite corner the shell is considerably thicker, the cavity of which is rounded, having rather a smaller opening, in which cavity the viscera of the animal lie.

"This shell is studded over with small points like prickles: within this there is a membrane which belongs to the body of the animal, lining it everywhere, but only in contact with it. This membrane is ribbed circularly, as it were, having a number of belts or bands going irregularly round it. Where it lines the projecting opening, it has there rugæ somewhat penniform, which I suspect to be the lungs†. In the opposite corner, within the globular and thick part of the shell, are placed the digestive powers, whose openings are within the general cavity of the membrane: from this part passes down a ligament towards the large opening at the end, and is fixed at its extremity in this membrane.

"The digestive organ is an intestine making a little more than one turn, the two ends crossing one another a little. This canal or intestine has two cæca, one on each side, which are turned into the centre of the curve of the intestine."

483. The digestive organs of *Salpa infundibuliformis*, removed from the cavity of the shell in which they are lodged: they exhibit precisely the structure described above.

See original drawing, No. 22. pl. iv. fig. 2, 3, 4, Cube II. dr. 3. engraved in Home's *Comp. Anat. pl.* lxxii.

* Mr. Hunter included the genera *Salpa* and *Ascidia* (*Acéphales sans coquilles* of Cuvier) in one group under the above term.

† This however is an appearance peculiar to the species, whereas the part which Cuvier considers as the breathing organ (*Annales du Mus.* iv. p. 369.), viz. the plicated ribbon-like body attached at its two extremities, is constant in its character throughout the whole genus. Mr. Hunter being uncertain of the nature of this part, calls it the ligament uniting the digestive powers to the membrane behind.

484. The alimentary canal of a *Salpa*.

485. A specimen of Salpa (*Salpa cristata*, Cuv.), laid open longitudinally, to expose its contents.

The intestinal canal has been injected, and bristles are inserted at the oral and anal orifices ; a bristle is also introduced at the anterior aperture of the shell, and is placed beneath the ribbon-like branchia, which extends obliquely from the commencement of the alimentary canal to near the lower aperture of the shell, being attached at both extremities, but free in the intermediate part. The small oblong white body situated in an oval cavity immediately below the mouth, is the heart. The white body that runs parallel with the alimentary canal, is the liver. The two oblong glandular bodies attached to the sides of the shell, outside the inner envelope, (and which are more distinctly seen from the side of the preparation that is not laid open,) are presumed to be the ovaries. Besides the two openings at the extremities of the shell, there is a third at the summit of the lateral projection, or crest, as it is termed by Cuvier, and from which the specific name is derived.

See an original drawing of this specimen, No. 23. pl. iv.* Cube II. dr. 3. with the following description by Mr. Hunter.

" Plate iv.* is another of the Soft-shell Fish, which has an opening at each end, and another at the side. The opening at the small end gives the idea of having the power of motion, the other two do not. It has its mouth, stomach, intestine, and anus, all within its shell or covering, with some other parts not easily made out. The shell is cut through on one side, and across near the small end, so as to preserve its appearance ; and the upper half is turned out, which exposes the contents."

486. Three specimens of Salpa (*Salpa polycratica*, Forskael, *Ægypt. Descr. Animal.* p. 116. 12, pl. 36. F.). The upper one is entire, and a bristle is passed through both orifices, which are not terminal as in the preceding species, but on one side near the ends. The inner envelope is provided with six broad transverse bands, probably muscular. The other two specimens have been laid open, exposing the alimentary canal collected into a small ball, or nucleus, as it is termed, near the anterior extremity, and

also the longitudinal furrow that is continued from it, together with the branchia, which is preserved entire in the lowest specimen.

See original drawing (No. 25. pl. vi. Cube II. dr. 3.), with the following description by Mr. Hunter.

"Plate vi. fig. 1. seems to be nearly the same animal as Plate v. However there are several differences, the principal of which is, that the openings are on the side near the ends, and there appears to be a stomach and intestines at the end of the ligament described in Plate v. and without the white bodies described in the same figure."

487. Two specimens of *Teredo navalis*, showing the boring valves and stomach.

487 A. The labial tentacles, alimentary canal, and liver, of a species of *Clavagella*. The labial tentacles are of a flattened form, vascular, and finely laminated, and extend from the angles of the mouth, two on either side, as in most bivalves. A bristle is passed through the mouth into the stomach, which has been laid open: it is a dilated cavity, everywhere surrounded by the liver, which is a finely granular viscus of a green colour, and pours its secretion by many distinct apertures into the stomach. A little way beyond the stomach, there may be observed a small cæcum, which has also been laid open: the rest of the intestinal canal is of an uniform diameter, and winds among the mass of ova, the impressions of which have given to the external surface of the intestine a honey-combed appearance. *Prepared by Mr. Owen.*

487 B. The soft parts of a bivalve, with the alimentary canal exposed. The stomach, which is imbedded in the green liver, has been laid open. A little below the place where the intestine is continued from the stomach, a very long cæcum is given off, which passes forwards among the ova at the base of the foot: it contains a transparent substance of a firm homogeneous texture, called the crystalline style, whose large extremity projects into the stomach. The use of this singular part is not known.

Prepared by Mr. Owen.

488. A Limpet (*Patella vulgata*, Lam.), with the foot removed, to show the retracted tongue, and a portion of the alimentary canal.

489. A small specimen of Haliotis (*Hal. tuberculata*, Linn.), prepared to show the stomach. The floor of the branchial cavity, the gills, and anus, are turned back, and the integument is removed from above the œsophagus and first stomach. A bristle is passed through the mouth into the œsophagus, and another from the first to the second stomach. The latter cavity is imbedded in the liver, and receives the secretion of that gland by such wide orifices, that portions of the alimentary substances have entered the biliary ducts, which thus appear to be ramifications of the alimentary canal.

490. A specimen of *Scyllæa pelagica*, Linn., with the parietes of the right side of the body removed, to expose the contained viscera, and especially the stomach and alimentary canal. A brown bristle is inserted at the mouth, from which the alimentary canal extends to the middle of the body, passing above the genital organs :—having reached the liver, it dilates into a small stomach, which is laid open. The cavity is armed internally with a circular series of hard horny laminæ, of a brown colour, disposed longitudinally, with sharp edges projecting inwards. The intestine makes a slight turn upon itself, and terminates on the back. A white bristle is inserted at the anus, and a black one into the orifice of the generative apparatus, which is near the mouth.

491. A part of a Slug (*Limax*), with the mouth laid open, and a bristle passed into the œsophagus.

492. A Bulla (*Bulla lignaria*, Cuv.), with the mantle removed, to expose the œsophagus and gizzard. The right valve or calcareous plate of the gizzard has been removed, and lies at the bottom of the bottle : a bristle is passed into the cavity of the gizzard from the œsophagus, and a second from the gizzard into the duodenum. The gizzard in this species consists of two lateral calcareous plates of an irregular triangular form with the angles rounded off, slightly concave externally, and convex towards the cavity. These lateral plates are united by strong transverse fibres passing between them at their circumference, except at the upper part of the gizzard, where a third valve of an oblong form is interposed between the two lateral ones.

493. This preparation exhibits an entire *Bullæa aperta*, and the stomach from another specimen. The former is laid open to show the positions both of the gizzard and of the shell; a bristle is inserted at the mouth. The stomach below, is laid open to show the dark-coloured hard substances with which it is armed.

494. The anterior moiety of a *Bullæa aperta*, showing the stomach, and the hard substances surrounding it. These are three in number, of nearly equal sizes, concave externally, and convex towards the cavity of the gizzard, forming a triangular apparatus for triturating the food.

495. The stomach and spiral cæcal appendage of the Cuttle-fish (*Sepia officinalis*, Linn.) distended and entire. A part of the vein with its glandular appendages is attached to the stomach.

496. The stomach and spiral cæcal appendage of the Cuttle-fish laid open. The former cavity has a smooth inner surface; the latter is closely beset with transverse laminæ.

497. A part of the laminated cæcal appendage removed from the preceding preparation.

498. The œsophagus, stomach, spiral cæcum, and intestine, laid open, of a Calamary (*Loligo sagittata*, Lam.). The œsophagus is narrow, and is furnished with close-set longitudinal rugæ; it gradually dilates into the stomach without forming any crop or preparatory cavity. The stomach is similarly traversed by longitudinal rugæ, which become wavy at the lower part of the cavity. The muscular coat is three lines in thickness at the middle part of the stomach. The pylorus is small, and opens into the commencement of the spiral cæcum, the cavity of which, as in the preceding species, is occupied by close-set, parallel, transverse laminæ. This cæcal appendage receives the biliary secretion, which, together with the proper secretion of the cavity, is conveyed into the intestine along a distinct groove, formed between two thickened ridges which extend from the spiral cæcum into the intestine. The latter is of considerable width, and is provided with longitudinal rugæ.

499. The cuticular lining of the gizzard, removed from the preceding preparation.

499 A. The crop, gizzard, and laminated pancreatic pouch of the Pearly Nautilus (*Naut. Pompilius,* Linn.). The natural proportions of these several parts are in some measure altered in their present position; but the following is the description of them as they appeared in the dissection of the specimen.

"The pharynx has numerous longitudinal rugæ internally, and is evidently capable of considerable dilatation. The œsophagus is three fourths of an inch in length, and after having passed beneath the brain, or commissure of the optic ganglions, dilates into a capacious pouch or crop, which is of a pyriform figure, two inches and three lines long, and an inch in diameter at the broadest part. From the bottom of this crop there is continued a contracted canal, of about three lines diameter, and half an inch in length, which enters the upper part of an oval gizzard, situated at the bottom of the pallial sac. Close to where this tube terminates, the intestine commences, and after a course of a few lines, communicates with a small, round, laminated pouch, analogous to the spiral cæcum of the Cuttlefish, and into which the biliary secretion is poured."—*Memoir on the Nautilus,* p. 23. Pl. 4. and *original drawing,* Dr. 4. No. 29 A.

In the preparation, the parts are kept distended with bristles; a portion of porcupine's quill is passed through the pyloric aperture of the gizzard.

Prepared from a specimen of the animal presented by
Geo. Bennett, Esq., F.L.S.

7. *Stomachs of Fishes.*

500. Part of the œsophagus, the stomach, and the intestinal canal of the Electrical Eel (*Gymnotus electricus,* Linn.).

The œsophagus is wide and irregularly rugous, and communicates with the common duct of the air-bladders near the cardiac orifice.

The stomach is a globular cavity, corresponding in form to the small and circumscribed abdomen of this fish. It is laid open, showing the reticulate inner surface. The duodenum passes out on the right side, about the middle of the stomach; and the intestine, after making some turns about the stomach, is directed forward near its termination, and opens externally just under the root of the tongue. A white bristle is inserted at the anus, and a large black one into the dilated termination of the ureters. In this preparation may also be observed the pyloric appendages, and the spleen.

501. The stomach and part of the intestine, laid open, of the Wolf-fish (*Anarrhicas Lupus*, LINN.). The former is a muscular cavity, of a globular form, having the cardiac orifice narrower than in most fish, and the inner membrane of the œsophagus raised in thick folds above it. The cardiac moiety of the stomach is tolerably smooth ; the pyloric end irregularly rugous. This becomes suddenly contracted near the pylorus, and turns up towards the head : the pylorus is protected by a circular valve. The intestine is thin in its coats, very capacious, and the inner membrane raised in reticulate folds, with jagged edges.

"The food of fish is principally of one sort, namely, animal : which, however, with regard to the digestive powers, is to be distinguished into two kinds ; viz. common soft fish, and shell-fish. Such fish as live on the first kind, have, like the carnivorous quadrupeds and birds, no apparatus for mastication ; their teeth being intended merely for catching the food and fitting it to be swallowed. But the shells of the second kind of food render some degree of masticating power necessary, to fit it for its passage either into the stomach or through the intestines, and accordingly we find in certain fish a structure suited to that purpose. Thus the mouth of the Wolf-fish is almost paved with teeth, by means of which it can break shells to pieces, and fit them for the œsophagus of the fish ; and so effectually disengage the food from them, that though it lives upon such hard food, the stomach does not differ from that of other fish : the organs of mastication and digestion, therefore, in this animal, exactly correspond to those of many granivorous quadrupeds."

John Hunter, On the Animal Œconomy, p. 184.

501 A. The tongue, pharynx, œsophagus, stomach, and part of the intestine of the Gillaroo Trout (*Salmo Fario*, var.).

The tongue is armed with teeth ; the stomach bent upon itself about the middle ; the duodenum provided with many cæcal appendages.

Presented by Sir E. Home, Bart.

501 B. The same parts, laid open, of another Gillaroo Trout. The œsophagus is provided with longitudinal rugæ, which are continued into the stomach. The muscular parietes of the pyloric moiety are nearly three lines in thickness: this part wants, however, the essential character of a gizzard, viz. the cuticular lining. The cæcal appendages open in greatest number immediately beyond the pylorus. *Presented by Sir E. Home, Bart.*

"The stomach of the Gillaroo Trout is, however, more globular than that of most fish, better adapted for small food, and endued with sufficient strength to break the shells of small shell-fish; which will probably be best done by having more than one in the stomach at a time; and also by taking pretty large and smooth stones into the stomach, which will answer the purpose of breaking; but not so well that of grinding; nor will they hurt the stomach as they are smooth, when swallowed; but this stomach can scarcely possess any power of grinding, as the whole cavity is lined with a fine villous coat, the internal surface of which appears everywhere to be digestive, and by no means fitted for mastication.

"The stomach of the common Stream Trout is exactly of the same structure with that of the Gillaroo; but its coat not so thick by two thirds. How far this difference in thickness of stomach is sufficient to form a distinct species, or barely a variety of the same, is only to be determined by experiment.

"The œsophagus in the Trout is considerably longer and smaller than in many other classes of fish.

"The intestines are similar to those of the Salmon, Herring, Sprat, &c.

"The pancreas is appendiculated.

"The teeth show them to be fish of prey.

"So far as we are led to determine by analogy, we must not consider the stomach of this fish as a gizzard, but as a true stomach."

John Hunter, ut supra, p. 185.

502. The stomach of a Mullet (*Mugil Capito,* Cuv.). The œsophagus is continued for four inches below the cardiac orifice, terminating obtusely, and forming a sort of crop. The gizzard goes off at right angles to this pouch, and is of a pear shape, with the narrow end towards the intestine.

Its internal surface is disposed in longitudinal rugæ, and is lined with a distinct layer of rough and easily separable cuticle. The muscular coat is half an inch thick. Six wide cæcal appendages open into the duodenum immediately beyond the pylorus.

"Of all the fish I have seen, the Mullet is the most complete instance of this (the grinding) structure; its strong muscular stomach being evidently adapted, like the gizzard of birds, to the two offices of mastication and digestion." *John Hunter, ut supra*, p. 185.

503. A Crop-fish (*Tetraodon ocellatus*, Bloch), with the crop *, or dilatable cavity connected with the œsophagus, laid open. A bristle is passed from this cavity into what Mr. Hunter termed the second œsophagus. The crop is in the undistended state.

504. The œsophagus, stomach, part of the intestinal canal, and pancreas of the Sturgeon (*Acipenser Sturio*, Linn.).

The œsophagus is characterized by obtuse conical projections, disposed in longitudinal rows. The stomach is dilated at its commencement, and there communicates with the air-bladder. A quill is passed through this orifice. The stomach then becomes contracted, descends, and rises again as high as the œsophagus; and in this course it is marked internally by longitudinal rugæ: where it begins to turn down again, it dilates, is smooth within, becomes thicker in its coats, and terminates at the pylorus in the usual valvular manner. Immediately beyond the pylorus is the orifice of the pancreas. The small intestine is thick and honey-combed within. A portion of intestine is also preserved, which shows the commencement of the spiral valve peculiar to the great intestine of the higher organized cartilaginous fishes. A black bristle is stuck into the pancreas.

505. The stomach of a Ray, with part of the intestinal canal, and the spleen.

506. The pyloric end of the stomach, and part of the duodenum, of the Torpedo or Electric Ray (*Raia Torpedo*, Linn.).

* As this structure relates to the peculiar habits of the Tetraodon, rather than to digestion, the other Preparations illustrative of it are removed to the series of "Peculiarities."

507. Part of the pharynx, the œsophagus, and the stomach, of a Dog-fish (*Spinax Acanthias*, Cuv.). The œsophagus is lined with cuticle, and beset with numerous conical processes; its diameter equals that of the stomach; but it is very short. The lining membrane of the stomach is thrown into longitudinal rugæ, which terminate about half way down the cardiac division of the cavity. The pyloric portion of the stomach (which in a succeeding preparation, 507 B., may be seen to become more analogous to an intestine,) is much narrower, has a smooth internal surface, and terminates by an oblique contracted aperture in the duodenum.

507 A. Part of the œsophagus and stomach of the same species, finely injected, showing the high vascularity of the lining membrane of the digestive cavity. *Prepared by Mr. Clift.*

507 B. The stomach of a Shark (*Squalus Alopecias*, PERRAULT; *Carcharias Vulpes*, CUV.).

The small portion of œsophagus preserved in this preparation, shows that it is not provided with conical processes, as in the preceding species, and that it is separated from the stomach by a more distinct and circumscribed cardiac orifice, which may render the above structure less necessary. The cardiac portion of the stomach is of considerable width, and preserves a nearly uniform diameter throughout: the inner membrane is produced into irregular, wavy, longitudinal rugæ. The pyloric portion of the stomach is not an uninterrupted continuation of the cardiac, as in the preceding specimens, but is separated from it by a contracted aperture: it is very narrow; but of an uniform diameter throughout: it extends upwards, or towards the head, and terminates by a valvular mammilloid prominence in the duodenum. Although this is termed the pyloric portion of the stomach, the cardiac cavity has doubtless the chief share in the performance of digestion; and the chyme is carried, by means of the narrow canal, into the commencement of the intestine, which lies parallel with the stomach. The parts have been minutely injected, showing their high degree of vascularity: the coats of the stomach were found partially destroyed by the action of the gastric juice. The pancreas and spleen are preserved in this preparation. *Prepared by Mr. Clift.*

507 c. A portion of the upper or cardiac end of the stomach of the Basking Shark (*Selache maxima*, Cuv.). It is characterized by large longitudinal and small reticulate rugæ. *Prepared by Mr. Clift.*

507 d. A portion from the lower end of the stomach of the same species, characterized by large longitudinal rugæ. *Prepared by Mr. Clift.*

507 e. Fish bones, half digested, from the stomach of the blue Shark.
Presented by Mr. Clift.

"The better to pursue my inquiry on the subject of digestion, I procured the stomachs of a vast variety of fishes, whose deaths are always violent; and who may be said to die in perfect health, with their stomachs usually full. In them we can observe the progress of digestion most distinctly; the shape of their stomachs being very favourable for that purpose. They likewise swallow their food whole, that is, without mastication; and swallow fish that are much larger than the digesting part of the stomach can contain: therefore, in many instances, the part swallowed, which was lodged in the digesting part of the stomach, was found more or less dissolved, while that which remained in the œsophagus was perfectly sound: and in many of these I saw the digesting part of the stomach itself reduced to the same dissolved state as the digested part of the food." *John Hunter, ut supra,* p. 230.

8. *Stomachs of Reptiles.*

508. The stomach of a Water Snake (*Pelamis bicolor*, Daudin; *Anguis platurus*, Linn.). It is laid open, showing its internal longitudinal rugæ, and the gradual contraction to the pylorus. The gall-bladder, pancreas, and part of the small intestine are also preserved.

508 a. The stomach, with part of the œsophagus and intestine, injected and inverted, of a large African Snake (*Python*, Daudin).

The œsophagus, as in all the Ophidian reptiles, is very capacious, smooth internally, and thin in its coats. The commencement of the stomach may be detected by the more vascular and rugous character of its lining membrane. The larger rugæ are longitudinal; the interspaces reticulate. The stomach gradually diminishes in size, and there is a constriction, like a pylorus, about one inch and a half from the intestine. A narrow canal, of uniform diameter, analogous to that in the Shark, conducts to the intestine, which suddenly becomes wider, and is beset internally with small flattened scale-like processes.

Prepared by Mr. Clift.

509. The stomach and part of the intestine of the common Tortoise (*Testudo Græca*, LINN.)

In the Chelonian Reptiles the stomach accords with the broad and flattened form of the body; and instead of being longitudinal in its position, as in the preceding example, it is placed transversely, and is more or less bent upon itself as it passes from the left to the right side. In this preparation the posterior parietes of the stomach have been removed, so that the disproportionate size of the cardia compared with the pylorus may be seen, and also, when viewed from within against the light, the radiate disposition of the muscular fibres, which arise principally from a tendon situated at the angle of flexion. The lining membrane of the duodenum is disposed in longitudinal rugæ.

510. The stomach, injected and inverted, of the East Indian Tortoise (*Testudo Indica*, VOSMAER). It is more elongated in its form, and is thicker in its coats than the preceding: the rugæ are longitudinal, but are slightly marked: numerous minute orifices of gastric follicles may be observed at the pyloric extremity. The duodenum has a reticulate lining membrane.

511. The stomach, inverted, of the East Indian Tortoise. This species is a vegetable feeder.

512. A section of the stomach of a Tortoise, injected. The cellular coat is seen to be very vascular; but the injection has not coloured the mucous membrane uniformly, appearing only in minute scattered points.

513. A portion of the œsophagus and stomach of a Tortoise.

514. A portion of the stomach of a Turtle (*Chelonia Mydas*). The muscular

coat is remarkably thick, being adapted for compressing with great force the sea-weeds which constitute the natural food of this species.

515. A transverse section of the contracted stomach of a Turtle, showing the relative thickness of the muscular, cellular, and mucous coats.

516. The stomach and part of the œsophagus of a very young Turtle, showing that at this period the stomach is membranous, not having acquired the thickness of the muscular coat which adapts it for the kind of food peculiar to the adult state.

517. Part of the œsophagus and stomach of an Alligator (*Crocodilus Lucius*, Cuv.). The œsophagus is lined with cuticle, and is longitudinally plicated. The first cavity of the stomach is large, and is lined with a mucous membrane. It communicates with the œsophagus by a large aperture; but with the second, or pyloric cavity, by a very small one. The second cavity is small, and of a rounded form, and communicates with the intestine by a very small oblique aperture. The villi of the intestine are flattened in form, and numerous.

518. The stomach of a Crocodile (*Crocodilus acutus*, Cuv.), laid open, after having been inflated and dried. The form of the cavity is well shown in this preparation ; also the relative sizes and the proximity of the cardiac and pyloric apertures. The muscular fibres radiate, as in the gizzard of the bird, from two lateral tendons. The apertures of the small pyloric cavity appear rather for the purpose of opposing the progress of the alimentary substances into the intestine than otherwise. The duodenum in this species makes two close turns upon itself, analogous to its disposition in the bird, before it is continued on into the jejunum. Bristles are placed in the hepatic ducts.

518 A. Pebbles which were found in the stomach of a young sharp-nosed Crocodile. In the Description of the Reptiles of Ægypt, M. Geoffroy St. Hilaire states, that pebbles were commonly met with in the stomach of the Crocodile of the Nile, and that they were rendered smooth by the act of triturating the alimentary substances. *Presented by Mr. Owen.*

9. *Stomachs of Birds.*

519. A portion of the stomach of a Pelican (*Pelecanus Onocrotalus*, Linn.). The œsophagus is continued into the proventriculus or glandular cavity, without any marked constriction; and the latter passes insensibly into the part analogous to gizzard. This part communicates by a transverse aperture with a small globular cavity, which is lined by a vascular membrane, and communicates with the duodenum by a very small oblique aperture. This superadded cavity renders the analogy between this stomach and that of the Crocodile complete, with the exception of the absence in the latter of distinctly developed gastric glands. These, in the Pelican, are simple elongated follicles, closely compacted together, and extended over a large surface.

519 a. The stomach of the Argala, or Indian Gigantic Crane (*Ciconia Argala*, Stephens).

In this preparation the peculiarities of the digestive apparatus of the Crane and Stork tribe are well exhibited; viz., the ample œsophagus; the large proventriculus—compensating for the absence of a crop; the small and weak gizzard; and the superadded pyloric cavity, which, however, is less developed than in the Pelican. In the Argala, the cuticular lining is continued from the œsophagus over the proventriculus and gizzard, where it attains a considerable thickness: the gastric follicles are arranged in two circular clusters: there is no appearance of constriction between the œsophagus and proventriculus, nor between the latter cavity and the gizzard: the pylorus is protected by a broad transverse ridge, which effectually prevents the passage of undissolved matter into the intestine. The pyloric cavity is narrow and elongated.

Prepared by Mr. Clift.

519 b. The gizzard of the Marabou, or African Gigantic Crane (*Ciconia Marabou*, Vigors). It is laid open, with a view to show the form and position of the pyloric valve, the pylorus, the extent of the pyloric cavity, and the place where the duodenum leaves that cavity. In this preparation may also be observed two oval prominences, on opposite sides of the com-

mencement of the gizzard, which would tend to close the entrance into the cavity, on the contraction of the circular fibres.

Prepared by Mr. Owen.

520. The stomach, injected, of the Night Heron (*Ardea Nycticorax*, Linn.). It is a pear-shaped cavity, narrowed where the œsophagus terminates. This tube, being contracted, is thrown into well marked longitudinal rugæ. There is no constriction between the proventriculus and gizzard; the former is indicated only by a thick zone of close-set gastric glands, which are simple, as in the Pelican. The gizzard communicates with a small globular pyloric cavity, by a transverse orifice, situated just below the glandular zone. The pyloric cavity, like that of the Pelican and Crocodile, opens by a very minute orifice into the duodenum.

521. The œsophagus and stomach of the same species of Heron, laid open, showing more distinctly the cuticular lining and longitudinal rugæ of the former part, and the orifices of the gastric glands in the latter cavity. A bristle is passed through the pyloric cavity into the duodenum.

522. The stomach of the Gibraltar Heron (*Ardea Caboga*, Pennant). It is of a more elongated form than the preceding, and the proventriculus is more distinctly separated from the gizzard. The lateral tendon in the latter cavity is more distinct, and the radiating fibres more strongly marked. The entry into the pyloric cavity is guarded by a transverse valvular prominence.

522 a. The stomach of the Golden Eagle (*Falco Chrysaetos*, Linn.). It is laid open, so as to show the orifices of the numerous gastric glands of the proventriculus, the smooth lining membrane of the gizzard, and the valvular structure of the pylorus. The œsophagus is very wide, so that externally it appears to form one continued cavity with the proventriculus and stomach. On the outer surface of the latter may be observed the two shining tendons, from which the muscular fibres radiate: these, however, form a very thin layer in this and other carnivorous birds. A small quill is passed through the pylorus, which is guarded within by three cuticular tubercles, two on the upper side of the orifice and one

below, which fits into the interspace of the preceding. (The crop has not been preserved in this preparation.)

Presented by Dr. John Thompson, F.R.S.E.

522 B. The pyloric end of the stomach, and part of the duodenum, of the Gannet (*Sula Bassana*, BRISSON), showing the bilobed valve of the pylorus, which is so placed as to prevent the undigested parts of the food from passing out at that aperture. *Prepared by Mr. Owen.*

522 C. The stomach of the Little Awk (*Alca Alle*, LINN.). It is distinctly divided into proventriculus and gizzard. The former is of an elongated form, and of great extent, and is furrowed longitudinally; the latter is a small oval cavity, lined with a distinct dark-coloured horny membrane. The gastric follicles are dispersed uniformly over the whole of the proventriculus, giving to its inner surface a reticulate character.

Prepared by Mr. Clift.

522 D. The stomach of a Sea Gull (*Larus marinus*, LINN.), in which the proventriculus is of much less extent than in the preceding species. The gizzard is more muscular, and is lined by a very dark and thick cuticular membrane. *Prepared by Mr. Clift.*

523. The stomach of a Sea Gull, which had been brought to feed on barley, showing that the muscular parietes of the gizzard were become much thicker in consequence.

Sir Everard Home, in his "Lectures on Comparative Anatomy," thus alludes to this preparation. "To illustrate this, in birds of prey, the digastric muscle has the bellies which compose it so weak, that nothing but an accurate examination can determine the existence of such a muscle; the strength being proportioned to the force required. But if a bird of this kind, from want of animal food, is obliged to live on grain, the bellies of this muscle become so large, that they would not be recognised as belonging to the stomach of a bird of prey. This admirable provision of nature is illustrated by a preparation of the stomach of a Sea Gull, which had been kept by Mr. Hunter for a year, living, contrary to its nature, upon grain; the strength acquired by the muscle is very great, when compared with what it was in its natural state while living upon fish, as may be seen by examining the preparation opposed to it."—Vol. i. p. 271.

Mr. Hunter, in his "Observations on Digestion," alludes to a similar experiment which he made on an Accipitrine bird. "There are few animals that do not eat flesh in some form or other, while there are many who do not eat vegetables at all; and therefore the difficulty to make the herbivorous eat meat is not so great as to make the carnivorous eat vegetables. Where there is an instinctive principle in an animal, directing it either to the one species of food or the other, the animal will certainly die, rather than break through, of its own accord, that natural law; but it may be made to violate every natural principle by artificial means. That the Hawk tribe can be made to feed upon bread, I have known these thirty years; for to a tame Kite I first gave fat, which it ate very readily; then tallow and butter; and afterwards small balls of bread rolled in fat or butter; and by decreasing the fat gradually, it at last ate bread alone, and seemed to thrive as well as when fed with meat. This, however, produced a difference in the consistence of the excrements; for when it ate meat, they were thin, and it had the power of throwing them to some distance; but when it ate bread, they became firmer in texture, and dropped like the excrement of a common fowl. Spalanzani attempted, in vain, to make an Eagle eat bread by itself; but by inclosing the bread in meat, so as to deceive the Eagle, the bread was swallowed, and digested in the stomach."—*On the Animal Œconomy*, p. 221.

524. A small gizzard, with a remarkably dark cuticular lining.

524 A. The proventriculus and gizzard of the Raven (*Corvus Corax*, Linn.).
Prepared by Mr. Clift.

524 B. The proventriculus and gizzard of the Crow (*Corvus Corone*, Linn.).
Prepared by Mr. Clift.

524 C. The proventriculus and gizzard of the Rook (*Corvus frugilegus*, Linn.).
Prepared by Mr. Clift.

The correspondence in the thickness of the digastric muscle in the three preceding species, would indicate a greater similarity in the nature of their food than the Linnæan name of the Rook implies.

524 D. The proventriculus and gizzard of a Toucan (*Ramphastos Ariel*, VIGORS).

The lining membrane at the termination of the œsophagus is thrown into narrow but distinct longitudinal folds ; as it passes into the proventriculus it becomes finely reticulate, the orifices of the gastric glands being situate in the interstices of the meshes. These glands are simple cylindrical follicles, forming a complete zone at the end of the gullet, and not separated from that tube by any constriction. The proventriculus communicates with the gizzard by an equally wide aperture. The muscular coat of the gizzard does not exceed half a line in thickness : the lateral tendons are small, but very distinct. The lining membrane is of a horny texture, and was stained of a deep yellow colour. The pyloric orifice is remarkably contrasted in its diminutive size with the ample entrance to the gizzard; a structure which facilitates the regurgitation of the alimentary substances. As the regurgitated morsels have been observed to undergo a second mastication, the digestive processes exhibit in this bird an analogy with those of the Ruminant quadrupeds; and as the thin parietes of the gizzard of this omnivorous bird are sometimes unequal to the comminution of the food, the utility of the extraordinary developed beak becomes apparent, which thus compensates by additional mastication for the absence of the grinding structures so peculiar to the stomachs of the true vegetable feeders. *Prepared by Mr. Owen.*

524 E. The crop, proventriculus, and gizzard of a Flamingo (*Phœnicopterus ruber*, LINN.).

The crop is situated at the lower part of the neck : it is a simple dilatation of the œsophagus. It possesses none of the characters of a true preparatory digestive cavity : but seems to be only a convenient temporary receptacle for the food. Beyond this pouch the œsophagus again contracts in size, and, for the extent of three inches, continues of the diameter of five lines. The gastric glands in the proventriculus are short and simple follicles ; they are arranged in two large oval groups, which blend together at the edges. The gizzard is a flattened spheroidal cavity, with the digastric muscle half an inch in thickness: it is lined with a thick yellow cuticle. The cardiac orifice is, as usual, large; the pyloric, a small oblique slit, guarded with a ribbed valve. *Prepared by Mr. Owen.*

525. A portion of the œsophagus and crop of the Crown Pigeon (*Columba coronata*, LINN.).

526. The crop of the Crop Pigeon (*Columba domestica*, var.).

This is thin and membranous, and in that state which is adapted for ordinary digestion. By the time the young are about to be hatched, the whole, except what lies on the trachea, becomes thicker, and takes on a glandular appearance, having its internal surface very irregular. In the preparation, the crop has been turned inside out, to show the smoothness of the inner surface at ordinary periods.

527. The gizzard, duodenum, and pancreas, injected, of a Pigeon.

528. The proventriculus and gizzard, injected and laid open, of a Turkey (*Meleagris Gallo pavo*, LINN.).

A bristle is passed through the pyloric aperture.

528 A. The proventriculus and gizzard of the Honduras Turkey (*Meleagris ocellata*, CUV.). The construetion is the same as in the domestic species; but the size is less, the gizzard measuring only two inches two lines in length, and one inch nine lines in breadth. *Prepared by Mr. Owen.*

529. The cuticular lining of a gizzard, showing the valve of the pylorus, which prevents the expulsion of the alimentary substances while undergoing the act of trituration, as well as of the pebbles that are swallowed for that purpose.

530. The proventriculus and gizzard, injected and laid open, of a Swan.

531. The proventriculus and gizzard of a Swan, longitudinally divided.

532. The gizzard of a Swan, transversely divided.

The following description will apply equally to the six preceding preparations. "The two extremes of true gizzard and membranous stomach are easily defined; but they run so into each other, that the end of one and the beginning of the other is quite imperceptible. Similar gradations are observable in the food; the kinds suited to the two extremes mixing together in different proportions, adapted to the intermediate states of stomach.

"A true gizzard is composed of two strong muscles, placed opposite, and acting upon each other, like two broad grindstones. These muscles are joined together at their sides by a middle tendon, into which the muscular fibres are inserted, and which forms the narrow anterior and posterior sides of the flat quadrangular cavity, in which the grinding is performed. The upper end of this cavity is occupied by the termination of the œsophagus and the beginning of the intestine. The lower end consists of a thin muscular bag, connecting the edges of the two muscles together.

