PALÆONTOGRAPHICAL SOCIETY.

MONOGRAPH:

FOSSIL REPTILIA

OF THE

LONDON CLAY.

BY PROFESSOR OWEN.

PART II.—CROCODILIA AND OPHIDIA.

1849.

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PART II.

CROCODILIA, OPHIDIA.

BY

PROFESSOR OWEN, F.R.S., F.L.S., F.G.S., &c.

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MONOGRAPH

ON THE

FOSSIL REPTILIA OF THE LONDON CLAY.

SUPPLEMENT TO THE ORDER—*CHELONIA.*

Family—PALUDINOSA.

PLATEMYS BOWERBANKII (?). Tab. XXIX, figs. 1, 2.

The evidence of species of Chelonia of the Fresh-water or Marsh-dwelling family, *Paludinosa,* has hitherto been derived only from such parts of the skeleton of the trunk as have been described, figured, and referred to the genera *Platemys* and *Emys,* in Part I of the present Monograph, pp. 62-76.

Since those pages were sent to press, Mr. Bowerbank has been so fortunate as to obtain from the Eocene clay at Sheppy the portion of fossil skull, of which two views are given of the natural size in T. XXIX, figs. 1, 2. If these figures, and especially the side view, fig. 1, be compared with the corresponding view of the skulls, T. I, fig. 1; T. III, fig. 1; T. XV, fig. 1, or T. XI, fig. 2, a marked difference will be discerned in the form and proportion of the orbit, which is smaller and more nearly circular in fig. 1, T. XXIX.

But the bony chamber for the eyeball forms one of the characters by which the skull is distinguished in the marine and fresh-water families of the order *Chelonia.* The orbit, for example, is always much larger in proportion to the entire skull in the marine species, and commonly of the oval form, which is preserved in the beautiful fossil skull of the *Chelone cuneiceps,* T. XV, fig. 1; or with the upper and outer part even more produced and angular than is there represented. In the families *Fluvialia* (Trionyx) and *Paludinosa* (Emydians), the orbit is not merely much smaller in proportion to the skull, it is circular, or nearly so, and not produced at the upper and outer angle. By this character, we are led to refer the fossil skull under description to the fresh-water division of the Chelonian order.

Our choice between the Fluviatile or Paludinose families of that division is guided by the formation of the border of the orbit, and by the proportionate length and the form of the face or muzzle in advance of it.

In the species of *Emys* (*Podocnemys expansa*) which I have selected for comparison, as offering upon the whole the nearest approach, which any Chelonian skull at my command gives, to the unique fossil in question, the malar bone (*i*, in Cuvier's figure of the skull of *Emys expansa*, pl. xi, fig. 9, of the 'Ossemens Fossiles,' tom. v, pt. ii, 1825; 26 in the figure of the fossil, fig. 1, T. XXIX), becomes much contracted as it approaches the orbit, to which it contributes a small part of the posterior border. In the *Chelones* the malar bone forms a larger proportion of the orbital rim (see Cuvier, tom. cit., pl. xi, fig. 1 *i*), and contributes more to its under than its back part, which is chiefly formed by the characteristically large postfrontal 12 (*g* in Cuvier's figs.); and this character was manifested in the ancient Eocene turtles as well as in the modern species, as may be seen by reference to the bones numbered 26 and 12, in T. I, fig. 1; T. XV, fig. 1, of the present work. The superior maxillary bone 21 (*b* in Cuvier's figs.) is longer in the *Emys*, extends further back in the orbit, and is deeper at its posterior termination, than in the *Chelones*. In all these characters, derived from the bones entering into the formation of the orbit, the fossil under comparison agrees with the *Emys*, and, indeed, departs further from the *Chelones* than the *Podocnemys expansa* does, by the much smaller proportion in which the anteriorly contracted malar bone (26) contributes to the rim of the orbit. In the *Trionyces*, the malar bone forms a larger proportion of the border of the orbit than in the *Podocnemys expansa*, and *a fortiori*, than in the fossil in question.

The choice between the Fluviatile or Paludinose tribes of the fresh-water Chelonians, in the determination of this fossil, is better guided by the form and proportions of the skull anterior to the orbit. In the recent *Trionyces* the muzzle is more acute, and in most of them more prolonged than in the Emydians, with which the fossil skull agrees in the shortness of the muzzle; whilst it departs further than most recent Emydians from the *Trionycidæ*, in the broad truncated character of its anterior termination. There is also a very well-marked character of affinity to the *Podocnemys expansa*, in the smooth and shallow canal which extends from the fore part of the orbit forwards to the border of the external nostril across the upper part or nasal process of the superior maxillary bone (21). This groove is very accurately represented in fig. 1, T. XXIX, in the fossil; it is rather broader in proportion to its length in the *Podocnemys expansa*; but so far as it has depended upon the presence and arrangement of the facial scutes, it is decisive against the fossil having appertained to any species of soft turtle (*Trionyx*), in which such epidermal parts were entirely wanting.

The marks of the supracranial scutes in the fossil are, as in some Emydians, too feebly and obscurely traceable to permit of a satisfactory comparison of their arrangement. The exterior surface of the prefrontal (16), frontal (11), postfrontal (12), and parietal (7) bones is subreticulate. The substance of the bones is thick and coarsely cancellous. The nasal bone is connate with the prefrontal, as in most modern Emydians; in the proportion of this compound bone the fossil resembles more the ordinary

Emydians (*Emys europæa*, e. g.) than it does the *Podocnemys expansa*. The border of the prefronto-nasal bone forming the upper part of the nostril is thick and rounded; as is also the lateral border of the same cavity formed by the maxillary. The lower part of this border of the maxillary shows the suture for the premaxillary, which must have presented similar proportions to the premaxillary of the *Podocnemys expansa* and other Emydians. The shape of the frontal (11), the proportion of the upper border of the orbit which it forms, and the course of its sutures with the contiguous bones, are clearly indicated in fig. 2, T. XXIX. The straight line formed by the suture between the frontal (11) and postfrontal (12) resembles that in the *Podocnemys expansa;* it is bent or curved in the *Chelones*. To what extent the postfrontal (12) was continued backwards, whether so, as with the parietal, to roof over the temporal fossa, as in the *Podocnemys expansa*,* or, in a less degree, leaving that fossa open superiorly, as in the Emydians generally, is a question which will require for its determination a more perfect specimen than the fossil under description. The thickness, however, of the fractured posterior part of the postfrontal indicates that the bone had been broken not very close to its natural posterior border, on the supposition that this was free, as in the Emydians generally; and the part of the suture of the postfrontal with the parietal which has been preserved, extends obliquely outwards and backwards, as in *Podocnemys expansa*, not directly backwards, as in most of the *Emydes* with open temporal fossæ. (Compare Cuvier, loc. cit., fig. 10 with fig. 14, the suture between *g* and *h*.) With respect to the parietal bones (7), these are too much mutilated to show more than the position and extent of the coronal suture.

A few words may be perhaps expected relative to the difference which the fossil in question presents to the land-tortoises. In comparison with the skull of a *Testudo indica* of corresponding dimensions with the fossil, the larger proportional size of the orbits distinguishes the skull of that terrestrial species almost as strongly as the same character does the skull of the marine turtles. But in addition to this, the malar bone forms a larger proportion of the back part of the orbit in the *Testudo*, and the prefronto-nasal part of the skull is more bent down; the suture between the frontals and prefrontals describes a curve convex forwards in the *Testudo*, whilst it deviates very little from a straight line in the fossil, and that little is convex backwards. The extent also of the upper surface of the postfrontals and parietals, so far as these are preserved in the fossil, is greater than the whole of those bones in the land-tortoise compared.

Having been led by the foregoing comparisons to refer the fragment of the fossil skull (T. XXIX, figs. 1, 2) to the family *Paludinosa*, it is reasonable to conjecture that it may have appertained to some one of the large Emydians, which we already know to have left their carapaces in the Eocene clay of Sheppy. One commonly finds in

* See Cuvier, loc. cit., pl. xi, fig. 1 *a*.

the recent skeletons of Emydians, that any particular character of the exterior surface of the bones of the trunk is repeated on the upper surface at least of the bones of the head. This comparison, in the present instance, indisposes me to regard the fossil in question as having belonged to the *Emys levis*, or to the *Emys bicarinata*, or to the *Platemys Bullockii* with the punctate plastron. I should be rather led to select the *Platemys Bowerbankii* from the character in question, as exhibited by the carapace and plastron described at p. 66. But, in provisionally registering the fossil skull in question under the name of *Platemys Bowerbankii*, I should wish to be understood as by no means vouching for the accuracy of the reference. The conjecture rests solely on the character above referred to, which is far from being decisive; and its only value is, that it happens to be the only one by which we can be guided at present in forming any opinion at all as to the specific relations of the fossil in question.

PART II.

ORDER—*CROCODILIA.*

CROCODILES, ALLIGATORS, GAVIALS.

OF the numerous and various kinds of Reptiles, the fossil remains of which have been discovered in the tertiary and secondary strata of Great Britain, many are found to have their nearest representatives, amongst the actual members of the class, in the present order; and here more particularly in the long and narrow-snouted genus called, through a corrupt latinization of its native name, *Gavialis*, which is now represented by the Gavial or, more properly, Garrhiāl, of the river Ganges.

In the interpretation of the fossil remains of Reptiles, no skeleton has more frequently to be referred to than that of the Gavial or Crocodile, or has thrown more light on the nature of those singularly modified forms of the class which have long since passed away.

It is accordingly requisite for the palæontologist who would describe the fossil remains of reptiles, to make himself, in the first place, thoroughly conversant with the osteology of the recent *Crocodilia.* This knowledge can be gained only by assiduous study of the skeletons themselves, with the aid of the best descriptions, or the guide of a competent teacher. But to enable the reader to follow or comprehend the description of the fossil Saurians, some elementary account of the Crocodilian skeleton is at least necessary, accompanied with illustrations of the parts which, in the sequel, will have to be frequently referred to under special or technical names.

In Tab. XI of the present part of this Monogragh is given a reduced or miniature side view of the skeleton of a Gavial which was twenty-five feet in length—dimensions which are rarely found to be surpassed in the present day. Beneath it is a restoration of the skeleton of the Teleosaur, or extinct Gavial of the Triassic or Oolitic period, showing how closely the general type of conformation has been adhered to, the modifications of the more ancient form of Crocodile evidently adapting it for moving with greater speed and facility through the water, and indicating it to have been more strictly aquatic, and probably marine.

The particular nature of these modifications will be explained when I come to describe the Crocodiles of the secondary strata. I propose at present to give a preliminary sketch of the osteology of the recent *Crocodilia.*

A glance at a natural or well-articulated skeleton of one of these reptiles, such as is figured in T. XI, will show that it consists mainly of a series of segments, more or less alike. From the back of the head to the end of the tail, the chief part of each segment consists of a cylindrical portion or 'body,' differing only in its proportions, and diminishing as it recedes from the trunk. Every segment sends a plate of bone upwards from its upper or dorsal surface, which plate or 'spine' is supported by an arch of bone, except in the diminishing segments at the end of the tail.

Other plates of bone, of more variable forms and dimensions, project from each side of the segments of the trunk and basal part of the tail. In a less proportion, but still in a great number of the segments, an arch of bone is formed below, or on the ventral side of the cylindrical body ; but this lower arch is more variable in its proportions and mode of composition than the upper arch : it is open or incomplete in the neck. Under all these variations, however, there is plainly manifested a fundamental unity of plan in the composition of the different segments, which have accordingly received the common appellation of 'vertebra.'

For the convenience of description, the vertebræ are divided, though somewhat arbitrarily, into groups bearing special or specific names. Those next the head, with the inferior arch incomplete below, are called 'cervical vertebræ;' they are usually nine in number : those that follow with the inferior arch closed below, or which have the laterally projecting parts slender and freely moveable, are called 'dorsal vertebræ ;' the other vertebræ of the trunk that have no lateral moveable appendages, are called 'lumbar vertebræ ;' the last vertebræ of the trunk, always two in number in the *Crocodilia*, the inferior arches of which coalesce to support and be supported by the hind limbs, are the 'sacral vertebræ ;' the segments of the tail are the 'coccygeal,' or 'caudal vertebræ,' whether they possess or not an inferior arch, or whatever other modifications they may offer.

These names, 'cervical,' 'dorsal,' 'lumbar,' 'sacral,' 'coccygeal,' were originally applied to corresponding segments or vertebræ in the human skeleton, from the study of which the nomenclature of osteology takes its date : it may well be supposed, therefore, that a classification and designation of vertebræ based upon knowledge limited to their characters in a single example of the vertebrated series, and that example one in which the common type has been most departed from, to adapt it to the peculiar attitude and powers of the human species, would fall far short of what is required to express the general ideas derived from a comparison of all the leading modifications of the vertebrate skeleton ; and accordingly the anatomist who passes from a previous acquaintance with human osteology only, to the study of those of the lower Vertebrata, finds that he has to rectify, in the first place, the erroneous notions which anthropotomy has taught him of the nature of the primary segment of his own and other vertebrated skeletons, and to acquire true ideas, with the concomitant nomenclature, of the essential constituents or anatomical elements of such segment.

In human anatomy, for example, the costal elements are only recognised when they retain throughout life that distinctness, or moveable union with the rest of their segment, which they manifest at their first appearance; and they are then classified as distinct bones from the rest of their segment, to which the term 'vertebra' is restricted, and which is equally regarded as a single bone; as, e. g., in the dorsal region of the skeleton. In the cervical region the whole segment is called 'vertebra,' and is recognised as the equivalent bone to a dorsal vertebra, although it includes the costal elements, because these have coalesced with the rest of their segment, which anchylosis is misinterpreted as a mere modification of a transverse process; and the 'cervical vertebra' is distinguished by having that process 'perforated,' and not entire as in the other vertebræ.

But, in the Crocodile, the embryonic condition of the cervical ribs in Man is retained throughout life; and, therefore, if we were to be guided by the characters laid down by the recognised authorities in anthropotomy for the classification of its vertebræ, we should seek in vain for any vertebræ with "transverse processes perforated for the transmission of vertebral arteries," whilst we should find all the vertebræ from the head to the loins, "with articular surfaces, either on their sides or their transverse processes, where they join with ribs," and should accordingly have to reckon these as "dorsal vertebræ."

These and many similar instances which might be adduced, have compelled me to premise a few brief explanations of the principles and nomenclature by which I shall describe the fossil remains of the *Reptilia*, and illustrate their nature by reference to the skeletons of their existing representatives, in the present and succeeding Monographs.

The primary segment of the skeleton of all Vertebrata is a natural group of bones, which may be severally recognised and defined under all the modifications to which such segment may have been subjected in subservient adaptation to the habits and exigencies of a particular species.

A view of such a segment, as it exists in the thorax of the crocodile, the tortoise, and the bird, is given at p. 5, Part I, of the present Monograph.

The part marked *c* is the 'centrum,' or body of the vertebral segment; it is always developed originally as a separate element, and retains its character of individuality in the tortoise and crocodile. The bony arch above the centrum was formed originally by two distinct side-plates,—the 'neurapophyses,' *n*, which coalesce with one another at their summits and thence develope a median plate or process of bone called the 'neural spine' *ns*. Other bony processes which shoot out from the neurapophyses are more variable, and will be afterwards noticed. The arch so formed coalesces with the centrum in the bird, and constitutes an apparently single bone, to which, in anthropotomy, the name 'vertebra' would be restricted. But it would be as reasonable to confine it to the central element (*c*) in the tortoise and crocodile; for the parts of the inferior arch are not less essentially parts of the same natural segment, than the neurapophyses which have formed the upper arch. The next pair of elements, then, which we have to notice, is marked in figs. 4, 5, and 6, *pl*, signifying 'pleurapophysis,' the name of these elements. In the segments figured they retain their primitive distinctness, and acquire unusual length, in order to aid in encompassing the dilated canal or cavity for the heart and lungs: so modified, these elements are commonly called 'ribs,' or 'vertebral ribs.'