"By these two more soft and flexible substances being thus interposed between the two strong grinding muscles, a double advantage is gained; for whilst one gives an easy passage to the œsophagus and gut, when both act together they serve in some degree as a hinge, on which the two muscles may be said to move, by the middle tendon allowing of a free motion of the grinding surfaces on each other, which is necessary for the comminution of the food.

"The two flat lateral sides of the grinding cavity are lined with a thick horny substance, similar to a hard and thick cuticle: the narrow anterior and posterior tendinous parts are also lined with a cuticle, but not so strong as the former. This horny substance is gradually lost at one end in a very thin cuticle, which lines the passages of the œsophagus and intestine for a little way, and at the other end is lost in the same manner in the membranous bag.

"The two large muscles may be considered as a pair of jaws, whose teeth are occasionally supplied, being small rough stones or pebbles, which the animal swallows; who, from the feeling of the tongue, can distinguish such as are proper, from those which are not; instantly dropping out of its mouth such as are smooth, and otherwise unfit for the purpose.

"Some birds, with gizzards, have also a craw, or crop, which serves as a reservoir, and for softening the grain."

John Hunter, On the Animal Œconomy, p. 182.

533. A portion of the gizzard, with the pylorus, of the Ostrich, showing the valvular structure at that part, adapted, as has been shown in the preparation from the Turkey, to prevent the escape of the contents of the gizzard until they have been sufficiently comminuted, if alimentary; or diminished in size by friction, if pebbles swallowed for the purposes of trituration.

533 A. The stomach, laid open, of the Emeu (*Dromaius Novæ Hollandiæ*, LATHAM).

The gastric glands are scattered over the whole inner surface of the proventriculus, and are of large size; they terminate towards the gizzard by two oblique lines. A considerable space intervenes between the proventriculus and gizzard, which may be termed the membranous portion of the stomach, in contradistinction to the muscular part or gizzard. The entrance and outlet of the latter cavity, which are closely approximated in all birds, are here of such large size, and so blended together, that the membranous portion of the stomach appears to pass into the intestine by a continuous canal, and the gizzard to be simply a lateral dilatation: its parietes are thickest at its commencement; at the remainder of the cavity they are comparatively weak and thin. A portion of the thick cuticle which lined this cavity is left. A circular valve intervenes between the stomach and duodenum; the latter commences by a considerable dilatation. *Presented by Sir E. Home, Bart.*

533 B. The stomach, laid open, of the Cassowary (*Cassuarius galeatus*, VIEILLOT).

This is constructed on the same type as the preceding. The gastric glands are dispersed over the proventriculus with a similar degree of uniformity; but they are smaller, and their lower boundary is transverse. The cuticular lining being here preserved, shows that the membranous part of the stomach is lined with a thin layer of that substance, which commences just where the glandular part terminates. The gizzard has a similar lateral position, out of the direct passage of the food, as in the Emeu; but is evidently more muscular. Its inner surface is thrown into irregular longitudinal rugæ. The pylorus is protected by a similar circular valve; but the commencement of the duodenum is still more capacious than in the Emeu, reminding one of the pyloric cavity in many of the Wading birds (*Grallatores*). Beyond this dilated part the duodenum presents some transverse rugæ, analogous to valvulæ conniventes.

Presented by Sir E. Home, Bart.

533 c. The stomach, laid open, of the Nandu, or American Ostrich (*Rhea Americana*, LATHAM).

In this preparation we observe a type of structure very different from that of the preceding. The gizzard is more capacious, and, as in the Gallinaceous birds, is continued directly from the proventriculus, with the intestine arising near the entry. The parietes of the gizzard, though strongly muscular, are not remarkable for their thickness: the cuticular lining is very thick, and is fortunately preserved in the preparation, showing its irregular surface, so well adapted for triturating. The gastric glands are more complex than in the preceding preparations, and are aggregated in a mass of a circular form; their orifices are very conspicuous. The pylorus is protected by a projecting valve, irregularly ribbed. The duodenum is of moderate width;—it has been partially inverted, to show the peculiar flocculent character of its lining membrane.

Presented by Sir E. Home, Bart.

533 d. A longitudinal section of the membranous and muscular parts of the stomach of an Ostrich (*Struthio Camelus*, LINN.). The parts have been minutely injected, and the cuticle, which separates very readily after death, has been almost entirely removed, showing the vascular surface beneath. The gizzard, as in the preceding species, is a direct continuation of the membranous part; but its parietes are much thicker. The slit-like form of the pylorus, and its ribbed valve, may be seen on one side of the preparation; and on the opposite side, the duodenum is seen laid open to show its villous inner surface. *Presented by Sir E. Home, Bart.*,

By whom the following description is given of the stomach of the Ostrich.

"In the African Ostrich, the gastric glands are similar in their structure to those of the American, only the processes belonging to each gland are much more numerous: they are, in general, twenty or thereabouts. The cardiac cavity into which they open is not only very large, but is continued down in the abdomen below the liver to a considerable length, and then is bent up to the right side, and is there connected with a gizzard, the digastric muscle of which is as strong as in Granivorous birds in general. This gizzard is situated so high up, as to be nearly on a level with the termination of the œsophagus. The cardiac cavity is everywhere lined with a thin cuticle, except where the ducts of the gastric glands open. Their orifices occupy an oval space on the left side, extending from the top to the bottom of the cavity, and about four inches broad. The size of the gizzard is small, when compared with that of the bird. The grinding surfaces do not admit of being separated to any great distance from one another. On one side there are two grooves, and two corresponding ridges on the other. Beyond the cavity of the gizzard is an oval aperture with six ridges, covered with cuticle, which oppose the passage of the contents of the cavity till they are reduced to a small size.

"In the Cassowaries and American Ostrich, the stones and other hard bodies which those birds swallow must, from their weight, force their way into the gizzard, which has a cavity adapted to receive them; but in the African Ostrich, all such substances must remain in the cardiac cavity, both from its being the most depending part, and from the cavity of the gizzard being too small to admit of their entering it.

"The cardiac cavity, in the instance which I examined, contained stones of various sizes, pieces of iron, and halfpence; but between the grinding surfaces of the gizzard there were only broken glass beads, of different colours, and hard gravel, mixed with food."

Lectures on Comp. Anat. i. *p.* 294.

533 E. Pebbles from the gizzard of an Ostrich. *Presented by Mr. Clift.*

533 F. Pebbles, and an iron nail, from the gizzard of an Ostrich.

Presented by Mr. Clift.

534. Balls, composed of fine hairs, from the stomach of a Cuckoo.

"The same motion seems also to take place in the bird kind; and of this the Cuckoo is an example; which, in certain seasons, living on Caterpillars, some of whom have hairs of a considerable length on their bodies, the ends of these are found sticking in the inner horny coat of the stomach or gizzard, while the hairs themselves are laid flat on its surface; not in every direction, which would be the case if there was no regular motion, but all one way, arising from a central point placed in the middle of the horny part; and the appearance on the surface of both sides of the gizzard evidently corresponding. These two facts prove, in my opinion, a regular circular motion taking place in the gizzard and membranous stomach; and, therefore, most probably, something similar is carried on in stomachs of all the various kinds."

John Hunter, On the Animal Œconomy, p. 201.

10. *Stomachs of Mammalia.*

534 A. The stomach of a Seal (*Phoca vitulina*, LINN.), injected, and its posterior parietes removed, to show the character of the internal surface, and the situation and form of the cardiac and pyloric orifices.

The circumstances most worthy of notice in this simple form of stomach, are,—the absence of the *saccus cæcus* to the left of the cardiac orifice,—the large size of that orifice,—and the very small size of the pyloric aperture, which is further provided with a small valvular projection, in order to prevent more effectually the passage of undigested substances into the duodenum. The rugæ of the lining membrane are hardly perceptible in this specimen, and its vascularity appears to be slight, except at the pyloric end: this portion is acutely bent upon the cardiac.

Prepared by Mr. Owen.

534 B. The stomach of the Suricate (*Ryzæna tetradactyla*, ILLIGER), with part of the œsophagus, and the duodenum.

All these parts are exposed by the removal of their anterior parietes.

As in the Seal, a very small proportion of the stomach lies to the left of the cardia; and the interior of the cavity, which has been distended, presents a simple and uniform villous surface. The pyloric aperture is also very small, but without a valve. *Prepared by Mr. Owen.*

535. The stomach of a Dog, inverted, showing the numerous and well marked rugæ into which the lining membrane is thrown when the cavity is contracted.

535 A. A similar preparation, showing the rugæ still more marked, from a Dog that was starved to death. *Purchased.*

535 B. The stomach, injected and laid open, of an Orang Utan (*Simia Satyrus*, LINN.). It differs from the human stomach in having the villous coat of less extent, no rugæ being perceptible in a moderately distended state: the cardiac extremity projects in a less degree beyond the termination of the œsophagus. The pyloric end is more abruptly bent upon the cardiac, and its coats are proportionally thicker. In all these differences it approaches nearer the structure of the true carnivorous stomach; and it is interesting to observe that a deviation towards the same type is exhibited in a marked degree in the dentition of the adult Orang.

Prepared from the specimen brought to England by Dr. Abel, which died in the Menagerie at Exeter 'Change.

536. The human stomach in a contracted state, laid open, showing the rugæ of the villous coat, and the cardiac and pyloric apertures. It has been laid open along the greater curvature, and it may be observed that the rugæ along the lesser curvature extend longitudinally between the two orifices.

536 A. A human stomach, in a similar state, laid open along the lesser curvature. It exhibits the same disposition of rugæ; and shows distinctly the size and form of the pylorus, and its muscular sphincter.

Donor, Sir William Blizard, F.R.S.

537. Transverse sections of the pyloric end of the human stomach, in a contracted state, showing the duplicatures of the mucous membrane projecting into, and filling up the cavity.

538. A longitudinal section of the human pylorus, showing the accession of

muscular fibres around that aperture, which form its sphincter, and give rise to the valvular internal projection of the cellular and mucous coats.

539. The human fœtal stomach, injected, dried, and preserved in oil of turpentine; showing its general form, and the manner of ramification of the arteries.

539 A. The human fœtal stomach, finely injected and inverted, to show the vascularity of the lining membrane. *Donor*, Sir William Blizard, F.R.S.

540. Portions of the human adult stomach, similarly injected, to show the same circumstance.

541. The stomach of a female American Opossum (*Didelphis marsupialis*, Linn.).

It is distended with spirit, and inverted. The inner membrane presents an uniform villous surface, but the *villi* are largest at the pyloric end. The œsophagus terminates at the middle of the stomach, leaving a considerable sacculus to the left. Around the pylorus may be observed the orifices of a circular series of follicles. The portion of œsophagus attached to the preparation exhibits large circular folds of the internal membrane, analogous to those found in the Lion, and shown in No. 451.

541 A. The stomach of the *Ornithorhynchus paradoxus*.

The cardiac and pyloric orifices are closely approximated, as in the stomachs of birds: the greater part of the cavity extends beyond these orifices, and increases in diameter as it descends into the abdomen. The parietes are thin: the two layers of muscular fibres run in opposite directions, and are thickest along the lesser curvature and round the pylorus.

Prepared by Mr. Owen.

541 B. Debris of insects belonging to a genus of the *Nauceridæ*, which were found in the cheek-pouches of the *Ornithorhynchus paradoxus*.

Donor, Mr. Clift.

541 C. The pyloric end of the stomach of the *Echidna Hystrix*, showing the cuticular lining membrane and papillæ at that part.

Donor, Sir Everard Home, Bart.

542. The pyloric end of the stomach of a Manis, showing its thickened and papillose cuticular lining, together with the very great thickness of the muscular coat, and the oval valvular projection which prevents the passage of insects into the duodenum, until they have undergone the requisite trituration. To assist this process stones are swallowed, which serve in this edentulous animal, as in birds, in lieu of teeth.

543. A portion of the cuticular lining from the stomach of a Manis.

543 A. The entire stomach of a young Manis (*Manis pentadactyla*, LINN.), showing its general form.

543 B. The stomach of the Weasel-headed Armadillo (*Dasypus* 6-*cinctus*, LINN.).

The anterior parietes are removed, to show the internal surface. The lining membrane is uniformly villous, with a few longitudinal rugæ at the middle of the cavity, converging towards the pylorus. The muscular coat is thin where it invests the great or cardiac end of the stomach, but becomes increased, by additional fibres, towards the pylorus, where it attains a thickness of two lines. That aperture is very small and oblique, and is guarded by valvular projections of the inner membrane, serving the same office as the pyloric tubercle in the Manis. The opposite side of the preparation shows a tendinous appearance at the pyloric end of the stomach. The spleen is appended to this preparation.

Prepared by Mr. Owen.

543 C. The stomach of the 9-banded Armadillo (*Dasypus Peba*, DESM.), laid open, showing more distinctly the pyloric valve, which makes an external projection, and has a bristle passed through it. The muscular coat at the pyloric end of the stomach is similarly increased in thickness.

Prepared by Mr. Owen.

543 D. The pyloric end of the stomach of the labiated or Sloth Bear (*Ursus labiatus*, DE BLAINVILLE).

The muscular fibres are proportionally augmented at the pyloric end, and the pylorus is shut up towards the stomach by a valvular protuberance, as in the Manis and Armadillo. This species is also insectivorous in its natural state. *Prepared by Mr. Owen.*

544. The pyloric end of the stomach of the Norway Hare (*Lepus variabilis*, PALLAS), prepared to show two lateral tendons from which the muscular fibres surrounding that part of the cavity proceed.

544 A. The stomach of a Porcupine (*Hystrix cristata*, LINN.).

It has been injected, and the anterior parietes have been removed, to show the interior of the cavity and the cardiac and pyloric orifices.

A considerable portion of the stomach lies to the left of the œsophagus, forming a large *saccus cæcus*, or cardiac reservoir; there is also a smaller cavity, or sacculus, between the cardia and the pylorus, bounded on either side by a projecting ridge; the pyloric division extends for some distance to the right of the pylorus; so that there are reckoned three divisions in the stomach of the Porcupine; but they are very slightly separated from each other in the distended state of the cavity. The pyloric aperture is much larger than the cardiac, and is bounded towards the left side with a valvular ridge. A portion of the duodenum is attached, showing its great width. A large porcupine's quill is inserted at the cardia, and a small one through the biliary duct, which opens close to the pylorus. The spleen is attached to the left side of the preparation.

Prepared by Mr. Owen.

545. The stomach of a Foal, injected and inverted, to show the situation and extent of the cuticular lining of that cavity.

546. A section of the termination of the œsophagus, and of the cardiac extremity of the stomach, of a Horse, showing the continuation of the cuticle from the œsophagus to the stomach, and its abrupt mode of termination. On the cut surfaces may be observed the great thickness of the muscular tunic around the cardiac orifice.

547. A portion of the stomach of a Horse, showing the line of termination of the cuticular coat.

548. The stomach of a young Hog, injected, and the anterior parietes removed. The cuticle may be observed to be continued for a little way into the stomach: on the left side of the cardia it extends as far as a ridge which partially divides the general cavity of the stomach from a small blind

pouch at that end: on the right side the cuticle terminates at the ridge formed by the angle between the cardiac and pyloric portions of the stomach. The pylorus is laid open, exhibiting an oval protuberance, which acts as a valve to that aperture, in the same way as has been described in the Sloth Bear, Armadillos, Manis, &c.

549. A portion of the stomach of a Hog, including the cardiac orifice and the part lined with cuticle. The entrance to the stomach is by an oblique slit, and on its left side it is guarded by a valvular ridge, calculated to prevent the retrogression of food.

550. A portion of the stomach of a Hog, including the cardiac aperture, the lesser curvature, and the cardiac sacculus. The extent of the cuticular lining may be more distinctly traced in this preparation. Bristles are inserted into the orifices of follicular glands around the commencement of the pyloric end of the stomach.

551. The pyloric extremity of the same stomach. The cut surface at the larger end of the preparation shows the excessive thickness of the muscular tunic at that part of the stomach: on looking in at the opposite end, the mode in which the pylorus is shut up by the valvular protuberance is clearly shown. A bristle is inserted into the biliary duct.

551 A. The stomach of a Peccari (*Dicotyles torquatus*).

This singular viscus is divided into three compartments, by the production of the two ridges, which are situated, one to the left, and the other to the right of the cardiac orifices, analogous to those in the stomach of the Hog. The cardiac or left division is greatly extended in the transverse direction, and terminates into two moderately elongated *cul-de-sacs*. This division communicates with the middle compartment by a broad circular aperture. The œsophagus opens into the middle compartment, which is of less extent than the preceding, and communicates by a smaller transverse aperture with the pyloric division. The whole of the middle compartment is lined with cuticle, continued from the œsophagus. The left and right divisions being laid open, show the extent to which the cuticle is prolonged into them. The greater part of the cardiac cavity, with the two *cul-de-sacs*, being lined by a villous membrane, proves that it has a greater share in the digestive processes than as a mere preparatory receptacle. The villous coat of the pyloric cavity is remarkably thick, and the muscular coat is considerably increased near the pylorus, the valvular structure of which is better seen in the preceding preparation. *Prepared by Mr. Owen.*

552. The pyloric division of the stomach of a Peccari, showing the termination of the cuticular lining, which is continued from the œsophagus; the smooth surface and great thickness of the villous coat; and the valvular tubercle at the pylorus.

553. A portion of the pyloric division of the stomach of a Peccari, showing the wrinkled and dark-coloured cuticle, terminating abruptly along the great curvature of that cavity.

553 A. The stomach, injected and laid open, of a young Kangaroo (*Macropus major*, SHAW).

This stomach, like the preceding, may be divided into three portions, —a cardiac,—a middle,—and a pyloric division: the two former are sacculated, their parietes being puckered up upon two narrow longitudinal bands, analogous to those of the colon; they are also partially lined with cuticle: the last division is not sacculated, but has the ordinary form of a simple stomach, and is lined uniformly with a vascular villous membrane. The cardiac division terminates in two *cul-de-sacs*, one of which is lined with cuticle; the other, which is laid open, is lined with a villous membrane only. The œsophagus enters at the angle between the cardiac and middle division. The cardiac orifice, through which a porcupine's quill is passed, is very oblique, and a ridge is continued from its left side into the middle division, where a second transverse ridge may be observed, parallel to the preceding, and forming with it a canal analogous to that in the ruminating stomachs, and along which, food, not requiring previous preparation in the cardiac cavity, might be conducted to the middle compartment. The internal structure of the Kangaroo's stomach is thus described by Sir Everard Home. "When the cavity of the stomach is laid open, the cuticular lining of the œsophagus is found to be continued over the portion immediately below it, and extends to the termination of the smallest process at the left extremity, and nearly to the same distance in the opposite direction; the cuticular covering is very thin, and extremely smooth.

"The lining of the larger process at the left extremity is thick and glandular, and in the living body probably receives no part of the food, but is to be considered as a glandular appendage. On the right of the œsophagus the cuticle does not end by a transverse line, but terminates first upon the middle of the great curvature, where a villous surface begins by a point, and gradually increases in breadth till it extends all round the cavity: its origin therefore is in the form of an acute angle. The villous surface is continued over the remaining cavity as far as the longitudinal bands extend: and that half of it next the pylorus has three rows of clusters of glands; one row is situated along the great curvature, and consists of fifteen in number; the other two rows are close to the two longitudinal bands, and consist only of nine. Besides these there are two large clusters of an oblong form, situated transversely, where the longitudinal bands terminate. The internal surface of the rounded cavity next the pylorus has a different structure, putting on a tessellated appearance, formed by a corrugated state of the membrane. Immediately beyond the pylorus is a ring of a glandular structure surrounding the inner surface of the duodenum.

"The stomach of the Kangaroo in the peculiarities of its structure, forms an intermediate link between the stomachs of animals which occasionally ruminate; those which have a cuticular reservoir; and those with processes or pouches at their cardiac extremity, the internal membrane of which is more or less glandular. The Kangaroo is found to ruminate when fed on hard food. This was observed by Sir Joseph Banks, who has several of these animals in his possession, and frequently amused himself in observing their habits. It is not, however, their constant practice, since those kept in Exeter 'Change have not been detected in that act. This occasional rumination connects the Kangaroo with the ruminant. The stomach having a portion of its surface covered by cuticle, renders it similar to those with cuticular reservoirs; and the small process from the cardia gives it the third distinctive character; indeed it is so small, that it would appear as if it were placed there for no other purpose.

"The Kangaroo's stomach is occasionally divided into a greater number of portions than any other, since every part of it, like a portion of intestine, can be contracted separately; and when its length, and the thinness of its coats are considered, this action becomes necessary to propel the food from one extremity to the other.

"Such a structure of stomach makes regurgitation of its contents into the mouth very easily performed. The food in this stomach goes through several preparatory processes: it is macerated in the cuticular portion; it has the secretion from the pouch at the cardia mixed with it; and is occasionally ruminated. Thus prepared, it is acted on by the secretion of the gastric glands, which probably are those met with in clusters in the course of the longitudinal bands, and afterwards converted by the secretions near the pylorus into chyle."

Lectures on Comparative Anatomy, i. p. 157.

554. The stomach of a small ruminant, probably of the genus *Moschus*, Linn.

The first cavity, or *rumen*, is very large and of a subglobular form. It is divided into two chambers by the remarkable extension of the ridge which is continued from the extremity of the œsophagus. The second cavity, or *reticulum*, is less distinctly separated from the rumen than in other ruminants; a part of its parietes, which are turned down, show that the cells are very shallow: this cavity terminates in an elongated appendix, into which several bristles are inserted. The passage leading from the œsophagus to the third cavity, or *psalterium*, is beset with minute cuticular papillæ; the longitudinal lamellæ which are the peculiar characteristic of this cavity are wanting; but as it appears to have had a cuticular lining, we may regard it as a rudimentary form of this cavity, and distinct from the fourth cavity. This, which is termed *abomasus*, is lined with a villous membrane, which is produced into longitudinal rugæ: the muscular tunic of this cavity is very thick at the pyloric end. It is this stomach which Sir Everard Home alludes to at p. 566, Vol. I. of his 'Lectures on Comparative Anatomy.'—"In the small deer from Prince of Wales's Island in the East Indies, which differs from the rest of its tribe in having no third cavity to the stomach, the cæcum is larger, longer, and the rectum of unusual size, although the course of the colon is nearly the same, as will be seen in the engraving, Pl. cxxvii."

555. The stomach and small intestines of a fœtal Calf, (*Bos Taurus*, Linn.).

The rumen is laid open, showing its communication with the œsophagus and the reticulum, and the several compartments into which it is divided: the two larger occupy the upper part of the paunch; the two smaller form sacculi visible exteriorly at the lower part of the paunch; the latter appear to be analogous to the cardiac sacculi of the Peccary and Kangaroo, but are both lined with cuticle. The reticulum, or honey-comb bag, is laid open, so as to exhibit the large aperture of communication with the preceding cavity, and the groove or canal leading from the œsophagus to the psalterium or plicated cavity. It is along this canal that the re-masticated food is conveyed to the psalterium, the muscular walls of the groove shutting out the reticulum equally with the rumen. A black bristle is passed through this communication, and the psalterium laid open, showing the laminæ within it, and the opening into the abomasus, which is left entire.

556. Portions of the four cavities of the stomach of a Calf, exhibiting their manner of communication with each other and with the œsophagus, more especially the canal which leads from the œsophagus to the psalterium, and the muscular sphincter surrounding it. This sphincter is endowed with a peculiar irritability, which occasions it to contract upon the deglutition which follows rumination, and to dilate when food is swallowed after having undergone the first mastication only. It is obvious that by the contraction of this sphincter the re-masticated food is in great measure prevented from entering either the rumen or reticulum, but must pass directly into the third cavity, the orifice of which is by the same act drawn up towards the œsophagus to receive it.

The villi of the rumen are very short and pointed. The alveolæ of the reticulum, and the laminæ of the psalterium, are also beset with villi. The vascular lining of the abomasus is seen to be thrown into broad rugæ, in the small portion of the cavity which is here preserved.

557. The stomach of a Goat (*Capra Hircus*, Linn.).

The greater portion of the rumen, reticulum, and abomasus, have been removed, but the psalterium left entire, showing the different characters of their inner surfaces, and their several communications with each other, and with the œsophagus. The inner surface of the rumen is beset with elongated villi, spatulate at the extremity; these become shorter as they approach the reticulum, and gradually blend with the alveolæ of that cavity. The communication between these two cavities is so free as to lead to the belief that food, when first swallowed, passes into both cavities. The muscular sphincter bounding the canal which conducts the re-masticated food from the œsophagus to the psalterium is also clearly shown in this preparation, and the necessary result of its contraction in shutting out the rumen and reticulum from the œsophagus may be as readily understood. A bristle is placed across the commencement of the abomasus, showing the width of the orifice leading from the psalterium.

558. A portion of the rumen of a Sheep (*Ovis Aries*, Linn.). The villi are flattened and dilated towards the extremity.

559. A portion of the rumen of an Ox. The villi in this species are still more flattened in shape, and are pointed at the extremity, except near the reticulum, where they assume the form of laminæ, with irregular jagged margins.

560. A small portion of the rumen of the Bison or Bonassus (*Bos Americanus*, Gmel.), in which the villi are much longer, coarser, and of a darker colour.

561. A small portion of the rumen of a Reindeer (*Cervus Tarandus*, Linn.), showing the form of the villi, which are longitudinally plicated.

562. A small portion of the rumen of a Sheep. A part of the cuticle with

which this cavity is lined is turned down; and the stomach has been injected, to show the vascularity of the subjacent mucous membrane.

563. A portion of the rumen and reticulum, uninjected, of a Sheep, with part of the cuticular lining reflected.

563 A. A portion of the reticulum of a Reindeer, with the cuticular lining partially removed. The cells are remarkably shallow in this species.

Prepared by Mr. Clift.

564. A portion of the reticulum of a Goat, with the cuticular lining partially reflected. The cells may be observed to be partially divided into smaller cells.

564 A. A portion of the reticulum of an Ox. In this species the cells are seen chiefly disposed between broad parallel septa; and the larger cells, formed by the narrower transverse septa, are again divided into smaller cells.

Prepared by Mr. Owen.

564 B. A small portion of the psalterium of an Ox, prepared to show the different sizes of the laminæ in this cavity. The laminæ are of two kinds, large and small: the larger ones are of two sizes, which alternate with each other; but between each of the larger laminæ a small one is interposed. They are all beset with papillæ, and lined with cuticle, part of which has been turned down from one of the largest laminæ.

Prepared by Mr. Owen.

565. A portion of the reticulum and psalterium, injected, of a Lamb. The latter cavity has been divided transversely, showing the longitudinal disposition of the laminæ, and how nearly they occupy the whole cavity. Their different sizes and relative positions are also well shown by this section. Bristles are inserted in the interspaces of the different laminæ.

566. The remainder of the psalterium, and the abomasus, of the same stomach.

The chief characteristic of the fourth cavity, viz. its vascular villous lining membrane, is well shown in this preparation. This tunic is thrown into large oblique rugæ, at what may be termed the cardiac end. The pylorus is protected by a valvular protuberance. In its shape and function this cavity resembles the stomach of carnivorous quadrupeds.

566 A. The stomach of a Wapiti Fawn (*Cervus Canadensis*, BRISSON), six days old. At this period, the food, consisting of milk only, is conveyed directly to the fourth stomach to be digested: as it requires no preparation in the preceding cavities, they are accordingly collapsed, and of comparatively very small size. *Prepared by Mr. Clift.*

566 B. The stomach of a fœtal Llama (*Auchenia Glama*, DESMAREST).

This singular form of ruminating stomach is peculiar to the Camel tribe; it is in some respects simpler than that of the horned ruminants, and in others more complicated. Like the stomach of the small species of Moschus (No. 554), the psalterium is less distinctly separated from the abomasus, and at this early period of existence it exhibits in the Llama a similar deficiency of the characteristic laminæ. The reticulum, however, is much more complex, each of the larger alveolæ being developed into many smaller ones,—a structure partially indicated in the reticulum of the Goat (No. 564), and more strongly marked in that of the Ox (No. 464 A). There are, moreover, two groups of cells developed from the rumen, which differ from those of the reticulum in being shallower, and being visible from without, giving a sacculated character to those parts of the paunch.

The several compartments of the stomach have been laid open in this preparation, to show their communications with each other, and the character of their inner surface.

The rumen is lined with cuticle, but is wholly destitute of the villi which characterize it in the horned ruminants. It is partially divided into two compartments by a strong fasciculus of muscular fibres, which, commencing on the left side of the cardiac orifice, traverses the paunch longitudinally. On the right side of this ridge, about fourteen smaller muscular fasciculi pass off at right angles, and these ridges are connected by still smaller fasciculi, running transversely between them, at definite distances from each other; the quadrangular spaces which result from the above arrangement of fasciculi are partly closed by a production of the lining membrane, leaving a circular aperture in the centre of each square for the passage of liquids into the cells beneath.

The compartment of the paunch, to the left of the great longitudinal ridge, terminates in two sacculi, at what may be considered the cardiac extremity. The sacculus nearest the œsophagus is simple; the one furthest from it is developed into a series of cells, of a smaller size, but of precisely similar construction to those on the opposite side of the paunch,—a series of smaller muscular bands passing off at right angles from the larger one which separates the two sacculi, and these lesser bands being connected by transverse fasciculi, in the intervals of which the cells are developed. The reticulum or water-bag is laid open, showing that the cells are situated between a series of parallel muscular fasciculi, as in the rumen; but their further subdivision is carried to a greater extent, and their orifices are not guarded by membranous productions. The external muscular coat of this cavity is so disposed that its exterior is smooth and uniform, and the cells are scarcely visible from without.

The œsophagus is laid open, so as to show the muscular ridge which traverses it longitudinally, and winds round the upper part of the reticulum to terminate at the orifice of the psalterium. It is obvious that by the contraction of this fasciculus, all communication between the first two cavities and the œsophagus would be cut off, and the remasticated food would be conducted, as in the stomachs of horned ruminants, into the third cavity. A slighter degree of contraction would cut off the communication with the rumen, and allow the passage of fluids direct into the reticulum, or water-bag, which probably takes place when the Camel or Llama drinks. A free communication, however, subsists between the water-bag and paunch.

A porcupine's quill is passed through the oblique canal leading to the third cavity: this cavity in the Camel is a small sacculus, distinct from, and intervening between the reticulum and psalterium; it is not so distinct in the Llama; but on a close inspection, the inner membrane nearest the orifice above mentioned may be seen to be produced into ridges, which are arranged in a reticulate or alveolar form; and as a similar structure is more distinctly observable in the Camel, this cavity was considered by Daubenton as the true analogue of the reticulum, and the water-bag as a peculiar superaddition. The remainder of the stomach, in the fœtal Llama, may be seen to form one elongated continuous cavity, bent upon itself at its lower third; without rugæ or laminæ; the latter being afterwards developed at the cardiac half of this cavity. The pylorus is a small transverse aperture, protected by a large oval protuberance. The duodenum is considerably dilated at its commencement. *Prepared by Mr. Owen.*

566 C. A small portion of the stomach of the adult Llama, showing the canal which passes along the upper part of the reticulum, and conducts the ruminated food from the œsophagus to the third cavity.

The muscular fibres of the greater ridge, forming the upper boundary of this canal, are displayed: some of the fibres wind round the aperture of the third cavity, while others return, and pass into the lesser ridge. It is these latter fibres which, by a forcible contraction, draw up the orifice of the third cavity towards the cardia, and close the communication between the œsophagus and water-bag. The commencement of the reticulum, analogous to the third or supernumerary cavity in the Camel, is kept distended by a bristle. *Prepared by Mr. Owen.*

566 D. A portion of the greater group of cells from the paunch of the adult Llama. The cuticle which lines these cells is turned down, and the subjacent membrane removed, to show the muscular fibres of the larger fasciculi, and also those of the lesser connecting bands, which are distinctly muscular, and evidently calculated to close the orifices of the cells.

After death, when these contractile parts have ceased to act, the smaller matters contained in the paunch, as grains of oats, &c., may pass into these cells; but their contents are always found to be chiefly fluid.

Prepared by Mr. Owen.

566 E. The reticulum, second cavity, or true water-bag of the Llama. This cavity is not lined with cuticle, as in the horned ruminants; the other differences are pointed out in the description of the following preparation. The muscular fibres of two of the larger ridges have been dissected: they form by no means such powerful fasciculi as in the corresponding ridges of the paunch-cells. The middle fibres in each ridge become tendinous; but the lateral fibres continue muscular, and pass off to the different connecting ridges, from which they spread over the entire circumference

of the cells, and constitute the second or internal muscular tunic of this part of the stomach. On the opposite side of the preparation, a portion of the external layer of fibres is exhibited.

Prepared by Mr. Owen.

567. A portion of the reticulum or water-bag of a Camel. It has been injected, which shows more distinctly the nature of its lining membrane, and that the inner surface of this cavity is a secreting and absorbing surface. This membrane has been removed from one of the greater, and from some of the lesser bands, showing the muscularity of these parts, and that none of the fibres become tendinous, as in the Llama, in the larger bands.

There exists a general belief, founded on the concurrent testimonies of travellers who have visited the desert regions inhabited by the Camel, that that animal can retain a quantity of water in its stomach, unmixed with the food, and capable of being recovered after the animal has been killed. Perrault * and Daubenton † drew the same conclusion from their dissections of the Camel; but it has been said that "Mr. Hunter did not give credit to the assertion." On referring, however, to the work stated by Sir Everard Home in his *Lectures on Comparative Anatomy*, to contain Mr. Hunter's observations on the subject, he would appear rather to have maintained the contrary opinion. The passage occurs in the following note by Dr. Patrick Russell, in the Appendix to his brother's *History of Aleppo*. "That water, in cases of emergency, is taken from the stomach of camels, is a fact neither doubted in Syria nor thought strange. I never was myself in a caravan reduced to such an expedient; but I had the less reason to distrust the report of others, particularly of the Arabs, seeing that even the love of the marvellous could in such a case be no inducement to invention. It may perhaps be superfluous to produce the authority of an Arab historian (Beidawi), who, in his account of the Prophet's expedition to Tabuc against the Greeks, relates, among other distresses of the army, that they were reduced to the necessity of killing their Camels for the sake of the water contained in their sto-

* *Mém. pour servir à l'Hist. Nat.* Paris, 1676.

† Buffon, *Hist. Nat.* 4to, t. xi. p. 227.

machs.—*Sale, Koran, p.* 164. *Gibbon, Decline and Fall of the Roman Empire,* v. *p.* 245.

"On my return from the East Indies in 1789, hearing accidentally that my friend Mr. John Hunter had dissected a Camel, and was supposed to have expressed an opinion that the animal's power of preserving water in its stomach was rather improbable, I took an opportunity of conversing with him on the subject, when (to the best of my recollection,) he told me 'that he by no means drew any such absolute inference from his dissection; that he saw no reason for assigning more than four stomachs to the Camel; though he could conceive that water might be found in the paunch little impregnated by the dry provender of the desert, and readily separating or draining from it.'

"In hopes that other particulars might be found among the papers of my lately deceased friend, I applied to his brother-in-law, Mr. Home, who informed me that he had examined them, but without discovering any observations on the subject."—*vol.* ii. *p.* 425.

From these remarks, then, it appears, that the small cavity regarded by Daubenton as analogous to a reticulum, was not considered by Mr. Hunter as of sufficient importance to be ranked as a distinct stomach; and the water-bag must, therefore, in his opinion, have held the place of the honey-comb bag in the horned ruminants. And when we compare the relation of the reticulum to the rumen in that tribe, with the corresponding free communication which subsists between the water-bag and rumen in the Camel tribe; and when also we observe in both the precise correspondence in the mode of communication of these two cavities with the œsophagus, and with the muscular apparatus destined to convey the remasticated food beyond their apertures into the third cavity, and at the same time find an approach to the peculiar disposition of the cells of the water-bag in the reticulum of some of the horned ruminants,—it becomes evident that the two cavities are analogous; the reticulum of the Camel, being modified for its destined functions by the greater development of the secondary cells, by the absence of a cuticular lining, and by the production of the inner layer of the muscular tunic, which forms the apparatus for closing the orifices of the primary cells. The third cavity, therefore, which could not have been recognised as a distinct compartment in the Llama, and which undoubtedly receives the remasticated food in the Camel, ought rather to be regarded as a peculiar structure, to which nothing analogous is to be found in the stomachs of the horned ruminants.

568. A portion of the psalterium of a Camel:—this part of the stomach immediately succeeds the third or peculiar cavity above mentioned. The laminæ are simple productions of the lining membrane, which is extremely thin; they are not covered with cuticle as in the horned ruminants, that substance not being extended in the Camel beyond the rumen.

569. A portion of the psalterium and abomasus of a Camel, taken from where they are continuous with each other, and showing that the distinction of these parts in this ruminating stomach is founded rather on a difference in the disposition of the inner membrane, than on a separation of the two cavities by a natural constriction. It may be observed, that besides a difference in the form of the rugæ, the lining membrane of the abomasus, or true digestive cavity, puts on a more villous appearance than that of the psalterium.

569 A. The corresponding part of the stomach of a Llama, showing the same structure on a somewhat smaller scale. By comparing this preparation with No. 566 B, it will be seen that the laminæ characterizing the psalterium are not developed in the fœtal stomach of the Llama. In the Ox, however, the laminæ of the psalterium preserve the same proportions in the fœtal as in the adult state:—see No. 555. *Prepared by Mr. Owen.*

569 B. The pyloric end of the abomasus, and the commencement of the duodenum, of a Llama. This preparation has been made for the purpose of showing the form, position, and structure of the valvular protuberance at the pylorus. It has been divided by a longitudinal incision, and seems principally composed of an accumulation of the sub-mucous cellular texture, the cells of which are large, and being filled with fluid, must render the part elastic. No glandular follicles are perceptible, nor any conspicuous orifices in the mucous membrane covering the protuberance; yet it has been called glandular. (*Home's Comparative Anatomy*, i.

p. 173.) Daubenton, however, terms it simply "boursuflure," without hinting at its use. Its office seems to be merely mechanical; if pressed on by any mass of undigested matter, it would shut up the pylorus, and prevent the passage of such matter into the duodenum; while substances, sufficiently comminuted and digested, would pass beneath the protuberance, through the semilunar pylorus, into the duodenum. This gut forms at its commencement a capacious reservoir, a small part of which only is preserved in this preparation. *Prepared by Mr. Owen.*

569 c. The stomach of a Porpesse (*Phocæna communis*, Cuv.). It is composed of a series of cavities, succeeding one another, and not appended to the œsophagus, as in ruminating animals. The first cavity may be regarded as a continuation of the œsophagus beyond the entry into the succeeding bag, forming a *cul-de-sac* analogous to that in the Mullet (No. 502). Being more dilated, however, it forms a cavity of an ovate form, which is lined with cuticle, continued from the œsophagus, and its inner surface is rendered irregular by wrinkles and small rugæ. A number of irregular projections may be observed to surround the aperture leading to the second cavity (through which aperture a porcupine's quill has been passed). These projections are naturally calculated to prevent the passage of any substances not of a very small size; and it has been observed, that the digestive processes are considerably advanced in the first cavity, notwithstanding the nature of its lining membrane. Sir Everard Home remarks: "The first cavity of the stomach of the Whale is not only a reservoir, but the food undergoes a considerable change in it. The flesh of its prey is entirely separated from the bones, which proves that the secretion from the glandular part has a solvent power. This was found to be the case in the bottle-nose Porpesse and large bottle-nose Whale. In both of them several handfuls of bones were found in the first cavity, without the smallest remains of the fish to which they belonged. In others the earth had been absorbed, so that only the soft parts remained; and, indeed, it is only those that can be conveyed into the second and third cavities, the orifices being too small to permit bones to pass."—*Lectures on Comp. Anat.* i. *p.* 255.

The cuticular lining terminates at the orifice leading into thc second cavity. The interior of this compartment presents a series of thick longitudinal wavy rugæ, laterally indented into one another. The lining mcmbrane has been subjected to microscopical examination, and has thus been described by Dr. Brewstcr. "It seems, in its wet state, to consist of tubcs or fibres, perpendicular to the two membranes which inclose them, thus, ; and the upper surface of one of the membranes is covered with hollows or depressions corresponding with the extremities of the tubes or fibres. A more minute examination, conducted in a different way, proves these perpendicular portions to be tubes. In order to dry it, I pressed it between folds of paper, and the cffcct of the compression was to press together nearly all the tubes, and make the whole one dense mass, of a dark-brown colour ; but when it became dry, and slightly indurated, I drew it out as if it had been India-rubber, and the tubes opened, and the mass became white."

The membrane next the cavity of the stomach is perfectly smooth ; the one external to thc fibres is a vascular and cellular tunic, and is invested by the layer of muscular fibres continued from the preceding cavity. The communication with the third stomach is near the lower end of this cavity. The succeeding cavities resemble in their structure the stomach of the carnivora, and are lined with a vascular villous membrane. They are better displayed in No. 579. *Prepared by Mr. Clift.*

570. A portion of the first cavity of the stomach of the Piked Whale, showing the thickness of its cuticular lining, which is partly turned down.

571. A small portion of the cuticular lining from the same stomach.

572. A portion of thc first cavity of the stomach of the Bottle-nose Whale (*Delphinus Dalei*, Cuv.), showing the abrupt termination of the cuticle in that cavity.

573. A portion of the first cavity of the stomach of a Cetaccous animal.

574. A portion of the first and second cavities of the stomach of a Porpesse,

showing their aperture of communication, and their difference of structure, as described at No. 569 c.

575. A portion of the second cavity of the stomach of a Porpesse, with the longitudinal rugæ drawn apart, to show the mode in which they fit into each other by lateral indentations.

576. A portion of the second cavity of the stomach of the Piked Whale, showing the rugæ to be very large, but more irregular than in the Porpesse.

577. A portion of the fourth cavity of the stomach of the Piked Whale.

578. A portion of the fifth cavity of the same stomach as the preceding. The parietes of this cavity are much thinner than those of the fourth.

579. The stomach, injected, of a Porpesse. The first and second cavities are laid open, but have been already described. The third cavity is the small round vascular chamber into which the second stomach obliquely opens; it is not easily distinguishable from what is usually considered the fourth stomach. This cavity passes on in a sigmoid form to the pylorus, which is a contracted circular aperture. Beyond it is seen the duodenum, much dilated.

"Those parts that respect the nourishment of this (the Whale) tribe do not all so exactly correspond as in the land animals; for in these one in some degree leads to the other. Thus the teeth in the ruminating tribe point out the kind of stomach, cæcum, and colon; while in others, as the Horse, Hare, Lion, &c., the appearances of the teeth only give us the kind of colon and cæcum; but in this tribe, whether teeth or no teeth, the stomachs do not vary much, nor does the circumstance of cæcum seem to depend on either the teeth or stomach. The circumstances by which, from the form of one part, we judge what others are, fail us here; but this may arise from not knowing all the circumstances.

"The stomach, in all that I have examined, consists of several bags, continued from the first on the left, towards the right, where the last terminates in duodenum. The number is not the same in all; for, in the

Porpesse, Grampus, and Piked Whale, there are five, in the Bottle-nose, seven. Their size, respecting one another, differs very considerably, so that the largest in one species may in another be only the second. The two first, in the Porpesse, Bottle-nose, and Piked Whale, are by much the largest; the others are smaller, although irregularly so.

"The first stomach has, I believe, in all, very much the shape of an egg, with the small end downwards. It is lined everywhere with a continuation of the cuticle from the œsophagus. In the Porpesse, the œsophagus enters the superior end of the stomach. In the Piked Whale, its entrance is a little way on the posterior part of the upper end, and is oblique.

"The second stomach, in the Piked Whale, is very large, and rather longer than the first. It is of the shape of the italic *S*, passing out from the upper end of the first on its right side, by nearly as large a beginning as the body of the bag. In the Porpesse, it by no means bears the same proportion to the first, and opens by a narrower orifice; then passing down along the right side of the first stomach, it bends a little outwards at the lower end, and terminates in the third. Where this second stomach begins, the cuticle of the first ends. The whole of the inside of this stomach is thrown into unequal rugæ, appearing like a large irregular honeycomb. In the Piked Whale, the rugæ are longitudinal, and in many places very deep, some of them being united by cross bands; and in the Porpesse, the folds are very thick, massy, and indented into one another. This stomach opens into the third by a round contracted orifice, which does not seem to be valvular.

"The third stomach is by much the smallest, and appears to be only a passage between the second and fourth. It has no peculiar structure on the inside, but terminates in the fourth, by nearly as large an opening as its beginning. In the Porpesse it is not above one, and in the Bottle-nose about five inches long.

"The fourth stomach is of a considerable size: but a good deal less than either the first or second. In the Piked Whale, it is not round; but seems flattened between the second and fifth. In the Porpesse, it is long, passing in a serpentine course, almost like an intestine. The internal surface is regular, but villous, and opens on its right side into the fifth, by a round opening, smaller than the entrance from the third.

"The fifth stomach is in the Piked Whale round, and in the Porpesse oval; it is small, and terminates in the pylorus, which has little of a valvular appearance. Its coats are thinner than those of the fourth, having an even inner surface, which is commonly tinged with bile.

"The Piked Whale, and, I believe, the large Whalebone Whale, have a cæcum; but it is wanting in the Porpesse, Grampus, and Bottle-nose Whale.

"The structure of the inner surface of the intestine is in some very singular, and different from that of the others.

"The inner surface of the duodenum, in the Piked Whale, is thrown into longitudinal rugæ, or valves, which are at some distance from each other, and these receive lateral folds. The duodenum, in the Bottle-nose, swells out into a large cavity, and might almost be reckoned an eighth stomach; but as the gall ducts enter it, I shall call it duodenum."

J. Hunter, On the Structure and Œconomy of Whales. Phil. Trans., lxxvii. 1787, p. 407.

580. A portion of flesh and adeps of a Cetaceous animal, found partly digested in the stomach of a Grampus.

581. The sclerotic coat of the eye of a Cetaceous animal, found in the same stomach.

11. *Gastric Glands.*

582. Part of the proventriculus of the Pelican (*Pelecanus Onocrotalus*, Linn.), with the gastric glands dissected, which are of a simple elongated form.

582 a. The stomach, injected and laid open, of the Gannet or Soland Goose (*Sula Bassana*, Brisson). The muscular tunic has been removed from the proventriculus, and the gastric glands dissected, to show their form. They do not encircle the proventriculus in an uninterrupted zone, but are arranged in two large and closely approximated oval groups.

Prepared by Mr. Clift.

582 B. The œsophagus, proventriculus, and gizzard of the Java Swallow (*Hirundo esculenta*, LINN.). The proventriculus is kept open by means of a bristle, exposing the orifices of the gastric glands.

Prepared by Mr. Clift.

583. The proventriculus of the Crown Pigeon (*Columba coronata*, LINN.), with the gastric glands dissected.

583 A. A portion of the proventriculus of the Emeu (*Dromaius Novæ Hollandiæ*, LATHAM), with the gastric glands dissected: bristles are inserted into some of the orifices of these glands, which are large, broad, and flattened, but of a simple form.

584. A small portion of the proventriculus of the Ostrich (*Struthio Camelus*, LINN.), with the gastric glands dissected, to show their complex lobulated structure. Bristles are inserted into the excretory orifices of these glands.

585. A larger portion of the proventriculus of the Ostrich, including the upper part of the long narrow band which the gastric glands form in that cavity. On the cut surface of this preparation may be seen the small processes into which each gland is divided.

586. A portion of the proventriculus of an Ostrich, injected, including part of the lower boundary of the longitudinal glandular band. A part of the muscular tunic has been dissected off, to show the large size of the gastric glands.

587. A small portion of the stomach of the Beaver (*Castor Fiber*, LINN.), including the cardiac orifice and gland. The latter is of large size, situated on the lesser curvature of the stomach, to the right of the œsophagus. It is composed of numerous branched follicles, the blind extremities of which, when exposed by the removal of the exterior muscular investment, give to the gland a minutely lobulated appearance. The follicles open into the stomach, and their orifices are arranged in three longitudinal series, on as many slightly elevated ridges.

588. A longitudinal section of the cardiac gland, and of the termination of the œsophagus, of the Beaver. On the cut surface of the gland may be observed the processes or branches of the follicles.

589. The corresponding section of the same gland, showing, in a more distinct manner, the same circumstances as the preceding preparation.

590. A portion of the stomach, with the cardiac gland, of a young Beaver, in which may be observed the strong layer of muscular fibres, which covers the exterior of the gland, and contributes to the expulsion of its contents.

590 A. The stomach of a Dormouse, laid open, showing the gastric glands surrounding the termination of the œsophagus, in a manner analogous to those of the proventriculus in birds. *Prepared by Mr. Owen.*

590 B. The stomach of the Wombat (*Phascolomys Vombatus*, LEACH). It has been inverted, and partially distended with spirit. On the right of the cardia may be observed numerous large orifices, irregularly disposed, of a gland, analogous to that of the Beaver.

Presented by Sir E. Home, Bart.

590 C. The stomach of the short-tailed Manis (*Manis brachyura*, ERXLEBEN), laid open, to expose the large gastric gland, situated at the middle of the great curvature. It is composed of numerous lenticular follicles, which communicate together, and open by a single common orifice into the cavity of the stomach. A bristle is inserted at this orifice.

Prepared by Mr. Owen.

12. *Effects of the Gastric Juice after Death.*

" On the Digestion of the Stomach after Death.—The following account of the stomach being digested after death, was drawn up at the desire of the late Sir John Pringle, when he was President of the Royal Society; and the circumstance which led to it was as follows: I had opened, in his presence, the body of a patient who had been under his care, in which the stomach was found to be in part dissolved; a thing that appeared to him very unaccountable, there having been no previous symptom which could have led him to suspect any disease in the stomach. I took that opportunity of explaining to him my ideas respecting it; and that having long been employed in making experiments on digestion, I had been induced to consider this as one of the facts which proved a converting power in the gastric juice. I mentioned my intention of publishing the whole of my observations on digestion at some future period; but he desired me, in the mean time, to give this fact by itself, with my remarks, as it would prove that there is a solvent power existing in the stomach, and would be of use in the examination of dead bodies.

"An accurate knowledge of the appearances in animal bodies, where death has been the consequence of some violence, while they were otherwise in health, ought certainly to be considered as necessary to qualify us to judge truly of the state of the body in those that die of diseases. An animal body undergoes changes after death; but it has never been sufficiently considered what those changes are, or how soon they may take place; yet till this be done, it is impossible we can form an accurate judgment of the appearances which present themselves at the time of inspection. The diseases of an animal body (mortification excepted,) are always connected with the living principle, and are not in the least similar to the changes which take place in the dead body: without a knowledge of this, an opinion, drawn from dissections, must always be very imperfect, or very erroneous. Appearances which are in themselves natural, may be mistaken for those of disease; we may see diseased parts, and suppose them in a natural state; we may consider a circumstance to have existed before death, which was really a consequence of it; or we may imagine it to be a natural change after death, when it was in fact a disease of the living body. It is easy to see, therefore, how a man in this state of ignorance must blunder, when he comes to connect the appearances in a dead body with the symptoms that were observed in life; and, indeed, all the advantage to be derived from opening dead bodies depends upon the judgment and sagacity with which this sort of comparison is made.

"There is a case of a mixed nature, which can neither be reckoned a process of the living body, nor of the dead; it participates of both, inasmuch as its cause arises from life, and the effect cannot take place till after death. To render this more intelligible, it will be necessary to state some general ideas concerning this cause and effect.

"An animal substance, when joined with the living principle, cannot undergo any change in its properties but as an animal; this principle always acting and preserving the substance possessed of it from dissolution, and from being changed according to the natural changes which other substances undergo.

"There are a great many powers in nature, which the living principle does not enable the animal matter, with which it is combined, to resist, viz. the mechanical and most of the strongest chemical solvents. It renders it, however, capable of resisting the powers of fermentation, digestion, (and perhaps several others,) which are well known to act on this same matter, and entirely to decompose it, when deprived of the living principle. The number of powers which thus act differently on the living and dead animal substance not being ascertained, we shall only take notice of two,—putrefaction and digestion,—which do not affect this substance, unless when it is deprived of the living principle. Putrefaction is an effect which arises spontaneously: digestion is an effect of another principle, and shall here be considered a little more particularly.

"Animals, or parts of animals, possessed of the living principle, when taken into the stomach, are not in the least affected by the powers of that viscus, so long as the animal principle remains; hence it is that we find animals of various kinds not only can live in the stomach, but are even hatched and bred there: yet the moment that any of these lose the living principle, they become subject to the digestive powers of the stomach. If it were possible for a man's hand, for example, to be introduced into the stomach of a living animal, and kept there for some considerable time, it would be found that the dissolvent powers of the stomach could have no effect upon it; but if the same hand were separated from the body, and introduced into the same stomach, we should then find that the stomach could immediately act upon it. Indeed, if the first were not the case, the stomach itself ought to have been made of indigestible materials; for, were not the living principle capable of preserving animal substances from being acted upon by the process of digestion, the stomach itself would be digested; and accordingly we find that the stomach, which, at one instant, that is, while possessed of the living principle, was capable of resisting the digestive powers which it contained, the next moment, viz. when deprived of the living principle, is itself capable of being digested, not only by the digestive powers of other stomachs, but even by the remains of that power which itself had of digesting other things.

"These observations lead us to account for an appearance which we often find in the stomachs of dead bodies; and they at the same time throw considerable light upon the nature of digestion: the appearance we allude to is a dissolution of the stomach at its great extremity, in consequence of which there is frequently a considerable aperture made in that viscus. The edges of this opening appear to be half dissolved, very much like that kind of solution which fleshy parts undergo when half digested in a living stomach, or when acted upon by a caustic alkali, viz. pulpy, tender, and ragged.

"In these cases the contents of the stomach are generally found loose in the cavity of the abdomen, about the spleen and diaphragm; and in many subjects the influence of this digestive power extends much further than through the stomach. I have often found, that after the stomach had been dissolved at the usual place, its contents, let loose, had come into contact with the spleen and diaphragm, had dissolved the diaphragm quite through, and had partly affected the adjacent side of the spleen, so that what had been contained in the stomach, was found in the cavity of the thorax, and had even affected the lungs to a small degree.

"There are very few dead bodies in which the stomach at its great end is not in some degree digested; and one who is acquainted with dissections can easily trace these gradations. To be sensible of this effect, nothing more is necessary than to compare the inner surface of the great end of the stomach with any other part of its inner surface: the sound portions will appear soft, spongy, and granulated, and without distinct blood-vessels, opake, and thick; while the others will appear smooth, thin, and more transparent; and the vessels will be seen ramifying in its substance, and upon squeezing the blood which they contain from the larger branches to the smaller, it will be found to pass out at the digested ends of the vessels, and to appear like drops on the inner surface.

"Though I have often seen such appearances, and supposed that they must have been seen by others, yet I was quite at a loss to account for them. At first, I supposed them to have been produced during life, and was therefore inclined to look upon them as the cause of death, only that I never found they had any connexion with the patient's symptoms; but I was still more at a loss to account for them, when I discovered they were most frequent in those who died by sudden violence, a circumstance which made me suspect that the true cause was not guessed at *.

"At this time I was employed in making experiments upon digestion in different animals, all of which were killed at different times, after having been fed with various kinds of food; many of these were not opened immediately after death, and in some of them I found the above-described appearances in the stomach."—"Being employed upon this subject, and therefore enabled to account more readily for appearances which had any connexion with it, and observing that the half-dissolved parts of the stomach were similar to the half-digested food, it immediately struck me that it was the process of digestion going on after death; and that the stomach, being dead, was no longer capable of resisting the powers of that menstruum, which itself had formed for the digestion of food.

"These appearances of the stomach after death throw considerable light on the principles of digestion, and show, that it neither depends on a mechanical power, nor contractions of the stomach, nor on heat, but something secreted in the coats of the stomach, and thrown into its cavity, which there animalizes the food, or assimilates it to the nature of the blood.

* "The first time that I had occasion to observe this appearance, where death had been produced by violence, and where it could not, therefore, easily be supposed to be the effect of disease, was in a man who had his skull fractured by one blow of a poker. Just before this accident he had been in perfect health, and had taken a hearty supper of cold meat, cheese, bread, and ale. Upon opening the abdomen, I found that the stomach, though it still contained a good deal, was dissolved at its great end, and a considerable part of its contents lay loose in the general cavity of the belly, a circumstance which puzzled me very much. The second instance was in a man who died at St. George's Hospital a few hours after receiving a blow on his head which fractured his skull. From these two cases, among various conjectures about so strange an appearance, I began to suspect it might be peculiar to cases of fractured skull; and therefore, whenever I had an opportunity, I examined the stomach of every person who died from that accident; but I found many of them which had not this appearance. I afterwards met with the same appearance in a man who had been hanged."

"The power of the gastrie juiee is confined or limited to certain substanees, generally of the vegetable and animal kingdoms ; and although this menstruum is eapable of aeting independently of the stomaeh, yet it is indebted to that viseus for its existenee and eontinuanee."

John Hunter, On the Animal Œconomy, p. 226.

591. A portion of the human stomaeh, with the internal membrane destroyed in some places by the aetion of the gastrie juiee.

592. The stomaeh of a Boy, with the whole of the cardiac extremity destroyed after death by the aetion of the gastric juice.

Among Mr. Hunter's posthumous papers there is the following ease, whieh is probably the history of this speeimen. "No. 150. *The appearances upon opening the body of Master Stephens.*—The whole of the abdominal viscera were to appearance sound, excepting the great end of the stomach, which was dissolved through and through, having a large hole in it. This hole was eontiguous to the diaphragm and spleen, where the same dissolving power had also destroyed the diaphragm at this part; and also part of the spleen and lungs of the left side, opposite to this hole in the diaphragm, were also ehanged in consistenee.

"There was some extravasated blood in the left side of the thorax, and spots of extravasated blood in many parts of the lungs themselves of this side. The gall-bladder was extremely full and inclosed, but the ducts were free ; it looked as if it had lost the museular power of eontraetion.

"The hole in the stomach and diaphragm, with the destruction of the spleen, and change in part of the lungs, were eertainly produeed *after* death ; but at what time the extravasation of the blood that was found in the eavity of the thorax and in the lungs happened, is not so easily determined. It is not easy to conceive that it was in eonsequenee of the dissolution of the diaphragm, &e., as then it must have happened some time after death."

593. The eardiae half of an adult stomach, in which the greater part of the viseus to the left of the œsophagus has been similarly destroyed. This was probably the stomaeh of the man with the fractured skull, referred to in the note in the introduetory observations to the present Subseries ; and

in the second of the following cases preserved in the posthumous papers of Mr. Hunter: "No. 18. In the winter, 1755, I dissected a girl that had died of a fractured skull. The brain was universally inflamed, and the stomach corroded quite through, at the great arch, just as we often see in children.

"In the winter, 1756, I dissected a man that died of the same injury, and his stomach was in the same way, which was the first time I ever saw it so in the adult."

593 A. A human stomach, with a greater part of the left extremity destroyed, and in other places both mucous and muscular coats dissolved, the peritoneal membrane at those parts preserving its transparency without showing the least trace of any previous inflammatory action. This lesion is presumed to be the effect of the gastric juice after death; but the preparation has no history. *Presented by* Sir W. Blizard, F.R.S.

594. A small portion of the human stomach, exhibiting the structure supposed to secrete the gastric juice.

594 A. The pyloric end of the human stomach, exhibiting the orifices of numerous small follicles. This is an appearance not commonly seen in the healthy stomach. *Prepared by Mr. Owen.*

Series III. Structure of the Intestines.

1. *Intestines of Annulosa.*

595. The alimentary canal of a Sea-mouse (*Aphrodita aculeata*, Linn.). The intestine is dilated at its commencement, and grows gradually narrower to its termination; it is rendered peculiar in this annellide by the numerous elongated lateral cæcums which communicate with it. The dilated blind extremities of these cavities are very distinctly shown in the preparation, and many of them contain an opake coagulated substance, either their own secretion, or chyle which they have received from the alimentary canal.

595 A. A Leech (*Hirudo medicinalis*, Linn.), with the dorsal parietes of the body

removed, to expose the alimentary canal, and more especially the intestinal portion. The latter forms a very narrow canal, situated between the last two long cells of the stomach. It is partially laid open, showing its internal surface to be transversely rugous : a white bristle is inserted at the anus, denoting its situation above the terminal sucker. A black bristle is inserted at the mouth. *Prepared by Mr. Owen.*

595 B. An Earth-worm (*Lumbricus terrestris*, LINN.), laid open longitudinally along the dorsal aspect, to expose the alimentary canal. The intestine has been filled with red injection, and the dorsal artery which runs along it may be distinctly seen. *Prepared by Mr. Clift.*

596. A specimen of *Helophilus pendulus*, MEIGEN, *Musca pendula*, LINN., with the ventral parietes of the thorax and abdomen removed, to expose the alimentary canal. The bifid crop or food-reservoir, with the long filiform tube leading to it from the mouth, is drawn aside: the rest of the alimentary canal is preserved *in situ.*

Among the anatomical papers of Mr. Hunter, of which copies were preserved by Mr. Clift, there is the following account of the digestive organs of dipterous insects.

" *Of the Fly-Tribe.*

" LARGE BLUE-BOTTLE FLY.

" The organs of circulation and respiration are similar to all of the flying insect kind. The organs of digestion are attended with a crop. They may be said to live on fluids, or such as may be raised either by suction or capillary attraction.

" The œsophagus when got to the neck, or through the head, has a swell, or is surrounded by a thickish substance probably glandular. It there divides into two canals. One, and the smallest, passes across the neck along the thorax, and when got into the abdomen it dilates into a pretty large bag of a particular shape, swelling out laterally, having the long axis across the abdomen. The other canal passes down behind the before-described, and along with it into the belly, then becomes larger, which increase of size may be called stomach ; and then again becomes smaller, forming intestine, which is soon thrown into close convolutions; and then becomes a more straight canal, into which enters the duct which I suppose to be either liver or pancreas.

"Where it commences rectum there is a valvular structure, and then a swell forming a kind of reservoir for the fæces, in which there is a particular appearance or structure: it is there flat, more firm in texture, and has two lateral conical bodies on each side whose bases adhere to the side of the gut, and the whole body projects into the cavity of the gut obliquely downwards. Into the base passes a dark vessel, which is an air vessel. We may suppose these so many glands opening at the apex into the gut *. Then the gut becomes small, and opens into the anus behind, or rather above the vagina.

"The bag belonging to the first-described canal is to be considered as a craw or crop, viz. a reservoir for the food to be ready for digestion; and as the abdomen contains almost every internal part of the animal, it is obliged to be situated in this cavity: but why it did not communicate with the œsophagus or true stomach lower down, I do not know. That it is a reservoir for food I proved by experiment: I kept some of these flies fasting for some time: I then gave them milk, which they drank readily; and when I thought they had filled their bellies, I put them into spirits which assisted in coagulating the milk wherever it might be. On opening the abdomen I found this bag full of curd and whey, as also some in the stomach. That I might be still more certain that this bag was a reservoir only, and that it had no other business in digestion, and that therefore food would be taken into the stomach immediately, if immediately wanted,—I repeated the above experiment, with this difference,—the milk was now coloured with cochineal; I not only found the bag full, but the stomach and intestines; so that the food, when wanted, was immediately carried into the stomach.

"I kept a fly for twelve hours without food, and then gave it milk and killed it, and found no milk in the crop, but it had got through almost the whole tract of intestines: here the animal had immediate occasion for

* The preparation which exhibits this structure is preserved in the series of "Peculiarities" along with the anal glands from the higher classes of animals.

food, therefore the milk did not go into the crop. This experiment at the same time shows that (probably) every part of the intestine digests, for the stomach makes no distinct bag. Is the crop only a reservoir, or is it a preparer of particular food as in other animals? I should suspect it is only a reservoir, as I find food in it that does not require being prepared, which is proved by the same food being found equally in both; therefore it appears that when there is more food than what is immediately necessary, then it is thrown into the crop to be used in future."—*Hunterian MSS.*

597. A Sumatran species of *Cicada,* with the ventral parietes of the thorax and abdomen removed, to expose the alimentary canal. The œsophagus is long and filiform: the stomach is an elongated, membranous, and sacculated cavity. The intestine appears to be continued from the stomach close to the cardia or termination of the œsophagus, but the further course of this part of the alimentary canal is much obscured in the specimen by the contorted biliary tubes. The intestine is dilated at its termination; but in the preceding part of its course it is very slender; the whole digestive apparatus being in accordance with the fluid nature of this insect's food*.

598. A Dragon-fly (*Æsthna grandis,* Fabr.), with the anterior parietes of the body removed, to expose the alimentary canal. The œsophagus and stomach are of great length; the biliary vessels at the commencement of the intestine are numerous and free: the intestinal canal is dilated at its commencement, and is plicated longitudinally as far as the rectum.

599. The alimentary canal of a Termite Ant (*Termes bellicosus*).

600. A female or Queen Termite, with the ovaries enlarged: the anterior parietes of the body are removed, to show the alimentary canal. The stomach is continued into the distended abdomen, where it becomes

* According to Ramdohr and Meckel the stomach is of a much more complex structure in this family of insects than would appear from the above specimen: it is described and figured by these anatomists; the one in *Cercopis spumaria,* the other in *Cicada plebeia,* as a double organ, the second stomach being very long and filiform, and terminating by its pyloric extremity in the first stomach, from which it was originally continued.

considerably dilated, and is bent upon itself. The biliary tubes enter at a short distance from the anus; the intestinal canal is enlarged at its commencement, and gradually contracts to its termination.

601. The digestive organs of a Humble-bee (*Bombus terrestris*, Latr.). The œsophagus is long and slender, and terminates in the dilated crop or honey-bag, which contains some red injection; this has not entered the true stomach, owing to the valvular mode of its connexion with the crop. The narrow intestine which succeeds, is very short in this specimen; it becomes dilated at a short distance from its termination.

602. A similar preparation from an older individual, in which the intestinal canal is longer; the bile-vessels are very numerous, short, and free.

603. A Humble-bee, with the ventral parietes of the abdomen removed, to show the dilated rectum full of fæcal matter.

604. A Hive-bee (*Apis mellifica*), similarly prepared, to show the intestinal canal, and especially the dilated rectum.

605. The alimentary canal of another Bee, prepared to show the same part distended with fæcal matter.

See Mr. Hunter's description of the digestive organs of the bee, appended to No. 477, at p. 129 of this Catalogue. With respect to the use of the dilated rectum he further observes: "In a fine day, they become very lively and active, going abroad, and appearing to enjoy it, at which time they get rid of their excrement; for I fancy they seldom throw out their excrement when in the hive. To prove this, I confined some bees in a small hive, and fed them with honey for some days; and the moment I let them out, they flew and threw out their excrement in large quantities; and therefore in the winter, I presume, they retain the contents of their bowels for a considerable time: indeed, when we consider their confinement in the winter, and that they have no place to deposit their excrement, we can hardly account for the whole of this operation in them. Their excrement is of a yellow colour, and according to their confinement it is found higher and higher up in the intestine, almost as high as the crop."

John Hunter, *Observations on Bees*, *Philos. Trans.* lxxxii. 1792, p. 161.

606. A Cockchafer (*Melolontha vulgaris*, Fabr.), with the anterior parietes of the body removed, to exhibit the alimentary canal. This is nearly five times the length of the body, and four fifths of it consist of the stomach ; the remaining fifth, or intestinal canal, is dilated at its commencement, and gradually contracts to the rectum, where it becomes again dilated.

607. The alimentary canal of a Cockroach (*Blatta orientalis*, Linn.). The œsophagus gradually dilates into a large membranous crop, which terminates in a small gizzard, beyond which a third small stomach is continued, having six processes or blind appendages at its upper end. Numerous short and free bile-vessels mark the commencement of the intestinal canal, which becomes gradually smaller to the rectum, where it is again dilated.

608. A similar preparation, in which the stomachs have been laid open.

609. The alimentary canal of a larger species of Cockroach, from Sumatra. The crop is more muscular, the gizzard larger, and the blind appendages to the third stomach proportionately longer; the intestinal canal is much distended in the preparation.

610. The alimentary canal of a large female Locust (*Acrida* ——, Kirby). The different parts of this canal correspond with those displayed in Nos. 474. and 475. of the preceding series. If the intestine be considered as commencing where the hepatic ducts terminate, it constitutes a very small proportion of the whole canal ; and the rectum is the widest portion. The long horny plates continued beyond the anus are the ovipositors.