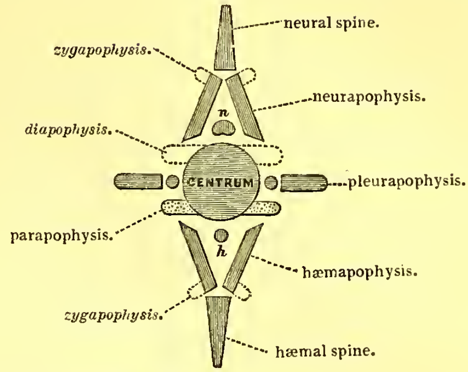
The elements more constantly employed to protect the vascular or 'hæmal' axis, in other words, to form the inferior or hæmal canal, are those marked *h* in figs. 4 and 6: they are the 'hæmapophyses,' which are usually articulated, like the neurapophyses, with the centrum, but are displaced by the great centres of the vascular system in the thorax, where they have got the special name of 'sternal ribs,' and also that of 'costal cartilages,' or 'cartilages of the ribs,' when they do not become ossified. The hæmal arch in the thorax is usually completed by a median element (*hs*), called a 'hæmal spine,' but which itself becomes vastly expanded in the bird (fig. 4); it is, nevertheless, the part in the hæmal arch which repeats below, or answers to the part (*ns*) in the upper arch. In the segments of the trunk and tail, the element (*ns*) retains its normal size and form as a 'neural spine;' but where the central axis of the nervous system becomes unusually developed, as in the head, e. g., analogously to the development of the vascular centres in the chest, the neural canal is correspondingly expanded, and the cavity acquires a special name, and is called 'cranium,' just as the analogously expanded hæmal canal is called 'thorax.' Into the formation of the wall of the cranium other vertebral elements enter besides the neurapophyses, those e. g. which are numbered 8 and 12 in fig. 9, p. 17, of the present Part; the neural spine (7 and 11 in the same figure) retains its primitive distinctness, is expanded horizontally, and, like the 'sternum' in the thorax of the bird (*hs*, fig. 4, p. 5, Part I), it receives a special name (7), e. g. of 'parietal', and (9) of 'frontal' in fig. 9. The elements *a a* (figs. 4 and 6, Part I) form a symmetrical pair of bones or cartilages, attached at one end to the hæmal arch, and projecting outwards and backwards. These are the 'prosartemata,' or appendages; they are, of all the elements of the vertebral segment, those that are least constant in regard to their presence, and, when present, are subject to the greatest amount of development and metamorphosis: they become, e. g., the pterygoid appendages in the nasal segment of the fish's skull, the opercular bones in the frontal segment of the fish, the branchiostegal rays in the parietal segment, the pectoral fins in the occipital segment, and they are developed into the fore limbs and hind limbs, the arms, wings, and legs of other Vertebrata.*

As the nervous and vascular centres become reduced in size, the bony canals or arches protecting them are simplified and contracted, and the vertebra assumes a symmetrical character. In the Crocodile, the hæmal arch, in the tail, e. g., is formed by the hæmapophyses, which ascend and articulate directly with the centrum; the pleurapophyses are shortened, directed outwards, and become anchylosed to

* The facts and arguments in support of this conclusion, are detailed in my works 'On the Nature of Limbs,' and 'On the Archetype of the Vertebrate Skeleton,' 8vo (Van Voorst).

form 'transverse processes;' but such a vertebra, when analysed as it is developed, resolves itself very nearly into the ideal type given in the subjoined diagrammatic cut (fig. 7); *n* is the neural axis, called 'myelon,' or 'spinal marrow;' *h* is the hæmal axis, the chief trunk of which is called 'aorta,' and 'caudal artery.' The names of the vertebral elements which, being usually developed from distinct centres, are called 'autogenous,' are printed in Roman type; the *Italics* denote the 'exogenous' parts, more properly called 'processes,' which shoot out from the preceding elements.

Fig. 7.



Ideal typical vertebra.

On comparing this form of the primary segment with that figured in Cut 4, p. 5, Part I, it will be seen that they differ by altered proportions with some change of position of certain elements; but every modification resulting in the various forms of the parts of the skeleton figured in T. XI, has its seat in one or other of the segmental or 'vertebral' elements above defined; and the same principle I believe that I have established with regard to the internal skeleton in all vertebrate animals.

With this preliminary explanation, the nature and relations to the typical vertebra of the parts of the Crocodilian vertebræ, figured in T. IV, V, IX, will be, it is hoped, readily appreciated. In T. IX, in which are figured, through opportunities kindly afforded by the Marchioness of Hastings, and Searles Wood, Esq., F.G.S., some of the most perfectly-preserved fossil reptilian vertebræ which have hitherto been discovered, the elements and processes are indicated by the initial letter of their names. Figs. 1 and 2 give a side view and a back view of a cervical vertebra, apparently the fourth, of the *Crocodilus Hastingsiæ*, from the Eocene deposits at Hordwell; *c* is the centrum, *n* the neural canal formed by the neurapophyses, which have coalesced superiorly with each other, and with the neural spine (*ns*). Inferiorly they articulate by a suture (which is shown by the wavy line on each side of the process *d* in fig. 1) with the centrum; *pl* is the pleurapophysis, which articulates by two parts, the lower one called the 'head' to the process from the centrum, the upper one called the 'tubercle' to the process from the neurapophysis; beyond the union of the head and tubercle, the pleurapophysis projects freely outwards and downwards, but instead of being elongated in that direction, it becomes expanded in the direction of the axis of the body, i. e. forwards and backwards, and so acquires a shape which has given rise to the name 'hatchet bone' or 'hatchet-shaped process,'* applied to this element in the *Plesiosaurus*.

* "To compensate for the weakness that would have attended this great elongation of the neck, the *Plesiosaurus* had an addition of a series of hatchet-shaped processes on each side of the lower part of the cervical vertebra." (Buckland, Bridgewater Treatise, vol. i, p. 206, and vol. ii, p. 30, 1836.)

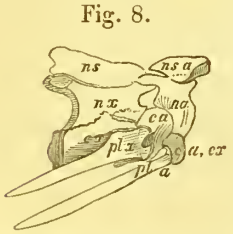
Cuvier recognised in these lateral bones, "en forme de hache," the homologues of the "petites côtes cervicales" of the Crocodile. (Ossemens Fossiles, 4to, tom. v, pt. ii, p. 479, 1824.) And Conybeare had

The purport of this modification is the same in the *Crocodilia* as that which seems to be more called for in the *Plesiosaurus,* viz. to augment the strength of the cervical region of the skeleton ; and this is so effectually done by the overlapping of the hatchet-shaped ribs of this region in the *Crocodilia,* as shown in T. XI, that the flexibility of the neck is much restricted, although the joint of the head allows that part to be bent from side to side at nearly right angles with the neck. When, however, the head is held firmly forwards by its powerful muscles, the imbricated vertebræ of the neck transmit with great effect the impulse which the strong and long tail gives to the rest of the body in the act of swimming.

In T. IX, fig. 3 the cervical vertebra is represented minus its pleurapophyses, and it answers accordingly to that portion of the natural segment to which the term 'vertebra' is usually restricted in the dorsal region of the trunk. The exogenous processes shown in this view of the vertebra are, *p,* the 'parapophysis' or inferior transverse process, developed from the centrum ; *d,* the 'diapophysis' or upper transverse process developed, as in most cases it is, from the neurapophysis ; *z, z′,* are the 'zygapophyses' or 'oblique processes,' which, from their function in articulating together contiguous vertebræ, are also called 'articular processes.' In most of the cervical, and in some of the dorsal, vertebræ of the Crocodile, an exogenous process is developed from the under surface of the centrum, called 'hypapophysis ;' it is indicated by the letters *hy* in fig. 2, T. IX. In some species it is double,* and beneath the atlas it becomes 'autogenous' or is developed as a separate element, *ca, cx,* of the subjoined Cut, fig. 8, in which condition the part is found beneath the centrums of two or three of the anterior cervical vertebræ in the Ichthyosaurus.†

The first and second vertebræ of the neck are peculiarly modified in most air-breathing Vertebrata, and have accordingly received the special names, the one of 'atlas,' the other of 'epistropheus' or 'axis.' In Comparative Anatomy these become arbitrary terms, the properties being soon lost which suggested those names to the human anatomist; the 'atlas' e. g. has no power of rotation upon the 'axis' in the Crocodile, and it is only in the upright skeleton of man that the large globular head is sustained upon the shoulder-like processes of the 'atlas.' In the Crocodile, these vertebræ are concealed by the peculiarly prolonged angle of the lower jaw in the side view of the skeleton in T. XI,

Fig. 8.



Atlas and Axis vertebræ of the Crocodile.

previously extended the same homology to the "particularly prominent wing-like appendages to the transverse processes in many of the long-necked quadrupeds, and the long styloid processes of the cervical vertebra of birds." (See his admirable Memoir of June 14th, 1822, in the Geol. Trans., 2d series, vol. i, p. 384.)

* In *Crocodilus basifissus,* e. g., see the Quarterly Journal of the Geological Society, November 1849, p. 381, pl. x, fig. 2.

† This interesting discovery was communicated by its author, Sir Philip de M. Grey Egerton, Bart., F.G.S., to the Geological Society of London, in 1836, and is published in the fifth volume of the second series of their Transactions, p. 187, pl. 14.

and a separate view of them is, therefore, given in figure 8. The pleurapophyses are retained in both segments, as in all the other vertebræ of the trunk. That of the atlas, fig. 8, *pl a*, is a simple slender style, articulated by the head only, to the independently developed inferior part of the centrum, or 'hypapophysis' (*ca, ex*). The neurapophyses (*na*) of the atlas retain their primitive distinctness; each rests in part upon the proper body of the atlas (*ca*), in part upon the hypapophysis. The neural spine (*ns, a*) is also here an independent part, and rests upon the upper extremities of the neurapophyses. It is broad and flat, and prepares us for the further metamorphosis of the corresponding element in the cranial vertebræ.

The centrum of the atlas (*ca*), called the odontoid process of the epistropheus in Human Anatomy, here supports the abnormally-advanced rib of that vertebra, which in some *Crocodilia* is articulated by a bifurcate extremity, like the ribs of the succeeding cervical vertebræ; but it is not expanded or hatchet-shaped at the free extremity. The proper centrum of the axis vertebra (*cx*) is the only one in the cervical series which does not support a rib; it articulates by suture with its neurapophyses (*nx*), and is characterised by having its anterior surface flat, and its posterior one convex.

With the exception of the two sacral vertebræ, the bodies of which have one articular surface flat and the other concave, and of the first caudal vertebra, the body of which has both articular surfaces convex, the bodies of all the vertebræ beyond the axis have the anterior articular surface concave, and the posterior one convex, and articulate with one another by ball-and-socket joints. This type of vertebra, which I have termed 'procœlian,'* characterises all the existing genera and species of the family *Crocodilia*, with all the extinct species of the tertiary periods, and also two extinct species of the Greensand formation in New Jersey.† Here, so far as our present knowledge extends, the type was lost, and other dispositions of the articular surfaces of the centrum occur in the vertebræ of the *Crocodilia* of the older secondary formations. The only known Crocodilian genus of the periods antecedent to the Chalk and Greensand deposits with vertebræ articulated together by ball-and-socket joints, have the position of the cup and the ball the reverse of that in the modern Crocodiles, and the genus, thus characterised by vertebræ of the 'opisthocœlian' type, has accordingly been termed *Streptospondylus*, signifying 'vertebræ reversed.' The aspects of the zygapophyses are, however, more constant; the anterior ones, T. IX, fig. 3 *z*, look obliquely inwards; the posterior ones, ib. *z'*, obliquely outwards. In looking, therefore, upon the cut surface of a vertical longitudinal section of a Crocodilian vertebra, the smooth, flattened inner surface of the anterior zygapophysis is turned towards the observer, and the convex outer surface of the posterior zygapophysis. Thus the anterior and posterior extremity of the vertebra being determined by observation of the aspect and direction of the zygapophyses, it is at once seen whether the body has the

* Προς, before; κοιλος, concave.

† Quarterly Journal of the Geological Society, November 1849.

procœlian structure, as in the true Crocodiles, T. IV, T. IX, or the opisthocœlian structure, as in the *Streptospondylus*. But the most prevalent type of vertebra amongst the Crocodilia of the secondary periods was that in which both articular surfaces of the centrum were concave, but in a less degree than in the single concave surface of the vertebræ united by ball and socket. A section of a vertebra of this 'amphicœlian' type, such as existed in the *Teleosaurus* and *Steneosaurus*, will be figured in a subsequent Monograph. In the *Ichthyosaurus*, the concave surfaces are usually remarkable for their depth, the vertebræ resembling in this respect those of fishes. Some of the most gigantic of the *Crocodilia* of the secondary strata had one end of the vertebral centrum flattened, and the other (hinder) end concave; this 'platycœlian' type we find in the dorsal and caudal vertebræ of the gigantic *Cetiosaurus*.

With a few exceptions, all the modern Reptiles of the order *Lacertilia* have the same procœlian type of vertebræ as the modern *Crocodilia*, and the same structure prevailed as far back as the period of the *Mosasaurus*, and in some smaller members of the Lacertilian order in the Cretaceous and Wealden epochs.

Resuming the special description of the osteology of the modern *Crocodilia*, we find the procœlian type of centrum established in the third cervical, which is shorter but broader than the second; a parapophysis is developed from the side of the centrum, and a diapophysis from the base of the neural arch; the pleurapophysis is shorter, its fixed extremity is bifid, articulating to the two above-named processes; its free extremity expands, and its anterior angle is directed forwards to abut against the inner surface of the extremity of the rib of both the axis and atlas, whilst its posterior prolongation overlaps the rib of the fourth vertebra.

The same general characters and imbricated coadaptation of the ribs characterise the succeeding cervical vertebræ to the seventh inclusive, the hypapophysis (*hy*, fig. 2, T. IX) progressively though slightly increasing in size. In the eighth cervical the rib becomes elongated and slender; the anterior angle is almost or quite suppressed, and the posterior one more developed and produced more downwards, so as to form the body of the rib, which terminates, however, in a free point. In the ninth cervical the rib is increased in length, but is still what would be termed a 'false' or 'floating rib' in anthropotomy.

In the succeeding vertebra the pleurapophysis articulates with a hæmapophysis, and the hæmal arch is completed by a hæmal spine; and by this completion of the typical segment we distinguish the commencement of the series of dorsal vertebræ. With regard to the so-called 'perforation of the transverse process,' this equally exists in the present vertebra, as in the cervicals, as may be seen by comparing fig. 6, p. 5, Part I of this Monograph, with fig. 2, T. IX, Part II; in both, the foramen is the vacuity intercepted between the bifurcate extremity of the rib and the rest of the vertebra with which that rib articulates; and, on the other hand, the cervical vertebræ equally show surfaces for the articulation of ribs. Cuvier, in including the proximal portions of the ribs with the rest of the vertebra, in his figure of a dorsal vertebra of a

Crocodile,* so far follows nature, and produces a parallel to his figure of a cervical vertebra; but the entire natural vertebra or segment includes the parts delineated in outline in Cut 6, p. 5, Part I. In that figure is shown the semiossified bar *h'* which is interposed between the pleurapophysis *pl* and hæmapophysis *h* in the Crocodilia and some existing Lizards. The typical characters of the segment due to the completion of both neural and hæmal arches, is continued in some species of *Crocodilia* to the sixteenth, in some (*Crocodilus acutus*) to the eighteenth vertebra. In the *Crocodilus acutus* and the *Alligator lucius*, the hæmapophysis of the eighth dorsal rib (seventeenth segment from the head) joins that of the antecedent vertebra. The pleurapophyses project freely outwards, and become 'floating ribs' in the eighteenth, nineteenth, and twentieth vertebræ, in which they become rapidly shorter, and in the last appear as mere appendages to the end of the long and broad diapophyses: but the hæmapophyses by no means disappear after the solution of their union with their pleurapophyses; they are essentially independent elements of the segment, and they are continued, therefore, in pairs along the ventral surface of the abdomen of the Crocodilia, as far as their modified homotypes the pubic bones. They are more or less ossified, and are generally divided into two or three pieces.