611. The alimentary canal of a Mole-cricket (*Gryllotalpa vulgaris*, Latr.). The structure of this canal bears a general resemblance to the preceding, but the crop instead of being a gradual dilatation of the œsophagus, is appended to the side of that tube like the crop of a gallinaceous fowl, and a longer canal intervenes between it and the gizzard. Two large and laterally disposed cæcal appendages open, as in locusts, into the termination of the gizzard, from which the true digestive stomach is continued; this part is narrow at its commencement, then becomes dilated, and afterwards gradually contracts to the situation where the biliary organ

communicates with the alimentary canal. The intestine is short, dilated at its commencement, and becomes narrower to the rectum, where it is again dilated.

The two processes projecting beyond the anus, which have been conjectured to act as antennæ in the retrograde motions of the animal, are preserved in this specimen. The black colour of the parts was derived from the piece of wood to which they were originally attached.

612. A Scorpion (*Buthus Africanus*, Leach,) with the dorsal parietes of the abdomen and tail removed, to expose the intestinal canal. This is of a simple structure, and passes down, without forming any convolutions, to the space between the two last joints of the tail, where it terminates. A bristle is inserted at the anus.

612 a. A Hermit-crab (*Pagurus punctulatus*, Oliv.), laid open on the ventral aspect to expose the intestinal canal. Its structure and disposition are as simple as in the preceding specimen; the canal grows gradually narrower to its termination, which is just below the last crustaceous appendage of the tail. *Prepared by Mr. Owen.*

612 b. A portion of the intestine of the Robber-crab (*Birgus Latro*, Leach), showing the delicate transparent texture of its coats, and the minute conical processes which everywhere beset its inner surface.

Prepared by Mr. Owen.

613. Two species of Cirripeds dissected, to show their alimentary canal: the upper specimens (*Otion Cuvieri*, Leach,) are parasitically attached to a fine barnacle (*Coronula Diadema*, Lam.), which is itself parasitically attached to a portion of the skin of a whale.

In the dissected *Otion* a black bristle is inserted at the mouth, which is provided with three pairs of laterally disposed jaws; the stomach, which is a dilated cavity, is laid open; the intestine is continued to the bottom of the cartilaginous envelope, where it winds round to the dorsal aspect of the animal, along which aspect it passes to the base of the posterior tube, where its termination is indicated by a white bristle.

In the *Coronula*, which has also been dissected, the commencement and termination of the alimentary canal are similarly indicated; the stomach is laid open, and portions of bristle mark the course of the intestinal canal.

In this preparation may also be observed an interesting change which has taken place in the portion of whale's skin beneath the parasite: the cuticular papillæ have been resolved into long white filamentary processes, resembling thick-set bristles, of which processes agglutinated together the dense and smooth cuticular covering of the whale appears to be composed.

2. *Intestines of Mollusca.*

614. A pedunculated Ascidian (*Boltenia reniformis*, MacLeay) dissected, to show its alimentary canal. The coriaceous envelope or shell on the right side, and the corresponding portions of the muscular mantle and branchial sac have been removed, but the two orifices of the shell branchial and anal, have been left entire. Into the former of these orifices a black bristle has been inserted, which after traversing the branchial sac enters by its opposite extremity the mouth, or commencement of the alimentary canal. The pharynx after a course of half an inch dilates into the stomach, to the sides of which the lobes of the granulated liver are attached; from the stomach the intestine is continued to the part of the body opposite the attachment of the pedicle, where it suddenly returns upon itself, and terminates in an anus with a scolloped margin directed towards the anal aperture. A white bristle denotes the passage of the excrement.

In this preparation the right ovary, which was lodged in the loop of intestine, has been removed; the left ovary may be seen attached to the mantle on the opposite side. Two of the fringed tentacula which guard the entrance to the branchial sac are preserved, and the plicated disposition and reticulate structure of the respiratory organ may be seen; but as every particle of food must necessarily traverse this branchial sac before it reaches the mouth, it may also be regarded as forming a part of the alimentary canal.

614 a. A portion of a sessile Ascidian (*Cynthia tuberculata*, nobis), showing the alimentary canal; the whole of the outer envelope and the branchial sac

being removed. A black bristle is passed through the pharynx into the stomach, which is laid open; the intestine returns upon itself, forming a loop, which embraces the liver and right ovary; it is then directed towards the anal aperture of the mantle, at the base of which it terminates. Many glandular or fatty appendages may be observed upon the outer tunic of the intestine.

The left ovary, adhering to the muscular tunic or mantle, is turned aside from the other viscera. *Prepared by Mr. Owen.*

615. A sessile Ascidian (*Phallusia nigra,* SAVIGNY); with the right side of the cartilaginous outer envelope, the corresponding parts of the muscular mantle, and the greater part of the branchial sac removed, to show the alimentary canal. A small white bristle is passed into the commencement of the branchial sac through the branchial aperture of the outer envelope and mantle; a black bristle is inserted into the pharynx; and a larger white bristle extends from the rectum through the anal apertures of the mantle and outer envelope; the sigmoid course of the intestine may be distinctly traced. The granular body in the hollow of the first curve is the ovary.

616. A group of sessile Ascidians (*Ascidia intestinalis,* LINN.) attached to a portion of bivalve shell. In the larger specimen the membranaceous envelope has been removed on the left side, together with the corresponding portions of the muscular mantle and branchial sac, to show the course of the intestine. A black bristle is passed into the latter through the branchial aperture: and a brown bristle is continued from the anus through the corresponding apertures in the muscular tunic and outer envelope.

It is necessary to observe, that both in this and the preceding preparation the mantle is unnaturally separated from its points of attachment to the outer envelope, viz. the margins of the two apertures above mentioned.

617. The animal or soft parts of a Solen or Razor-shell (*Solen siliqua,* LINN.), prepared, to show the alimentary canal. The lobes of the mantle are separated and are divided where they inclosed the gills, as far as the anal and

respiratory tubes. A short bristle is inserted at the mouth, which is anterior to the base of the foot; the two labial tentacles and the gills of the left side are preserved, those of the opposite side are removed ; and a part of the foot is dissected away, to show the stomach, the liver, and the convolutions of the intestinal canal, which, having penetrated a little way into the foot, returns and passes straight down behind the posterior adductor muscle, projecting freely towards the anal tube of the mantle. A long bristle is inserted at the anus, and thicker bristles into the anal and branchial tubes.

618. The soft parts of a large species of Cockle (*Cardium echinatum?* Linn.).
It has been prepared in the same manner as the preceding specimen, to show the convolutions of the alimentary canal, which penetrates further into the substance of the foot than it does in the Solen. The branchial tube is laid open; but the anal tube is left entire, and the valve is preserved which intervenes between the anus and the branchial canal.

619. The soft parts of a smaller specimen of the same species of Cockle, with bristles inserted at the oral and anal apertures.

620. A longitudinal section of the soft parts of a Clam (*Tridacna Gigas,* Lam.). The windings of the alimentary canal through the substance of the liver and ovary are indicated by a fine bristle. In the cavity of the stomach may be observed the large apertures by which the bile enters.

621. The corresponding section of the preceding specimen, similarly prepared. A thick bristle is inserted at the anal tube of the mantle.

622. The soft parts of a fresh-water Muscle (*Anodon cygneus,* Sowerby). The mantle has been removed, together with the gills and labial tentacles of the right side, and a portion of the foot dissected away, to expose the alimentary canal, the course of which is indicated by bristles. The stomach has been laid open, to show the vascularity of its inner surface, the parts being minutely injected.

623. The soft parts of a Scallop (*Pecten maximus,* Linn.), from which the left lobe of the mantle and the corresponding gills and labial tentacles have

been removed, to show the alimentary canal. The stomach is laid open, exposing the apertures by which the bile enters; the intestine is then traced through the projecting mass of ova to the apex of that part, where it suddenly returns upon itself; then winding round the great adductor muscle, it terminates opposite the posterior extremities of the branchiæ. A bristle is inserted at the anus.

624. A Chiton (*Chiton squamosus*, LAM.), with the foot or ventral parietes of the body removed, to expose the stomach and the convolutions of the alimentary canal. Bristles are inserted at the mouth and anus.

625. An Aplysia (*Aplysia alba*, CUV.), in which the mantle has been laid open on the left side, and the peritoneal membrane dissected away, to show the intestinal canal winding among the lobes of the liver: the tunics of the intestine being thin and transparent, permit the contents of the canal to be distinctly seen; these consist of particles of sand with comminuted fragments of zoophytes and shells. Bristles are inserted at the mouth and anus: the latter orifice is situated in the branchial cavity, below the gills.

626. The intestinal canal of a larger species of Aplysia, distended with similar particles of earthy matter.

This preparation affords a striking example of the powers of living organized matter, and cannot be contemplated without surprise, when we consider the force that must be exerted to propel a column of such heavy and rude materials along a tortuous canal provided with parietes apparently so inadequate to sustain the necessary pressure.

626 A. A portion of the intestinal canal of the Pearly Nautilus (*Naut. Pompilius*, LINN.). The parietes are more muscular than in the Aplysia; the fold of the intestine is connected by a process of peritoneum analogous to a mesentery, in which the artery is shown, injected with mercury.

Prepared by Mr. Owen.

627. The alimentary canal of the Cuttle-fish (*Sepia officinalis*, LINN.). The œsophagus is by far the longest portion, and is continued into the stomach without undergoing, as in the Nautilus and Octopus, any previous dila-

tation. The stomach is less muscular, and the laminated spiral cavity is shorter than in the latter genus or in the Calamary. The intestine, after forming a slight fold, is continued forwards towards the base of the funnel, and there terminates. A portion of the excretory tube of the ink-bag is preserved in this preparation; it runs parallel with the intestine, and terminates near the anus: a bristle is passed through it.

3. *Intestines of Fishes.*

628. The viscera of the Electric Eel (*Gymnotus electricus*, Linn.) prepared, to show principally the disposition and termination of the intestinal canal. The duodenum commences about the middle of the stomach, on the right side, but is concealed in the preparation by the numerous cæcal appendages which communicate with it: the rest of the intestinal canal first descends to the lower end of the stomach; then passing to the left side ascends as high as the œsophagus, and winds backwards and downwards so as to encircle the stomach; lastly, advancing forwards, it again ascends on the ventral aspect of the abdomen as in the cephalopods, and terminates anterior to the heart. A thick black bristle is inserted into the rectum, and a small white one into the elongated urinary bladder.

628 A. A Flying-fish (*Exocœtus volitans*, Linn.), with the ventral parietes of the abdomen removed, to show the intestinal canal. This is unprovided with cæcal appendages, and passes straight to the anus, which is situated about the middle of the body; affording an example of the simplest form of intestine known in this class of animals. The rectum is laid open, showing the valve which separates it from the rest of the alimentary canal. *Prepared by Mr. Owen.*

629. The alimentary canal of a Mullet (*Mugil Capito*, Cuv.). The stomach is laid open, showing its complex structure as described at No. 502. The intestine, after communicating at its commencement with the cæcal appendages, is convoluted in a peculiarly regular and concentric manner, forming a mass of a triangular form, adapted to the shape of the abdo-

minal cavity, and affording an example of proportionately the longest, and, in its disposition, the most complex intestinal canal of any of the class.

630. A portion of the intestine of the Zebra-eel (*Muræna Zebra,* Shaw), showing the structure of the inner surface. The lining membrane is produced into folds intercepting irregular oblong spaces, which are again decussated by smaller folds.

631. A portion of the intestine of a Wolf-fish (*Anarrhicas Lupus,* Linn.). The lining membrane is here produced into puckered folds obliquely disposed, which are decussated by smaller irregular folds.

632. The Father-lasher (*Cottus Scorpio,* Linn.), with part of the abdomen laid open, to show the rectum, and the valve which separates it from the rest of the intestinal canal. A portion of quill is passed through the valvular part.

633. A portion of the intestine, injected, of a Cod (*Gadus Morrhua,* Linn.), showing its smooth internal surface, and the valve at the commencement of the rectum.

634. A similar portion of the intestine of a Turbot (*Rhombus maximus,* Cuv.), in which the rectum is much dilated, and is separated by a considerable valve from the small intestine. The lining membrane in the latter part of the intestinal canal is produced into small wavy folds obliquely disposed: in the rectum it forms large puckered scale-like processes.

635. A similar portion of the intestinal canal of the Salmon. The rugæ of the small intestine are numerous, corrugated, and obliquely disposed; but become fewer, larger, and less oblique as they approach the rectum: this intestine commences with a large transverse fold or valve, which is succeeded by several others that are less produced, giving to the intestine an appearance analogous to that which is shown in the subsequent preparations from the Cartilaginous Fishes.

636. A transverse section of the intestinal canal of a Sturgeon (*Acipenser Sturio,* Linn.). This section has been taken from the intestine near its commencement, and shows the great thickness of the muscular and internal

tunics of the canal, and the complicated glandular structure of the latter.

637. A similar section, in which the peritoneal coat has been removed from one side to show the partial distribution of the longitudinal fibres, and the great preponderance of the circular stratum.

638. A transverse section of the intestine of a Sturgeon, laid open, to show the character of the inner surface, which is reticulate or honey-combed; the larger meshes including irregular spaces, which are again subdivided into smaller cells.

639. A similar section, from which the peritoneal coat has been removed, to show the disposition of the muscular coat; a part of which has also been removed, to show the thickness of the reticulate and glandular coat.

640. A longitudinal section of the same intestine from a lower part of the canal, where the meshes of the mucous lining, and the spaces they intercept, become smaller.

641. A portion of the same intestine, showing the commencement of the spiral valve.

642. A transverse section of the same intestine, showing the extent to which the spiral valve projects into the canal.

643. A larger portion of the same intestine, from which a portion of the parietes has been removed in the course of the valve, showing the distance of its turns, and the smoothness of the mucous membrane covering the columella of the spire.

This and the preceding preparations from the Sturgeon have been injected with size and vermillion.

644. The last portion of the intestinal canal of a Sturgeon: it has been laid open longitudinally, to show the termination of the spiral valve, and the smooth inner surface of the intestine beyond it, or rectum. A bristle indicates the spiral course which the alimentary substances must take in the valvular part of the gut; and a quill is inserted at the passage of the ureters into the cloaca.

645. The pyloric end of the stomach and a portion of the intestine of a Ray (*Raia Batis*, LINN.), showing the commencement of the spiral valve, which is of considerable breadth, corresponding to the width of the alimentary canal, but with the turns distant from each other: the mucous membrane which constitutes the valve is coarsely villous.

646. A portion of the same intestine, showing the termination of the spiral valve, in which the mucous membrane may be observed to become gradually less villous as it approaches the rectum, where it becomes quite smooth. A bristle is inserted into the duct of the anal bag.

Both these preparations have been injected with size and vermilion, showing the arteries ramifying beautifully upon the valve.

647. A portion of the intestinal canal of a Dog-fish (*Spinax Acanthias*, CUV.). It has been inverted, to show the spiral valve, and the delicate reticulation of the mucous membrane.

648. A portion of the intestinal spiral valve of the same species of Dog-fish, to show the puckering of the valve at its free margin, which contains an elastic substance for the purpose of retaining the valve on the stretch, and restoring it to its original position when it may have yielded to the pressure of the alimentary substances.

649. A similar preparation, in which the elastic margin of the valve has been forcibly stretched.

Both preparations have been minutely injected, to show the vascularity of the mucous membrane.

650. A small portion of the intestinal spiral valve, injected, of the Monk-fish, (*Squatina Angelus*, DUMERIL), showing the puckering of the free margin on the elastic ligament which forms the columella of the spire. The mucous membrane in this species is smooth.

651. The pyloric end of the stomach, and a portion of the intestine, including the commencement of the spiral valve, of a large Shark (*Galeus communis*, CUV.). A thick bristle is passed through the pylorus, and a smaller one through the biliary duct which opens into the short tract of intestine which intervenes between the pylorus and the commence-

ment of the valve. The intestine has been laid open by a longitudinal section, showing the close turns of the spire.

652. A single turn of the spiral valve from the same intestine, showing how completely it opposes any direct passage of the food, from the extent to which it is produced into the cavity of the intestine. The mucous membrane on both sides of the valve is coarsely villous.

652 A. A longitudinal section of the intestine of a Shark (*Carcharias Vulpes*, Cuv.), showing the full extent of the spiral valve. The duodenum suddenly dilates, and terminates at a distance of two inches from the pylorus in the valvular part of the intestine; the rectum is as short as the duodenum, and the entire canal is scarcely a foot in length; whilst the animal from which it was taken measured longitudinally upwards of six feet.

The disproportionate shortness of the intestine is compensated by the valve in the interior, which retards the passage of the food, and affords the adequate extent of surface for chylification and absorption. The number of turns of the valve in this preparation is thirty-four; after the twenty-fourth the valve becomes gradually less produced until it terminates. The mucous membrane is minutely honeycombed. The coats of the intestine on one side of this section appear to be thickened by a layer of fine spongy, and probably glandular substance, lying immediately beneath the peritoneal coat. *Prepared by Mr. Clift.*

652 B. A portion of the intestine of the Basking Shark (*Selache maxima*, Cuv.), showing the termination of the spiral valve, which gradually diminishes in extent as it makes the last three or four gyrations. The free margin of the valve may be observed to be drawn into festoons, by the elastic substance interposed at that part between the layers of the mucous membrane. On the opposite side of the preparation may be observed the great thickness of that membrane. *Prepared by Mr. Clift.*

4. *Intestines of Reptiles.*

653. A specimen of *Cecilia lumbricoides*, Daudin, with the ventral parietes of the abdomen removed, to show the intestinal canal. This is continued in a

slightly convoluted manner to near the extremity of the body; the last portion of it contains a quantity of earthy matter.

654. The viscera of the Kattewagoe, or Hellbender of the United States (*Menopoma gigantea,* HARLAN), showing the outward form and disposition of the alimentary canal. The small intestine passes to the right side, and is variously convoluted before terminating in the great intestine: this commences by a sudden dilatation, and continues of the same diameter, but without forming a cæcum, straight to the anus.

655. A Lizard (*Lacerta agilis,* LINN.), with the anterior parietes of the abdomen removed, to show the intestinal canal. The stomach, which is of an elongated form and very muscular, occupies the left side of the abdomen:—a bristle is placed between it and the spleen. The intestine, which is very wide at the beginning, passes to the right side, where it performs a few convolutions, and gradually diminishes in diameter, till it terminates in the commencement of a dilated colon. This intestine is slightly bent upon itself before it reaches the anus. The mesentery in this tribe of animals may be observed to be very simple; the intestine carries it forward immediately beyond the pylorus, and runs along its right edge till it becomes colon or rectum.

656. A portion of the intestine of the Sharp-nosed Crocodile (*Crocodilus acutus,* CUV.). This has been taken from near the commencement of the intestinal canal, and shows the delicate reticulation of the lining membrane, and the zigzag disposition of the principal rugæ. The arteries have been filled with fine red injection.

657. A portion of the same intestine, taken from a lower part of the canal, where the zigzag rugæ become more strongly marked. The veins have been filled with fine yellow injection.

658. A portion of the same intestine, from a contracted part of the canal, inverted, to show a similar disposition of the rugæ.

659. The pyloric end of the stomach, and beginning of the duodenum, of the East Indian Tortoise (*Testudo Indica,* VASMAER). The parts have been

injected and inverted, to show the vascularity of the inner membrane and its reticular disposition in the intestine.

660. A portion of the intestine of a Tortoise (*Testudo* ——, Linn.), in which the lining membrane is disposed in small and numerous longitudinal rugæ.

661. A portion of the intestine of another species of Tortoise, in which the rugæ are also longitudinally disposed, but are fewer and smaller.

662. A portion of the duodenum of the Hawk's-bill Turtle (*Chelonia imbricata*, Brongn.), showing the reticulation of the inner membrane of that intestine, and the wavy or slightly zigzag disposition of the principal rugæ.

663. A portion of the great intestine or colon of the same animal, inverted, to show the principal rugæ, now become more produced, and having a longitudinal disposition.

664. A similar specimen, from a lower part of the canal, where the longitudinal rugæ have become smaller.

665. A small portion of the intestine of the Green Turtle (*Chelonia Mydas*, Brongn.), in which the inner membrane has been successfully injected, and the zigzag disposition of the rugæ is well marked.

666. A transverse section of the intestine of a Turtle in a state of contraction, during which the canal becomes almost obliterated.

667. A similar section of the same intestine, laid open, to show the appearance of the internal membrane in this state; the peritoneum and a portion of the thin outer layer of muscular fibres have been removed.

668. A longitudinal section of the same intestine, in which a small portion of the outer longitudinal layer of muscular fibres has been removed, to show the great thickness of the internal circular stratum.

669. A portion of the small and great intestine, injected, of a Frog (*Rana temporaria*, Linn.), showing the peculiar reflected course of the former, and its oblique termination in the latter, which is suddenly dilated.

670. The large intestine of a Crocodile (*Crocodilus acutus*, Cuv.). From the oblique manner in which the ileum enters the colon, a projection of the latter intestine is seen, like a rudimentary cæcum, on one side of the ileo-

colic valve. The relative thickness of the two layers of the muscular tunic are very distinctly shown in the two portions of the intestinal canal, and the circular fibres are plainly seen to enter into the composition of the ileo-colic valve; they are also observed to become largely developed around the valvular termination of the rectum in the genito-urinal cavity. The lining membrane of the ileum is thrown into longitudinal folds; in the large intestine it is minutely reticulate, and thrown into irregular rugæ.

671. A portion of the intestinal canal of the common Tortoise (*Testudo græca*, Linn.), showing a small cæcum at the commencement of the great intestine; the latter has been laid open, so that the form of the orifice by which the ileum communicates with it may be seen. The margins of this orifice are puckered up into folds, two of which are continued into the colon, leaving between them a canal or groove, which runs for a short distance along the curve of the colon.

671 a. The corresponding portion of the intestinal canal of a Serpent (*Python Tigris*, Daudin), showing the elongated pointed cæcum, the orifice by which the cæcum communicates with the ileum, and the plaited valvular production at the lower part of that orifice. *Prepared by Mr. Owen.*

671 b. The corresponding portion of the intestinal canal of the Iguana (*Iguana tuberculata*, Cuv.), showing the form and singular structure of the cæcum. The ileum terminates in a slit-like aperture, situated at the extremity of a ridge which projects for some distance into the cæcum, into which a bristle has been passed from the small intestine. The cæcum is continued downwards for some way, and terminates in a spiral passage, which rapidly diminishes in diameter, and opens into the colon by a rounded puckered orifice, at the extremity of a conical valvular prominence. Below this prominence are seen some valvular folds of the mucous membrane, projecting considerably into the colon from its concave side, and appearing like a series of shelves, decreasing in breadth as they descend. The coats of the intestine may be observed to make smaller indentations from the convex side of the intestine, opposite the

intervals of the larger septa, and would, if further produced, occasion an alternate series of incomplete valvulæ conniventes, similar to those presented in the great intestine of the Ostrich at No. 689, &c. Below these valves the colon diminishes in diameter, and makes a sudden turn upon itself before becoming rectum.

The cæcum is here seen to be not a mere *caput coli,* but to form a distinct element of the alimentary canal; having two orifices, one for the ingress, the other for the outlet of the alimentary matters, analogous to the cardia and pylorus of the stomach, and having its parietes distinctly more muscular than either of the intestines with which it communicates. *Prepared by Mr. Owen.*

5. *Intestines of Birds.*

672. A portion of the small intestine, minutely injected, of a Duck (*Anas Boschas,* LINN.), showing the small flattened diagonally-arranged villi.

673. A portion of the duodenum of a Goose (*Anser palustris,* BRISSON), similarly prepared, and showing the delicate elongated and irregularly arranged villi.

674. A portion of the small intestine of a Swan (*Cygnus Olor,* BRISSON), similarly prepared, and showing coarser laminated villi.

675. A portion of the intestine, injected and inverted, of a Pelican (*Pelecanus Onocrotalus,* LINN.), showing the minute filiform villi, like fine down.

676. A smaller portion of intestine, uninjected, of a Pelican, showing the inner surface, covered with similarly delicate, but more elongated villi.

677. A portion of the small intestine, injected and inverted, of an Ostrich? exhibiting the inner surface beset with elongated, but coarser villi than in the Pelican.

678. A portion of the small intestine of an Ostrich (*Struthio Camelus,* LINN.), similarly prepared, and showing the villi of a flattened angular form, and arranged in regular transverse lines.

679. A similar preparation, beautifully injected, to show the vascularity of the villous membrane.

680. A portion of the small intestine of an Ostrich, laid open, and showing the villous membrane brilliantly injected.

681. A similar portion of intestine, with the veins as well as arteries injected, the former being filled with yellow injection.

682. A portion of the small intestine, inverted, of an Ostrich, in which the veins (chiefly of the villi) are injected.

683. A portion of the same intestine similarly prepared, but suspended so as to show the relative thickness of the intestinal tunics.

684. A portion of the small intestine of an Ostrich, similarly injected, and showing two processes of peritoneum going off at right angles to the mesenteric process, from the sides of the intestine, and trunks of the great vessels. A portion of the peritoneal coat has been removed from one end of this preparation, to show the external longitudinal and internal circular layers of the muscular tunic.

684 A. A portion of the intestinal canal of a Spoonbill (*Platalea leucorodia*, Linn.), showing the slight separation of the small from the large intestine. Two small lateral swellings at the commencement of the rectum alone indicate the cæcums usually found in birds.

Prepared by Mr. Owen.

684 B. The corresponding portion of the intestine of a Bittern (*Ardea stellaris*, Linn.), showing a single small cæcum, at the commencement of the large intestine. The lining membrane of the ileum is very minutely reticulate; in the rectum it is quite smooth. *Prepared by Mr. Owen.*

685. The corresponding portion of the intestine of a Sparrow (*Fringilla domestica*, Linn.), showing the two very small cæcums opening into a wide rectum, which is not separated from the ileum by any valvular apparatus.

686. The corresponding portion of the intestinal canal, injected, of the Herring-gull (*Larus argentatus*, Temm.), showing the two small but wide cæcums. The glandular bag, called *Bursa Fabricii*, may be observed attached to the cloaca both in this and the preceding specimen.

686 A. The corresponding portion of the intestinal canal of a Flamingo (*Phœni-*

copterus ruber, LINN.), showing the two moderately sized cæcums. The ileum and rectum are laid open to show the character of their lining membrane and the orifices of the cæcums. In the ileum the villi are arranged in a zigzag form; in the rectum they are coarser, and less regular in their arrangement. A portion of porcupine's quill is inserted into one of the cæcums, which has been laid open, showing its inner surface to be without villi, excepting in the narrow neck near its communication with the large intestine. *Prepared by Mr. Owen.*

687. One of the cæcums of the Guan (*Penelope cristata*, MERREM,) laid open. The inner surface is smooth in the dilated portion, honeycombed and glandular in the vermiform extremity, and longitudinally plicated in the narrow neck which communicates with the rectum.

688. The opposite cæcum of the same bird, in which the glandular extremity is preserved entire, and the degree of vascularity of the whole inner membrane of the cæcum is more clearly shown than in the preceding specimen.

688 A. A portion of the intestinal canal with the vermiform cæcums of the Red-knobbed Curassow (*Crax Yarrellii*, BENNETT). The ileum and rectum are laid open to show the minute flattened triangular villi, scattered over their inner surface. One of the cæcums is also laid open, showing its smooth internal surface: they both communicate by very small orifices with the intestine. *Prepared by Mr. Owen.*

688 B. The corresponding portion of the intestinal canal of the Pea-hen (*Numida Meleagris*, LINN.), showing the great length and capacity of the cæcums in this bird. *Prepared by Mr. Clift.*

689. A portion of the rectum, injected and inverted, of an Ostrich, showing the peculiar disposition of its lining membrane, which is thrown into alternate transverse semilunar folds, which severally extend into the cavity of the intestine from about two thirds of its internal circumference. A strong band of longitudinal fibres extends along one side of the gut, throwing it into sacculated convolutions.

690. A longitudinal section of the same intestine, in which moieties of each series of valves are shown alternating with each other.

691. A similar section suspended transversely, showing the same circumstance. A substance similar to exuded lymph is seen adhering to parts of the valves.

692. A transverse section of the same intestine, in which the valves of one series are preserved entire, and the extremities of the opposite series are shown.

6. *Intestines of Mammalia.*

693. A transverse section of the small intestine, injected, of a Lion (*Felis Leo*, Linn.). It shows the width of the canal, and the relative thickness of the different tunics.

694. A similar section, from a lower part of the intestinal canal, showing the longitudinal rugæ into which the lining membrane is thrown by the contraction o fthe circular fibres of the muscular coat.

695. A longitudinal section of the small intestine of a Lion, showing the fine and close-set villi of the lining membrane.

696. A similar section, showing, in addition to the villi, a longitudinal band of glandulæ aggregatæ.

The four preceding preparations are from the same Lion; they have been minutely injected, and show the simple disposition and limited extent of the intestinal mucous membrane in this carnivorous animal.

697. A portion of the small intestine, injected, of a Seal (*Phoca vitulina*, Linn.), showing the simple disposition of the mucous membrane, and the villi shorter and less numerous than in the Lion.

698. A longitudinal section of the small intestine, injected, of a Bear (*Ursus Arctos*, Linn.), in which the mucous membrane, as in the Lion, is not produced into valvulæ conniventes, but the villi are longer and coarser, and of a flattened instead of a cylindrical form.

699. A similar preparation.

700. A similar section, from a lower part of the intestinal canal of the same Bear, showing that the villi have here disappeared, and that the mucous

coat is raised into slight transverse rugæ: some small patches of glands may also be noticed in this part of the intestine.

701. A portion of the small intestine of a Dog (*Canis familiaris*, Linn.), in which the villi are long and very fine, giving to the interior of the intestine a woolly appearance. Small patches of glandulæ aggregatæ may be observed.

701 a. A portion of the small intestine of the Cape Hyrax (*Hyrax capensis*, Schreber), in which the villi are much shorter and fewer than in the preceding species. *Prepared by Mr. Owen.*

702. A portion of the small intestine of an Elephant (*Elephas Indicus*, Cuv.). The lining membrane is irregularly rugous; the villi are so minute as to be only perceptible by the aid of a lens.

703. A similar but larger portion of intestine, from the same animal.

704. A portion of intestine from a Porpesse (*Phocæna communis*, Cuv.), showing the internal coat produced into large longitudinal folds, and smooth, or without villi perceptible to the naked eye.

705. A similar portion of the intestine of a Dolphin (*Delphinus Tursio*, Fabr.), showing a similar production of the lining membrane into large longitudinal folds.

706. A small portion of the duodenum, inverted, of the Piked Whale (*Balæna Boops*, Linn.), showing the lining membrane produced into longitudinal wavy folds, which run into each other, and are connected by smaller lateral folds. These rugæ, or valvulæ conniventes, have the villi too minute to be perceptible with the naked eye. The sub-mucous cellular substance may be observed to be very loose and abundant.

707. A portion of the jejunum, injected, of the same Whale, showing the longitudinal rugæ now become more wavy, whilst the transverse folds passing off from them are more prominent.

708. A similar preparation, in which the disposition and relative thickness of the strata of the muscular coat are shown.

709. A transverse section of the intestine of the Bottle-nose Whale (*Delphinus*

Dalei, Cuv.), showing the width of the canal, the relative thickness of its coats, and especially the sacculated structure of the internal tunic.

710. A similar preparation.

711. A longitudinal section of the intestine of the same Whale, showing the orifices of the sacculi directed downwards, allowing a free passage to the alimentary substances in that direction, but opposing a retrograde course.

712. A similar section of the same intestine, in which the sacculi of the mucous membrane are seen opened, as they may be supposed to be when the contents of the canal are pressed in a direction contrary to their own: in this state the subdivision of the larger sacculi into smaller ones may be distinctly seen, presenting a structure analogous to that of the intestine of the Sturgeon, as in Nos. 638, 639, &c.

The following are Mr. Hunter's observations on the structures displayed in the preceding preparations from the Whale tribe:—

"The structure of the inner surface of the intestine is in some very singular, and different from that of the others.

"The inner surface of the duodenum in the Piked Whale is thrown into longitudinal rugæ, or valves, which are at some distance from each other, and these receive lateral folds. The duodenum in the Bottle-nose swells out into a large cavity, and might almost be reckoned an eighth stomach; but as the gall-ducts enter it, I shall call it duodenum.

"The inner coat of the jejunum and ileum, (in the Piked Whale,) appears in irregular folds, which may vary according as the muscular coat of the intestine acts: yet I do not believe that their form depends entirely on that circumstance, as they run longitudinally, and take a serpentine course when the gut is shortened by the contraction of the longitudinal muscular fibres. The intestinal canal of the Porpoise has several longitudinal folds of the inner coat passing along it, through the whole of its length. In the Bottle-nose, the inner coat, through nearly the whole track of the intestine, is thrown into large cells, and these again subdivided into smaller; the axis of which cells is not perpendicular to a transverse section of the intestine, but oblique, forming pouches with the mouths downwards, and acting almost like valves, when any thing is attempted to be passed in a contrary direction: they begin faintly in the duodenum, before it makes its quick turn, and terminate near the anus. The colon and rectum have the rugæ very flat, which seems to depend entirely on the contraction of the gut.

"The rectum near the anus appears, for four or five inches, much contracted, is glandular, covered by a soft cuticle, and the anus small*.

"I never found any air in the intestines of this tribe; nor indeed in any of the aquatic animals.

"The mesenteric artery anastomoses by large branches . . . . .

"Although this tribe cannot be said to ruminate, yet in the number of stomachs they come nearest to that order; but here I suspect that the order of digestion is in some degree inverted. In both the ruminants, and this tribe, I think it must be allowed that the first stomach is a reservoir. In the ruminants the precise use of the second and third stomachs is perhaps not known; but digestion is certainly carried on in the fourth; while in this tribe, I imagine, digestion is performed in the second, and the use of the third and fourth is not exactly ascertained.

"The cæcum and colon do not assist in pointing out the nature of the food and mode of digestion in this tribe. The Porpoise which has teeth, and four cavities to the stomach, has no cæcum, similar to some land animals, as the Bear, Badger, Racoon, Ferret, Polecat, &c.; neither has the Bottle-nose a cæcum which has only two small teeth in the lower jaw; and the Piked Whale, which has no teeth, has a cæcum, almost exactly like the Lion, which has teeth and a very different kind of stomach.