Another character afforded by the hæmal arch is the more important in reference to palæontology, as it affects the centrum and neural arch of the vertebra as well as the pleurapophysis; and thus aids in the determination of the vertebra. The parapophysis progressively ascends upon the side of the centrum in the two anterior dorsal vertebræ, and disappears in the third, or, passing upon its neurapophysis, blends with the base of the diapophysis. In this segment, therefore, the proximal end of the rib ceases to be bifurcate, but is simply notched, the curtailed head being applied to the end of the thickened anterior part of the transverse process, and the tubercle abutting against its extremity; in the five following dorsals the head and tubercle of the rib progressively approximate and blend together, or the head disappears in the tenth dorsal, in which the rib is simply attached to the end of the diapophysis. The hypapophysis ceases to be developed after the third or fourth dorsal vertebræ. The zygapophyses become gradually more horizontal, the anterior ones looking more directly upwards, the posterior ones downwards.

The 'lumbar vertebræ' are those in which the diapophyses cease to support moveable pleurapophyses, although they are elongated by the coalesced rudiments of such which are distinct in the young *Crocodilia.* The development and persistent individuality of more or fewer of these rudimental ribs determines the number of the dorsal and lumbar vertebræ respectively, and exemplifies the purely artificial character of the distinction. The number of vertebræ or segments between the skull and the sacrum, in all the *Crocodilia* I have yet examined, is twenty-four. In the skeleton of

* Ossemens Fossiles, 4to, tom. v, pt. ii, pl. iv, fig. 4.

a Gavial I have seen thirteen dorsal and two lumbar; in that of a *Crocodilus cataphractus* twelve dorsal and three lumbar; in those of a *Crocodilus acutus,* and *Alligator lucius,* eleven dorsal and four lumbar, and this is the most common number; but in the skeleton of the Crocodile, I believe of the species called *Croc. biporcatus,* described by Cuvier,* he gives five as the number of the lumbar vertebræ. But these varieties in the development or coalescence of the stunted pleurapophysis are of little essential moment; and only serve to show the artificial character of the 'dorsal' and 'lumbar' vertebræ. The coalescence of the rib with the diapophysis obliterates of course the character of the 'costal articular surfaces;' which we have seen to be common to both dorsal and cervical vertebræ. The lumbar zygapophyses have their articular surfaces almost horizontal, and the diapophyses, if not longer, have their antero-posterior extent somewhat increased; they are much depressed, or flattened horizontally.

The sacral vertebræ are very distinctly marked by the flatness of the coadapted ends of their centrums: there are never more than two such vertebræ in the *Crocodilia* recent or extinct; in the first the anterior surface of the centrum is concave, in the second it is the posterior surface; the zygapophyses are not obliterated in either of these sacral vertebræ, so that the aspects of their articular surface—upwards in the anterior pair, downwards in the posterior pair—determines at once the corresponding extremity of a detached sacral vertebra. The thick and strong transverse processes form another characteristic of these vertebræ; for a long period the suture near their base remains to show how large a proportion is formed by the pleurapophysis. This element articulates more with the centrum than with the diapophysis developed from the neural arch; † it terminates by a rough, truncate, expanded extremity, which almost or quite joins that of the similarly but more expanded rib of the other sacral vertebræ. Against these extremities is applied a supplementary costal piece, serially homologous with the superadded piece to the proper pleurapophysis in the dorsal vertebræ (*h'*, fig. 6, p. 5, Part I), but here interposing itself between the pleurapophyses and hæmapophyses of both sacral vertebræ, not of one only. This intermediate pleurapophysial piece is called the 'ilium;' it is short, thick, very broad, and subtriangular, the lower truncated apex forming with the connected extremities of the hæmapophysis an articular cavity for the diverging appendage, called the 'hind leg.' The hæmapophysis of the anterior sacral vertebra is called 'pubis;' it is moderately long and slender, but expanded and flattened at its lower extremity, which is directed forwards towards that of its fellow, and joined to it through the intermedium of a broad, cartilaginous, hæmal spine, completing the hæmal canal. The posterior hæmapophysis is broader, subdepressed, and subtriangular, expanding as it approaches its fellow to complete the second hæmal

* Tom. cit., p. 95. It is to be observed that Cuvier begins to count the dorsal vertebra when the rib has changed its hatchet-shape for a styloid shape.

† Cuvier, who well describes this structure, remarks, "aussi méritent-elles plutôt le nom des côtes que celui d'apophyses transverses." (Tom. cit., p. 98.)

arch; it is termed 'ischium.' The great development of all the elements of these hæmal arches, and the peculiar and distinctive forms of those that have thereby acquired, from the earliest dawn of anatomical science, special names, relates physiologically to the functions of the diverging appendage which is developed into a potent locomotive member. This limb appertains properly, as the proportion contributed by the ischium to the articular socket and the greater breadth of the pleurapophysis show, to the second sacral vertebra; to which the ilium chiefly belongs.

The first caudal vertebra, which presents a ball for articulating with a cup on the back part of the last sacral, retains, nevertheless, the typical position of the ball on the back part of the centrum; it is thus biconvex, and the only vertebra of the series which presents that structure. I have had this vertebra in three different species of extinct Eocene *Crocodilia*. In the *Crocodilus toliapicus*, T. IV, fig. 7; in the *Croc. champsoïdes*, T. V, fig. 10; and in the *Crocodilus Hastingsiæ*, T. IX, fig. 7.

The advantage of possessing such definite characters for a particular vertebra is, that the homologous vertebra may be compared in different species, and may yield such distinctive characters as will be hereafter pointed out in those of the three species above cited.

The first caudal vertebra, moreover, is distinguished from the rest by having no articular surfaces for the hæmapophyses, which in the succeeding caudals form a hæmal arch, like the neurapophyses above, by articulating directly with the centrum. The arch so formed has its base not applied over the middle of a single centrum, but like the neural arch in the back of the tortoise and sacrum of the bird, across the interspace between two centrums. The first hæmal arch of the tail belongs, however, to the second caudal vertebra, but it is displaced a little backwards from its typical position.

The detached centrum of a caudal vertebra, besides being more slender and compressed, is distinguished from those of the before-described vertebræ by the two articular surfaces at the posterior border of their under surface T. IV, fig. 9. The zygapophyses become vertical as far as the sixteenth or seventeenth, beyond which the two posterior zygapophyses coalesce in an oblique plane notched in the middle, which is received into a wider notch at the fore part of the neural arch of the succeeding vertebra. The sutures between the pleurapophyses and diapophyses are maintained during a long period of the animal's growth, and demonstrate the share which these two elements respectively take in the formation of the transverse process. So constituted, these processes progressively decrease in length to the fifteenth or sixteenth caudal vertebra, and then disappear. The neural spines progressively decrease in every dimension, save length, which is rather increased as far as the twenty-second or twenty-third vertebra, beyond which they begin again to shorten, and finally subside in the terminal vertebræ of the tail.

The caudal hæmapophyses coalesce at their lower or distal ends, from which a spinous process is prolonged downwards and backwards; this grows shorter towards the end of the tail, but is compressed and somewhat expanded antero-posteriorly. The hæmal arch so constituted has received the name of 'chevron bone.'

A side view of the body of a middle caudal vertebra of the *Crocodilus toliapicus* is given in T. III, fig. 8, and an under view of the same in fig. 9, showing the two hypapophysial ridges extending from the articular facets for the hæmapophyses at one end to the other end of the centrum.

The segments of the endo-skeleton composing the skull are more modified than those of the pelvis; but just as the vertebral pattern is best preserved in the neural arches of the pelvis, which are called collectively 'sacrum,' so, also, is it in the same arches of the skull, which are called collectively 'cranium.' The elements of which these cranial arches are composed preserve, moreover, their primitive or normal individuality more completely than in any of the vertebræ of the trunk, except the atlas, and consequently the archetypal character can be more completely demonstrated.

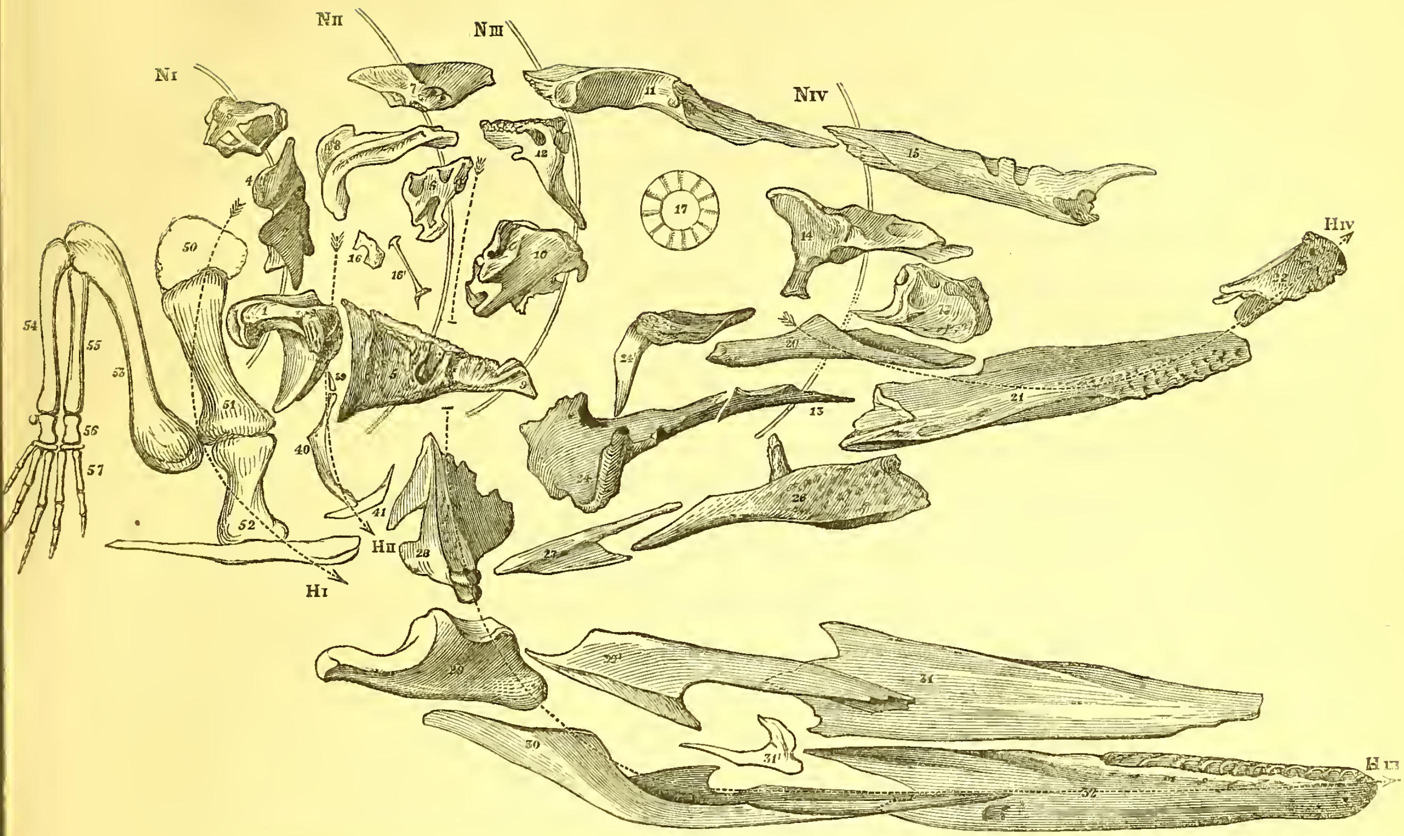
In fossil *Crocodilia*, and many other reptiles, the bones of the head are very liable from this cause to a greater extent of dislocation and separation than happens to the skull of the warm-blooded animal, in which a greater proportion of those primitive bones coalesce with age. It not unfrequently happens that detached bones of the skull of a reptile are found fossil, and the usually much modified form of these vertebral elements renders their determination difficult. In order to diminish this difficulty, especially as the bones of the cranium are least familiar to the palæontologist in their detached state, I have subjoined a side view of them, fig. 9, nearly as they are arranged in the formation of the successive natural segments of the skull. Such figures are the more necessary in the present state of anatomy and palæontology, since the illustrations of the osteology of the crocodile which have hitherto been prefixed to the descriptions of the fossil remains of the Reptilian class, as, e. g., in the great work of Cuvier, include only figures of the bones in question as they are naturally combined together in the entire skull.

For the anatomical description and determination of the individual bones, as constituent elements of the vertebral segments of the head, I must refer the reader to my work 'On the Archetype of the Vertebrate Skeleton,' pp. 115-25, figs. 18-21, and pl. 2, fig. 3; and here limit myself to an exemplification of the natural arrangement and names of the bones according to the letters and numbers in figure 9.

The bones of the head of the Crocodiles, as of all other vertebrate animals, are primarily classified into those of

The Endo-skeleton,
The Splanchno-skeleton, and
The Exo-skeleton.

Fig. 9



Disarticulated bones of the Skull of an Alligator, N I to IV the neural arches; H I to IV the hæmal arches and appendages.

The bones of the *endo-skeleton* of the head form naturally four segments, called

Occipital vertebra, N I, H I ; Parietal vertebra, N II, H II ; Frontal vertebra, N III, H III ; Nasal vertebra, N IV, H IV.	Fig. 9.

These segments are subdivided into the neural arches, called

Epencephalic arch (1 basioccipital, 2 exoccipital, 3 superoccipital, 4 connate paroccipital) ;

Mesencephalic arch (5 basisphenoid, 6 alisphenoid, 7 parietal, 8 mastoid) ;

Prosencephalic arch (9 presphenoid, 10 orbitosphenoid, 11 frontal, 12 post-frontal) ;

Rhinencephalic arch (13 vomer, 14 prefrontal, 15 nasal) :

and into the hæmal arches and their appendages, called

Maxillary arch (20 palatine, 21 maxillary, 22 premaxillary) and appendages (24 pterygoid, 24′ ectopterygoid, 26 malar, 27 squamosal) ;

Mandibular arch (28 tympanic, 29—32 mandible) ;

Hyoidean arch (39 epihyal, 40 ceratohyal, 41 basihyal) ;

Scapular arch (50 suprascapula, 51 scapula, 52 coracoid) and appendages (53—58 bones of fore-limb).

The bones of the *splanchno-skeleton,* are

The petrosal (16) and otosteals (16′) ;

The sclerotals (17) which in most retain their primitive histological condition as fibrous membrane.

The turbinals (18 and 19) and teeth.

The bones of the *exo-skeleton,* are

The lacrymals (73).

The superorbitals (present in *Alligator sclerops*).

To the foregoing brief analysis of the constituent parts of the framework of the *Crocodilia,* which are petrifiable or conservable in a fossil state, and from the study and comparison of which we have to gain our insight into the nature and affinities of the extinct Reptiles, it seems here only requisite to add a few observations on the characteristic mode in which the bones are associated together in certain parts of the skeleton in the present order, and especially in the skull.

With regard to the trunk, the *Crocodilia* are distinguished from the *Lacertilia* and from all other existing orders of Reptiles, by the articulation of the vertebral ribs (pleurapophyses) in the cervical and anterior part of the dorsal segments by a head and tubercle to a parapophysis and diapophysis. As this double joint is associated with a double ventricle of the heart, and as the single articulation of every rib in other Reptiles is associated with a single ventricle of the heart, we may infer a like difference in the structure of the central organ of circulation in the extinct reptiles, manifesting the above-defined modifications in the proximal joints of the ribs.

The sacrum consists of two vertebræ only, in *Crocodilia* as in *Lacertilia:* they are modified in the present order, as before described, p. 14.