"The food of the whole of this tribe, I believe, is fish; probably each may have a particular kind, of which it is fondest, yet does not refuse a variety. In the stomach of the large Bottle-nose, I found the beaks of some hundreds of Cuttlefish. In the Grampus I found the tail of a Porpoise; so that they eat their own genus. In the stomach of the Piked Whale, I found the bones of different fish, but particularly those of the Dog-fish. From the size of the œsophagus we may conclude, that they do not swallow fish so large in proportion to their size as many fish do,

* See Nos. 740 to 744.

that we have reason to believe take their food in the same way; for fish often attempt to swallow what is larger than their stomachs can at one time contain, and part remains in the œsophagus till the rest is digested."

J. Hunter, On the Structure and Œconomy of Whales, Philos. Trans. lxxvii. 1787, p. 409.

713. A portion of Human intestine, taken from the commencement of the jejunum, and laid open to show the transverse folds of the mucous membrane, or valvulæ conniventes.

714. A similar portion of Human intestine, from a lower part of the jejunum, where the coats of the intestine are thinner, and the valvulæ conniventes smaller.

715. Portions of Human intestine, one from the jejunum, showing the valvulæ conniventes, and the other two from the ileum, where these productions of the lining membrane degenerate into irregular transverse rugæ. The two pieces of ileum were taken, one from a contracted, the other from a dilated part of the canal, and show the difference in the appearance of the lining membrane dependent on these two conditions. Compared with the jejunum, they show how the extent of the surface on which the operations of chylification and absorption take place, is diminished in its extent as the intestine recedes from the stomach. Some patches of the glandulæ aggregatæ may be observed on the portions of ileum.

716. A portion of Human jejunum, inverted, of which the lower moiety has been minutely and brilliantly injected, showing the great vascularity of the mucous coat, and, more clearly than in the preceding preparations, the form of the minute and delicate villi with which its inner surface is covered.

717. A portion of Human jejunum, which has been minutely injected and dissected, to show the outer longitudinal and the inner circular layers of the muscular tunic, and also the transverse folds and villi of the mucous coat; the valvulæ conniventes, it may be observed, rarely project inwards to the same extent from the whole circumference of the gut, but pass obliquely into, or alternate with, each other.

The six following preparations have been finely injected, dried, and preserved in oil of turpentine, to show the vascularity of human intestine.

718. A portion of small intestine, in which both arteries and veins appear to be filled with the red injection.

719. A similar preparation.

720. A similar preparation, in which the cavity of the intestine is laid open by the removal of a longitudinal strip from the parietes opposite the attachment of the mesentery.

721. A similar preparation, but with the part of the parietes to which the mesentery was attached removed, so that the anastomoses of the minute branches on the opposite side may be seen.

722. A similar preparation laid open longitudinally, so that the minute capillaries may be seen by transmitted light.

723. A portion of ileum with the arteries only injected, showing the decreasing vascularity of the intestine as it descends. In this preparation is beautifully shown the wavy disposition of the lateral branches given off in a direction corresponding to the longitudinal axis of the intestine; a disposition by which they are enabled to accommodate themselves to the ever-varying length of the part on which they are ramified.

723 A. A portion of the ileum of a young Orang Utan (*Simia Satyrus*, Linn.). It has been injected, and twisted spirally round the mesentery while drying, and afterwards put into oil of turpentine.

Presented by Sir Everard Home, Bart.

723 B. Part of the small intestines of a Wapiti Fawn (*Cervus canadensis*, Brisson), injected, dried, and put into oil of turpentine. It shows the limited extent of the convolutions of the intestine arising from the shortness of the mesentery, and the mesenteric artery forming in consequence only a single series of arches. *Prepared by Mr. Clift.*

723 C. A portion of the colon of an Aguti (*Dasyprocta Aguti*, Illig.), with the arteries injected with quicksilver, dried, and preserved in oil of turpentine.

This was prepared to show the peculiar course of the arteries, which are extended parallel to each other along the gut, without dividing or ramifying, but connected at distant intervals by vessels running at right angles to them.

Prepared by Sir Anthony Carlisle, F.R.S. F.L.S., and figured to illustrate his Paper 'On the peculiar Arrangement of the Arteries in slow-moving Animals,' in the 94*th volume of the Philosophical Transactions, pl.* i. *p.* 22.

723 D. The termination of the ileum, and the whole extent of the large intestine of a Suricate (*Ryzæna tetradactyla*, ILLIG.). The latter commences by a small and simple cæcum, and runs straight to the anus, gradually widening as it descends. In the ileum, which is laid open, there may be observed a large oval patch of glandulæ aggregatæ; the apex of the cæcum is occupied by a similar glandular structure. The terminal orifice of the ileum is of a circular form, about two lines in diameter, with a tumid margin, but unprovided with true valvular folds. In no part of the short extent of large intestine are villi apparent to the naked eye.

Prepared by Mr. Owen.

724. The termination of the ileum with the cæcum or caput coli, injected, of a Lion. The cæcum is simple, resembling that of the preceding species, with its apex similarly occupied by a cluster of glands; the terminal orifice of the ileum is also of a circular form, but it is situated on a valvular prominence in the large intestine.

725. A fœtal Puppy (*Canis familiaris*), with the ventral parietes of the abdomen removed, to show the cæcum and course of the great intestine. The cæcum is more elongated in the canine tribe than in either the feline or viverrine tribes; it makes two turns and a half before terminating in the colon, which winds round the root of the mesentery before descending to form the rectum. A white bristle is inserted at the commencement of the jejunum, and a black one into the termination of the ileum.

The great extent of duodenum, downwards, before crossing the spine to form the jejunum, may also be observed in this preparation.

725 A. The termination of the ileum, cæcum, and part of the colon, injected, of a Monkey (*Macacus Cynomolgus*, CUV.). In this species the ileum forms

a valvular protuberance into the cæcum, and its terminal orifice is of a circular form. The commencement of the longitudinal bands which draw the colon into folds may be observed on the exterior of the cæcum, and it may be seen to be separated from the colon by a well marked constriction, analogous to, though not so complete as, that which is shown in the Iguana, No. 671 B. *Prepared by Mr. Owen.*

725 B. The termination of the ileum with the cæcum, appendix vermiformis cæci, and commencement of the colon, injected, of an Orang Utan (*Simia Satyrus*, LINN.). The cæcum is laid open, to show the contracted circular terminal aperture of the ileum, protected only by a tumid margin as in the Carnivora, not by semilunar valves. Above this orifice may be seen the constriction, which, as in the preceding example, separates the cæcum from the colon. The appendix vermiformis is continued from the apex of the cæcum, and is much contorted: it is laid open near its extremity, to show its inner surface, which is smooth and destitute of villi.

Prepared by Mr. Owen.

725 C. The termination of the ileum with the cæcum, appendix vermiformis cæci, and commencement of the colon, injected and inverted, of a Human fœtus. The diameter of the cæcum is very little greater than that of its appendix, which is also at this period a direct continuation of the cæcum, the whole apparatus presenting a close resemblance to the elongated cæcum of the dog. Villi, which are obvious in both great and small intestine, are not distinguishable in the appendix vermiformis, which in this particular resembles the cæcums of birds.

Presented by Sir Everard Home, Bart.

726. The corresponding parts of the intestinal canal of an Adult, showing the cæcum, now greatly enlarged, and projecting beyond the vermiform appendage, which has increased comparatively little beyond its original diameter.

726 A. A similar preparation, injected, dried, and laid open, so as to show the valvular projection of the ileum into the great intestine, and the slit-like form of its terminal aperture; the sides of the projection forming the two semilunar valves. *Presented by Sir W. Blizard, F.R.S.*

726 B. A similar preparation, minutely injected, from a younger subject, showing the valve as it appears when closed by the pressure of the contents of the large intestine. *Presented by W. Lawrence, Esq. F.R.S.*

726 C. The termination of the ileum, with the cæcum and commencement of the colon, of a Vicugna (*Auchenia Vicugna*, Illig.). The cæcum is of a simple elongated form, and serves as a good example of the Ruminant type of this intestine: it is laid open opposite the terminal orifice of the ileum, which is surrounded by a small circular ridge: beyond this orifice, in the colon, may be observed a patch of glands lodged in a semicircular depression. *Prepared by Mr. Owen.*

726 D. A small portion of intestine, showing the ileo-cæcal orifice and contiguous glandular pouch in the Llama (*Auchenia Glama*, Illig.).
Prepared by Mr. Owen.

726 E. The cæcum, with part of the ileum and colon, injected, of a young Kangaroo (*Macropus major*, Shaw). It is of a simple elongated form, as in the Ruminant tribe, but the longitudinal muscular fibres are gradually collected into two narrow bands, which commence about three inches from the end of the cæcum, and are continued on to the colon, drawing it up into sacculi. The parietes of the intestine have been removed opposite the ileo-cæcal orifice, showing it to be of a transverse form.

This cæcum is from the same animal as the stomach No. 553 A.
Prepared by Mr. Owen.

726 F. The cæcum, with part of the ileum and colon, injected, of a Porcupine (*Hystrix cristata*, Linn.). It is of great size, bent upon itself, and drawn up into sacculi by three longitudinal bands, two of which are continued on to the colon. Portions of the parietes have been removed, to show the valvular orifice of the ileum, situated on the margin of the ridge which separates the cæcum from the colon. The disproportionate size of the ileum and colon is worthy of notice, and may be compared with the corresponding disproportion of the cardiac and pyloric orifices of the stomach, No. 544 A., which is from the same animal.

These cæcums also, when compared with their respective stomachs, afford a striking example of the mode in which the simplicity of one reservoir of the alimentary canal in the herbivorous feeders is compensated by a complexity of the other. *Prepared by Mr. Owen.*

726 G. The cæcum and commencement of the colon of the Chinchilla (*Chinchilla lanigera*, BENNETT). The cæcum is drawn into sacculi and puckered up on two longitudinal bands, being dilated alternately from side to side. It is laid open at its commencement, to show two oval patches of glandulæ aggregatæ situated one on either side of the ileo-cæcal orifice. Two black bristles indicate the situation of this orifice and extend to opposite sides of the large intestine. A white bristle passes through the colon.

Prepared by Mr. Owen.

727. The termination of the small, and commencement of the large intestines of the Hare (*Lepus timidus*, LINN.).

The glandular pouch at the termination of the ileum is laid open, showing the thickness of its parietes and the orifices of the numerous follicles which open into it: it communicates by a small rounded aperture with the commencement of the cæcum. The greater part of this intestine has been removed; in the small portion that remains may be observed part of the valvular production of the lining membrane which extends in a spiral form through the whole cæcum, also the cluster of glands which open into its commencement, and the constriction below the ileo-cæcal aperture which divides it from the colon. The colon is dilated at its commencement and sacculated, being puckered up on three longitudinal bands: it is laid open at this part, so that the vascularity of its internal surface, and the short obtuse villi with which it is covered, may be seen. Two of the longitudinal bands become blended together as the colon grows narrower, and at their point of union a part of the parietes of the gut has been removed, showing the regular cells or sacculi now situated on one side only of the intestine, in which the pellet-shaped fæces are formed. After the colon has completed its first large fold and has returned to near its commencement, the longitudinal bands and sacculi disappear, and the intestine is continued of small size and simple structure to the rectum.

728. The termination of the cæcum and vermiform appendage of a Hare, laid open to show the valvular structure of the former and the glandular structure of the latter portion of intestine.

729. A Mouse (*Mus Musculus,* LINN.), with the ventral parietes of the abdomen removed to show the large cæcum and colon; the former is seen hanging out of the abdominal cavity.

729 A. A portion of the intestinal canal of the Weasel-headed Armadillo (*Dasypus mustelinus,* nobis), showing the two small cæcums between which the ileum terminates: one of them is laid open, to show the slit-like form of the terminal aperture of the ileum, which being situated on the projecting ridge, must of course be effectually closed by the lateral pressure of the contents of the cæcums, and with a force proportionate to the distention of those cavities. *Prepared by Mr. Owen.*

729 B. A portion of the intestinal canal of a fœtal Hyrax (*Hyrax capensis,* SCHREB.), showing the three cæcums peculiar to this animal. The superior one, analogous to the ordinary cæcum of quadrupeds, is single, large, and dilated at the extremity; the other two form a pair similar to those of the armadillo and of birds. They are situated considerably lower down the alimentary canal, and may be regarded as marking the commencement of the rectum, as the preceding one does that of the colon; they gradually taper to their extremities, which are glandular and resemble vermiform appendages. *Prepared by Mr. Owen.*

730. A section of the colon, injected, of a Lion. The longitudinal muscular fibres are very strong, and are disposed around the whole circumference of the intestine, which consequently is not drawn up into sacculi. The lining membrane is smooth, and is thrown into zigzag rugæ.

731. A longitudinal section of the Human colon, including one of the three longitudinal bands into which the outer layer of muscular fibres is collected; and showing also the structure of the mucous coat. The internal surface of this coat appears to be smooth on a superficial inspection, especially when contrasted with the corresponding surface of small intestines; but with the aid of a lens it may be observed to be covered with minute depressions.

731 A. A portion of the colon, injected and inverted, of an Orang Utan (*Simia Satyrus*, LINN.). The internal surface of the intestine presents a similar punctulated structure, but is rendered still more irregular by small transverse depressions. *Prepared by Mr. Clift.*

731 B. A transverse section of the colon, injected, of a Chimpanzee (*Simia Troglodytes*, LINN.), showing the sacculi produced by the three longitudinal bands. *Prepared by Mr. Owen.*

731 C. A longitudinal section of the same intestine, showing two of the longitudinal bands, and the appendices epiploicæ, on the external surface: the mucous membrane has a smoother surface than in the preceding species. *Prepared by Mr. Owen.*

732. A transverse section of the colon of a Horse (*Equus Caballus*, LINN.), showing the sacculi formed by two broad longitudinal bands.

733. A longitudinal section of the same intestine, showing externally one of the longitudinal bands, and internally the smooth lining membrane of the colon.

These two preparations are stated in the original MS. Catalogue to be from "a Horse which had a rupture. The longitudinal bands are much thicker and plainer seen than common."

734. The stomach, with the cæcum and colon, of a fœtal Hog. It is prepared chiefly to show the concentric folds of the colon. The cæcum may be observed to be short and simple in form.

735. A portion of the intestinal canal of a small Deer (*Moschus*), showing similar concentric folds of the colon. This disposition is met with in all the Ruminants.

736. A portion of the rectum of a Lioness, showing the strong round fasciculi of longitudinal fibres forming the outer stratum of the muscular coat, part of which has been turned down, to show the inner circular fibres.

737. A longitudinal section of the rectum and anus of an European. The two layers of the muscular tunic have been similarly displayed. The parts, being injected, the vascularity of the lining membrane and its gradual continuation into the common outward integuments are shown. On the

cut surfaces the relative thickness and extent of the two sphincters may be observed.

738. A longitudinal section of the termination of the intestinal canal of a Negro, showing the smooth surface of the mucous membrane of the rectum, and its continuation into the dark-coloured outward integument.

739. A portion of the rectum, injected, of a Porpesse, showing the continuation of the epidermis from the outward integument into the rectum.

740. A longitudinal section of the termination of the intestinal canal of a Dolphin (*Delphinus Tursio*, Fabr.), showing a similar continuation of cuticle for a considerable distance into the rectum.

741. A longitudinal section of the rectum of the same Dolphin, showing the large longitudinal and small transverse rugæ of the lining membrane.

742. A longitudinal section of the commencement of the rectum of the Bottle-nose Whale (*Delphinus Dalei*, Cuv.), showing a similar disposition of its lining membrane. A small portion of the soft cuticle is turned down where the rectum begins. In the preceding part of the intestine numerous orifices of muciparous glands are obvious.

743. A longitudinal section of the rectum and anus of the Piked Whale (*Balæna Boops*, Linn.), showing the zigzag rugæ and cuticular covering of the internal coat, and the orifices of the numerous muciparous glands that are imbedded in it.

7. *Termination of the Intestinal Canal.*

744. The posterior moiety of a Lump-fish (*Cyclopterus Lumpus*, Linn.), in which the dorsal parietes of the abdomen have been removed, to expose the alimentary canal, urinary bladder, and parts of generation.

On the opposite side of the body is seen the manner in which they terminate externally. The anus is a distinct orifice ; the ducts of the urinary bladder and the vasa deferentia terminate in a canal which perforates the conical process situated posterior to the anus. A black bristle is passed through the canal from the urinary bladder.

745. The posterior moiety of the larva of the Jakie (*Rana paradoxa*, Linn.), showing the terminal aperture of the cloaca situated between, and protected by, two broad folds of membrane, which unite and form the lower membranous expansion of the tail fin.

746. The cloaca of an Iguana (*Iguana tuberculata*, Linn.). The rectum is seen opening into the anterior part of this cavity; the ureters into the posterior part. Bristles are inserted into the latter tubes.

747. The rectum and cloaca of a young male Crocodile (*Crocodilus acutus*, Cuv.). The rectum is laid open, to show its oblique and valvular communication with the fundus of the urinary bladder. This cavity is also laid open, showing the insertion of the ureters into its lower part,—black bristles being inserted into their orifices. The urinary bladder (through which the fæces must pass, and which therefore may be regarded as a segment of the intestinal canal,) communicates with the preputial or external division of the cloaca by a narrow chink, the lower part of which is continued into the groove of the clitoris. White bristles are passed through the peritoneal canals, which partly terminate on the extremities of papillæ situated on either side the base of the penis;—a mode of termination evidently calculated to obviate the ingress of water or other fluids into the abdominal cavity.

748. The cloaca, with a portion of the pelvis, of a Swan (*Cygnus Olor*, Briss.). The rectum and cloaca have been laid open on the left side, exposing the termination of the rectum in the rudimentary urinary bladder. The orifices of the ureters are indicated by white bristles, those of the oviducts by black ones: the left oviduct, the only one which in birds becomes fully developed for the performance of the sexual function, is here seen to terminate much nearer the external outlet than the ureters. It may be observed that the last inch of the rectum has a different character of internal surface from the preceding, the lining membrane having lost its villi and assumed the character of cuticle.

749. The cloaca of an Emeu (*Dromaius Novæ Hollandiæ*, Lath.). It has been laid open posteriorly, to show the valvular manner in which the rectum projects into the urinary cavity. Small black bristles are passed

into the ureters, and a larger one into the left oviduct. The rectum is laid open posteriorly, showing its beautiful villous internal membrane.

750. A portion of the rectum and urinary receptacle of an Ostrich, showing the valvular manner in which the gut terminates, as in the Crocodile, at the fundus of the latter cavity.

751. The cloaca of a small male Tortoise. It has been laid open posteriorly, and shows the rectum terminating, not in the urinary bladder, but in the preputial or outer cavity: the aperture of communication is puckered up, and on the cut edges may be observed the sphincter muscle which surrounds it: a little below the fæcal orifice may be seen that of the genito-urinary cavity, which is of a transverse form: the two bristles which project from it have been passed through the ureters, immediately above whose orifices are situated those of the vasa deferentia: the allantoid or urinary bladder opens into the fundus of the genito-urinary cavity. The common outer cavity is seen to be almost wholly occupied with the penis, which is grooved, and terminates in the complex glans commonly found in the Chelonian reptiles.

752. The cloaca of a small female Tortoise. The outer cavity is laid open posteriorly, to show the termination of the rectum at its fundus, and the semilunar fold of membrane which separates the fæcal from the genito-urinary orifice. The outer cavity is also laid open anteriorly, together with the cervix of the allantoid bladder, to show the genito-urinary depression, and the relative positions of the terminal apertures of the ovaries and ureters; the former being indicated by black bristles, the latter, which are situated below them, by white ones. The common terminal outlet is left entire.

753. The cloaca of a female Turtle (*Chelonia Mydas*, Brongn.). The rectum and common outer cavity have been laid open posteriorly, showing the place of their communication; immediately anterior to the fæcal orifice is the genito-urinary orifice, which is of a semilunar form. The allantoid bladder and genito-urinary cavity have been laid open anteriorly, showing their communication with each other; and also

the orifices by which the oviducts and ureters communicate with the genito-urinary cavity ;—black bristles are inserted into the former, and white ones into the latter tubes. The parts being injected, the difference between the vascularity of the lining membrane of the rectum and that of the cloaca is distinctly shown ; the common external outlet is preserved entire, showing its transverse semilunar form.

753 A. The cloaca of an Ornithorhynchus (*Ornith. paradoxus*, Blum.). The rectum is laid open posteriorly, to show its termination at the fundus of the outer or common cavity just behind the orifice of the genito-urinary cavity ; two patches of glands may be observed, one on either side the fæcal orifice. The genito-urinary cavity is laid open anteriorly, showing the orifice of the urinary bladder at its fundus, and those of the ureters and oviducts at its sides. White bristles are placed in the former, black ones in the latter, which may be observed to be nearer the urinary bladder than the orifices of the ureters are. *Prepared by Mr. Owen.*

754. The anus of a Tapir (*Tapirus Americanus*, Linn.). In this, as in ordinary Mammalia, the intestinal canal has a distinct external orifice, situated behind, and not as in the osseous fishes in front of, the genito-urinary outlet. This example of the mammiferous type of anus is preserved on account of the peculiar jagged appearance and abrupt termination of the common integument at the verge of the anus.

755. The anus, with the anal glands, of a Raccoon (*Procyon Lotor*, Storr). Bristles are placed in the excretory orifices of the glands, which open on either side, within the verge of the anus. They are surrounded by a strong capsule of muscular fibres, necessary for the expulsion of the unctuous secretion ; these fibres have been removed from one of the glands.

756. The anus, anal glands, and genito-urinary canal of a Hyena (*Canis Hyæna*, Linn.). In this preparation the separate outlets of the genito-urinary and intestinal canals are shown. The anal glands are of very large size, and open into a common cavity of a semilunar form, situated above or behind the anus. The gland on the left side has been laid open, showing its cavity and lobulated structure.

8. *Intestinal Glands.*

757. A small portion of the ileum of a Lion, showing an oblong depression formed by a group of glandulæ aggregatæ.

758. A similar portion of the ileum of a Dog, showing two circular depressions occupied by glandulæ aggregatæ: the depth of these follicles may be observed on the cut edge of the preparation.

759. A similar portion of Human ileum, showing a large oval patch of glandulæ aggregatæ.

760. A small portion of the ileum of an Elephant (*Elephas Indicus,* Cuv.), showing a circular patch of glandulæ aggregatæ.

760 a. A portion of the ileum of the Cape Hyrax, showing the sacculi of the mucous membrane, in which the glandulæ aggregatæ are lodged.

Prepared by Mr. Owen.

"On laying open the small intestines, they presented a peculiarity I have not met with in any other quadruped, viz., a series of about twelve small pouches, distant from three to five inches from each other, about three lines in diameter, and the same in depth, their orifices pointing *distad,* or towards the cæcum. These pouches make no projection externally, being situated wholly beneath the muscular coat. They consist of duplicatures of the mucous membrane, and are surrounded by the glandulæ aggregatæ, which open into them by numerous orifices. Their use would appear to be to alter, and probably heighten the qualities of the secretion of those glands by retaining it for a while, and preventing it being mixed as soon as formed with the chyme."

Dissection of the Cape Hyrax, Zoological Proceedings, ii. p. 203.

760 b. A portion of the ileum, injected, of the Labiated Bear (*Ursus labiatus,* Blainv.), showing a long narrow patch of glandulæ aggregatæ.

Prepared by Mr. Owen.

760 c. A portion of the ileum of a Dugong (*Halicore Dugong,* Illig.), showing a narrower strip of glandulæ aggregatæ, which runs along the side of the intestine nearest the line of the attachment of the mesentery throughout its whole extent. *Prepared by Mr. Clift.*

761. A portion of the ileum, injected, of a Seal (*Calocephalus vitulinus*, Cuv.), showing a similar but broader strip of glandulæ aggregatæ, which runs along the ileum in the same situation as in the dugong.

762. A portion of the colon, injected and inverted, of the same animal, showing the transverse orifices of the glandulæ solitariæ.

762 A. A portion of Human rectum, injected and inverted, showing the orifices of the muciparous glandulæ solitariæ.

Presented by Sir W. Blizard, F.R.S.

763. A transverse section of the rectum, inverted, of a Wolverine (*Gulo Luscus*, Storr.). The glandulæ solitariæ are very numerous and of a honey-combed structure.

Series IV. Glandular Organs of the Digestive System.

1. *Salivary Glands.*

764. The mouth, tentacles, and salivary apparatus of a Holothuria (*Holothuria regalis*, Cuv.). The salivary organs consist of a series of elongated cæcal processes, of a semi-transparent membranous texture, which surround the œsophagus, and are continued into the branched tentacles which surround the mouth. This communication is indicated by the black bristle which passes from one of the salivary cæcums into its corresponding tentacle. The mouth and œsophagus are laid open.

765. The corresponding parts from another Holothuria of the same species, in which some of the salivary cæcums have been cut off, and one of them has been injected with size and vermillion, to show the subdivision and continuation of its duct into all the terminal branches of the ramified tentacle. The viscid secretion thus exuding from these processes assists in entangling the objects which constitute the food of this animal, whilst at the same time it lubricates and adapts them for deglutition. In this preparation may also be seen a larger membranous bag which opens by a narrow duct into the beginning of the alimentary canal.

766. The corresponding parts from another Holothuria of the same species;

exhibiting the whole of the salivary cæcums, together with the larger and inferior cæcum.

767. The soft parts of a Snail (*Helix pomatia*, LINN.). The alimentary canal has been injected with size and vermilion; so that the salivary glands, from their white colour, may be distinctly perceived upon the parietes of the stomach. These glands are of a flattened, elongated, and irregular form, and of a conglomerate structure; they may be seen diminishing in breadth as they extend upwards towards the pharynx, where their ducts terminate.

In this preparation the semicircular, dentated, horny jaw, the course and termination of the alimentary canal, and the position and form of the liver, are all well displayed.

768. The mouth, œsophagus, stomach, and salivary glands of the same species of Snail. In this preparation the junction of the two salivary glands at their lower extremities, and the termination of their ducts, are shown. The œsophagus and stomach are laid open, showing their internal structure.

769. The alimentary canal, liver, and salivary glands of a Slug (*Limax ater*, LINN.). The latter organs are of a similar form and structure to those of a Snail, but are of smaller size.

770. The mouth, œsophagus, and salivary glands of the Cuttle-fish (*Sepia officinalis*, LINN.). The two inferior and larger salivary glands are shown, and a bristle is inserted into their common duct, which is seen penetrating the muscular apparatus of the superior mandible, to terminate immediately anterior to the spinous part of the tongue: a bristle has also been inserted into the duct of one of the superior salivary glands.

771. The lower part of the face, injected, of a Man, showing the aperture of the mouth, the smooth and vascular membrane of the lips, and the orifices of the ducts of the parotid glands, through which bristles have been passed.

772. The tongue, fauces, pharynx, larynx, with the remainder of the salivary apparatus, of the same individual. On the left side the submaxillary gland, and on the right both the submaxillary and sublingual salivary glands are shown, into the ducts of which bristles are inserted. On the sides of the

fauces the orifices of the mucous crypts which constitute the tonsils may be seen; above the faucial aperture or isthmus is the soft palate, which protects the posterior apertures of the nostrils during deglutition; below is the epiglottis, which at the same moment guards the orifice of the larynx. The pharynx is laid open posteriorly, so as to afford a clear and satisfactory view of the whole of this beautiful mechanism.

772 A. The zygomatic salivary glands with part of the lips of a Jackall (*Canis aureus*, Linn.). These glands are superadded to the parotid, submaxillary and sublingual glands in the dog tribe, and some other quadrupeds. Their ducts, into which bristles are inserted in the preparation, terminate opposite the posterior grinders of the upper jaw. *Prepared by Mr. Owen.*

772 B. The lower jaw, tongue, fauces, and salivary apparatus of one side, of an Armadillo (*Dasypus Peba*, Desm.). The principal object of this preparation is to show the salivary reservoir or bladder appended to the submaxillary gland. This reservoir receives the saliva by small ducts which open into it posteriorly in a valvular manner; a single long duct is continued from its anterior part, and terminates just behind the symphysis of the lower jaw. Bristles are inserted into this and the duct of the opposite gland. The parotid gland is small; a bristle is passed through its duct, showing its termination near the angle of the mouth.

Prepared by Mr. Owen.

772 C. The submaxillary salivary gland and bladder from the opposite side of the same animal. The small ducts opening into the bladder have been filled with quicksilver: the bladder itself is laid open.

The saliva which these reservoirs contain is very tenacious, the serous part being probably absorbed during its detention. Thus prepared and accumulated, it is expelled at the extremity of the mouth, in order to lubricate the tongue, which is by this means rendered subservient, as in the anteater, to the catching of insects. *Prepared by Mr. Owen.*

2. *Pancreas.*

773. The pyloric end of the stomach, the duodenum, and pancreatic cæcal ap-

pendages of a Salmon (*Salmo Salar*, LINN.). The latter are of an elongated form, and very numerous; the duodenum is laid open to show the orifices by which they communicate with that intestine. Some of the cæcums are also laid open, showing their thick glandular lining membrane; they are connected together by processes of peritoneum, and the interspaces are filled up by depositions of fat. Bristles are inserted into the cystic and hepatic ducts, which open close to the pylorus.

773 A. The stomach and duodenum of the Gillaroo Trout (*Salmo Fario*, var.). They have been laid open to show,—the former its muscular parietes,—the latter the orifices of the numerous pancreatic cæcal appendages which open into it. Many of these have been injected from the intestine, showing their free communication with it.

Prepared by Mr. Clift.

774. The stomach, intestines, and pancreatic cæcal appendages of a Cod (*Gadus Morrhua*, LINN.). The pancreatic cæcums may be observed to unite together as they approach the duodenum, so as to communicate with that intestine by comparatively few orifices: these are situated close to the pylorus.

775. The alimentary canal, liver, pancreas and ink-gland of a Cuttle-fish (*Sepia officinalis*, LINN.). The principal object of this preparation, according to the manuscript catalogue, is to show the "Pancreas of the Cuttle-fish." This consists of numerous granular follicles, which communicate together so as to form small elongated groups or lobes, whose common ducts open, not directly into the intestine as in osseous fishes, but into the hepatic ducts, extending along them from the lower part of the liver to the spiral laminated cavity. This cavity (which, from the great extension of its lining membrane, may also be regarded rather as a secretory appendage to the alimentary canal than a digestive cavity,) is laid open, showing the termination of the hepatic ducts, and the canal which is continued from that termination to the intestine. The ink-bag is also laid open; its duct may be distinguished from the dark colour of its contents accompanying the intestine to the anus, where it terminates.

776. The pancreas, injected, of the Monk-fish (*Squatina Angelus*, Cuv.). A bristle is inserted into the duct.

777. The pancreas, with part of the stomach and intestine of a Dog-fish (*Spinax Acanthias*, Cuv.). Its principal lobe is long and flattened, from the middle of which a second lobe of an irregular figure passes off, and is bent upon itself before terminating on the duodenum. A white bristle is inserted into the pancreatic duct, which in the section of the duodenum has been divided; the remainder of the duct may be observed running obliquely for half an inch between the coats of the intestine. A black bristle is inserted into the biliary duct, which also runs obliquely between the coats of the duodenum for a considerable distance. The orifices of these two ducts are at some distance from each other, and are not situated on eminences.

778. The pancreas, with parts of the stomach, intestine, and gall-bladder of a Rattle-snake (*Crotalus horridus*, Linn.). The pancreas is of a triangular form, closely attached to the commencement of the intestine, and perforated by the biliary duets. The form of the pylorus is well shown in this preparation; the rugæ of the intestine commence from it in a radiated manner.

778 a. The pyloric end of the stomach, duodenum, pancreas, and spleen of a Tortoise (*Chelydra serpentina*, Schweig.). The pancreas is an elongated gland, extending from the pylorus for several inches along the duodenum, then dividing, and again uniting so as to form a loop, and giving off a process which extends to the spleen. *Prepared by Mr. Owen.*

779. The pancreas and a portion of the duodenum, injected, of a Goose (*Anser palustris*, Brisson). The pancreas consists of two elongated lobes, united by a narrow strip near their lower extremities; a long and separate duct passes from each lobe to the upper part of the second bend of the duodenum, where they terminate separately, but close together. White bristles are placed in these orifices, and blaek ones into the hepatic and cystic ducts, which open separately into the duodenum, close to the preceding.

780. The pancreas of an Elephant (*Elephas Indicus*, Cuv.), showing its lo-

bulated form and conglomerate structure: the arteries have been injected red, the veins yellow; a porcupine's quill is placed in the duct.

780 A. The pyloric end of the stomach, duodenum, spleen and pancreas of a Hedgehog (*Erinaceus Europæus*, LINN.). The pancreas extends, as is usual among mammalia, from the spleen transversely across the spine, behind the stomach, to the duodenum; it there extends into a flattened mass lodged between the layers of the duodenal mesentery, and also gives off a process which hangs freely in the abdomen with an entire investment of peritoneum. The duodenum is laid open, and a bristle is placed in the pancreatic duct. *Prepared by Mr. Owen.*

781. The duodenum and a portion of the pancreas, injected, of a Bear (*Ursus Arctos*, LINN.). The duodenum has been laid open, and a bristle inserted into the orifice of the pancreatic duct.

3. *Liver.*

782. The alimentary canal and intestinal cæcal appendages of a Sea-mouse (*Aphrodita aculeata*, LINN.). The intestine is laid open, showing the orifices of the cæcums, into some of which orifices bristles have been placed.

This preparation is called by Mr. Hunter, in the original manuscript Catalogue, "No. 429. Intestinal canal and liver of the Sea-mouse," evidently regarding the cæcal appendages as representing that viscus. Thus, after exhibiting the salivary glands under the form of elongated cæcums in the Holothuria, and the pancreas under the same form in the osseous fishes, he lastly shows us the complicated liver of the higher classes also commencing in the animal series by separate and simple follicles.

783. The intestine and hepatic cæcums of a Sea-mouse. The dilated extremities of the latter are filled with a dark-coloured substance, with which the intestine is also distended.

784. A Locust (*Acrida viridissima*, KIRBY), dissected, so as to show the alimentary canal, and more especially the filamentary hepatic tubes, which are numerous, and surround the commencement of the intestine. A piece of dark paper is placed behind them.