The skull consists, as above defined, of four segments. The hinder or occipital surface of the skull presents, in the *Crocodilia* as in the *Lacertilia,* a single convex occipital condyle, formed principally by the basioccipital, and not showing the trefoil character which it bears in the *Chelonia* (Part I, T. XV, fig. 4), in which the exoccipitals contribute equal shares to its formation. In the *Batrachia,* the exoccipitals exclusively form the joint with the atlas, and there are accordingly two condyles. The occipital region of the crocodilian skull is remarkable for its solidity and complete ossification, and for the great extent of the surface which descends below the condyle. (T. VI, fig. 2.) In the *Lacertilia,* a wide vacuity is left between the mastoid, exoccipital, and paroccipital: but in the *Crocodilia* this is reduced to the small depressions or foramina near 3, fig. 2, T. VI. The tympanic pedicles (28) extend outwards and downwards, firmly wedged between the paroccipital, mastoid, and squamosal; in the Lacertians these pedicles are suspended vertically from the point of union of the mastoid and paroccipital.

The chief foramen in the occipital region is that called 'foramen magnum' (between 2 and 2, in fig. 2, T. VI), through which the nervous axis is continued from the skull. On each side of the foramen magnum is a small hole, called 'precondyloid foramen,' for the exit of the hypoglossal nerve. External to this is a larger foramen, marked *n* in fig. 2, for the transmission of the nervus vagus and a vein. Below this is the 'carotid foramen' *c*. All these are perforated in the exoccipital. Below the condyle there is usually a foramen, and sometimes two, for the transmission of blood-vessels. Lower down, at the suture between the basioccipital and basisphenoid, is a larger and more constant median foramen, indicated by the dotted line from *e t;* it is the bony outlet of a median system of eustachian tubes, peculiar to the *Crocodilia.* On each side of the median eustachian foramen, and in the same suture, is a smaller foramen, which is the bony orifice of the ordinary lateral eustachian tube. The membranous continuations of the lateral eustachian tubes unite with the shorter continuation from the median tube, and all three terminate by a common valvular aperture, upon the middle line of the faucial palate, behind the posterior or palatal nostril. The large, bony aperture of this nostril is formed by the pterygoids (24 in fig. 2). The carotid canal, *c*, opens by a short bony tube into the tympanic cavity, and is described as the 'eustachian canal' in the 'Leçons d'Anatomie comparée' of Cuvier. The artery crosses the tympanic cavity, and enters a bony canal at its fore part, which conducts to the 'sella turcica' in the interior of the cranium.

The median eustachian foramen is described by Cuvier as the 'arterial foramen,'* the canal from which divides and terminates in the 'sella turcica.'† By MM. Bronn, Kaup, and De Blainville, the median eustachian foramen is contended to be the bony aperture of the posterior nostrils.‡

The results of the dissections and injections of recent Crocodiles and Alligators, by which I have been able to rectify the discrepant opinions regarding the carotid, eustachian, and naso-palatal foramina, and which have led to the discovery of a third median eustachian canal, or rather system of canals, between the tympanic cavities and fauces, peculiar to the Crocodilian Reptiles, are given in detail in the 'Philosophical Transactions' for 1850. The complexity of the superadded system has doubtless chiefly contributed to mislead the justly-esteemed authorities who have believed that they saw in it characters of the carotid canals or of the posterior nasal passages. The eustachian apparatus in the *Crocodilia* may be briefly described as follows: From the floor of each tympanic cavity two air-passages are continued; the canal from the fore part of the cavity extends downwards, backwards, and inwards, in the basisphenoid, which

* Ossemens Fossiles, tom. v, pt. ii, p. 133.

† Ib. p. 78.

‡ Abhandlungen über die Gavialärtigen Reptilien der Lias-formation, folio, 1841, pp. 12, 16, 44.

unites with its fellow from the opposite tympanum, to form a short median canal, which descends backwards to the suture between the basisphenoid and the basioccipital, where it joins the median canal formed by the union of the two air-passages from the back part of the floor of the tympanum, which traverse the basioccipital. The common canal formed by the junction of the two median canals descends along the suture to the median foramen *e t*, fig. 2, T. VI. The air-passage from the back part of the tympanum, which traverses the basioccipital, swells out into a rhomboidal sinus in its convergent course towards its fellow, and from this sinus is continued the normal lateral eustachian canal, which, on each side, terminates below in the small aperture, external to the median eustachian foramen.

That part of the outer surface of the skull which is covered by the common integument is more or less sculptured with wrinkles and pits in the *Crocodilia:* the modifications of this pattern are shown in T. I, fig. 1, in the nilotic Crocodile, and in T. VI, in the eocene Crocodile from Hordwell. The flat platform of the upper surface of the cranium is perforated by two large apertures, surrounded by the bones numbered 7, 8, 11, 12; these apertures are the upper outlets of the temporal fossæ, divided from the lower and lateral outlets by the conjoined prolongations of the mastoid 8 and postfrontal 12: if ossification were continued thence to the parietal 7, the temporal fossæ would be roofed over by bone, as in the *Chelones.* In old Crocodiles and Alligators there is an approximation to this structure, and the upper temporal apertures are much diminished in size. In the Gavials (T. XI, fig. 1 *a*) they remain more widely open, and, in the fossil Gavials of the secondary strata, they are still wider, as seen in T. XI, fig. 2 *a*; by which the structure of the cranium approaches more nearly to that of the Lacertian reptiles, where the temporal fossa is either not divided into an upper and lateral outlet, or is bridged over by a very slender longitudinal bar from the postfrontal to the mastoid. The lateral outlets of the temporal fossæ (T. VI, fig. 1) are divided from the orbits by a bar of bone developed from the postfrontal (12) and malar (26), and against the inner side of the base of which the ectopterygoid abuts; the posterior boundary of the fossa is made by the tympanic (28) and squamosal (27). The orbits, having the postfronto-malar bar (12, 26) behind, are surrounded in the rest of their circumference by the frontal (11), the prefrontal (14), the lachrymal (73), and the malar (26). The supraorbital or palpebral ossicle is rarely preserved in fossil specimens.

The facial or rostral part of the skull anterior to the orbit, is of great extent, broad and flat in the Alligators and some Crocodiles, narrower, rounder, and longer in other Crocodiles, always most narrow, cylindrical, and elongated in the Gavials. The anterior or external nostril is single, and is perforated in the middle of the anterior terminal expansion of the upper jaw. This expansion is least marked in the broad-headed species (compare T. VI, fig. 1, with T. III, fig. 1); in existing Crocodiles and Alligators the points of the nasal bones penetrate its hind border, as at 15, fig. 1,

T. I. In the Gavials (T. XI, fig. 1 *a*) the nasals (*n*) terminate a long way from the nostril. The *Crocodilia* resemble the *Chelonia* in the single median nostril.* In the *Lacertilia* there is a pair of nostrils, one on each side the median plane, which is occupied by a bridge of bone extending from the usually single premaxillary to the nasals. The plane of the single nostril is almost horizontal in all existing and tertiary *Crocodilia.*

On the inferior or palatal surface of the skull (T. VII, fig. 2), the most anterior aperture is the circular prepalatal foramen surrounded by the premaxillaries 22; then follows an extensive smooth, horizontal, bony plate, formed by the premaxillaries (22), the maxillaries (21), and the palatines (20). The postpalatal apertures are always large in the *Crocodilia,* and are bounded by the palatines (20), maxillaries (21), pterygoids (24), and ectopterygoids (25). The posterior aperture of the nostril is formed wholly by the pterygoids; it is shown in T. VI, fig. 3, between the bones marked 24. Behind it is the median and lateral eustachian foramen already described, as belonging rather to the posterior region of the head.

The scapulo-coracoid arch, both elements (fig. 9, 51, 52) of which retain the form of strong and thick vertebral and sternal ribs in the crocodile, is applied in the skeleton of that animal over the anterior thoracic hæmal arches (T. XI). Viewed as a more robust hæmal arch, it is obviously out of place in reference to the rest of its vertebral segment. If we seek to determine that segment by the mode in which we restore to their centrums the less displaced neural arches of the antecedent vertebræ of the cranium or in the sacrum of the bird,† we proceed to examine the vertebræ before and behind the displaced arch, with the view to discover the one which needs it, in order to be made typically complete. Finding no centrum and neural arch without its pleurapophyses from the scapula to the pelvis, we give up our search in that direction; and in the opposite direction we find no vertebra without its ribs until we reach the occiput: there we have centrum and neural arch, with coalesced parapophyses—the elements answering to those included in the arch N 1, fig. 9—but without the arch H 1; which arch can only be supplied, without destroying the typical completeness of antecedent cranial segments, by a restoration of the bones 50—52, to the place which they naturally occupy in the skeleton of the fish. And since anatomists are generally agreed to regard the bones 50—52 in the crocodile as specially homologous with those so numbered in the fish,‡ we must conclude that they are likewise homologous in a higher sense; that in the fish, the scapulo-coracoid arch is in its natural or typical position, whereas in the crocodile it has been displaced for a special purpose. Thus, agreeably with a general principle, we perceive that, as the lower vertebrate

* In a skeleton of the *Alligator lucius* in the Museum of the Royal College of Surgeons, a slender bar of bone is continued from the nasals to the premaxillary, across the median nasal aperture, as it is in the skull of the same species figured in the 'Ossemens Fossiles,' tom. v, pt. ii, pl. i, fig. 8.

† See 'On the Archetype and Homologies of the Vertebrate Skeleton,' p. 117, p. 159.

‡ Op. cit., fig. 5, p. 17.

animal illustrates the closer adhesion to the archetype by the natural articulation of the scapulo-coracoid arch to the occiput, so the higher vertebrate manifests the superior influence of the antagonising power of adaptive modification by the removal of that arch from its proper segment.

The anthropotomist, by his mode of counting and defining the dorsal vertebræ and ribs, admits, unconsciously perhaps, the important principle in general homology which is here exemplified, and which, pursued to its legitimate consequences and further applied, demonstrates that the scapula is the modified rib of that centrum and neural arch which he calls the 'occipital bone,' and that the change of place which chiefly masks that relation (for a very elementary acquaintance with comparative anatomy shows how little mere form and proportion affect the homological characters of bones) differs only in extent and not in kind from the modification which makes a minor amount of comparative observation requisite, in order to determine the relation of the shifted dorsal rib to its proper centrum in the human skeleton.

With reference, therefore, to the occipital vertebra of the crocodile, if the comparatively well-developed and permanently distinct ribs of all the cervical vertebræ prove the scapular arch to belong to none of those segments, and, if that hæmal arch be required to complete the occipital segment, which it actually does complete in fishes, then the same conclusion must apply to the same arch in other animals, and we must regard the occipital vertebra of the tortoise as completed below by its scapulo-coracoid arch and not, as Bojanus supposed, by its hyoidean arch.*

Having thus endeavoured to show what the scapular arch of the crocodile is, I proceed to point out the characteristic form of its chief elements. The upper and principal part of the scapula (51, fig. 9) is flattened, and gradually becomes narrower to the part called its neck, which is rounded, bent inwards, and then suddenly expanded to form a rough articular surface for the coracoid, and a portion of a smoother surface for the shoulder-joint. The contiguous end of the coracoid (52) presents a similar form, having not only the rough surface for its junction with the scapula, but contributing, also, one half of the cavity for the head of the humerus. It is perforated near the interspace between these two surfaces. As it recedes from them, it contracts, then expands and becomes flattened, terminating in a somewhat broader margin than the base of the

* Anatome Testudinis Europæa, fol., 1819, p. 44. Geoffroy St. Hilaire selected the opercular and sub-opercular bones to form the inverted arch of his seventh (occipital) cranial vertebra, and took no account of the instructive natural connexions and relative position of the hyoidean and scapular arches in fishes. With regard to the scapular arch, he alludes to its articulation with the skull in the lowest of the vertebrate classes as an 'amalgame inattendue' (*Anatomie Philosophique*, p. 481): and elsewhere describes it as a "disposition véritablement très singulière, et que le manque absolu du cou et une combinaison des pièces du sternum avec celles de la tête pouvoient seules rendre possible."—*Annales du Muséum*, ix, p. 361. A due appreciation of the law of vegetative uniformity or repetition, and of the ratio of its prevalence and power to the grade of organization of the species, was, perhaps, essential in order to discern the true signification of the connexion of the scapular arch in fishes.

scapula, which margin is morticed into a groove at the anterior border of the broad rhomboidal cartilage continued beyond the ossified part of the manubrium, which forms the key-bone of the scapular arch. The anterior locomotive extremity is the diverging appendage of the arch, under one of its numerous modes and grades of development.*

The proximal element of this appendage or that nearest the arch, is called the 'humerus' (53, fig. 9): its head is subcompressed and convex; its shaft bent in two directions, with a deltoid crest developed from its upper and fore part; its distal end is transversely extended, and divided anteriorly into two condyles. The shaft of this bone has a medullary cavity, but relatively smaller than in the mammalian humerus.

The second segment of the limb consists of two bones: the larger one (54) is called the 'ulna:' it articulates with the outer condyle of the humerus by an oval facet, the thick convex border of which swells a little out behind, and forms a kind of rudimental 'olecranon;' the shaft of the ulna is compressed transversely, and curves slightly outwards; the distal end is much less than the proximal one, and is most produced at the radial side.

The radius (55) has an oval head; its shaft is cylindrical; its distal end oblong and subcompressed.

The small bones (56) which intervene between these and the row of five longer bones, are called 'carpals:' they are four in number in the Crocodilia. One seems to be a continuation of the radius, another of the ulna; these two are the principal carpals; they are compressed in the middle and expanded at their two extremities; that on the radial side of the wrist is the largest. A third small ossicle projects slightly backwards from the proximal end of the ulnar metacarpal: it answers to the bone called 'pisiforme' in the human wrist. The fourth ossicle is interposed between the ulnar carpal and the metacarpals of the three ulnar digits.

These five terminal jointed rays of the appendage are counted from the radial to the ulnar side, and have received special names: the first is called 'pollex,' the second 'index,' the third 'medius,' the fourth 'annularis,' and the fifth 'minimus.' The first joint of each digit is called 'metacarpal;' the others are termed 'phalanx.' In the Crocodilia the pollex has two phalanges, the index three, the medius four, the annularis four, and the minimus three. The terminal phalanges, which are modified to support claws, are called 'ungual' phalanges.

As the above-described bones of the scapular extremity are developments of the appendage of the scapular arch, which is the hæmal arch of the occipital vertebra, it follows, that, like the branchiostegal rays and opercular bones in fishes, they are essentially bones of the head.

The diverging appendage of the pelvic arch being a repetition of the same element

* See my Discourse 'On the Nature of Limbs,' 8vo, Van Voorst, 1849, pp. 64-70.

as the appendage of the scapular arch modified and developed for a similar office, a close resemblance is maintained in the subdivisions of the framework of both limbs. The first bone of the pelvic limb, called the 'femur,' is longer than the humerus, and, like it, presents an enlargement of both extremities, with a double curvature of the intervening shaft, but the directions are the reverse of those of the humerus, as may be seen in T. XI, where the upper or proximal half of the femur is concave, and the distal half convex, anteriorly. The head of the femur is compressed from side to side, not from before backwards as in the humerus; a pyramidal protuberance from the inner surface of its upper fourth represents a 'trochanter;' the distal end is expanded transversely, and divided at its back part into two condyles.

The next segment or 'leg,' includes, like the corresponding segment of the forelimb called 'forearm,' two bones. The largest of these is the 'tibia,' and answers to the radius. It presents a large, triangular head to the femur; it terminates below by an oblique crescent with a convex surface.

The 'fibula' is much compressed above; its shaft is slender and cylindrical, its lower end is enlarged and triangular.

All these long bones have a narrow medullary cavity.

The group of small bones which succeed those of the leg, are the tarsals; they are four in number, and have each a special name. The 'astragalus' articulates with the tibia, and supports the first and part of the second toe. It is figured in Cuvier's 'Ossemens Fossiles,' tom. v, pt. ii, pl. iv, figs. 19 *A, B, C, D*. The 'calcaneum' intervenes between the fibula and the ossicle supporting the two outer toes; it has a short but strong posterior tuberosity.

The ossicle referred to represents the bone called 'cuboid' in the human tarsus. A smaller ossicle, wedged between the astragalus and the metatarsals of the second and third toes is the 'ectocuneiform.'

Four toes only are normally developed in the hind-foot of the *Crocodilia;* the fifth is represented by a stunted rudiment of its metatarsal, which is articulated to the cuboid and to the base of the fourth metatarsal.

The four normal metatarsals are much longer than the corresponding metacarpals. That of the first or innermost toe is the shortest and strongest; it supports two phalanges. The other three metatarsals are of nearly equal length, but progressively diminish in thickness from the second to the fourth. The second metatarsal supports three phalanges; the third four; and the fourth also has four phalanges, but does not support a claw. The fifth digit is represented by a rudiment of its metatarsal in the form of a flattened triangular plate of bone, attached to the outer side of the cuboid, and slightly curved at its pointed and prominent end.

In the skull of the Crocodile, as of most other vertebrates, there are intercalated a few bones, or ossified parts of special organs, which, as is shown in the classed Table of the bones of the head, do not belong to the vertebral system of bones.

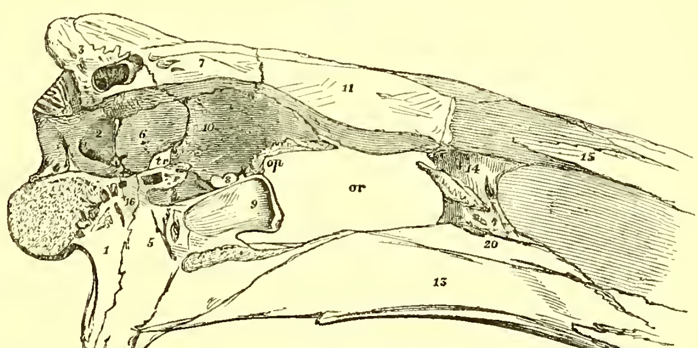
The bone anterior to the orbit, marked 73 in fig. 9, and in T. I and T. VI is perforated at its orbital border by the duct of the lachrymal gland, whence it is termed the 'lachrymal bone,' and its facial part extends forwards between the bones marked 14, 15, 21, and 26 in the same plates. In many Crocodilia there is a bone at the upper border of the orbit, which extends into the substance of the upper eyelid; it is called 'superorbital.' In the *Crocodilus palpebrosus* there are two of these ossicles.

Both the lachrymal and superorbital bones answer to a series of bones found commonly in fishes, and called 'suborbitals' and 'superorbitals.' The lachrymal is the most anterior of the suborbital series, and is the largest in fishes; it is also the most constant in the vertebrate series, and is grooved or perforated by a mucous duct. These ossicles appertain to the dermal or muco-dermal system or 'exoskeleton.'

The little slender bone, marked 16′ in fig. 9, has one of its extremities in the form of a long, narrow, elliptic plate, which is applied to the 'fenestra ovalis' of the internal ear; from this plate extends a long and slender bony stem, which grows somewhat cartilaginous, expands and bends down, as it approaches the tympanum or ear-drum, to which it is attached.

The cartilaginous capsule of the labyrinth or internal ear is partially ossified by sinuous plates of bone connate with the neurapophyses (fig. 10, 2 and 6), between which that organ is lodged; I apply the term 'petrosal' to the principal and most independent of those ossifications of the ear-capsule, to that, e. g., which retains some mobility after it has contracted a partial anchylosis to the exoccipital (2), and which appears upon the inner surface of the cranial walls at the part marked 16 in the subjoined Cut 10, between 2 and 6. It is the only independent bone on that surface of the cranium which, in my opinion, answers to the 'petrous portion of the temporal' in human anatomy, and to which the term 'rocher can be properly applied, in the language of the French comparative anatomists. Cuvier, however, restricts that name to the 'alisphenoid' (6, figs. 9, 10) in the Crocodiles.

Fig. 10.



Vertical longitudinal section of the cranium of a Crocodile (*Crocodilus acutus*).

The ossicles, (16 and 16′, fig. 9), together with the partial ossifications in the sclerotic capsule of the organ of sight, (17, fig. 9)—always more distinct in *Chelonia* than in *Crocodilia*— belong to that category of visceral bones to which the term 'splanchno-skeleton' has been given; they also are foreign to the true vertebrate system of the skeleton.

The teeth.—The most readily recognisable character by which the existing Crocodilians are classified and grouped in appropriate genera, are derived from modifications of the dental system.

In the Caimans (genus *Alligator*) the teeth vary in number from $\frac{18-18}{18-18}$ to $\frac{22-22}{22-22}$: the fourth tooth of the lower jaw is *received into a cavity* of the alveolar surface of the upper jaw, where it is concealed when the mouth is shut. In T. VIII, fig. 2, these pits are shown behind the last premaxillary tooth *e*, in an Eocene Alligator from Hordwell. In old individuals of the existing species of Alligator, the upper jaw is perforated by the large inferior teeth in question, and the fossæ are converted into foramina.

In the Crocodiles (genus *Crocodilus*) the fourth tooth in the lower jaw is *received into a notch* excavated in the side of the alveolar border of the upper jaw, as in fig. 1, T. VIII, behind the tooth *e*, and is visible externally when the mouth is closed, as in T. VII, fig. 1. In most Crocodiles, also, the first tooth in the lower jaw perforates the premaxillary bone when the mouth is closed, as in T. I, between the teeth marked *a* and *b*.

In the two preceding genera the alveolar borders of the jaw have an uneven or wavy contour, and the teeth are of an unequal size.

In the Gavials, (genus *Gavialis*) the teeth are nearly equal in size and similar in form in both jaws, and the first as well as the fourth tooth in the lower jaw, passes into a groove in the margin of the upper jaw when the mouth is closed, T. XI.

In the Alligators and Crocodiles the teeth are more unequal in size, and less regular in arrangement, and more diversified in form than in the Gavials: witness the strong thick conical laniary teeth at the fore part of the jaw, as shown in T. VII and T. III, fig. 6, as contrasted with the blunt mammillate summits of the posterior teeth, as shown in T. V, fig. 12. The teeth of the Gavial are subequal, most of them are long, slender, pointed, subcompressed from before backwards, with a trenchant edge on the right and left sides, between which a few faint longitudinal ridges traverse the basal part of the enamelled crown.

The teeth of both the existing and extinct Crocodilian reptiles consist of a body of compact dentine forming a crown covered by a coat of enamel, and a root invested by a moderately thick layer of cement. The root slightly enlarges, or maintains the same breadth to its base, which is deeply excavated by a conical pulp-cavity extending into the crown, and is commonly either perforated or notched at its concave or inner side.

The dentinal tubes in the crown of a fully-developed tooth form short curvatures at their commencement at the surface of the pulp-cavity, and then proceed nearly straight to the periphery of the crown; they very soon bifurcate, the divisions slightly diverging; then continuing their course with gentle parallel undulations, they subdivide near the enamel, and terminate in fine and irregular branches, which anastomose generally by the medium of cells. The dentinal tubes send off from both sides, throughout their progress, minute branches into the intervening substance, and terminate in the dentinal cells. These cells are subhexagonal, about $\frac{1}{800}$ of an inch in diameter, and are traversed by from ten to fourteen of the dentinal tubes; they are usually arranged in planes parallel with the periphery of the crown, near which they are most conspicuous, and towards which their best defined outline is directed: they combine with the parallel curvatures of the dentinal tubes to form the striæ, visible in sections of the teeth by the naked eye, which cause the stratified appearance of the dentine as if it were composed of a succession of superimposed cones. The diameter of the dentinal tube before the first bifurcation is $\frac{1}{12000}$th of an inch, both the trunks and bifurcations of the tubes have interspaces equal to four of their respective diameters.

The enamel viewed in a transverse section of the crown presents some delicate striæ parallel with its surface, whilst the appearance of fibres vertical to that surface is only to be detected, and these faintly, on the fractured edge. It is a very compact and dense substance; the dark brownish tint is strongly marked in the middle of the enamel when viewed by transmitted light.

The cells with which the fine tubes of the basal cement communicate, are oblong, about $\frac{1}{2000}$th of an inch across their long axis, which is transverse to that of the tooth; the inter-communicating tubes, which radiate from the cells, giving them a stellate figure. I have entered into these particulars of the microscopic texture of the teeth of the Crocodile because it will be seen in the sequel that important modifications of the dental tissues characterise some of the extinct *Reptilia*.

In the black Alligator of Guiana the first fourteen teeth of the lower jaw are implanted in distinct sockets, the remaining posterior teeth are lodged close together in a continuous groove, in which the divisions for sockets are faintly indicated by vertical ridges, as in the jaws of the Ichthyosaurs. A thin compact floor of bone separates this groove, and the sockets anterior to it, from the large cavity of the ramus of the jaw; it is pierced by blood-vessels for the supply of the pulps of the growing teeth and the vascular dentiparous membrane which lines the alveolar cavities.

The tooth-germ is developed from the membrane covering the angle between the floor and the inner wall of the socket. It becomes in this situation completely enveloped by its capsule, and an enamel-organ is formed at the inner surface of the capsule before the young tooth penetrates the interior of the pulp-cavity of its predecessor.

The matrix of the young growing tooth affects, by its pressure, the inner wall of the socket, and forms for itself a shallow recess; at the same time it attacks the side of the base of the contained tooth; then, gaining a more extensive attachment by its basis and increased size, it penetrates the large pulp-cavity of the previously formed tooth, either by a circular or semicircular perforation. The size of the calcified part of the tooth matrix which has produced the corresponding absorption of the previously formed tooth on the one side, and of the alveolar process on the other, is represented in the second exposed alveolus of the portion of jaw figured in Pl. 75, fig. 4, of my 'Odontography,' the tooth marked *a* in that figure, having been displaced and turned round to show the effects of the stimulus of the pressure. The size of the perforation in the tooth, and of the depression in the jaw, proves them to have been, in great part, caused by the soft matrix, exciting dissolution and absorbent action, and not by mere mechanical force. The resistance of the wall of the pulp-cavity having been thus overcome, the growing tooth and its matrix recede from the temporary alveolar depression, and sink into the substance of the pulp contained in the cavity of the fully-formed tooth. As the new tooth grows, the pulp of the old one is removed; the old tooth itself is next attacked, and the crown being undermined by the absorption of the inner surface of its base, may be broken off by a slight external force, when the point of the new tooth is exposed.

The new tooth disembarrasses itself of the cylindrical base of its predecessor, with which it is sheathed, by maintaining the excitement of the absorbent process so long as the cement of the old fang retains any vital connexion with the periosteum of the socket; but the frail remains of the old cylinder, thus reduced, are sometimes lifted off the socket upon the crown of the new tooth, when they are speedily removed by the action of the jaws. This is, however, the only part of the process which is immediately produced by mechanical force: an attentive observation of the more important previous stages of growth, teaches that the pressure of the growing tooth operates upon the one to be displaced only through the medium of the vital dissolvent and absorbent action which it has excited.

Most of the stages in the development and succession of the teeth of the Crocodiles are described by Cuvier* with his wonted clearness and accuracy; but the mechanical explanation of the expulsion of the old tooth, which Cuvier adopts from M. Tenon, is opposed by the disproportion of the hard part of the new tooth to the vacuity in the walls of the old one, and by the fact that the matter impressing—viz. the uncalcified part of the tooth-matrix—is less dense than the part impressed.

No sooner has the young tooth penetrated the interior of the old one, than another germ begins to be developed from the angle between the base of the young tooth and the inner alveolar process, or in the same relative position as that in which its immediate predecessor began to rise, and the processes of succession and displacement are carried on, uninterruptedly, throughout the long life of these cold-blooded carnivorous reptiles.

From the period of exclusion from the egg, the teeth of the crocodile succeed each other in the vertical direction; none are added from behind forwards, like the true

* Op. cit., pp. 90-3.

molars in Mammalia. It follows, therefore, that the number of the teeth of the crocodile is as great when it first sees the light as when it has acquired its full size; and, owing to the rapidity of the succession, the cavity at the base of the fully-formed tooth is never consolidated.

The fossil jaws of the extinct Crocodilians demonstrate that the same law regulated the succession of the teeth at the ancient epochs when those highly organized reptiles prevailed in greatest numbers, and under the most varied generic and specific modifications, as at the present period, when they are reduced to a single family, composed of so few and slightly varied species, as to have constituted in the *Systema Naturæ* of Linnæus, a small fraction of the genus *Lacerta*.

CROCODILUS TOLIAPICUS, *Owen*. Tab. II, fig. 1, and Tab. II *A*.

Syn. CROCODILE DE SHEPPY (?), *Cuvier*. Ossemens Fossiles, 4to, tom. v, pt. ii, p. 165.
CROCODILUS SPENCERI, *Buckland*. Bridgewater Treatise, vol. i, p. 251. "Crocodile with a short and broad snout." Vol. ii, p. 36, pl. 25′, fig. 1.
— — *Owen*. Reports of the British Association, 1841, p. 65.

In proceeding to the comparison, and preparing for the description of the British fossil *Crocodilia*, I endeavoured, in the first place, to obtain the bones of the species which now exists in a locality nearest to Great Britain, and also of an individual of that same species which had lived at a remote period; and I have been favoured by the kindness of my esteemed friend Philip Duncan, Esq., Fellow of New College, Oxford, and Conservator of the Ashmolean Museum, with the opportunity of examining the bones of a mummified Crocodile from a sarcophagus at Thebes, in that collection at Oxford. Two views of the skull of this old Egyptian Crocodile are given in T. I. The total length of the skull from the bone marked 28 to the end of 22, is twice the breadth of the back part of the skull. The upper apertures of the temporal fossæ are subcircular; the point of the squamosal (27) projects into the lateral aperture. The breadth of the back part of the sculptured cranial platform (8, 8), is less by one fourth than the breadth of the skull anterior to the orbits. The breadth of the interorbital space is nearly equal to the transverse diameter of the orbit. The points of the nasals (15) project into the external nostril. The postpalatal apertures reach as far forwards as the seventh tooth, counting from the hindmost; there are nineteen alveoli on each side of the upper jaw, the five anterior teeth being lodged in the premaxillary, which is perforated by the first tooth of the lower jaw.

Geoffroy St. Hilaire has applied the old Egyptian name Σοῦχος to the mummified Crocodiles of that country; but there is no good specific character which distinguishes them from the modern Crocodiles of the Nile, to which Cuvier has given the name of *Crocodilus vulgaris*.

Cuvier appears to have first called the attention of palæontologists to the remains of *Crocodilia* in the Eocene clay forming the Isle of Sheppy, in the last volume of the second edition of his great work on the 'Ossemens Fossiles,' p. 165, 1824. He there specifies a third cervical vertebra, which was obtained by M. G. A. Deluc, at Sheppy, and of which Cuvier made a drawing at Geneva; he says it much resembles the corresponding vertebra in one of our living Crocodiles, and might have come from an individual about five feet in length. "M. Deluc," he adds, "found very near it a much smaller vertebra, which I recognised as belonging to a monitor or some allied genus."*

Our knowledge of the Eocene Crocodiles of Sheppy received a remarkable accession at the publication of the highly interesting and instructive 'Bridgewater Treatise' of Dr. Buckland, in which he states that "true Crocodiles, with a short and broad snout, like that of the Caiman and the Alligator, appear, for the first time, in strata of the tertiary periods, in which the remains of mammalia abound. . . . One of these," he adds, "found by Mr. Spencer in the London Clay of the Isle of Sheppy, is engraved Pl. 25′, fig. 1," and the name '*Crocodilus Spenceri*' is appended to that figure.

In preparing my 'Report on British Fossil Reptiles' for the British Association in 1841, I examined the original specimen figured by Dr. Buckland, in which unfortunately the end of the snout with the intermaxillaries and an indeterminate proportion of the maxillaries having been broken off and lost, no exact idea could be formed of the proportions of the facial or rostral part of the skull.

In a larger specimen of the fossil skull of a Crocodile from Sheppy, in the British Museum, T. II *A*, the whole of the upper, as well as the lower jaw, were preserved, and as the proportions of the snout agreed with those of some true Crocodiles, and differed in an equal degree with those species from the Gavial; and as, like the Crocodiles and Caimans, it presented the more important distinction of a different composition of that part of the skull, I retained for the specimen in that 'Report' the name of *Crocodilus Spenceri*, proposed by the author of the Bridgewater Treatise for the Sheppy Crocodile, so differing from the Gavial.