784 A. The stomach, intestinal canal, and hepatic organ of a Mole-cricket (*Gryl-*

lotalpa vulgaris, LATR.). The liver in this insect is represented by a great number (150 to 200) of minute, but long, capillary cæcums, which all unite into one common tube, or duct, which conveys the biliary secretion into the intestinal canal, close to the pylorus.

Prepared by Mr. Owen.

In the *Anatomy of the Mole-cricket,* by Dr. Kidd, there are the following observations on this organ.

"A similar organ is represented in Sir Everard Home's *Comparative Anatomy,* vol. i. pl. 84, as belonging to the Cape Grasshopper; it was originally considered by Mr. Hunter, and is considered generally at present, as answering to the liver of the higher classes of animals.

"Each of these tubes springs out of a common cavity in which the white tube from the intestine terminates; but at their free extremity they are all impervious. Each tube appears partially filled with a granular pulpy substance, which is almost universally of a bright yellow colour; though sometimes a particle is visible here and there of a clear light green colour, and I have seen similar green particles in the duct leading from the intestines.

"The following peculiarity is observable in the individual structure of these tubes: their diameter for about one third of their course from the closed extremity is very small, and they are colourless, and apparently empty; after which they suddenly undergo a considerable enlargement, become yellow, and are partially filled with the contents above described.

"Maceration in water destroys the yellow colour in the course of a few minutes; from whence it may be inferred, that after death the colouring matter transudes through the tubes containing it—a circumstance observable also with respect to the biliary vessels of the higher orders of animals; but it seems certain that no such transudation takes place during the life of the animal; for, upon examination of the insect soon after death, I have never found the adjacent parts coloured, as they would have been by the escape of the contents of the tubes."

Philos. Trans. cxv. (1825.) p. 228.

785. The stomach, intestine, and a lobe of the liver of an Ascidian (*Boltenia reniformis,* MACLEAY). The lobe is seen to consist of numerous con-

voluted lobules of a minute granular structure. A bristle is inserted into the wide hepatic duct which opens into the stomach; and the aperture of the ducts of the other lobes of the liver may be seen in different parts of the interior of that cavity.

786. The alimentary canal and liver of a Snail (*Helix Pomatia*, LINN.). The liver is divided into lobes, which surround the intestinal canal; the lobes are minutely subdivided, and the constituent granular follicles may be readily seen. The arteries have been successfully filled with red injection, and may be observed ramifying beautifully over the parietes of the alimentary canal, and among the lobes of the liver. These vessels are of large size in the latter viscus, supplying not only the materials for its support, but also for its secretion; there being no system of the vena portæ in the molluscous animals.

787. The alimentary canal and liver of a Slug (*Limax ater*, LINN.). Red injection has been thrown into the alimentary canal, which, from the free manner of its communication with the hepatic ducts, has passed along them into the component follicles of some of the lobes of the liver.

788. The intestine and liver of the same species of Slug, showing the subdivided lobular structure and large size of the latter organ.

788 A. The liver of the Pearly Nautilus (*Naut. Pompilius*, LINN.), showing a similarly subdivided lobular structure. *Prepared by Mr. Owen.*

The following is the description of the liver as it appeared in the dissection of this very rare animal. " The liver is a bulky gland, extending on each side of the crop from the œsophagus to the gizzard. There is a parallelism of form, as will be afterwards seen, between this gland and the respiratory organs; for instead of being simple and undivided as in *Ocythoë*, or bilobed as in *Sepia*, it is here divided into two lobes on each side; and these are connected by a fifth portion, which passes transversely below the fundus of the crop. All these larger divisions are subdivided into numerous lobules of an angular form, which vary in size from three to five lines. These lobules are immediately invested by a very delicate capsule, and are more loosely surrounded by a peritoneal covering common to this gland and the crop.

"The liver is supplied by large branches which are given off from the aorta, as that artery winds round the bottom of the sac to gain the dorsal aspect of the crop. It is from the arterial blood alone, in this, as in other mollusks, that the secretion of the bile takes place; there being but one system of veins in the liver, which returns the blood from that viscus, and conveys it to the vena cava at its termination. The colour of the liver is a dull red with a violet shade; its texture is pulpy and yielding. When the capsule is removed by the forceps, the surface appears under the lens to be minutely granular or acinous; and these acini are readily separable by the needle into clusters hanging from branches of the blood-vessels and duct. The branches of the duct arising from the terminal groups of the acini, form, by repeated anastomoses, two main trunks, which unite into one at a distance of about two lines from the laminated or pancreatic cavity.

"Beyond this part no other foreign secretion enters the alimentary canal, as there is not in the Pearly Nautilus any trace of structure analogous to the ink-bag of the Dibranchiate Cephalopods."—*Memoir on the Nautilus*, p. 26, pl. 4, z z.

789. The liver of a Cuttle-fish. It is composed of two elongated lobes, slightly bifid at their upper extremities, pointed below. Part of the capsule has been removed from one of the lobes, showing the delicate structure of this viscus, which appears to be composed of minute capillary follicles loosely connected by a fine cellular substance. Bristles are inserted into the two hepatic ducts—the structure and termination of which are shown at No. 775.

790. The liver of the Electric Eel (*Gymnotus electricus*, Linn.). It is composed of two lobes, united by a small transverse strip; and is very small, being proportioned rather to the extent of the body occupied by the viscera than to the bulk of the entire animal. It has been injected with size and vermillion by the two large hepatic veins, which may be observed ramifying on its surface.

791. A small portion of the liver of an Electric Eel, similarly injected, and showing the ramifications of the hepatic duct in the substance of the viscus.

792. A small portion of the liver of a Cod; on the natural surfaces of which may be observed the granules or component acini of the liver. This appearance is stated in the original manuscript Catalogue, to have been produced by "steeping in nitrous acid."

793. The liver of a Sturgeon (*Acipenser Sturio*, LINN.). It has been injected with size of two colours, to show the undivided and parallel disposition of the arteries and veins.

794. The liver of a Sturgeon, a portion of which has been torn up, showing its apparently fibrous texture in the direction of the vessels just described. The subdivision of the gland into many lobules, a structure rarely found in fishes, may be observed on the inferior surface of the liver.

794 A. A portion of the liver of a Shark (*Carcharias Vulpes*, CUV.), in which the arteries have been injected, showing a similar parallel course in the substance of the liver. *Prepared by Mr. Clift.*

795. The hepatic vessels, injected, of a Dog-fish (*Spinax Acanthias*, LINN.), the parenchyma of the liver having been washed away, which is readily done in fishes, in consequence of its slight degree of coherence.

796. A portion of a Siren (*Siren lacertina*, LINN.), injected and dissected, to show the liver.

Mr. Hunter's description of this organ is as follows :—"The liver is principally one lobe, pretty close to the heart at the fore part, and passes back on the right of the stomach and intestines; at its anterior extremity on the left side there is a very short lobe ending abruptly. The gall-bladder lies in a fissure on the left side of the liver near its middle; there is no hepatic duct; the hepato-cystic ducts, which seem to be three in number, enter the gall-bladder at its anterior end or fundus, and the cystic duct passes out from the posterior end of the gall-bladder, and terminates in the gut, about half an inch from the pylorus."—*Philos. Trans.* lvi. (1766.) p. 309.

797. The anterior extremity of the liver of a Siren, showing the small left lobe described above.

798. The body of a Newt (*Triton palustris*, LAURENTI), with the abdominal pa-

rietes removed, so as to expose the liver *in situ*. It is composed of one large lobe slightly notched at the middle of its lower edge, into which the suspensory ligament passes. The gall-bladder may be seen lodged behind the right inferior angle of the liver.

799. The liver of a Salamander (*Salamandra maculosa*, Laurenti). In its general form it resembles that of the Newt; it is variously notched on the concave surface.

800. A Frog (*Rana temporaria*, Linn.), injected, and with the abdomen laid open to show the liver; this is composed of two divisions, the left of which is subdivided into lobes.

801. A Surinam Toad (*Rana Pipa*, Linn.), with the abdomen laid open to show principally the liver, the two divisions of which are quite distinct, and each of them is subdivided into lobes. The heart and pericardium, a portion of the lungs, and the allantoid bladder, are also shown in this preparation.

802. The anterior part of the liver of a Rattle-snake (*Crotalus horridus*, Linn.). It shows the terminations of the vena portæ and vena hepatica: the former is seen on one side of the liver, of small size, having expended itself in deep-seated branches destined to supply the materials for the biliary secretion; the latter is seen on the opposite side of the liver, of large size, increasing by the reception of superficial branches, which bring back the blood not immediately required for the function or nutrition of the viscus.

802 a. The entire liver, injected, of a large Snake (*Python*, Daudin). This shows more distinctly than the preceding specimen the characters peculiar to the two systems of veins, the arterial structure of the coats of the vena portæ, and the granular texture and general form of the liver.

Prepared by Mr. Clift.

803. The liver and parts with which it is connected, minutely injected, of a Duck (*Anas Boschas*, Linn.). It is composed of two divisions, each of which is partially subdivided. Between the divisions anteriorly is situated the heart, which is not separated from the liver, as in mammalia, by a dia-

phragm: posteriorly the lobes partially embrace the gizzard. The spleen, a small oval gland, may be observed lying by the side of the proventriculus. The panereas, of the usual elongated trihedral form, is situated between the long fold of duodenum peeuliar to birds : the lesser lobe of the panereas may be seen running parallel to the larger lobe on the opposite side of the fold.

804. The thoracie and abdominal viseera, injeeted, of a Human fœtus. The prineipal objeet of this preparation is to show the situation and connexions of the liver, and its great proportional size at this period of life. It is seen oecupying the right hypoehondriac, the epigastrie and part of the left hypoehondriae regions, and extending downwards into the lumbar and umbilieal regions. The coronary and suspensory ligaments are shown, the latter having the pervious umbilical vein at its lower edge. To the left of the liver may be observed the spleen, and between these viseera is the stomaeh laid open, with the great omentum depending from its great areh. Posteriorly may be observed the kidneys, one of whieh has had its eapsule removed to show its lobulated exterior, a strueture which characterizes them in the fœtal eondition, but is subsequently obliterated. Below the right kidney the eæeum and its appendage are situated; below the opposite kidney the sigmoid flexure of the colon is seen, which has been laid open to show the internal projecting folds of the coats of the intestine. The eonvoluted mass of small intestines occupy the lower regions of the abdomen.

The diaphragm here, as in all mammalia, forms a complete septum between the thoraeic and abdominal viscera. The lungs, the heart, and the thymus gland are preserved ; the pericardium is laid open, showing its extensive adhesion to the tendinous eentre of the diaphragm.

805. A small portion of the liver of a Seal, minutely injeeted, apparently by the hepatic veins.

806. The liver of a Cat (*Felis domesticus*), showing its subdivision, as in all earnivorous quadrupeds, into a great number of lobes. The second lobe from the left side, or cystie lobe, is deeply cleft for the insertion of the suspensory ligament ; to the right of this eleft it is perforated for the lodge-

ment of the gall-bladder. This preparation was preserved on account of this peculiarity, for it is described in the original manuscript Catalogue as "O No. 2. Liver of a ——, to show that the gall-bladder is situated in the middle of the substance of the large lobe; and appears on the convex surface of that lobe."

807. The cystic lobe of the same species, showing the situation of the gall bladder, as above described.

808. The liver, injected, of a Field-mouse (*Arvicola*). This is still more subdivided than in the preceding example: the second lobe from the left is, as usual, the cystic lobe; it has two notches, the left for the suspensory ligament, the right for the gall-bladder.

809. The liver, injected, of a Rat (*Mus decumanus*, Linn.). The lobe corresponding to the cystic lobe is here seen notched for the reception of the suspensory ligament only, there being no gall-bladder in this species.

810. A portion of the liver of a Camel (*Camelus Dromedarius*, Linn.), showing thinness of the lobes, and the numerous lobules on the concave surface, the interspaces and fissures of many of which extend to the convex surface of the liver.

810 a. A portion of the liver, with the gall-bladder, of a Capromys (*Capr. Fournieri*, Desm.). The liver of this quadruped is divided into the usual number of greater divisions, or lobes, each of which is again minutely and singularly subdivided, resembling the structure of the liver of the inferior mollusks. Red injection has been thrown into the hepatic artery, which in some of the lobules has penetrated the inter-acinous spaces; yellow injection has been thrown into the hepatic vein, which in a few situations has penetrated the acini themselves. The gall-bladder, which lies exposed in a broad cleft of the cystic lobe, has been laid open, showing its internal reticulate structure, and the minute ramifications of the veins on that surface. The hepatic, cystic, and common ducts are filled with mercury. The branches of the vena portæ may be observed surrounded by a network of small arteries. *Prepared by Mr. Owen.*

4. *Gall-bladder and Biliary Ducts.*

811. The pyloric end of the stomach, duodenum, and termination of the gall-duct of a Wolf-fish (*Anarrhichas Lupus*, Linn.). A thick bristle has been passed through the duct. There are no pancreatic cæcums in this fish.

811 a. The corresponding parts of the alimentary canal, with the gall-bladder and spleen, of a Turbot (*Rhombus maximus*, Cuv.). The hepatic ducts are numerous, and communicate with the cystic duct in several parts of its course; four hepatic ducts open into the dilated extremity of the common duct close to the intestine. A bristle is passed through the orifice by which the bile enters the duodenum. There are two pancreatic cæcums which open into the duodenum close to the pylorus.

Prepared by Mr. Owen.

812. The pyloric end of the stomach and duodenum, with the pancreas and spleen, of a Dog-fish (*Spinax Acanthias*, Cuv.). The duodenum is laid open, showing the orifices of the hepatic and pancreatic ducts, which are situated at a distance from each other just before the commencement of the spiral valve.

812 a. A portion of the band formed by a congeries of ducts, which convey the bile from the liver, in the Basking Shark (*Selache maxima*, Cuv.).

Prepared by Mr. Clift.

The following is the description of the biliary organs given by Sir Everard Home in his "Anatomical Description of the *Squalus maximus*." "The liver consists of two lobes nearly equal in size. They occupy the anterior part of the belly, from below the gills to the rectum. It yielded about three hogsheads of oil. No gall-bladder was discovered; and as a chord (like a navel string) consisting of twelve hepatic ducts passed from the liver to the duodenum, there is reason to believe that this fish has no gall-bladder." *Philos. Trans.* xcix. (1809,) p. 211.

In a subsequent dissection of this species of Shark by M. De Blainville, these ducts are described as entering a gall-bladder, of a globular form, from four to five inches in diameter, situated close to the duodenum, and six feet distant from the liver*." The existence of this receptacle was confirmed by Sir Everard Home in a second dissection of the Squalus maximus. In his account of that dissection he observes: "The ducts of the liver are six in number, and inclosed in a broad flat band, which passes obliquely down before the stomach, till it is connected to the duodenum; each of the ducts opens, by a separate oblique orifice, into a common cavity of an oval form, from which there is a direct opening into the duodenum. This swell or enlargement might be considered as a substitute for the gall-bladder, which is wanting, were it not that a similar enlargement is also met with in Fishes which have one. In the Cod there is the same dilatation, and the hepatic ducts open into it in the same oblique manner; but there is also a gall-bladder, and the cystic duct, as well as the others, terminates in this dilatation."

Philos. Trans., ciii. (1813.) p. 228.

812 B. A transverse section of the band of hepatic ducts of the Basking Shark. *Prepared by Mr. Clift.*

812 C. A transverse section of the band formed by the hepatic ducts of the Basking Shark, with a membrane connecting that band to two great vessels, an artery and a vein. *Prepared by Mr. Clift.*

812 D. The pyloric end of the stomach, and commencement of the intestinal canal, together with the extremity of the liver, hepatic duct, gall-bladder, and cystic ducts, pancreas and spleen, of a Boa (*Boa Scytale*, Linn.).

In the Ophidian reptiles the gall-bladder is situated at a distance from the liver, in close connexion with the duodenum. This preparation shows the consequent length of the hepatic duct. The cystic duct is seen to be single at its commencement, and afterwards to divide into numerous branches, which, together with the hepatic duct, penetrate the pancreas in their course to the intestine.

Prepared by Mr. Owen.

813. A portion of the duodenum, with the gall-bladder and hepatic ducts, of a Turtle (*Chelonia Mydas*, Brongn.). The duodenum is laid open, showing

* *Annales du Muséum*, xviii. (1811), p. 107.

the common orifice of the cystic, hepatic, and pancreatic ducts. A white bristle is placed in a hepato-cystic duct.

814. The corresponding part of the duodenum, with the gall-bladder, injected and laid open, of a Turtle. A small quill is placed in the cystic duct.

815. A similar preparation from the Hawk's-bill Turtle (*Chelonia imbricata*, Brongn.).

816. The stomach, duodenum, gall-bladder, and bile ducts, pancreas and spleen, injected, of a Swan.

The gall-bladder is laid open; a small portion of the liver, with a hepato-cystic duct, adheres to its fundus: a black bristle is passed into the duodenum through the cystic duct, and a white bristle is passed into a hepatic duct, which opens separately from the preceding. Another white bristle is inserted into one of the pancreatic ducts. These all open, close to each other, at the termination of the long fold of the duodenum, which is laid open. The spleen is seen near the junction of the proventriculus and gizzard, both of which are also laid open. The pancreas may be observed, consisting of two divisions, of the usual elongated form, situated within the fold of the duodenum.

817. A portion of the duodenum, with a section of the liver and the gall-bladder, of the Guan (*Penelope cristata*, Merrem). The gall-bladder is of a remarkably elongated and tortuous form. The hepatic duct being greatly dilated resembles a second gall-bladder. A bristle is passed through the cystic duct into the duodenum, which is laid open.

818. The pyloric end of the stomach, and commencement of the duodenum of an Ostrich (*Struthio Camelus*, Linn.), showing the entrance of an hepatic duct close to the pylorus, and in a direction inclining to that orifice. The thick cuticle of the gizzard and the valvular structure of the pylorus are also well displayed in this specimen.

819. A Human gall-bladder, inverted, to show the reticulate structure of its lining membrane.

820. The cystic and Spigelian lobes of the liver, with a portion of the duodenum of a Quadruped, showing an elongated tortuous gall-bladder, with

two smaller lateral dilatations, or accessory gall-bladders*. A bristle is passed from the duodenum into the ductus communis choledochus.

820 A. The pyloric end of a Human stomach, and commencement of the duodenum, with the termination of the hepatic and pancreatic ducts. A portion of quill is inserted into the ductus communis, and a black bristle into the principal pancreatic duct which opens into the ductus communis close to its termination. A smaller duct from the head of the pancreas is seen opening into the duodenum at some distance from the preceding: the form of the pylorus, and the gradual commencement of the valvulæ conniventes are well shown in this preparation. *Presented by Sir W. Blizard, F.R.S.*

821. A portion of the duodenum, with the termination of the hepatic and pancreatic ducts, of a Lion. A black bristle is passed into the ductus communis choledochus, and a white one into the pancreatic duct; the mucous coat of the intestine is laid open to show their junction. The orifice of a distinct pancreatic duct is preserved.

822. A similar preparation, with a portion of the pancreas, from a Zebra (*Equus Zebra*, LINN.). The white bristle is placed in the ductus communis choledochus, the black ones into the pancreatic ducts, one of which communicates with the ductus communis before opening into the duodenum; the other terminates by a distinct and distant orifice.

823. A portion of the pancreas, of the duodenum, and of the hepatic duct of the Piked Whale (*Balæna Boops*, LINN.). The hepatic duct is laid open; it is of great size, but communicates with the duodenum by a contracted circular orifice. A bristle is inserted into the pancreatic duct, which may be traced as it runs between the coats of the intestine by an elevation of the lining membrane.

* This preparation is called in Home's manuscript Catalogue, "Liver with three gall-bladders." Like many other of the more remarkable specimens in the collection, it has been left without entry in the original Catalogue, or any record of the species from which it was taken. Among the animals which I have dissected for the purpose of identifying these unnamed specimens, the Cape Hyrax presents a structure most nearly allied to the present—the hepatic ducts dilating into three globular receptacles immediately upon leaving the liver. None of these, however, are so large and distinct as the middle receptacle in No. 820; and as no parts of the Hyrax are to be found in the Hunterian Collection, this preparation may be concluded to belong to some other species.—R. O.

824. A portion of the lining membrane of the hepatic duct of the same Whale.

"There is a considerable degree of uniformity in the liver of this tribe of animals. In shape it nearly resembles the human, but is not so thick at the base, nor so sharp at the lower edge, and is probably not so firm in its texture. The right lobe is the largest and thickest, its falciform ligament broad, and there is a large fissure between the two lobes, in which the round ligament passes. The liver towards the left is very much attached to the stomach, the little epiploon being a thick substance. There is no gall-bladder ; the hepatic duct is large, and enters the duodenum about seven inches beyond the pylorus.

"The pancreas is a very long, flat body, having its left end attached to the right side of the first cavity of the stomach : it passes across the spine at the root of the mesentery, and near to the pylorus joins the hollow curve of the duodenum, along which it is continued, and adheres to that intestine, its duct entering that of the liver near the termination in the gut." *J. Hunter, On the Structure and Œconomy of Whales, Philos. Trans.*, lxxvii. (1787.) p. 410.

825. A portion of the duodenum, with the termination of the hepatic and pancreatic ducts, of the Elephant. The superior and larger duct is the hepatic duct ; it is laid open, showing its inner surface reticulate like a gall-bladder, just before it reaches the intestine. Between the coats of the intestine it dilates into an oval receptacle, irregularly sacculated on its interior ; the pancreatic duct opens into this receptacle, and there mingles with and dilutes the bile. A black bristle is passed along this duct, through the receptacle and into the duodenum, where the common orifice is seen situated on a mammilloid eminence. A little way below the large duct a smaller one may be observed, which also dilates into a sacculated receptacle before opening into the cavity of the intestine.

5. *Spleen and Appendages of the Alimentary Canal.*

826. The spleen of a Dog-fish, showing its inequilateral triangular form.

826 A. A portion of the spleen of the Basking Shark, showing its peculiar lobulated form. *Prepared by Mr. Clift.*

827. A portion of the liver, of the stomach, and of the intestine, with the spleen and pancreas, of a Siren (*Siren lacertina*, Linn.). The spleen is remarkable for its length, extending from the pyloric end of the stomach for several inches down the left side of the mesentery. A smaller body lying parallel with it, near its middle part, is the pancreas. The gall-bladder and its duct, and one of the hepato-cystic ducts, are also well shown in this preparation.

828. The spleen of an Iguana, injected, the arteries red and the veins yellow; the latter ramify chiefly on the exterior of the spleen.

829. The spleen of a Crocodile (*Croc. acutus*, Cuv.). It is of an elongated trihedral form, pointed at both ends, with a thin capsule of peritoneum; the orifice of the splenic vein may be observed on that portion from which the peritoneum has been removed.

830. A portion of intestine, with the pylorus, the pancreas, and spleen of a Tortoise. This preparation has been brilliantly injected: the intestine is laid open, showing the zigzag rugæ of the lining membrane: a bristle is inserted through the cystic duct: the spleen, a small oblong body, is seen attached to the mesentery, at the distance of six inches from the stomach.

831. The spleen of a Turtle, with the veins injected, showing their ramification on its exterior, as on the kidney of the Cat tribe.

832. The spleen of a Seal. It is thus described in the original Hunterian Catalogue: "The spleen of a Seal, well injected by the veins, and showing that the injection is not confined in vessels, but in cells." The distended cells give a granular appearance to the whole external surface.

833. A transverse section of the spleen of a Leopard (*Felis Leopardus*, Cuv.). It has been distended with spirit previous to the section being made, which shows its structure to be spongy and cellular, adapted as a receptacle of venous blood.

834. A longitudinal section of a portion of the spleen of a Leopard, showing the arterial ramifications and the venous cells.

835. A similar section of a larger portion of the spleen of a Leopard.

836. A transverse section of the spleen of a Horse (*Equus Caballus*, Linn.). It has been prepared in the same manner as the preceding preparations from the Leopard, and, from the larger size of the venous cells, shows more distinctly the true structure of the spleen. The meshes of the elastic cellular texture are seen to be interwoven in such a manner as to leave the communicating apertures of the cells of a regular circular form. Some of the ramifications of the splenic vein, which receives the blood deposited in this cavernous structure by the splenic arteries, are displayed, and bristles are inserted into them.

836 a. A small portion of the spleen of a Calf, (*Bos Taurus, jun.*), which has been macerated after distention of the cells, to show the meshes of the cavernous structure of the spleen, and the large size of the cells or spaces which they intercept. *Presented by Sir Everard Home, Bart.*

836 b. A transverse section of the Human spleen.

Presented by Sir Everard Home, Bart.

See a figure of a similar section in the *Philos. Trans.*, cxi. (1821.) pl. vii. fig. 1., in illustration of a paper by the donor, containing a microscopical description of the spleen by Francis Bauer, Esq.

837. The spleen, with a portion of the duodenum and pancreas, of a Cat (*Felis domesticus*). The spleen is of an elongated trihedral form, attached to the stomach by a duplicature of peritoneum inclosing its vessels: this duplicature passes off from the angle formed by the two lesser sides. The splenic vein is seen passing from the spleen along the pancreas, which extends from it to the duodenum.

838. The spleen of a young Kangaroo, showing a small process given off at right angles from near the lower end of the body, with which it is connected by a narrow isthmus.

839. The spleen of the Agouti (*Dasyprocta Aguti*, Illig.), with a small accessory spleen, attached to the peritoneal process of membrane below it.

839 a. The stomach, omentum, pancreas and spleens, of a Porpesse (*Phocæna communis*, Cuv.). The arteries and veins have been injected. The principal spleen is about the size of a walnut, attached to the parietes of the

first cavity of the stomach: the large splenic veins ramify on its surface. Bristles are stuck into several of the smaller spleens, which are also characterized by the superficial veins, and are attached to the parietes of the first cavity or to the omentum. The omentum is seen to be continued from the whole of what corresponds to the great curvature of the stomach, as far as the dilated commencement of the duodenum. It is thin, and of little extent, and does not contain fat. *Prepared by Mr. Owen.*

840. The stomach and duodenum, spleen, pancreas, and great omentum of a small carnivorous animal, apparently of a Cat. The parts have been injected, and show remarkably well the principal peculiarities in the form and disposition of these parts as they exist in the feline tribe. A part of the œsophagus has been inverted, to show the transverse rugæ of its lining membrane, near its termination. The stomach exhibits the broad dilated cardiac, and the narrow tubular pyloric divisions, which are acutely bent upon each other; in the duodenum may be observed its regular extended curve, and its broad mesentery, by which much greater freedom of motion is allowed to this portion of the intestinal canal than in the human subject. The small omentum is seen attached, not in a regular line along the lesser arch of the stomach, but advancing in an irregular scolloped manner upon its anterior surface: an analogous process of peritoneum is attached posterior to the lesser curvature. The great omentum, anteriorly, is continued from the greater arch of the stomach, from the left end of which it is continued down the spleen, and posteriorly along the pancreas, which is thus seen to have an entire investment of peritoneum: from the pancreas it extends to the pylorus, where it becomes continuous with the anterior layer, completing the circle, and leaving a large aperture behind the lesser arch of the stomach, which leads into the omental cavity, analogous to the foramen Winslowi. The form of the pancreas and its division into the transverse or greater lobe, and the circular or duodenal lobe, are well shown, and also the form and situation of the spleen.

841. The trunk of a Human fœtus, with the parietes of the abdomen removed, to show the great omentum.

DESCRIPTIONS OF THE PLATES.

Plates I. and II. include six figures*, taken from preparations of bones of the Hog, in a growing state, coloured with madder and forming part of the series preserved in the Collection to illustrate Mr. Hunter's theory of the growth of bone.

"It was some time anterior to the year 1772 that Mr. Hunter began to investigate this subject, and an account of the experiments and observations was given to me to copy in that year, as a part of his future lectures.

"Du Hamel had published a very ingenious theory upon the growth of bones, which he endeavoured to support by experiments, tending to prove that bones grow by an extension of their parts: with this doctrine Mr. Hunter was not satisfied, and instituted experiments to determine the truth of Du Hamel's opinion.

"Mr. Hunter began his experiments by feeding animals with madder, which has a property of tinging with a red colour that part only of the bone which is added while the animal is confined to this particular food.

"He fed two Pigs with madder for a fortnight, and at the end of that period one of them was killed. The bones, upon examination externally, had a red appearance: when sections were made of them, the exterior part was found to be principally coloured, and the interior was much less tinged.

"The other Pig was allowed to live a fortnight longer, but had now no madder in its food; it was then killed, and the exterior part of the Bones was found of the natural colour, but the interior was red.

"He made many other experiments of the same kind upon the increase of the thickness of the neck and head of the thigh bone. From these it appeared, that the addition of new matter was made to the upper surface, and a proportional quantity of the old removed from the lower, so as to keep the neck of the same form, and relatively in its place."—*Home, Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 278.

* Numbered 3, 4, and 5, in the *MS. Catalogue of Drawings.*

PLATE I.

SECTIONS OF THE LOWER JAW.

Fig. 1. A section of the lower jaw of a young Pig, which had been fed with madder for a fortnight, showing the new bone deposited on the outer surface coloured with the madder.

Fig. 2. A section of the lower jaw of a young Pig, which had been suffered to live some time longer without madder in its food. The coloured bone, which in the earlier stage of growth was exterior, now forms the internal layer by the absorption of the uncoloured bone upon which it was originally deposited; and the size of the medullary cavity is proportionate to such absorption. The latest-deposited and uncoloured bone is seen added in greatest proportion to the anterior surface of the jaw.

Fig. 3. A side view of the same preparation, showing the mode of increase of the ramus of the jaw, and of its two processes, the condyloid and coronoid.

PLATE II.

SECTIONS OF THE FEMORAL DIAPHYSES.

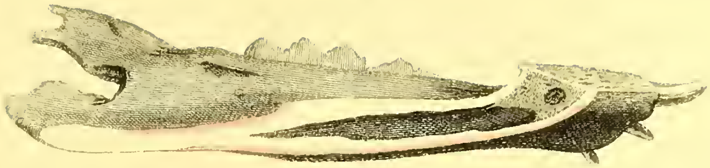
Fig. 1. A longitudinal section of the femoral diaphysis of a Pig, which had been fed on madder for a fortnight, showing the new bone to be deposited from the periosteum on the outer surface.

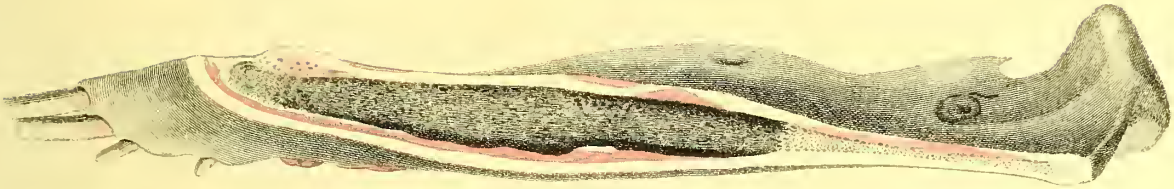
Fig. 2. A longitudinal section of the femoral diaphysis of a Pig, which had been suffered to live some time longer without madder in its food. The coloured bone is now seen advancing towards the medullary cavity, and included between two layers of uncoloured bone, of which the internal was previously, and the external has been subsequently, deposited.

Fig. 3. An exterior view of the same preparation, showing the mode of increase of its two extremities, as described in the introductory paragraph.

Pl 1

a.