The able keeper of the Mineralogical Department of the British Museum, Charles König, K.H., F.R.S., to whom I am indebted for every facility in describing and figuring this specimen, has suggested that the name by which Baron Cuvier first indicated the existence of a true Crocodile in the Eocene clay of Sheppy, should have the priority, and I adopt, therefore, the name *Crocodilus toliapicus*, which he has attached to the specimen in question, and with the more readiness since I have now reason to doubt whether the mutilated cranium, figured in the 'Bridgewater Treatise,' belongs to the same species.

* Could this have been a vertebra of the large serpent, which I have subsequently described under the name of *Palæophis?* I have not as yet met with a single lacertian vertebra from Sheppy. If the collection of M. Deluc be still preserved at Geneva, the vertebra in question might be compared with the figures of the *Palæophis toliapicus*, 'Ophidia,' T. XV.

The more entire fossil skull in question presents the following dimensions:

	Feet.	Inches.	Lines.
Total length from the hindmost part of the lower jaw .	2	2	0
Breadth between the articular ends of the tympanics .	0	10	0
Do. across the orbits	0	7	6
Do. of the intertemporal space	0	0	9
Do. of the interorbital space	0	1	4
From the articular end of the tympanic to the orbit .	0	8	6
From the occipital condyle to the orbit	0	7	0
From the orbit to the external nostril	0	14	0
Breadth of the cranium five inches in advance of the orbits	0	3	8
Do. across the external nostril	0	2	8
Depth of the lower jaw at the vacuity between the angular and surangular	0	3	6
Length of that vacuity	0	3	0
Breadth of the base of one of the larger maxillary teeth .	0	0	8

This remarkably fine fossil skull, which is figured one third of its natural size in T. II, fig. 1, presents proportions which come nearest to those of the *Crocodilus acutus*, being longer in proportion to its basal breadth than in the *Crocodilus Suchus*, in which the diameter between the articular ends of the tympanis (28) is just half the length of the entire skull. The interorbital space in the *Crocodilus toliapicus* is relatively narrower and flatter than in the *Croc. acutus* or *Croc. Suchus*, and the facial part of the skull becomes narrower before the expansion of the upper jaw, at the figure 15, than it does in either of those species. The narrow elongated nasals on which the figure 15 is placed, extend forwards to the external nostril (22), as in the true Crocodiles, and the alveolar border is festooned as is shown in the side view in T. II *A*. The teeth are $\frac{22-22}{20-20}=84$ in number: they are more uniform in size, and more regularly spaced than in the recent species above cited, and resemble in this respect the teeth of the *Crocodilus Schlegelii* of S. Müller, which is from Borneo. The extent of the symphysis of the lower jaw is greater in the *Crocodilus toliapicus* than in the *Croc. acutus*, and still greater than in the *Croc. Suchus;* the Sheppy species in this respect more nearly resembles the living species from Borneo above cited.

CROCODILUS CHAMPSOIDES, *Owen.* Tab. III. (Tab. II, fig. 2?)

Syn. CROCODILE DE SHEPPY (?), *Cuvier.* Loc. cit.
CROCOCILUS SPENCERI, or "Crocodile with a short and broad snout" (?) *Buckland.* Bridgewater Treatise, vol. ii, pl. xxv, fig. 1.

The fossil skull already described establishes the fact of the existence of a true Crocodile in the London Clay at Sheppy, but not of a species with a short and broad snout; the present specimen equally demonstrates the presence at the earliest period of the Tertiary geological epoch of *Crocodilia* with those modifications of the cranial and dental structure on which the characters of the restricted genus *Crocodilus* of modern Zoology are founded; but they are associated with a general form of the head which approaches more nearly to the Gavials than does that of the *Crocodilus toliapicus*, and which are most nearly paralleled amongst the known existing true Crocodiles by the *Crocodilus Schlegelii.* This Bornean species was, in fact, originally described as a new species of *Gavial*, but the nasal bones, as in the fossil from Sheppy figured in T. II, 15, extend to the hind border of the external nostril.

The fine subject of T. III, forms part of the collection of J. S. Bowerbank, Esq. F.R.S., which is well known for its rich and varied illustrations of the fossils of the Isle of Sheppy.

The following are some of its admeasurements:

	Feet.	Inches.	Lines.
Total length from the occipital condyle to the end of the premaxillaries	1	4	0
Breadth across the hinder angles of the supracranial platform	0	4	0
Do. across the orbits	0	5	0
Do. of the intertemporal space	0	0	4
Do. of the interorbital space	0	1	0
Do. across the external nostril	0	2	0
From the occipital condyle to the orbit . . .	0	3	4
From the orbit to the external nostril	0	10	0

The skull yielding the above dimensions is much smaller than that of the *Crocodilus toliapicus*, T. II; but it cannot have belonged to a younger individual of the same species, because, in existing Crocodiles, the part of the skull anterior to the orbits is proportionally shorter in the young than in the old individuals, as may be seen by comparing the figures which Cuvier has given of the skulls of three individuals of different ages of the *Crocodilus biporcatus*, in figures 4, 18, and 19, of plate 1 of the last volume of the 'Ossemens Fossiles,' 4to, 1824; whereas the part of the skull anterior to the orbits is relatively longer and more slender in the smaller fossil skull now described than in the larger one on which the species *Croc. toliapicus* is founded. We have, therefore, satisfactory proof that two species of true Crocodile existed during the deposition of the Eocene Clay at the actual mouth of the Thames, and have left their remains in that locality.

Their specific distinction is further illustrated by the different forms and proportions of particular parts of the skull. The alveolar border is more nearly straight; the transverse expansion of the maxillaries (21) is less, whilst that of the premaxillaries (22) is greater: the interorbital space is broader and more concave. The teeth are more uniform in size, are more regularly spaced, and are wider apart: they are, likewise, upon the whole, larger in proportion to the size of the jaw. Figure 5, T. III, shows the crown of a new tooth just emerging from the second socket of the maxillary bone of the natural size; figure 6 is the fourth tooth of the premaxillary, fully formed; fig. 7

is the displaced tooth which is cemented by the matrix to the palatal surface of the premaxillary in fig. 2. The enamelled crown shows the fine raised longitudinal ridges better developed than one usually sees them in modern Crocodiles. There are twenty-one alveoli on each side of the upper jaw.

In all the particulars in which the skull under description differs from that of the *Crocodilus toliapicus*, it departs further from the nilotic crocodile, and resembles more the Gavial-like Crocodile of Borneo; and as one of the old Egyptian names of the Crocodile, *Champsa*, has been applied generically to the Gavials by some recent Erpetologists, I have adopted the term '*Champsoïdes*' to signify the resemblance of the present extinct species of Eocene Crocodile to the Gavials.

The basioccipital condyle, together with the condyloid processes of the exoccipital, project backwards in the *Croc. champsoïdes* farther than in any modern Crocodile; and the supraoccipital 3, fig. 4, T. III, descends nearer to the foramen magnum.

The upper jaw is more depressed, and the suborbital part of the maxillary bone is much less inclined to the vertical in the present skull than in the original of Dr. Buckland's figure of the *Crocodilus Spenceri*, which in other respects more nearly resembles the *Croc. champsoïdes* than the *Croc. toliapicus*; the difference above specified seems to be greater than can be accounted for by any accidental pressure to which the fossil skull figured in T. III can have been subjected. The mutilated skull to which the term *Croc. Spenceri* was originally applied, is defective, as I have said, in the facial or maxillary portion which is requisite for its unequivocal determination to either of the two species which the more perfect specimens since acquired have proved to have existed at the Eocene tertiary period. The form of the mutilated portion of skull, and the figure of it given in Pl. 25′ of the 'Bridgewater Treatise,' might well appear to indicate a short and broad snouted species of true Crocodile; but if it be not distinct from the two better represented species above described, I should be more inclined to refer it to that which has the longest and narrowest snout, from the conformity of the characters of the part of the skull which is preserved. A view of the palatal surface of the specimen in question is given in T. II, fig. 2.

Crocodilian vertebræ referable to the two foregoing species of Sheppy Crocodiles.

Not more than two species of Crocodile are indicated by the detached vertebræ from Sheppy; but the different proportions of the homologous cervical vertebræ, fig. 3 and 7, T. V, and of the characteristic biconvex caudal vertebra, fig. 7, T. IV, and fig. 10, T. V, would have determined the fact of there being two distinct species, had their cranial characters, which are so satisfactorily demonstrated in T. II *A* and T. III, remained unknown. I refer, provisionally, the shorter and thicker vertebræ to the *Crocodilus toliapicus* with the shorter and thicker snout, and the longer and thinner vertebræ to the *Croc. champsoïdes* with the snout of similar proportions.

Vertebræ of the CROCODILUS TOLIAPICUS, Tab. IV and Tab. V, fig. 1, 2, 3, 5, 6.

The vertebra, fig. 1, 2, T. V, is the fourth cervical; it differs from that of the *Crocodilus acutus, Croc. Suchus,* and *Croc. biporcatus,* in the greater breadth and squareness of the base of the hypapophysis (fig. 2 *h*), which extends almost to the bases of the parapophyses *p*; the vertical diameter of the parapophyses is greater in comparison with their antero-posterior extent in the fossil than in the above-cited recent Crocodiles; the neurapophyses are thicker, and terminate in a more rounded border both before and behind; their bases extend inwards, and meet above the centrum, whilst a narrow groove divides them in the recent Crocodiles above cited; the length of the centrum is greater in proportion to the height and breadth in the fossil vertebra. In other respects the correspondence is very close, and the modern crocodilian characters are closely repeated. Traces of the suture between the centrum and neurapophysis remain, as shown at *n, n,* fig. 1. The diapophysis *d,* and the upper portion of the neural arch, with the zygapophyses and neural spine, have been broken away; the borders of the articular ends of the centrum have been worn away.

The vertebra (fig. 3, T. V) is the sixth cervical: in this specimen the base of the hypapophysis is contracted laterally and extended antero-posteriorly; the side of the centrum above the parapophysis (*p*) has become less concave; the vertebra has increased more in thickness than in length; in these changes it corresponds with the modern Crocodiles; it has been mutilated and worn in almost the same manner and degree as the fourth cervical.

The vertebra (fig. 1, 2, T. IV) is a seventh cervical of a smaller individual of the *Crocodilus toliapicus.* The hypapophysis has become more compressed and more extended antero-posteriorly; the parapophysis has become shortened antero-posteriorly, and increased in vertical diameter. The anterior concave surface of the centrum (fig. 1) is more circular, less extended transversely, than in the corresponding vertebra of the recent Crocodiles compared with the fossil.

Fig. 3, 4, T. IV, are two views of the eighth cervical of an individual of about the same size as that to which the fourth and sixth cervicals in T. V belong. Fig. 4, exemplifies the same difference which fig. 1 presents in regard to the more circular contour of the anterior concave surface of the centrum as compared with recent Crocodiles; the bases of the neurapophyses are thicker and more rounded anteriorly; the neural canal is rather more contracted; the base of the hypapophysis more extended in the axis of the vertebra (see fig. 3) than in the recent Crocodiles compared. The parapophyses have now risen, as in those Crocodiles, to the suture of the neurapophysis, and the diapophysis springs out at some distance above that suture.

Fig. 6, T. IV, shows the under surface of a dorsal vertebra, in which the hypapophysis ceases to be developed (probably the fourth or fifth).

Fig. 5, T. IV, gives the same view of one of the lumbar vertebræ, showing the elongation of the centrum, and the broad bases of the depressed diapophyses; there is an indication of two longitudinal risings towards the back part of the under surface of the centrum.

Fig. 5 and 6, T. V, give two views of the anterior sacral vertebra of the *Crocodilus toliapicus;* it is concave and much expanded transversely at its fore part (fig. 5), flattened and contracted behind. Traces of the suture remain to show the proportion of the anterior articular surface which is formed by the base of the pleurapophysis *p*; and fig. 6 shows the extension of that base from the side of the centrum upon the diapophysis or overhanging base of the neurapophysis; the under surface of the centrum of this vertebra has a slight median longitudinal rising.

Fig. 7, T. IV, gives a side view of the characteristic, biconvex, anterior caudal vertebra of the *Crocodilus toliapicus.*

Fig. 8, 9, T. IV, give two views of a middle caudal vertebra: in fig. 9 are shown the characteristic hypapophysial ridges extending from the articular surfaces for the hæmapophyses at the hind part of that aspect of the centrum: in fig. 8 the processes of the neural arch are restored in outline; a thick and low ridge extends from the middle of the side of the centrum to the base of the transverse process which it strengthens, like an underpropping buttress.

Vertebræ of the CROCODILUS CHAMPSOÏDES.

Fig. 7 and 8, T. V, give two views of the third cervical vertebra of the above-named gavial-like Crocodile, which vertebra, besides its longer and more slender proportions, differs in the smaller size of its hypapophysis from the corresponding vertebra in any existing species of Crocodile or Gavial: the process in question being in the form of a low crescentic ridge, as shown at figure 8, between the bases of the parapophyses (*p*).

Both parapophyses terminate by a convex surface, which appears to have been a natural one. Between the parapophysis (*p*) and diapophysis (*d*), fig. 7, the side of the centrum is more deeply excavated than in the *Crocodilus toliapicus.* The centrum contributes a small part to the base of the diapophysis, as in the third cervical vertebra of modern Crocodiles. The neurapophysis are thinner than in the *Croc. toliapicus,* and their bases do not join one another above the centrum. The longitudinal ridge extending from the anterior to the posterior zygapophysis is sharply defined.

Fig. 4, T. V, is the first dorsal vertebra of the *Crocodilus champsoïdes,* in which, as in existing Crocodiles, the parapophysis (*p*) has passed almost wholly from the centrum upon the neurapophysis, the diapophysis (*d*) having been subject to a corresponding ascent. The base of the compressed hypapophysis extends over the anterior third of the middle line of the under surface of the centrum. There is a remarkable transverse constriction at the base of the posterior ball of the centrum, as if a string had been tied round that part when it was soft, and there is no appearance of this groove having been produced by any erosion of the fossil, or being otherwise than natural.

The same character is repeated, though with less force, in the posterior dorsal vertebra, fig. 9, T. V, and, together with the general proportions of the specimen, supports the reference of that vertebra to the *Crocodilus champsoïdes*. There is a slight longitudinal depression at the middle of the side of the centrum near the suture with the neurapophysis (*n*, *n*).

Fig. 10 is a side view of the first caudal vertebra of the *Crocodilus champsoïdes*: besides being longer and more slender than that vertebra is in the *Croc. toliapicus*, the inferior surface of the centrum is less concave from before backwards.

The evidences of Crocodilian reptiles from the deposits at Sheppy less characteristic of particular species than those above described, are abundant. Mr. Bowerbank possesses numerous rolled and fractured vertebræ, condyloid extremities, and other portions of long bones; with fragments of jaws and teeth.

Mr. J. Whickham Flower, F.G.S., has transmitted to me some fragments of the skull of a Crocodile from Sheppy, including the articular end of the tympanic bone, equalling in size that of a *Crocodilus biporcatus* the skull of which measures two feet eight inches in length.

Mr. Leifchild, C.E., possesses a considerable portion of the lower jaw of a Crocodile of at least equal dimensions, also from Sheppy, showing the angle of union of the rami of the lower jaw which corresponds with that in the *Crocodilus toliapicus*, Pl. 2.

In the museum of my esteemed and lamented friend, the late Frederic Dixon, Esq., F.G.S., at Worthing, is preserved a portion of the fossilized skeleton of a Crocodile, from the Eocene clay at Bognor, in Sussex; it consists of a chain of eight vertebræ, including the lumbar, sacral, and the biconvex first caudal, which are represented of their natural size in tab. xv, of Mr. Dixon's beautiful and valuable work on the 'Geology of Sussex.' A dorso-lateral bony scute adheres to the same mass of clay close to the vertebræ, and doubtless belonged to the same individual. The proportions of the vertebræ agree with those of the *Crocodilus toliapicus*. This fine specimen was discovered, and presented to Mr. Dixon, by the Rev. John Austin, M.A., Rector of Pulbrough, Sussex. Mr. Dixon had also obtained from the same locality a posterior cervical vertebra of a Crocodile, similar in its general characters to those above mentioned, but belonging to a larger individual. The length of the body of this vertebra is two inches and a half.