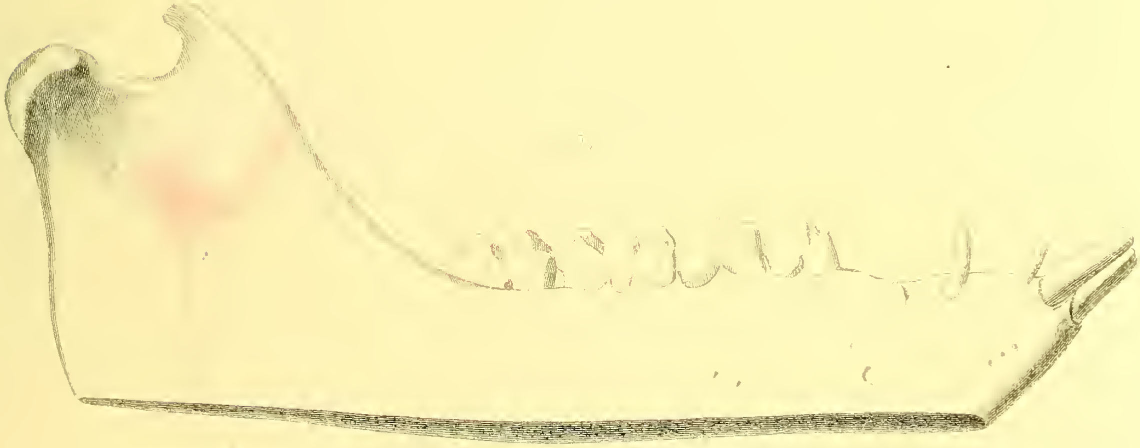


Fig. 1

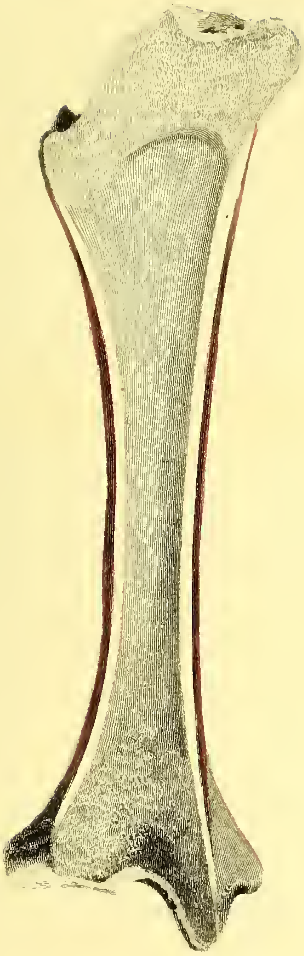


Fig. 2

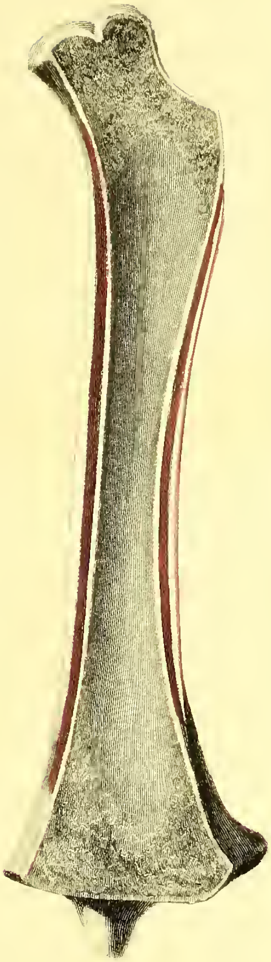


Fig. 3

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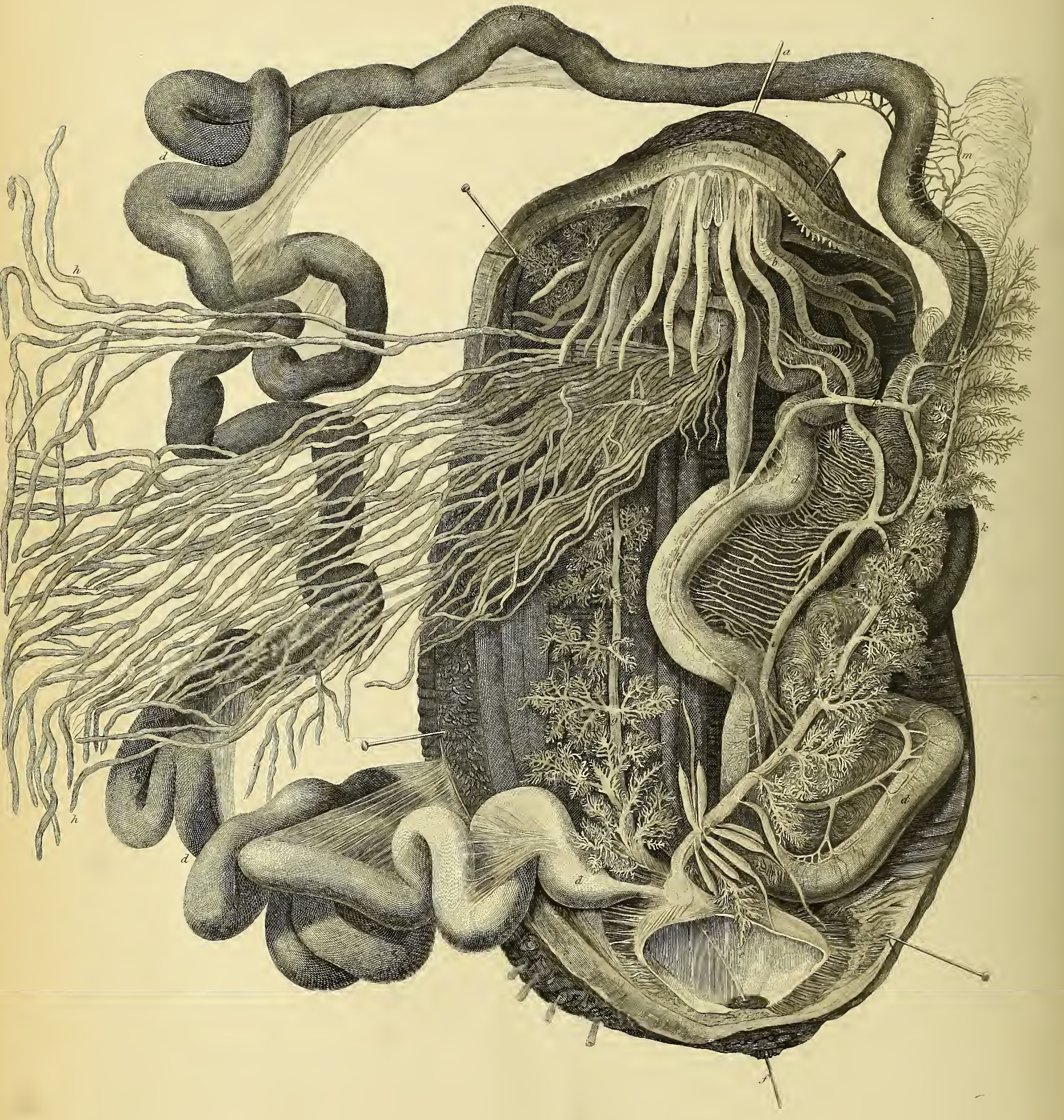

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PLATE III. *

ANATOMY OF THE *HOLOTHURIA TREMULA*, Linn.

Original description by Mr. Hunter of this figure :—

"Perhaps there is nothing so difficult in Natural History as the finding out the uses of the different parts of animals when they differ widely from those we are best acquainted with, especially so in those whose œconomy we can hardly observe. If the regular gradation from one species or genus of animal into that of another was well ascertained, we could most probably assign the uses to each part from analogy; but as that gradation is not yet known, and as we often are examining animals that seem in many of their parts to have no affinity to any animal we know,—for what answers any one purpose in the animal œconomy, and may exist in most animals, yet shall so vary in its form as not to give the least idea of its use,—therefore we are left to conjecture about their uses in such animals. The Priapism† is an instance of the above observation; many parts can be made out, but the uses of many must be left to conjecture till the analogy is made out complete.

"Plate III. is the internal parts of the Priapism enlarged, so as to make the parts more distinct. One part of the animal is very distinct, and is to be made out in every animal, because it is the true animal, viz. the stomach and intestines: the others are to be guessed at from analogy. The external covering or parietes of the cavity, which may be called wholly abdomen, is removed.

"*a*, Is a bristle introduced into the mouth of the animal.

"*b*, Appendicula cæca, which surround the mouth or fauces, into which they enter, and which I suppose to be salivary glands and ducts.

"*c*, A large one, which enters lower down, just at the beginning of the intestinal canal.

"*d*, *d*, Is the whole tract of the intestinal canal, which is of considerable length.

* No. 33, *MS. Catalogue of Drawings.*

† Mr. Hunter invariably speaks of the Holothuria under this term, probably taken from the *Holothuria Priapus* of Linnæus, which is a distinct species from the one under consideration, and now forms the genus *Priapulus* of Lamarck. Bellonius, in his description of one of these animals, with respect to its denomination observes, "Nos genitale nuncupamus marinum, à nonnullis Halesurion dictum."—*De Aquatilibus*, p. 441. (1553.)

"*e*, The dilated part of the intestine or rectum, or what seems to answer the same purpose as the dilated part of the gut at the anus in a bird.

"*f*, The anus.

"*g*, *g*, Are two branching bodies, almost like a tree, which consist of a duct with its branches, and which open into the dilated part of the rectum. These I suspect to be the kidneys, from their opening similar to the kidneys in birds, turtles, &c. On one side may be seen small oblong bodies near the opening of the principal trunk into the rectum.

"*h*, *h*, Are a vast number of hollow round tubes, all entering into one duct, which opens at the head, as will be best seen in Plate II.*, fig. 2.

"*i*, *i*, Are vessels which seem to have neither beginning nor end, somewhat like the vena portarum: they appear to be collecting at one end, while they are ramifying at the other, but which is the collecting end and which is the ramifying, I do not know; however, it is possible one end is the absorbing system, the other the arterial. Whenever there is a heart, one commonly can make out the motion of the blood from and to that viscus; but where we are deprived of that guide, it becomes difficult to determine.

"*k*, *k*, A distinct vessel from the former."

As the object of this figure is to show the general form of all the organs rather than the particular disposition of any single system, the vessels are not delineated in the position which is requisite to convey an idea of the whole course of the circulation. The principal trunks are, however, more or less clearly brought into view. According to Tiedemann's description †, *i*, *i* are the intestinal veins which receive the blood from *k*, *k*, the intestinal artery, and carry it by the trunks *l*, *l*, to the respiratory organ (regarded by Mr. Hunter as analogous to the kidney), whence it is returned by the branchial vein, part of which is seen at *m*, to the intestine, where it again passes into the intestinal artery: *k** is a large anastomosis joining two portions of the intestinal artery, and from which Tiedemann recommends the vessels to be injected.

In addition to the description of the Plate, Mr. Hunter has left the following general account of the *Holothuria*.

"This animal when caught, contracts itself in every direction, but more espe-

* This Plate will be published with the Fasciculus of the Catalogue relating to Generation.

† *Anat. der Röhren-Holothurie*, fol. 1816.

cially lengthways, like an Earthworm, and becomes in figure an oblong, or long ellipsis. It also draws in its tongues, or whatever we please to call them; as also its tentacula, which are placed all over its body, so that the animal may be very different in its natural state from what it appears to be when dead. The external skin appears to be gelatinous and very soft, something like the inner membrane of the [human] stomach, and it is perforated on one side in a thousand places for the tentacula; there it would appear to be hardly anything else but so many prepuces for those tentacula. These tentacula are placed as thick or close together as they can possibly be placed along one side of the animal, from near the head to near the tail. Whether this side is belly or back, I cannot possibly say. They are over every part of the animal's body, but not so thick: they pass through and through the skin of the animal, having their inner ends projecting into the cavity of the belly, terminating in increased rounded ends, forming little oblong bags. They are attached to the skin as they pass through, which is a kind of fixed point; but when that attachment is broken through, they may be pulled out. They are hollow, having a piston in them to draw in the centre of their external end, so as to act as suckers. Their external end swells out in an increased surface, which increases the surface of contact. They must be muscular, as they pulled themselves entirely within the external skin. The query is, what is the use of these tentacula? Are they suckers similar to those of the Echinus? Are they for holding or fixing the body as anchors? Or are they for catching other substances? Or are they feelers? This can only be known by observing them while alive. When they are all thrown out, or extended, they must make a singular appearance.

"Within the extended soft coat there is a strong tendinous one, which makes the proper body of the animal, through the substance of which pass the tentacula. This coat is principally a bag, inclosing the viscera. The head is at one end, which is the thickest, with the mouth in the middle; and surrounding the mouth there are stalks, terminating in a number of smaller branches, almost like a number of flowers on one stalk. These might be called *linguæ brachiales*. When dead, these are more or less drawn in, as it were, into the body of the animal, so that the external [sheath] is, as it were, drawn over them like the prepuce over the glans penis. These stalks are hollow, containing a thick slimy mucus, which is thrown out at the extremity of every flower, probably for catching or retaining the food. These hollow tubes of the *linguæ brachiales* are no more than ducts or reservoirs of glands that are in the form of long blind tubes hanging loose in the cavity of the abdomen, except being attached at one end to the inner surface of the head, as the *linguæ brachiales* are to the outer. They pass over the head and enter the stalks above mentioned: when the skin is removed, the head is discovered, and appears the same all round, composed of a long ligamentous substance with some bone in it. To the exterior end are fixed the above-named *linguæ brachiales*, and to the inner are fixed the bird-lime glands, which pass forwards over the head between it and the skin, and terminate as above mentioned. Some of these glands are no longer than what the head is thick, viz. not projecting or moving loose in the abdomen.

"There appears to be no distinction between the œsophagus, stomach and intestines; it is one regular canal from the head to the anus, all of the same size. Close to the head are two oblong ducts, which enter the œsophagus close to one another: the stomach and intestines are a very long tube, first passing down from the head to near the lower end, then up upon itself, and then turned down again to the anus. In this course it is very much convoluted: I should suppose it may be five or six times the length of the body of the animal.

"The gut does not terminate at the extreme end of the animal, but in a cavity common to it and the ducts of the kidneys, which cavity is the whole size or diameter of the body of the animal at this part, and is smooth on its inside. This cavity opens at the extreme end upon a projection inwards. The turns of the intestines are attached to the inside of the cavity by thin membranes or mesentery. The kidneys are two, passing up in the cavity through its whole length: they are composed of two tubes ramifying, and open into the cavity above described close by the termination of the gut. The parts of generation are something similar to those of the round worm from the human intestines. They consist of a pretty large opening near to the head, a little way behind the anterior end. Those tubes at once throw out several branches, which branches again subdivide, forming a considerable number of tubes in the whole."—*Hunterian MSS.*

Fig. 1.

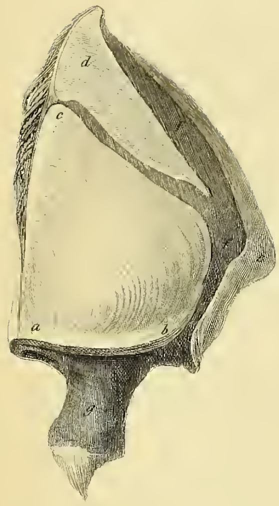

Fig. 2.

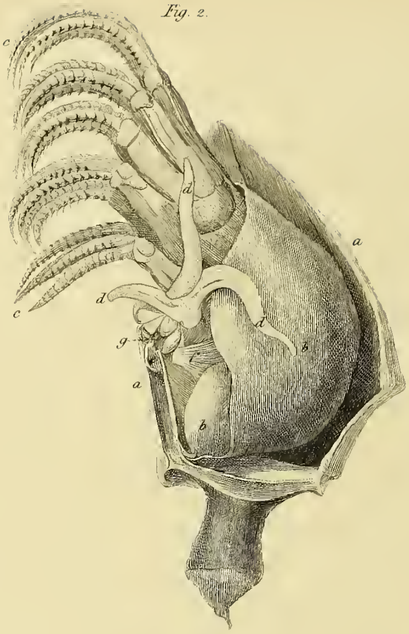

Fig. 3.

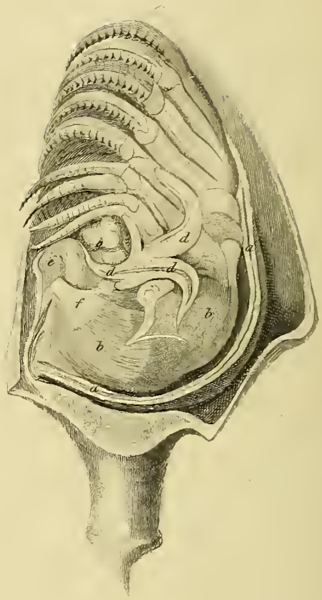

Fig. 4.

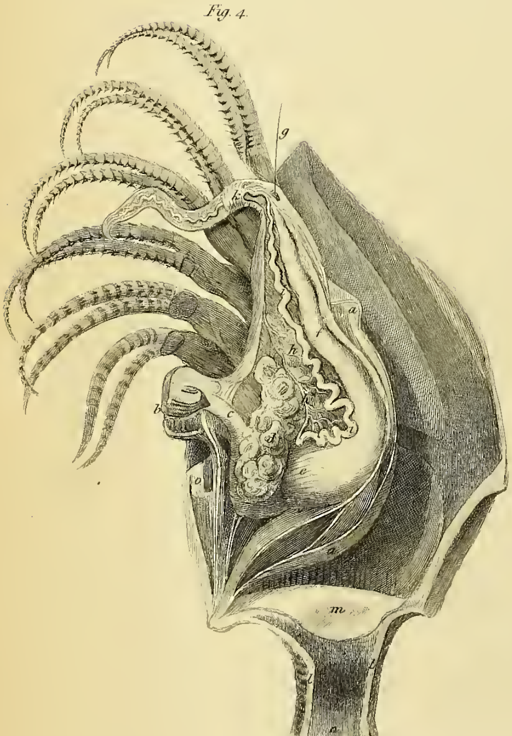

Fig. 5.

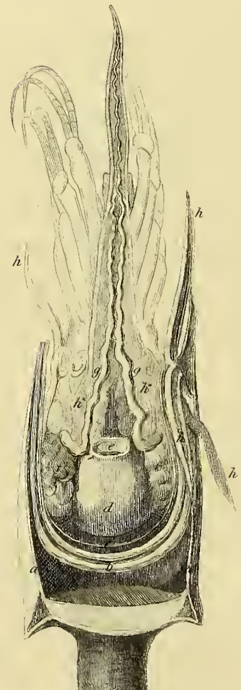

Fig. 6.

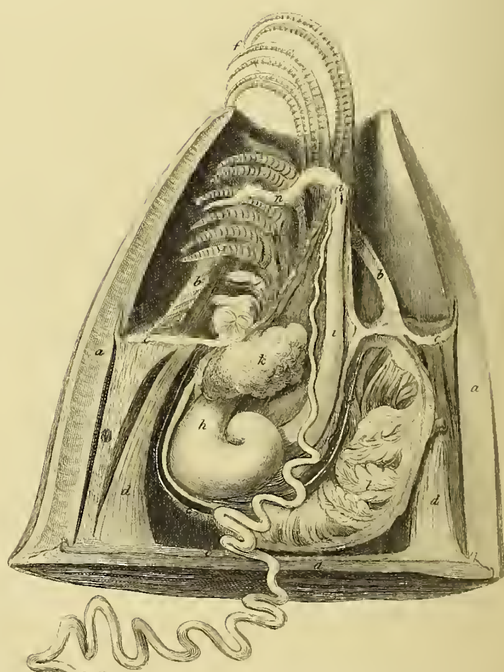

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PLATE IV.*

ANATOMY OF THE VITREOUS BARNACLE (*PENTELASMIS VITREA*, Leach,) AND THE BELL BARNACLE (*BALANUS TINTINNABULUM*, Lam.).

The species of Barnacle whose anatomy is illustrated in Figs. 1. to 5. of this Plate, appears to have been first described by Dr. Solander † under the name of *Lepas fascicularis*. In the changes of nomenclature which have subsequently resulted from the accession of new species and from a more precise and careful study of their mutual relations, it is now ranked in the systems of Zoology under the generic term *Pentelasmis*,—a term derived from the number of valves composing its shelly covering,—and in which genus the common Barnacle (*Lepas anatifera* of Linnæus) and some other analogous species are included.

Pentelasmis fascicularis, or *Pentelasmis vitrea*, as it is called by Dr. Leach, differs from the common *Pentelasmis anatifera* not only in the form and texture of the shell, but also in the length of the peduncle, which is rarely found to exceed an inch, and is commonly implanted in a ball, formed of concentric layers of a soft white substance, which serves as the medium of attachment to several individuals.

This species appears to be most common in the Australian and Pacific Oceans; but the specimen figured by Ellis is stated to have been taken in St. George's Channel. It is not known from what part of the world Mr. Hunter derived his specimens.

That he investigated the anatomy of this species with considerable interest and care, is evident from the numerous preparations of its different organs, which are placed in the several series of the Physiological Division. The beautiful drawings from these preparations, by Mr. William Bell, were destined to form part of the Illustrations of the general Exposition of the Collection for which the Founder was rapidly accumulating the necessary materials at the close of his useful career. Had it been permitted him to have completed that Work, it would have formed one of the most remarkable epochs in Natural History, and have reflected equal honour on its author and on the country and age in which he flourished.

* Nos. 30 and 31, *MS. Catalogue of Drawings*.

† Ellis's *Zoophytes*, p. 197, pl. 15, fig. 6.

Among the published accounts of the anatomy of the Cirripeds, the Essay of Mr. Ellis in the *Philosophical Transactions* for 1758, may be first noticed. In that paper a general description of the structure of the animal is given, together with some interesting observations on its vital phænomena. Poli—who, it is probable, derived his taste for these researches from Mr. Hunter, whose lectures he attended and whose friendship he enjoyed during a residence in London,—has given a more extended description of the anatomical structure of this class of animals, with illustrations, in his splendid work, *Testacea utriusque Siciliæ* *. Cuvier has also devoted an Essay to the same subject †, in which the anatomy of the common Barnacle is described with considerable detail, the principal differences observable in the structure of other genera of Cirripeds pointed out, and the organization and relations of the whole Class treated of with the author's usual clearness and research.

As the common Barnacle generally hangs downwards from the substances to which it adheres by its long peduncle, it is figured in the pendent position by Cuvier, who considers that as the natural one. The circumstance being less obvious in a species which projects in every direction from the circumference of a central sphere, Mr. Bell has delineated the animal in a contrary position, and thus makes it correspond with the *Balanus* (fig. 6.).

The following are the descriptions of this Plate left by Mr. Hunter.

"Plate IV. is five figures of the Barnacle, showing principally its internal structure.

"*Fig.* 1, Is one entire, having two shells on each side, with the holders or tentacula drawn in.

"*Fig.* 2, Is another, with the two shells on one side removed, showing the viscera, inclosed in a kind of granulated substance, placed between two membranes, the tentacula extended, and a substance made up of four or five rays, similar to a star fish.

"*a*, The cut edge of the external shell.

"*b*, The substance which incloses the viscera.

"*c*, The tentacula expanded.

"*d*, What I suspect to be the lungs.

* Tom. i. *Test. multivalva*, p. 11, tabb. iv. v. vi.

† *Mém. du Muséum*, tom. ii. p. 85.

" *Fig.* 3, Is the removal of *b*, *b*, or the granulated covering of the viscera, and which shows them still enveloped in a fine transparent membrane, in which is contained a purple fluid.

" *a*, The cut edge of the granulated membrane, marked *b*, in the former.

" *b*, The second membrane, which immediately incloses the viscera.

" *Fig.* 4, Is a side view of the viscera and parts of generation after the membrane *b*, of Fig. 3. is removed, and the viscera, &c., cleared of the interstitial, or uniting vascular substance.

" *a*, The membrane, *b* in Fig. 3.

" *b*, The mouth.

" *c*, The œsophagus.

" *d*, The liver.

" *e*, The stomach.

" *f*, The intestine.

" *g*, A bristle placed in the anus.

" *h*, Is the vascular substance probably the tubular parts of the testicle.

" *i*, The *vas deferens* of one side leading into

" *k*, The penis.

" *Fig.* 5, Is a posterior view of the containing and contained parts.

" *a*, The cut edges of the side shells.

" *b*, The granulated covering described in Fig. 2.

" *c*, The immediate investing membrane described in Fig. 3.

" *d*, The posterior part of the stomach.

" *e*, Where the intestine was cut off from it.

" *f*, The liver on each side of the stomach.

" *g*, The two *vasa deferentia*, which unite into one in the penis."

As there are some subordinate parts in the structure of the Barnacle also represented in the above figures, but not noticed in the MS. description, additional letters of reference are here subjoined.

Fig. 1. *a*, Principal lateral valve; the letter is placed on the part corresponding to what, in Bivalves, is termed the " nates " of the shell. From *a* to *b* is the margin of the valve, to which the pedicle is attached, corresponding to the part in the bivalve shell to which the ligament is attached. *c*, The anterior margin of the valve, corresponding to that by which the

Muscle protrudes its foot and byssus, and where the tentacles of the Barnacle pass out. *d*, The smaller lateral valve, formed from a distinct centre of calcareous deposition. *e*, The fifth or azygos valve, corresponding to the intervening shelly piece in the hinge of the *Pholades*. *f, f*, The membrane, analogous to the mantle of testaceous Mollusks, which secretes the valves, connects them together, and completes the outward protecting case of the animal. *g*, The short peduncle by which this species adheres to the central ball.

Fig. 2. *e*, The divided transverse muscle, which connects together and closes the larger lateral valves. *f*, The radiating muscle, which attaches the soft parts to the same valves. *g*, The mouth of the animal.

Fig. 3. *d, d*, The branchiæ. *e*, The transverse muscle. *f*, The radiating muscle. *g*, The mouth.

Fig. 4. *l, l*, The outer envelope of the peduncle, formed by a continuation of the epidermal and muscular layers of the mantle. *m*, The smooth lining membrane of the mantle passing over the peduncle, but not continued into it. *n*, The pulpy granular substance of the peduncle. *o*, Cut end of the transverse muscle.

Fig. 5. *h, h*, The branchiæ.

Fig. 6. There is no description of this figure in the MS. Catalogue of Drawings. The soft parts, removed from the shell, are preserved among the organs of generation in the gallery. The figure represents a Bell-Barnacle (*Balanus tintinnabulum*, Lam.), with a portion of the shell and investing membranes removed to expose the contained viscera, twice the natural size.

a, a, The divided shell, which answers to the peduncle of the preceding species.

b, b, The cut edges of the opercular pieces, which correspond to the shelly valves in the pedunculate Cirripeds.

c, c, c, The mantle.

d, d, Muscles attaching the soft parts to the base of the shell.

e, e, The delicate immediately investing membrane of the viscera.

f, f, The jointed and ciliated tentacles.

g, The mouth.

h, The stomach.

i, The intestine, terminating as in *Pentelasmis* at the base of the genital tube.

k, The liver, which here, as in *Pentelasmis* and many of the Mollusks, communicates with the stomach.

l, One of the branchiæ. These organs differ from those of *Pentelasmis* in number, form and position; being only two, which are attached to the inner surface of the mantle, and are of a foliated structure.

m, The seminal canal, or testicle.

n, The genital tube, or ovipositor.

Respecting this part Mr. Ellis observes: "It rises from the middle of the base of the larger claws, and is longer than any of them: this the animal moves about in any direction with great agility; it is of a tubular figure, transparent, composed of rings lessening gradually to the extremity, where it is surrounded with a circle of small bristles, which likewise are moveable at the will of the animal. These with other small hairs on the trunk disappear when the animal dies. Along the inside of the transparent proboscis, the spiral dark-coloured tongue appears very plain: this, the animal contracts and extends at pleasure."—*Phil. Trans.* vol. l. *p.* 847.

The part which Ellis calls the tongue is the canal which Hunter regards as the continuation of the *vasa deferentia*, and which Cuvier denominates the oviduct. The elongated process which it traverses, or the proboscis of Ellis, Hunter terms *penis*, at the same time being fully aware that it was not an organ of intromission; for with respect to the generation of the Cirripeds he observes: "It is most probable that all Barnacles are of both sexes, and of the first class, viz. self-impregnators, for I never could find two kinds of parts so as to be able to say, or even suppose the one was female, the other male."—*Hunterian MSS.*

Cuvier terms the part in question "*le tube en forme de trompe*," and gives the following account of the generative system of the Barnacle.

"Immediately under the fibres of these muscles (*f*, Figs. 2. and 3. of Plate IV.) is found a substance composed of an infinite number of minute grains, which cover the intestines and extend even to the base of the feet. I conclude these to be the ova. A white vessel (*h**, Figs. 4 and 5.) ramifies throughout this ovary, and receives, without doubt, the ova at the proper season, to conduct them to the common sinus, from which a straight and simple canal conveys them to another canal, which is much larger and disposed in a zigzag manner with thick white and glandular parietes : this tube, preceding authors have been well acquainted with, and have regarded as a testicle. I partake of their opinion, and I imagine the ova are fecundated as they traverse it. This canal loses its glandular texture when it reaches the anus; it becomes then a simple and very thin oviduct, which penetrates the proboscidiform tube, which we have previously often had occasion to mention ; there it unites with its fellow from the opposite side in a very thin canal, which traverses the whole length of the tube, and terminates in a minute orifice at its extremity. It is by this outlet that the eggs escape ; but before they are distributed abroad, the animal preserves them a long time in packets concealed between its body and the mantle, forming there two or three irregularly shaped layers. When we find them, the animal is emptied of its ova and has its testicles much less swollen, which proves that oviposition has taken place, and the season of love is over, if indeed we can call by that name this species of solitary fecundation."—*Mém. du Mus.* tom. ii. p. 93.

PLATE V.*

Is illustrative of the anatomy of a Sessile Ascidian †, belonging to that division of the class which Cuvier has characterized as having the branchial sac simple, and which Savigny has termed *Phallusia.* The present figure, taken from the specimen No. 615, is the *Phallusia nigra* of the latter naturalist.

Fig. 1. *Phallusia nigra,* dissected, a little magnified. Mr. Hunter describes it thus : " This is one of the Soft-shelled tribe ‡, which is considerably

* Nos. 26 and 27, *MS. Catalogue of Drawings.*

† *ασκιδιον,* utriculum, *Baster, Opuscula subsiciva,* fasc. ii. p. 84, who seems not to have been aware that both the anatomical structure and living phænomena of this genus of Mollusk were known to and accurately described by Aristotle ; see lib. iv. cap. vi. of the *Historia Animalium,* Περι *των τηθυων,* &c.

‡ Mr. Hunter, who perceived the relations subsisting between *Ascidia* and *Salpa,* and knew the true analogy of their exterior covering, proposed to distinguish them as a distinct group of Mollusks under the term "soft-shelled," which more truly accords with their real nature than "shell-less" (Acéphales *sans coquille,*) as they have been subsequently designated by Cuvier.

Fig. 1.

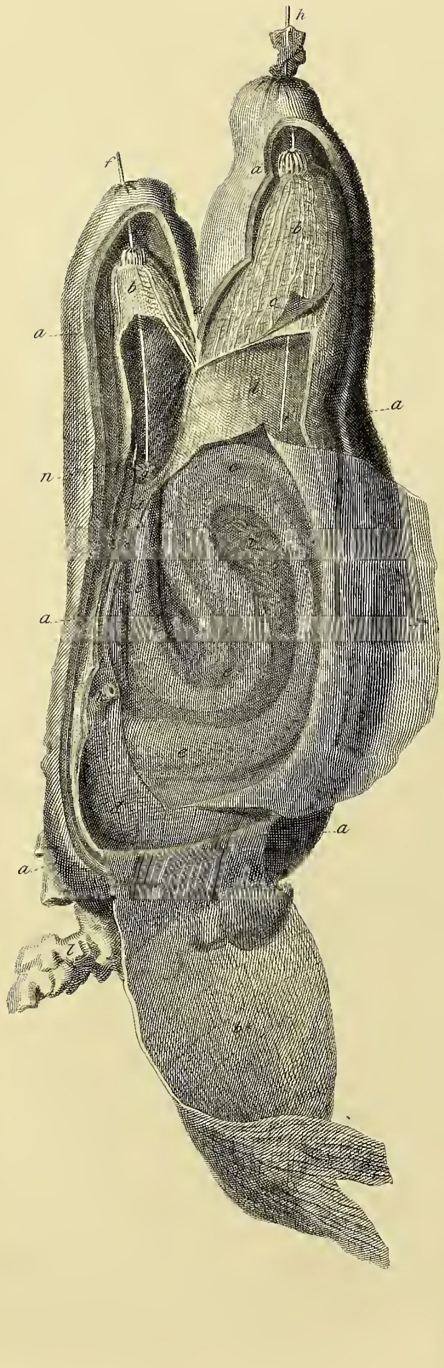
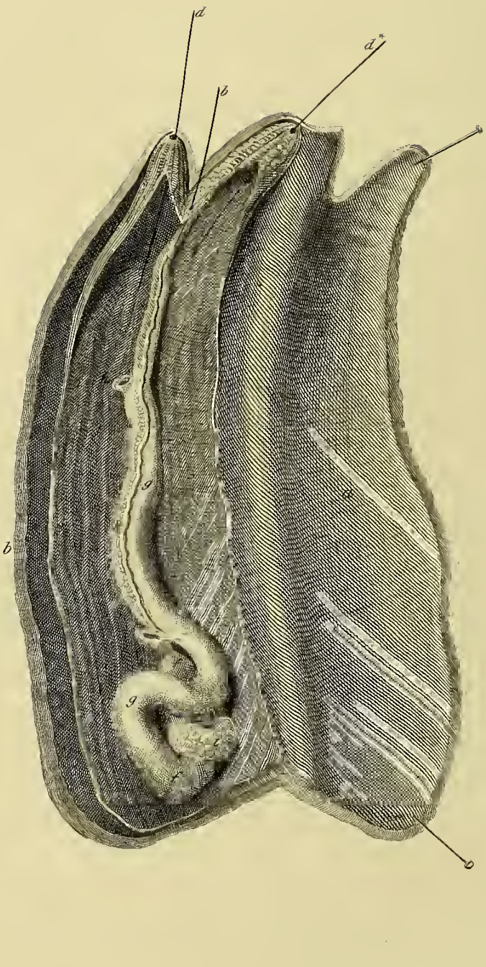


Fig. 2.



M. Bell del.

different from the former, (*Salpa,*) having two openings at one end, in two processes, within the soft shell. This animal is inclosed in a thin membrane, which is of the same shape with the external, and may be considered as a lining to it, the in- and out-lets of which are in the points of the processes opposite to those on the points of the outer shell. In this cavity are two orifices, which may be called mouth and anus, as they are the openings of a convoluted canal: this convoluted canal is intestine."—*MS. Catalogue of Drawings.*

a, The outer envelope, or soft shell.

b, The inner envelope, or that which lines the outer (analogous to the mantle of Bivalves).

b,* A portion of the same turned down, with the outer part of the branchial sac adhering to it.

c, A small portion of the mantle, reflected from the branchial sac.

d, d, The inside of the branchial sac. *d*,* The inner part of the branchial sac turned back to show the viscera.

e, e, e, The convolutions of the intestine.

f, A bristle introduced at the anal orifice of the shell, and passing into the anus, or termination of the intestine.

g, The anus.

h, A bristle introduced into the oral aperture of the shell, and passing through the corresponding aperture of the mantle into the branchial sac at *i.*

k, The mouth or entrance of the alimentary canal.

l, Some coral to which the animal had been attached.

m, The ovary.

n, The oviduct, into which a bristle has been passed.

Fig. 2. "Soft-shell. This drawing is made of one of those animals. Its shell is divided longitudinally nearly into two halves, with one half turned out: also one half of the inner lining wholly removed, to expose the different parts of the contents of the other."—*MS. Catalogue of Drawings.*

In this dissection the whole of the branchial sac has been removed.

No specimen in the collection answering to this figure has yet been found. In the smooth character and uniform thickness of the shell, it resembles the preceding species; but the intestinal canal is differently disposed, and a granular liver is distinctly indicated, which, according to Savigny, is wanting in the *Phallusiæ*, as it appears to be in Fig. 1.

a, One half of the outer envelope, turned aside.

b, The cut edge of the opposite side.

c, The mantle, which is ribbed or striped.

d, A bristle inserted at the anal apertures of the shell and mantle.

d *, A bristle inserted at the oral apertures of the same.

e, The mouth. *f*, *f*, The stomach. *g*, The intestine.

h, The anus. *i*, The liver.

k, "The granulated line lying on the intestine, and passing along to the end of the shell, along which granulated part is passing a line."

l, "A bristle introduced into a very small orifice, just at the union of the two forked ends of the shell, which leads into a canal or duct, and which is probably the opening of the parts of generation, or oviducts."—*MS. Catalogue.*

If this be really the termination of the oviduct, it is most probably an abnormal structure, that tube having been always observed to terminate below the anal outlet, as in the preceding figure.

PLATE VI.*

Is illustrative of the outward form and internal structure of a species of *Salpa*, or floating molluscous animal, called by Cuvier *Salpa cristata*.

Fig. 1. A small specimen undissected, but in which many points of the internal structure are visible through the transparent outward envelope.