I have examined some remains of *Crocodilia* from the London Clay at Hackney; but as these also are not sufficiently perfect or characteristic for decided specific determination, no adequate advantage would be obtained by a particular description, or by figures of them.

The chief conclusion arrived at from the study of the Crocodilian fossils from the Island of Sheppy has been the proof, by the specimens selected for depiction in the present work, that at least two species of true *Crocodile* have left their remains in that locality; that neither of these had a short and broad snout like the Caimans, but that one of them—the *Croc. champsoïdes*—much more nearly resembled the Gavial of the Ganges in the proportion of that part of the skull; although, in its composition, especially as regards the length and connexions of the nasal bones, it is a true Crocodile.

Amongst the existing species of Crocodile the *Croc. acutus* of the West Indies offers the nearest approach to the *Croc. toliapicus,* and the *Croc. Schlegelii* of Borneo most resembles the *Croc. champsoïdes.* But there are well-marked characters in both the skull and the vertebræ which specifically distinguish the two fossil Crocodiles of Sheppy from their above-cited nearest existing congeners.

CROCODILUS HASTINGSIÆ, *Owen.* Tab. VI, VII, VIII, IX, and T. XII, fig. 2 and 5.

Reports of the British Association, 1847, p. 65.

That Crocodiles with proportions of the jaws assigned to the Eocene species noticed in Dr. Buckland's 'Bridgewater Treatise' and especially adapted for grappling with strong mammiferous animals, actually existed at that ancient tertiary epoch, and have left their remains in this island, is shown by the singularly perfect fossil skull figured in the above-cited plates. This specimen was discovered by the Marchioness of Hastings, in the Eocene fresh-water deposits of the Hordle Cliffs in Hampshire, which her Ladyship has described in the volume of 'Reports of the British Association' above cited, (p. 63).

When the specimen was originally exposed, it was in the same extremely fragile and crumbling state as the beautiful carapaces of *Trionyx* obtained by Lady Hastings from the same locality, and described and figured in the First Part of this Monograph on the *Chelonia;* but thanks to the skill and care with which the noble and accomplished discoverer readjusted and cemented the numerous detached fragments of those specimens, the present unique fossil has been in like manner restored as nearly to its original state as is represented in the plates; and all the requisite characters for determining the nature and affinities of the species, can now be studied with the same facility as in the skulls of existing Crocodiles.

If the reader will compare the plates above cited with the section of Cuvier's 'Ossemens Fossiles,' in which the distinctions between the Alligators and Crocodiles are specified,* he will see, (in fig. 1, T. VII) for example, that the fourth tooth or canine of the lower jaw is not received into a circumscribed cavity of the upper jaw,

* "Les têtes des caïmans, outre le nombre des dents, et surtout la manière dont la quatrième d'en bas est reçue, outre les différences qui dépendent de la circonscription totale, se distinguent de celles des Crocodiles proprement dits, 1°, parce que le frontal antérieur et le lacrymal descendent beaucoup moins sur le museau; 2°, en ce que les trous percés à la face supérieure du crâne, entre le frontal postérieur, le pariétal et le mastoïdien, y sont beaucoup plus petits, souvent même y disparaissent tout-à-fait, comme dans le caïman à paupières osseuses; 3°, en ce que l'on aperçoit une partie du vomer dans le palais, entre les intermaxillaires et les maxillaires; 4°, en ce que les palatins avancent plus dans ce même palais, et s'y élargissent en avant; 5°, en ce que les narines postérieures y sont plus larges que longues, etc." (tom. v, pt. ii, p. 105.)

but is applied to a groove upon the side of the upper jaw, and is exposed. Fig. 1, T. VI, shows that the prefrontal (14) and lachrymal (73) bones, instead of descending much less upon the facial part of the skull, extend much more, and advance nearer to the end of the muzzle than in any Alligator, or even than in any actual species of broad-nosed Crocodile.

The vacuities left between the postfrontal (12), the parietal (7), and the mastoid (8) (T. VI, fig. 1, and T. II, fig. 3), are as wide as in the skull of a *Crocodilus biporcatus* of equal size, and are larger than in the *Alligator lucius* or *All. sclerops.* Fig. 2, T. VII, shows that no part of the vomer is visible between the premaxillaries (22) and maxillaries (21), or elsewhere on the palate. But the palatine expansion of the vomer is not a constant character; it is wanting, for example, in the *Alligator lucius* of North America. The palatines (20) are not more advanced in the fossil in question than they are in the true Crocodiles, and their anterior portion does not expand to its anterior truncated termination. The posterior nostril, the entire contour of which is shown in the portion of the skull of the same species figured in T. VI, fig. 3, is longer than it is broad.

There is but one character in which the fossil skull in question differs from the true Crocodile, and agrees with most species of Alligator; it is in the reception of the two anterior teeth of the lower jaw into cavities of the premaxillaries, shown in fig. 2, T. VII, which are not perforated; so that there are no foramina anterior to the bony nostril, as in T. I, in the bone marked 22. These foramina are not, however, absent in all Alligators; the skull of the *Alligator sclerops*, figured by Cuvier (tom. cit., pl. i, fig. 7), shows them, as do all the species of true Crocodile the skulls of which are figured in the same plate. There is one character by which the *Crocodilus Hastingsiæ* differs from all known species of both Crocodile and Alligator: it is that afforded by the broad and short nasal bones (15, fig. 1, T. VI), which do not reach the external nostril; this being formed, as in the Gavials, exclusively by the premaxillaries 22.

In the general proportions, however, of the skull of *Croc. Hastingsiæ*, especially the great breadth, shortness, and flatness of the obtusely-rounded snout, it resembles that of the Alligators more than that of any known species of true Crocodile, the length from the tympanic condyle to the end of the snout being to the breadth taken at the condyles as 16 to 9.

The following are dimensions of the fossil in question:

	Feet.	Inches.	Lines.
Length of skull from the angle of the lower jaw to the end of the snout	1	6	6
Do. from the tympanic condyle to ditto.	1	4	6
Do. do. to the orbit	0	5	4
Do. from the orbit to the external nostril	0	7	0
Breadth of the skull across the tympanic condyles	0	9	3
Do. the orbits	0	7	0
Do. the external nostril	0	4	0
Longest diameter of upper temporal aperture	0	1	9
Do. the post-palatal vacuities	0	4	9
Depth of the lower jaw at the posterior vacuity	0	3	0
Depth of the occipital region	0	4	3

The occipital region of the skull (T. VI, fig. 2), in the proportion of its breadth to the depth of the lateral parts formed by the conjoined paroccipitals (4) and mastoids (8), resembles that of the true Crocodiles rather than that of the Alligators, in which that region is proportionally deeper than in the Crocodiles; the vertical extent of the supraoccipital is less, and that of the conjoined parts of the exoccipitals above the foramen magnum is greater; the vertical extent of the descending part of the basioccipital is also greater in proportion to its breadth than in the Alligators. The proportion of the basisphenoid (5) and of the conjoined parts of the pterygoids (24) which appear in this view (fig. 2), is less than in the Alligators, but is greater than in most Crocodiles, thus presenting an intermediate character; but the entire exclusion of any part of the posterior nostril from this view is a character of the Alligators, and is due to the horizontal plane of that aperture in them, and to its position in advance of the posterior border of the pterygoids, from which it is partitioned off usually by a bony ridge. The posterior nostril has the same position and aspect in the *Crocodilus Hastingsiæ*, and these characters of the posterior nostril are perhaps more distinctive between Alligator and Crocodile than the shape of the aperture, in which the present fossil differs both from the Alligators and from most of the Crocodiles with which I have compared it. The backward extension of the exoccipitals and of the basioccipital condyle, is such as to bring both parts into view in looking directly upon the middle of the upper surface of the skull, as in T .VI, fig. 1. In this character the fossil resembles the Crocodiles more than the Alligators, but the projection is greater than in existing Crocodiles, and equals that in the Sheppy *Crocodilus champsoïdes*.

On the upper surface of the skull a distinctive character has been pointed out by Cuvier in the different proportions of the supra-temporal apertures in the Alligators and Crocodiles. The horizontal platform in which these apertures are perforated, is also square in the Alligators; the mastoidal angles being less produced outwards and backwards, and the postfrontal angles less rounded off; this difference is shown in the skulls figured in Cuvier's pl. i, tom. cit. The *Croc. Hastingsiæ*, both by the obtuseness of the postfrontal angles, and the acuteness and production of the mastoidal angles, resembles the Crocodiles, as well as by the size of the supra-temporal apertures; these are ovate with the small end turned forwards and a little outwards.

Another character may be noticed in the figures of the skulls of the three species of Alligators as compared with those of the three species of Crocodile in Cuvier's pl. i, viz. the larger proportional size of the orbits in the former, in which the orbit much exceeds in size the lateral temporal aperture. In the *Alligator niger*, also, I find the orbits enormous, and it is the encroachment of the narrow anterior part of the orbital cavity upon the facial part of the prefrontal and lachrymal, that renders that part of those bones relatively shorter in the Alligators. In the *Crocodilus Hastingsiæ* the proportions of the lateral temporal apertures (T. VI, fig. 1, 12, 26) and orbital (11, 14, 73) apertures, are like those in the species of Crocodile in which the orbits are smallest. The extent of the facial part of the prefrontal (14) and lachrymal (73) is greater in the *Croc. Hastingsiæ* than in any existing species of true Crocodile. Another characteristic of the present fossil presented by the upper surface of the skull, is the shortness as well as breadth of the nasal bones, and their almost truncate anterior termination at nearly one inch from the external nostril. In all the Alligators' skulls that I have examined or seen figured, the nasal bones are broadest at their posterior third part, and converge to a point anteriorly, where in the *Alligator lucius*, e. g., they extend across the nasal aperture.

The interorbital space is slightly concave in the *Crocodilus Hastingsiæ ;* two broad and slightly elevated longitudinal tracts are continued forwards upon the face from the fore part of the orbits ; but they are not developed into ridges, as in the *Croc. biporcatus*. The maxillaries swell out a little in advance of the middle of the nasals, and then contract to the crocodilian constriction at the suture with the premaxillaries, where the tips of the lower canines appear in the upper view (fig. 1, T. VI), and their whole crown is exposed in the side view (fig. 1, T. VII). The conjoined parts of the premaxillaries send a short pointed projection into the back part of the external nostril.

On the under or palatal surface of the skull (T. VII, fig. 2) the maxillo-premaxillary suture runs almost transversely across, as in the *Crocodilus rhombifer*, figured by Cuvier in pl. iii, fig. 2, of the volume above cited. There is no appearance of the vomer upon the palate. The palatal bones (20), though somewhat broader anteriorly, and more abruptly truncate than in any existing Crocodile that I have seen, are more like those bones in the true Crocodiles than in the Alligators. The portion between the post-palatal vacuities is longer and narrower; the posterior end of the palatines is narrower, and the part of the bone anterior to the notch receiving the posterior angle of the palatal plate of the maxillary does not expand in advancing forwards, as it does in the Alligators : in the *Alligator niger* this expansion is greater than in the *All. lucius*, and the posterior ends of the palatines are also remarkably expanded, and applied to the anterior borders of the pterygoids almost as far as their articulation with the ectopterygoids, the postpalatal vacuities not at all encroaching on the pterygoids, as they are seen to do at 24, T. VII, fig. 2, and also in the figure of the *Crocodilus rhombifer* above cited, and in other true Crocodiles. The form of the pterygoids (24, T. VII, fig. 2) is peculiar in the *Crocodilus Hastingsiæ :* they are contracted anteriorly, and send forwards a short truncated process to meet the narrow posterior ends of the palatines (20) ; and the same character being repeated in another skull of the same species, from Hordle, also in the collection of Lady Hastings, in which this part of the bony palate (T. VI, fig. 3) is more perfect than in the subject of T. VII, fig. 2, it may be regarded with some confidence as specific. In the *Crocodilus champsoïdes* of Sheppy it will be seen, by fig. 2, T. II, that the pterygoids (24, 24) are not produced where they join the palatines (20). In the Alligators, the posterior border of the conjoined pterygoids is deeply notched behind the posterior nostrils, the angles of the notch being slightly extended backwards : in most Crocodiles, the sides of the notch are so developed that it does not sink deeper than the line of the posterior border of the pterygoids; and this modification is exaggerated in the *Crocodilus Hastingsiæ* (T. VI, fig. 3) in which the notch in question is merely the interval between two slender diverging processes from the middle of the back part of the pterygoids, 24. The posterior aperture of the nasal passages is wholly surrounded in the *Crocodilus Hastingsiæ* by the horizontal plate of the pterygoids, and has the same position and aspect as in the Alligators; but its form is heart-shaped, with the apex directed backwards, and the antero-posterior diameter exceeding the transverse one. I have not met with this form of the posterior nostril in any other species of Crocodilian; but it is repeated in two individuals of the *Croc. Hastingsiæ*, and may be regarded as a specific character.

The ectopterygoid, 25, T. VI, fig. 3, T. II, fig. 2 (*d*, fig. 2, pl. iii, 'Ossemens Fossiles,' t. v, pt. ii) articulates with a larger proportion of the outer surface of the pterygoids (24) in the Crocodiles than in the Alligators: it agrees with the Crocodiles in the extent of this articulation in the *Croc. Hastingsiæ*.

The number of teeth in this species is $\frac{22-22}{20-20} = 84$.

In the upper jaw the fourth, ninth, and tenth are the largest; and the fifteenth and sixteenth exceed in size those immediately before and behind them. The alveolar border of the jaw increases in depth to form the sockets requisite for firmly lodging these larger teeth, and gives rise to the festooned outline of the jaw, which is found in all Crocodiles and Alligators in proportion as the teeth are unequal in size.

The lower jaw presents the same compound structure as that in the *Crocodilia*, with the general form characteristic of that in the Alligators and in most of the true Crocodiles: the symphysis, e. g. is as short as *Crocodilus biporcatus* and the *Alligator niger*, in which it extends as far back as the interval between the fourth and fifth socket. This is the relative position of the back end of the symphysis in a fine and perfect under jaw of the *Crocodilus Hastingsiæ* in the collection of the Marchioness of Hastings. In a portion of the under jaw of apparently the same species of Crocodile, from the same locality, in the collection of Searles Wood, Esq., F. G. S., the symphysis terminates opposite the interval between the third and fourth tooth.

The chief distinction observable between the modern Crocodiles and Alligators in the lower jaw is the greater relative size of the vacuity between the angular (30) and surangular (29) pieces, and the greater relative depth of the ramus at that part, in the Alligators. In these characters the lower jaw of the present species more resembles that of the true Crocodiles; although, as the vacuity in question is somewhat larger, a slight affinity to the Alligator might be inferred from that circumstance. The comparative figures of the hinder third of the mandibular ramus in T. XII, fig. 4, 5, 6, will exemplify the difference in question, and the degree of proximity to the crocodilian and alligatorial characters respectively.

With regard to another character deducible from the relation of the backwardly-produced angle of the jaw to the articular surface, the *Crocodilus Hastingsiæ* more decidedly resembles the Alligator: I allude to the depth of the excavation between the articular cavity (29) and the end of the angular bone (30), and to the lower or higher level of the angle itself: the fossil jaw (fig. 5) resembles the Alligator (fig. 6) in this respect more than the Crocodile (fig. 4).