Fig. 2. A similar specimen, with the outward envelope laid open, showing the more immediate covering of the viscera or mantle, which is traversed by muscular bands, and attached at the two orifices of the outer envelope, and at the base of the crest, or lateral process.

Fig. 3. A similar specimen, in which both the outer and the muscular envelopes are laid open, so as to show the contained viscera, the points of attachment of the mantle, and the valvular structure of the inferior aperture, by

* Nos. 23 and 24, *MS. Catalogue of Drawings.*

Fig. 1

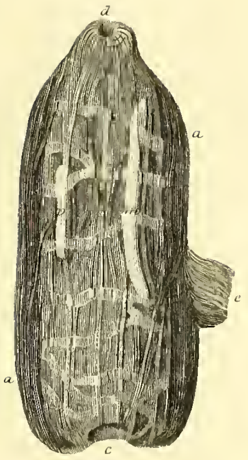


Fig. 2

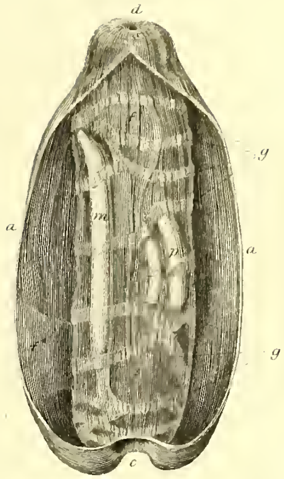


Fig. 3

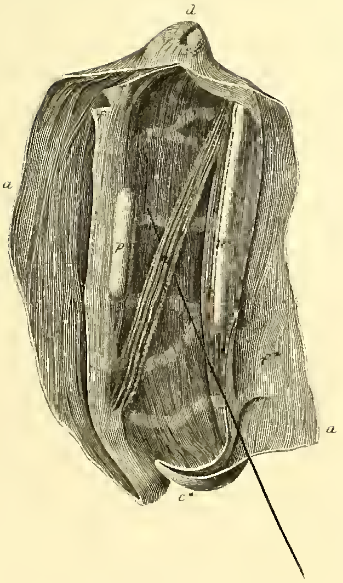
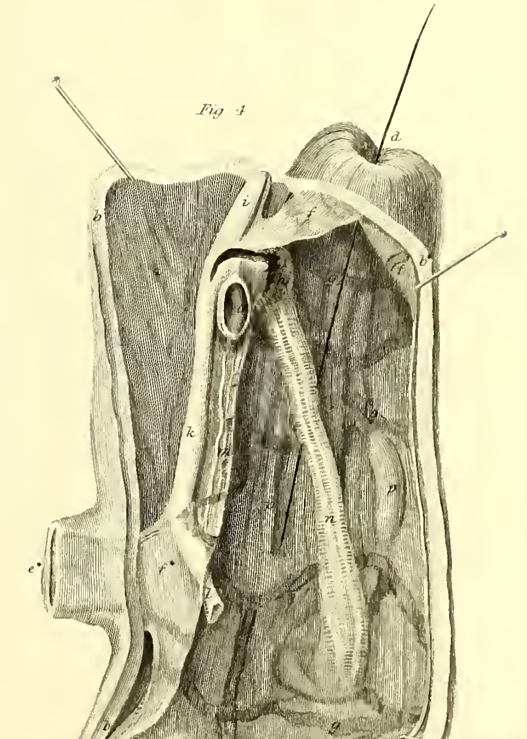


Fig. 4



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T. Bradley sc.

which the sea-water is admitted into the interior of the animal's body, and thence projected by the simultaneous contraction of the muscular bands through the opposite outlet.

This is the sole action observable in the living animal, and suffices at once for locomotion, nutrition, respiration and oviposition.

Fig. 4. A larger specimen dissected, so as to display more clearly the different organs. The outer envelope, as in the Ascidians, is analogous to the shell of the bivalve Mollusks : it is represented in this figure as being cut open and turned aside, which shows its thickness. The mantle is also laid open, but left adhering to its natural points of attachment: a bristle, inserted at the outlet of the shell, is placed beneath the branchial organ. In the preceding figure a bristle is also passed beneath the branchia from the opposite orifice of the shell.

The same letters are used in the different figures to denote the same parts.

a, The outer envelope or shell, of a firm gelatinous or cartilaginous texture. In *Fig.* 4, the letter is placed on the internal surface.

b, *Fig.* 4, The cut edges of the shell. *b**, The same of the opposite side.

c, The inferior aperture or inlet of the shell.

*c**, *Fig.* 3, Its valve.

d, The superior aperture or outlet of the shell.

e, The lateral process or crest, from which the *nomen triviale* of the species is derived: it is the part by which different individuals unite themselves into a chain, which is sometimes of considerable length.

*e**, in *Fig.* 4, shows an aperture in this process.

f, The inner envelope analogous to the mantle of the bivalve Mollusks.

*f**, Its attachment to the crest.

g, *g*, The muscular bands.

h, *Fig.* 4, The oral orifice of the alimentary canal laid open.

i, The blind end of the alimentary canal or stomach.

k, The intestine.

l, The anal orifice of the alimentary canal.

m, The liver.

n, The branchia, or respiratory organ.†

† See the Note †, p. 134 of this Catalogue.

o, The heart in its pericardium, which is laid open.

p, p, Two glandular organs, supposed to be the ovaries.

Respecting this species of *Salpa* Mr. Hunter observes: "Several of these bodies are attached longitudinally to one another like columns, their ends making the surface of the plane, like a honeycomb. Whether they are squares or hexagons I do not know. They consist of a transparent shell, open at both ends, but one end more contracted than the other, and a little pointing, and which would appear to be analogous to the projecting opening of the former: the opening at the other ends is similar to the opening of the former."—*MS. Catalogue of Drawings.*

Mr. Hunter's observations on Fig. 4, are appended to the description of the specimen from which the drawing was taken †.

PLATE VII. ‡

Is illustrative of the anatomy of *Salpa gibbosa*, Gaimard, (*Freycinet Zoologie de l'Oranie*, ii, p. 506 §).

Fig. 1. One half of the outer envelope is removed, showing the internal parts or viscera, the under part being cut off, and the whole a little magnified.

a, a, The cut edges of the outer envelope or shell.

b, b, The inner surface of the outer envelope or shell.

c, c, The inner envelope or mantle.

d, d, The ear-like processes, into the cavity of one of which, *d**, a bristle has been passed.

e, e, The outlet of the shell laid open. (Mr. Hunter calls it the mouth of the shell.)

f, A bristle inserted at the oral orifice of the alimentary canal (the mouth of the viscera).

g, g, The stomach and intestine laid open.

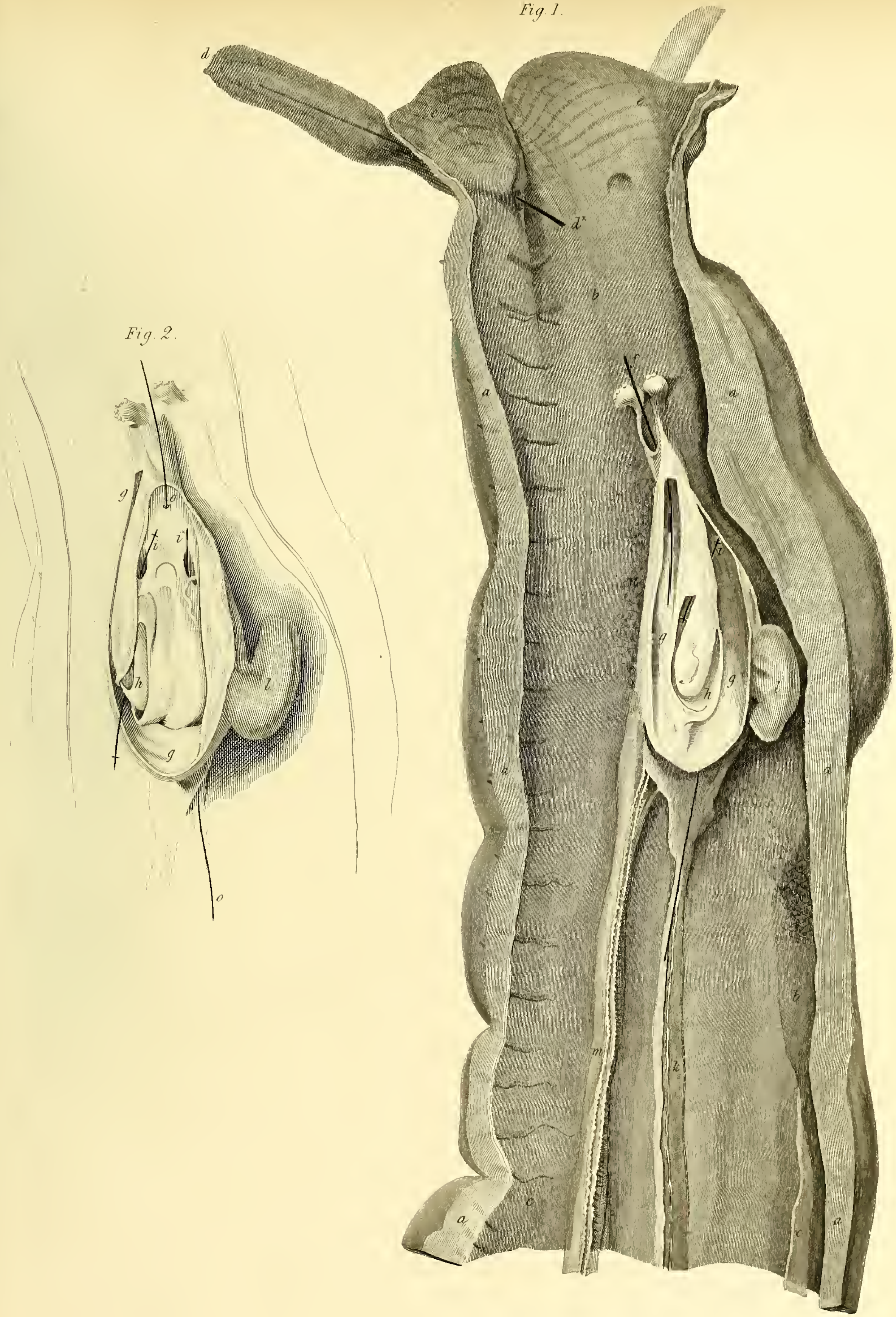
† See No. 485, p. 135 of this Catalogue.

‡ Nos. 20 and 21, *MS. Catalogue of Drawings.*

§ The specimens described by the French naturalists were taken at the Society Isles.

Fig. 1.

Fig. 2.



Wm Bell del.

Zeitter, sc

R.d Owen, del.

Zeitter sc.

h, One of the cæcums, laid open: a bristle, *i,* is passed through the communication of this cæcum with the intestine.

k, The furrow or canal leading from the vent to the inlet of the shell.

l, A glandular body, " the structure or use of which is not known."

m, The branchia.

n, Ova connected together, situated between the mantle and shell, behind the digestive organs.

Fig. 2. The digestive organs of *Salpa gibbosa,* turned a little to one side to show the orifice in which the bristle *i* is put at Fig. 1, as well as the orifice of the second cæcum, *i**. (Qu. Are these a rudimentary liver?)

g, h, and *l,* as in Fig. 1.

o, The orifice which leads to the continuation of the alimentary canal, with a bristle in it.

The specimen from which the above drawings were made is No. 480.

PLATE VIII.

The animal or soft parts of the Nautilus Pompilius, with the oral sheath laid open on the dorsal aspect, the tentacles displayed, and the digestive organs exposed†.

a, a, The superior surface of the oral sheath, longitudinally divided and separated.

b, b, The posterior lobes of the same.

c, c, The posterior concavity of the same.

d, d, The posterior ridge in that concavity.

e, e, The cut surfaces of the above.

f, f, The internal surface of the oral sheath.

g, g, The external labial processes.

h, h, The external labial tentacles.

i, i, The internal labial processes.

k, k, The internal labial tentacles.

l, The olfactory laminæ.

m, m, The circular fringed lip longitudinally divided.

† See Nos. 499 A, 788 A.

n, The superior mandible encased in
o, The inferior mandible.
p, The muscular basis on which the mandibles are fixed.
q, *q*, The superior pair of muscles which retract the jaws.
r, *r*, The semicircular muscle which protrudes the jaws.
s, The œsophagus.
t, The ingluvies, or crop.
u, The narrow canal leading to
v, The gizzard.
w, The intestine. *w'*. The terminal fold drawn out of its natural situation.
x, The anus.
y, The laminated pancreatic organ.
z, z, The liver.

15. A branch of the anterior aorta which ramifies in the membrane or mesentery, connecting the last two portions of the intestine. 19. The continuation of the posterior aorta along the dorsal aspect of the crop. 20. Its bifurcation at the œsophagus to form a vascular circle corresponding to the nervous circle round that tube.

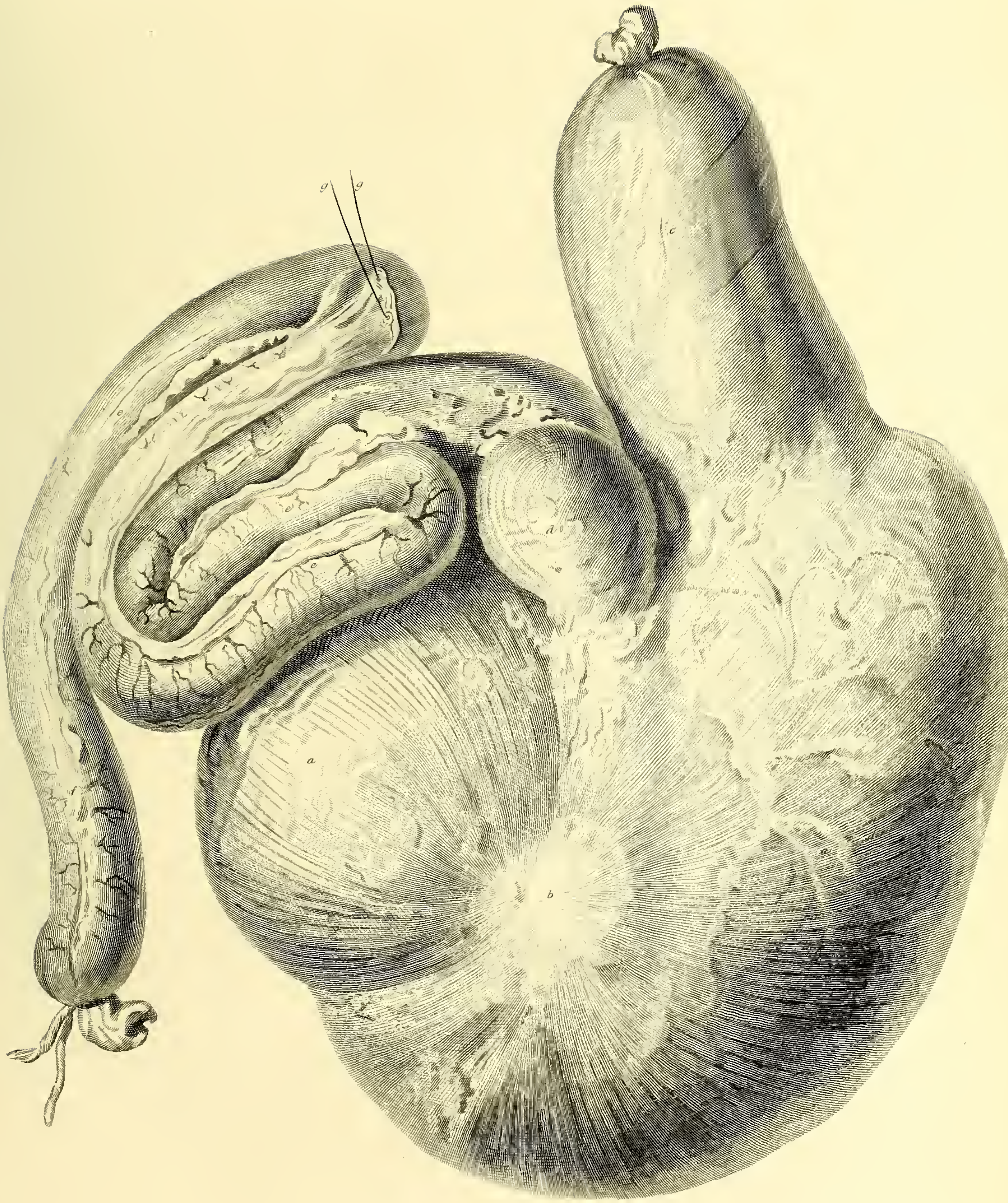
21. and 22. Arteries of the crop and gizzard.

PLATE IX.*

"The stomach of the Crocodile, (*Crocodilus acutus*, Cuv.,) which (similar to many other parts of the body,) is very like the stomach of a bird; and as it eats animal food, it is similar to those of the carnivorous kind. Its shape, the tendon in the middle, and the turns of the duodenum, are a good deal alike.

"*a*, The body of the stomach, which is muscular.
"*b*, The tendinous part of the stomach.
"*c*, The œsophagus.
"*d*, A small bag at the opening of the duodenum.
"*e*, The turns of the duodenum.
"*f*, Where the duodenum becomes loose.
"*g*, Two bristles where the ducts of the gall-bladder and liver enter."—*MS. Catalogue*

* No. 41, *MS. Catalogue of Drawings.*



J. Van Rymsdyk del.

Thos Bradley sculp.

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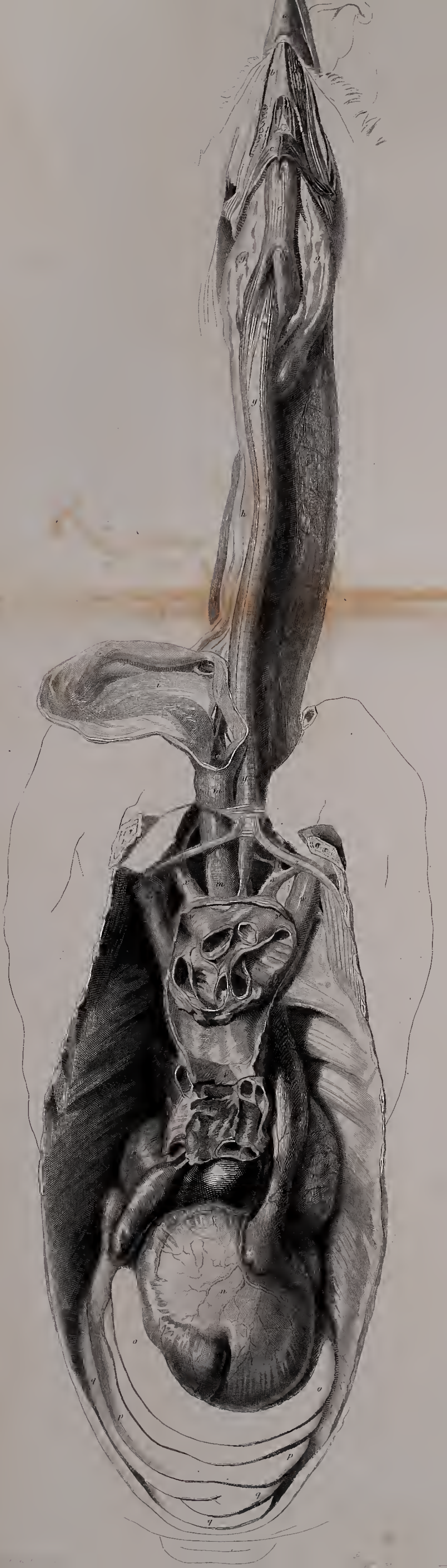


Fig. 2.

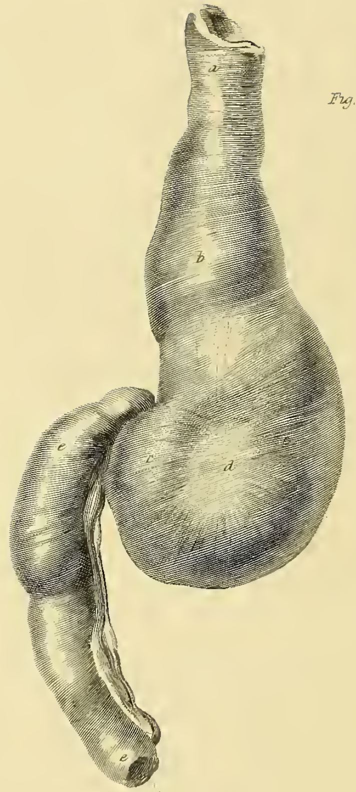


Fig. 1.

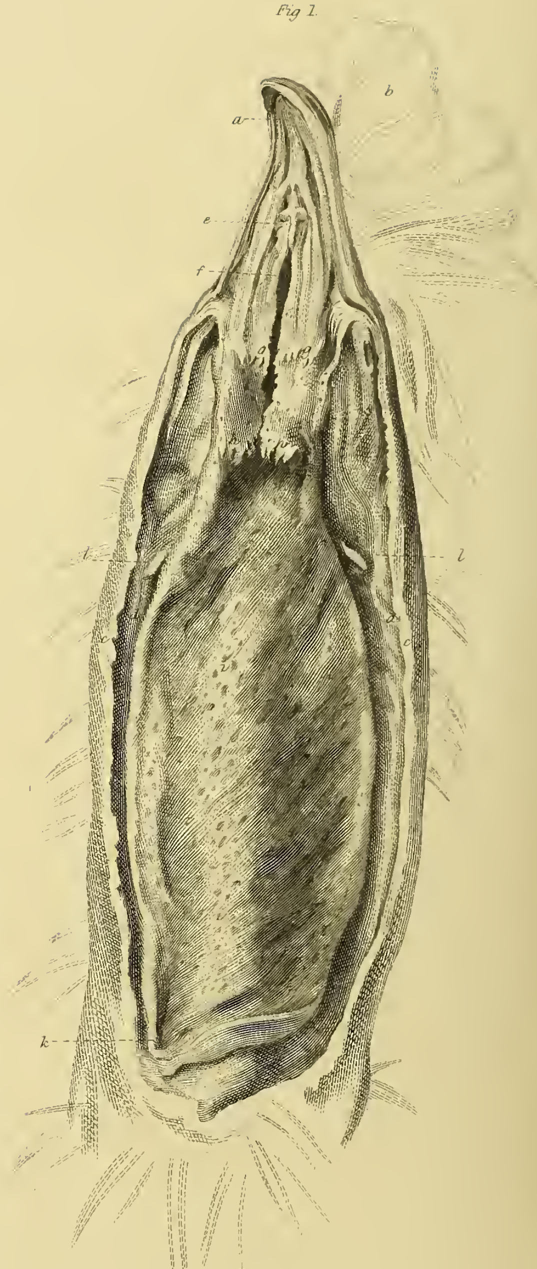
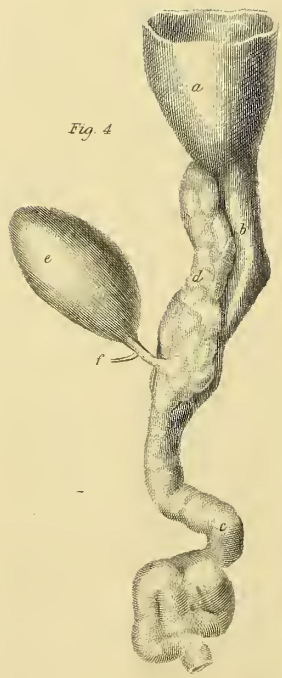


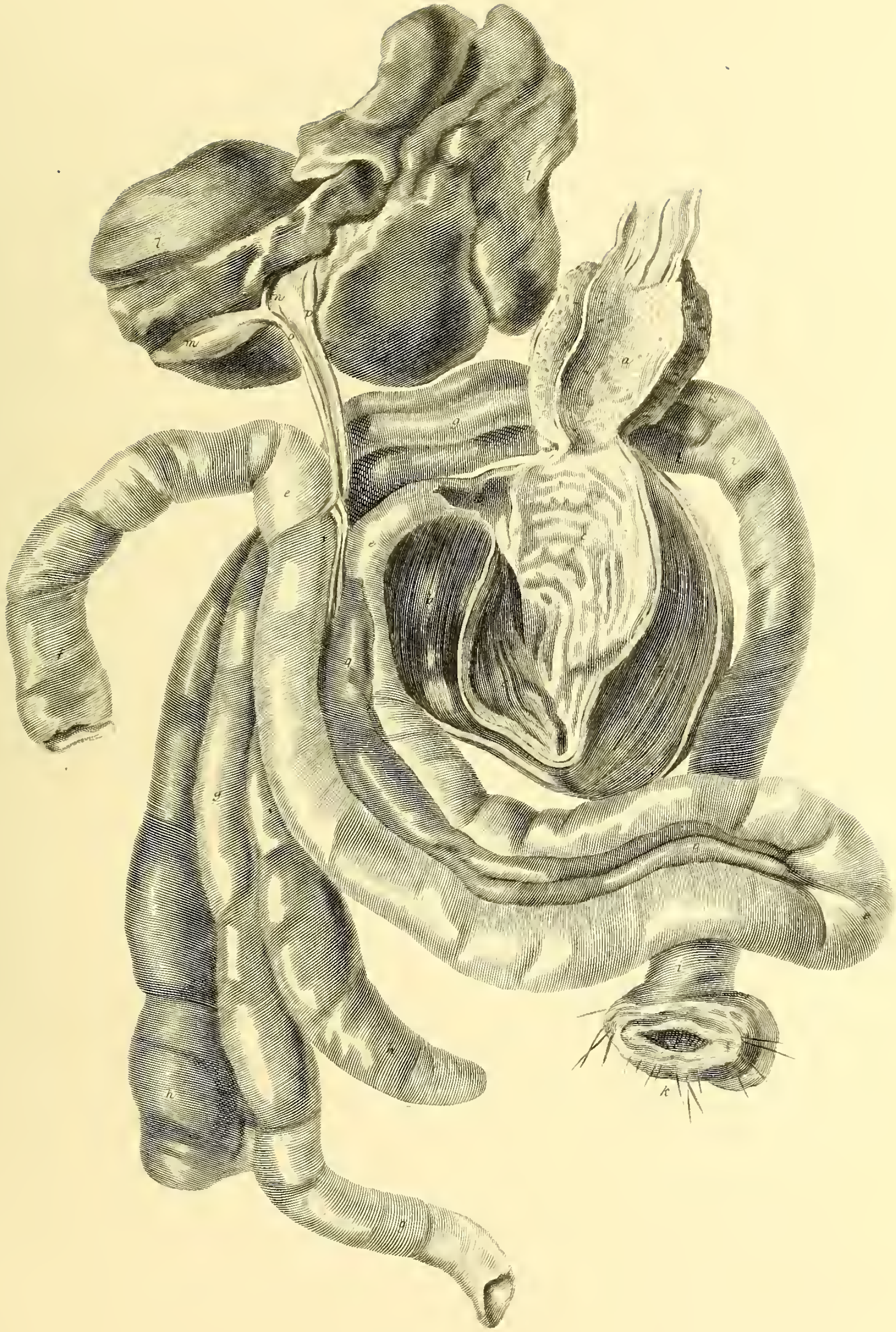
Fig. 3.

Fig. 4.



J. Van Rymsdyk del.

T. Bradley sculp.



J. Van Rymsdyk del.

Thos Bradley sculp.

PLATES X. XI. XII. XIII.

DIGESTIVE ORGANS OF BIRDS.

"*Of the Digestive Powers of the Fowl.*

"The construction and number of the digestive powers in the bird are not exactly similar to those of other animals. From the circumstance of birds not having teeth, which are to be considered the first parts relative to digestion, the other parts are obliged to be so constructed as to answer those purposes: and even their mode of hatching makes a division in the belly peculiar to them. But this difference in the construction of the digestive powers for the want of teeth, is not necessary in all birds, because many birds live on such food for which it is not necessary to have teeth, and of course not necessary to have a substitute for them in the other powers of digestion; such as those which live upon animal food; but more especially those which live upon small part of insects, where it requires not teeth to divide or masticate, nor any part as a reservoir, because the smallness of the object requires almost a constant feeding."—*MS. Catalogue.*

Plate X.* "Is taken from a Cock. The cavity of the lower part of the neck, the chest and belly are exposed; most of which have some connexion with digestion.

"*a*, Is the neck with the skin on.

"*b*, The pectoral muscle.

"*c*, The cut ends of the pectoral muscle.

"*d*, The muscles of the thigh.

"*e*, A panniculus carnosus.

"*f*, The ends of the ribs and abdominal muscles.

"*g*, The heart inclosed in its pericardium.

"*h*, A doubling of the pericardium uniting the basis of the liver and stomach together.

"*i*, The crop, with a thin muscle covering it, arising from the clavicle, and lost in the skin of the neck.

* No. 45, *MS. Catalogue of Drawings.*

"*k*, A part of the same muscle covering the pectoral muscles.

"*l*, The stomach or gizzard covered with a fat membrane, whose lateral and lower edges are attached to the abdominal muscles, acting as a kind of epiploon.

"*m*, *m*, The duodenum at its first turn and second turn.

"*n*, The other intestines.

"*o*, The upper lip of the anus flapped over the under.

"*p*, The right and left lobes of the liver.

"*q*, The pancreas between the two folds of the duodenum."—*MS. Catalogue.*

Plate XI.* "Is the exposure of some of the deeper seated parts, some of the more superficial being removed; besides which it exposes many parts that have no immediate connexion with digestion, therefore no further notice will be taken of them in this place than what is necessary to explain situation, &c., of parts essential to digestion.

"*a*, The under beak.

"*b*, The membrane of the mouth at the side of the tongue.

"*c*, The muscles of the tongue, os hyoides and lower jaw.

"*d*, A thin salivary gland that enters the mouth by several small orifices.

"*e*, A small salivary gland, whose duct passes through the membrane of the mouth at the side of the tongue: the right one is turned outwards to show these ducts.

"*f*, A small cartilage belonging to the os-hyoides.

"*g*, The fauces.

"*h*, The œsophagus above the crop.

"*i*, The crop opened.

"*k*, The upper orifice opening into the crop.

"*l*, The lower orifice.

"*m*, The lower œsophagus.

"*n*, The gizzard.

"*o*, The first turn of the duodenum.

"*p*, The second turn of ditto.

"*q*, The other intestines. (The three last are only in outline.)

* No. 46, *MS. Catalogue of Drawings.*

" *r*, The basis of the liver, the body of it being cut off, on which are seen six orifices of the vena cava hepatica and vena portarum.

" *s*, The gall-bladder.

" *t*, The spleen.

" *u*, The two testicles.

" *v*, The attachment of the pericardium, within which is seen the heart, exposing the mouths of the vessels coming in and going out.

" *w*, The two venæ cavæ superiores.

" *x*, The two carotids and subclavians.

" *y*, The trachea.

" z, The suspensory muscles of the trachea."—*MS. Catalogue*.

Plate XII. *Figs*. 1. and 2.* from the Hawk.

"The great difference in the bird, between the carnivorous and graminivorous, in the digestive powers, is in the stomach and cæca. In the carnivorous, it is rather a bag than a gizzard, being very thin in its coats. However it still retains some of the characters of the gizzard, such as shape, direction of its muscular fibres, and a small tendon.

" *Fig*. 1. *a*, The œsophagus.

" *b*, The membranous part of the œsophagus.

" *c*, The muscular part of the stomach.

" *d*, The tendinous part.

" *e*, The first part of the duodenum.

" *Fig*. 2. *a*, The last part of the ilium, where it enters into the rectum.

" *b*, The cæca.

" *c*, The rectum.

" *d*, The last and enlarged part of the rectum laid open.

" *e*, The anus laid open.

" *f*, The external skin of the anus.

" *g*, The two ureters.

" *Fig*. 3.† Is the head of a Cock, with the lower jaw taken off, and the fauces cut longitudinally into two, to show the glandular appearance of these parts, being orifices of small glands, which secrete a mucus for deglutition.

* No. 42, *MS. Catalogue of Drawings*. † No. 48, *Ibid.*

" *a*, The hollow of the upper jaw.

" *b*, An outline of the comb.

" *c*, The external skin of the head and neck.

" *d*, The neck behind the œsophagus.

" *e*, The roof of the mouth, having little eminences upon its surface.

" *f*, The posterior nares, which is a long slit in the posterior part of the roof of the mouth.

" *g*, A row of pyramidal bodies on each side of the posterior nares.

" *h*, A row of pyramidal bodies on each side of the posterior end of the slit.

" *i*, The fauces marked with the mouths of small glands.

" *k*, The opening into the beginning of the œsophagus, which is not cut through.

" *l*, The ends of the os hyoides."—*MS. Catalogue.*

Fig. 4.* " Part of the stomach and duodenum, with the gall-bladder and pancreas of the Water-snake" (*Pelamis bicolor*, Daudin, see No. 508.).

a, The stomach.

b, The pyloric canal.

c, The intestine.

d, The pancreas.

e, The gall-bladder, situated in this as in most of the Ophidian reptiles at some distance from the liver.

f, The hepatic duct.

" Plate XIII.† is taken from a Duck, and represents the liver, stomach, duodenum, pancreas, termination of the ilium, with the two cæca and rectum, the other intestines being cut off to avoid confusion. The parts are as much in their situation as possible to be, out of the body, and to show the parts distinct; for the liver is turned up, the rectum is more behind the gizzard, and the cæca turned round closer to the gizzard, and more behind than natural.

" The œsophagus is slit open, and a piece is taken out of the stomach to show its cavity.

" *a*, The lower glandular part of the œsophagus (or proventriculus), and its entry into the cavity of the stomach.

* No. 39, *MS. Catalogue of Drawings.* † No. 47, *Ibid.*

" *b*, Muscular parts of the stomach on each side of the cavity.
" *c*, The cavity of the stomach, with the horny coat on.
" *d*, The beginning of the duodenum opened a little way into the gut.
" *e*, *e*, The whole fold of the duodenum.
" *f*, The beginning of the jejunum.
" *g*, The termination of the ilium into the rectum.
" *h*, The two cæca.
" *i*, The rectum *.
" *k*, The anus.
" *l*, The under surface of the liver.
" *m*, The gall-bladder.
" *n*, The cyst-hepatic duct.
" *o*, The cystic duct.
" *p*, The hepatic duct.
" *q*, The pancreas, lying in the fold of the duodenum.
" *r*, The two ducts of the pancreas."—*MS. Catalogue*.

"* Birds cannot be said to have a colon."

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