The alveoli are twenty in number in each ramus of the *Crocodilus Hastingsiæ:* the third and fourth are large, of equal size, and close together; behind these the eleventh, twelfth, and thirteenth are the largest, and the alveolar ridge is raised to support them; after the seventeenth the summits of the crowns of the teeth become obtuse, and the crowns mammilloid, and divided by a constriction or neck from the fang; they each, however, have a separate socket, as in the Crocodiles, the septa not being incomplete at the hinder termination of the dental series, as in the *Alligator niger* figured in my 'Odontography.'*

Fig. 3, T. II, gives a representation, of the natural size, of the cranial platform of a young *Crocodilus Hastingsiæ* in the collection of Searles Wood, Esq.; the hemispheric depressions in the surface of the bone are more regular, distinct, and relatively larger, and the interorbital part of the frontal is narrower, concomitantly with the larger proportional eyeballs and orbits of the young animal. The relatively larger supratemporal apertures form another character of nonage; but there is no ground for deducing a specific distinction from any of the differences observable between this part of the young crocodile's cranium and the corresponding part of that of the more mature specimen (T. VI).

ALLIGATOR HANTONIENSIS, *Wood.* Tab. VIII, fig. 2.

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On reviewing the characters of the skull of the *Crocodilus Hastingsiæ* we perceive that they combine to a certain extent those which have been attributed to the genus *Crocodilus* and the genus *Alligator;* in general form it resembles most the latter, but agrees with the former in some of the particulars that have been regarded by Cuvier and other palæontologists as characteristic of the true Crocodiles. I allude more particularly to the exposed position of the inferior canines when the mouth is shut. Respecting which, however, I am disposed to ask, whether this be truly a distinctive character of importance? One sees that it needs but a slight extension of ossification from the outer border of the groove to convert it into a pit; yet the character has never been found to fail as discriminative of the several species of existing Crocodiles and Alligators hitherto determined. It constitutes, however, the only difference between the skulls of the *Crocodilus Hastingsiæ* in the collection of the Marchioness of Hastings and that fine portion of skull now, by the kindness of Mr. Searles Wood, before me, on which he has founded the species named at the head of the present section. So closely, in fact,

* Tom. ii, pl. lxxv, fig. 3.

do those specimens from the same rich locality correspond, that any other comparative view than that given in T. VIII appeared superfluous. In both the broad nasal bones terminate at the same distance from the external nostril, which is accordingly formed exclusively by the premaxillaries; in both, the palate-bones present the same narrow, truncate posterior ends, and the same equal breadth of their anterior portions included between the maxillaries; only these terminate rather more obliquely in Mr. Wood's specimen, their anterior ends forming together a very obtuse angle directed forwards. But this is comparatively an unimportant difference, and I regard as equally insignificant the slight interruption of the transverse line of the maxillo-premaxillary suture, at the middle part, which will be seen by comparing fig. 2 with fig. 1, in T. VIII. The teeth are the same in number, arrangement, and proportion in the *Alligator Hantoniensis* as in the *Crocodilus Hastingsiæ*, and the alveolar border of the jaws describes the same sinuous course.

Had the complete fossil skull first submitted to my inspection at the meeting of the British Association at Oxford presented the same fossæ for the reception of the lower canines which exist in fig. 2, T. VIII, I should have referred it to the Alligators, notwithstanding the crocodilian characters of the small orbits, the long facial plates of the prefrontal and lachrymal, the wide supratemporal apertures, the non-expansion of the fore part of the palatines, and the non-appearance of the vomer on the palate, with other minor marks of the like affinity. For all these characters arise out of secondary modifications, and are presented in different degrees in the different species of *Crocodile*, and are rather of a specific than a generic value. They determine the judgment by the extent of their concurrence rather than by their individual intrinsic worth, and for that reason, therefore, the exposed position of the lower canine in the lateral groove of the upper jaw inclined the balance in favour of a reference of the previously-described fossil to the true Crocodiles. One cannot, indeed, attach any real generic importance to the modification of the upper jaw in relation to the lower canines. In three examples, however, in the collection of the Marchioness of Hastings, the crocodilian modification of this character is repeated, as it is shown in T. VII, fig. 1; and we have to choose, therefore, between the conclusion that Mr. Wood's specimen (T. VIII, fig. 2) presents an accidental variety in this respect, or to view the fossæ in the upper jaw as indicative of not only a different species but a distinct genus from the *Crocodilus Hastingsiæ*. I should be glad to have more evidence on this point, and especially the opportunity of comparing the posterior nostrils, the orbits, the supra-temporal apertures, and the occipital part of the skull of a specimen from Hordwell, repeating the alligatorial character of the fossæ in the upper jaw for the lower canines. I am disposed to regard this character, notwithstanding its constancy in the living species of Alligator, as a mere variety in the Hordwell fossil; but pending the acquisition of further evidence, it seems best to record this fossil under the title proposed for it by the able geologist by whom it was discovered.

CROCODILUS HASTINGSIÆ.

Vertebræ referable to the CROCODILUS HASTINGSIÆ, Tab. IX.

The fossil crocodilian vertebræ obtained from the Eocene sand at Hordle, notwithstanding the comparatively limited extent of the researches in that interesting formation, are at least as abundant as those which have been discovered at Sheppy, but they do not, as at that locality, indicate two distinct species; all that have, hitherto, been found belong to one and the same kind of Crocodile, and from their robust proportions, would seem to have come from a species with a short and broad muzzle, like that of the Crocodile or Alligator, the fossil skulls of which have been described.

Perhaps the most perfect fossil reptilian vertebra that has hitherto been discovered is the one figured, of the natural size, in T. IX, fig. 1, 2, and 3. It is the fifth cervical vertebra. As compared with that of the *Crocodilus toliapicus* (T. V, fig. 1, 2), which it resembles in size, the hypapophysis, *hy* (fig. 2, T. IX), is much more compressed, and the under part of the centrum is more extensively and deeply excavated between it and the parapophyses (*p*); it is also excavated on each side behind the base of the hypapophysis, from which a progressively widening smooth ridge is continued to near the posterior surface of the centrum. The interspace at the side of the vertebra, between the parapophysis and diapophysis, is smaller but deeper in the *Crocodilus Hastingsiæ*. The neurapophyses meet above the centrum in both; but in the *Crocodilus Hastingsiæ* they are thicker anteriorly and thinner at their posterior border, and the neural canal (fig. 2, *n*) is more contracted than in the *Crocodilus toliapicus*.

As compared with the cervical vertebra of the *Crocodilus champsoïdes* from Sheppy, the present vertebra differs in the form of the hypapophysis in a greater degree than from the *Crocodilus toliapicus*. Fig. 8, T. V, shows as little as does fig. 2 in the same plate, the median ridge and lateral excavations of the under part of the centrum which characterise the present vertebra of the *Crocodilus Hastingsiæ*. The *Crocodilus champsoïdes* resembles the *Crocodilus Hastingsiæ* in the character of the proportion and depression of that part of the side of the centrum forming the interspace between the parapophysis and diapophysis; but the antero-posterior extent of the parapophysis is relatively less in that Sheppy species. The outer surfaces of the neurapophyses in the *Crocodilus Hastingsiæ* slope or converge towards each other from before backwards, in a much greater degree than in either of the Sheppy species. I have not observed in any recent Crocodile or Alligator the median ridge, continued backwards from the hypapophysis and the lateral depressions, so strongly developed, as in the *Crocodilus Hastingsiæ*. The fore part of the neurapophyses is relatively thicker in this than in the recent species. The pleurapophyses *pl*, (figs. 1, 2), are well developed both forwards and backwards, and the latter productions are expanded and excavated above for the reception of the fore part of the succeeding cervical rib. The zygapophyses (*z*) are thicker at their base, especially the hinder pair, where the base fills up the entire interval between the articular surface and the base of the spine (see fig. 2). There is the usual deep excavation at the fore and back part of the base of the spine (*ns*) for the insertion of the interspinal ligaments. The neural spine is compressed, moderately long, straight and truncate at its summit.

Although the hypapophysis maintains its characteristic form with much constancy in the homologous vertebræ of the same species of Crocodile, it varies in different cervical vertebræ of the same individual in certain existing species. It is, for example, shorter and thicker in the third and fourth vertebræ than in the succeeding ones in the *Crocodilus acutus;* whilst in the *Crocodilus biporcatus* the hypapophysis of the third cervical is more compressed than that of the sixth. The greatest difference is, however, presented, as far as I have yet made the comparison, by the cervical vertebræ of the *Alligator lucius,* in respect of the hypapophysis, which is broad and short in the third and fourth cervicals, but becomes long and slender in the succeeding cervicals. The small vertebral centrum (fig. 4, T. IX) resembles, in its broad and stunted hypapophysis, that of the third cervical vertebra of the Alligator, but with an indication of a median rising and lateral depressions, behind that process, like those which are more decisively shown in the fifth cervical vertebra of the larger individual of the *Crocodilus Hastingsiæ,* to which species I believe the specimen fig. 4 to belong. It is the homologous vertebra with fig. 8, T. V, and well illustrates the different proportions of the bones in different species of Crocodile.

Fig. 6 gives a view of the anterior surface of the first sacral vertebra of the *Crocodilus Hastingsiæ:* the under surface of the centrum has ceased to develope the median ridge; the short and thick ribs (*pl*) have completely coalesced with both the centrum and neural arch. The anterior concavity has a fuller and more exact elliptical form than that of the *Crocodilus toliapicus* (fig. 5, T. V); the anterior zygapophyses do not project over the rim of that concavity; but, like those of the Alligator and Crocodile, they are more transversely extended than in the Gavial.

The general proportions of the first caudal vertebra (fig. 7, T. IX) are intermediate between those of the *Crocodilus toliapicus* (fig. 7, T. IV) and of the *Crocodilus champsoïdes* (fig. 10, T. V): the under surface of the centrum is flat, not concave, lengthwise, as in both the Sheppy Crocodiles; the side of the centrum is irregularly tuberculate, not smooth, and concave lengthwise; the broad and high neural spine is deeply grooved at its fore part: a smaller proportion of the hinder end of the centrum (fig. 5) is occupied by the articular ball than we find in the antecedent vertebræ.

As none of the other numerous vertebræ and portions of vertebræ give any indications of a different species from the *Crocodilus Hastingsiæ,* or add any material characters to those of that species which have been deduced from the parts of the skeleton already described, I refrain from trespassing on the reader's attention or occupying further space by their description or figures.

Genus—GAVIALIS, Oppel.

GAVIALIS DIXONI, *Owen*. Tab. X.

The characters of the genus *Gavialis* are much more strongly marked than are those which distinguish the Alligators from the Crocodiles, and leave no ambiguity in the conclusions that may be deduced from them. The present interesting addition to the catalogue of British Fossil Reptiles, is due to the discovery in the Eocene deposits at Bracklesham, by my lamented friend the late Frederic Dixon, Esq., F.G.S., of the remains figured in T. X. The portions of the lower jaw demonstrate, by the slender proportions of the mandibular rami (figs. 1, 5), the extent of the symphysis, the uniform level of the alveolar series, and the nearly equal distance of the sockets of the comparatively small, slender, and equal-sized teeth, the former existence in England, during the early tertiary periods, of a Crocodilian with the maxillary and dental characters of the genus *Gavialis*. These characters are, however, participated in by some of the extinct Crocodilians of the secondary strata (see T. XI, fig. 2′); but in them they coexist with a different type of vertebra from that of the recent and known tertiary Crocodilian genera: it became necessary, therefore, to ascertain what form of vertebra might be so associated with the fossil Gavial-like jaws and teeth in the Bracklesham Eocene deposits, as to justify the conclusion that such vertebræ had belonged to the same species as the jaws. Now, the only Crocodilian vertebræ that have yet been found at Bracklesham, so far as I can ascertain, present the procœlian type of articular surfaces of the body (T. X), like that in Mr. Dixon's collection fig. 8. This vertebra answers to the fifth cervical vertebra in the existing Crocodilians, and accords in its proportions with that in the Gangetic Gavial. There are a few indications of specific distinction; the parapophysis (*p*) or lower transverse process articulating with the head of the rib, is relatively shorter antero-posteriorly. The broad, rough, neurapophysial sutures (*n*) meet upon the middle of the upper part of the centrum; the elsewhere intervening narrow neural tract sinks deeper into the centrum than in the modern Gavial, but is perforated, as in that species, by the two approximated vertical vascular fissures. The hypapophysis (*hs*) or process from the inferior surface of the centrum, has been broken off in the fossil, but it accords in its place and extent of origin with that in the fifth and following cervical vertebræ of the Gavial. Assuming the fossil procœlian vertebræ from Bracklesham, and the above-described vertebra in particular, to have belonged to the same individual or species as the portions of fossil jaw (figs. 1, 5), then these mandibular and dental fossils must be referred to the genus *Gavialis*, or to the long-, slender-, and subcylindrical-snouted *Crocodilia* with procœlian vertebræ.

This genus is now represented by one or two species peculiar to the great rivers of India, more especially the Ganges; and the fossil differs from both the *Gavialis* *gangeticus,* Auct., and from the (perhaps nominal) *Gavialis tenuirostris,* Cuv., in the form and relative size of the teeth. The crown (figs. 6, 7) is less slender in the fossil than in the existing Gavials, and less compressed, its transverse section being nearly circular. There are two opposite principal ridges, but they are less marked than in the existing Gavials; and are placed more obliquely to the axis of the jaw, i. e., the internal ridge is more forward, and the external one more backward, when the tooth is in its place in the jaw. In the modern Gavial, the opposite ridges, besides being more trenchant, are nearly in the same transverse line. The other longitudinal ridges on the enamel of the fossil teeth, are more numerous, more prominent, and better defined, than in the existing Gavials: the intermediate tracts of enamel present the same fine wrinkles in the fossil as in the existing Gavials' teeth.

The two chief portions of jaw (fig. 1, and figs. 4, 5) belong to two individuals of different ages; indicated by the difference in the breadth and depth of the ramus: both specimens being from the corresponding part of the jaw, viz. where it forms the long symphysis characteristic of the Gavials. The specimen (figs. 4, 5) includes a larger proportion of the jaw than the fragment delineated in fig. 1.

On comparing the latter fragment of the fossil lower jaw with a specimen of a lower jaw of the *Gavialis gangeticus* of the same breadth across the symphysial part, at the intervals of the sockets, which breadth is 3 centimeters (1 inch 3 lines), I find that the longitudinal extent of 10 centimeters (near 4 inches) of a ramus of the fossil jaw includes five sockets; but in the recent Gavial the same extent of jaw includes seven sockets, showing that the teeth are fewer as well as larger in the fossil Gavial, in proportion to the breadth of the jaws.

The second portion of the jaw (fig. 2) is from the part where the rami diverge posteriorly from the symphysis, and near the posterior termination of the dentary series. Here the teeth become shorter in proportion to their thickness, and somewhat closer placed together: there is a shallow depression (*c*) in each interspace of the teeth, for the reception of the crowns of the opposite teeth when the mouth is shut. These depressions are longer, deeper, and better defined in the fossil than in the recent Gavial of the same size.

The fragments of jaw and teeth of the fossil Gavial of Bracklesham show examples of young teeth penetrating the base of the old ones, according to the law of succession and shedding of the teeth, which characterises the existing *Crocodilia:* fig. 2 shows the apex of one of the successional teeth at *d*; and fig. 3 *d* the hollow base of the same incompletely formed tooth seen from below.

Besides the fossil jaws, teeth, and vertebræ of the extinct Gavial, a nearly entire femur (fig. 9) of a Crocodilian has been discovered in the Eocene deposits at Bracklesham, which in its proportions, agrees with that bone in the Gavial of the Ganges. Cuvier, in his comparison of the bones of the Gavial with those of the Alligators and true Crocodiles, merely observes, "La forme des os du Gavial ressemble aussi prodigieusement à celle des os du Crocodile, seulement les apophyses épineuses des vertèbres sont plus carrées."*

With regard to the femur, this bone is more slender in proportion to its length in the Gangetic Gavial, than in the *Crocodilus biporcatus* or the *Alligator lucius,* and the anterior convex bend of the shaft commences nearer the head of the bone; and in these characters the fossil femur from Bracklesham corresponds with the modern Gavial, and differs from the Crocodiles and Alligators, and also from the *Crocodilus Hastingsiæ,* of which species specimens of the fossil femur have been kindly submitted to me by the Marchioness of Hastings and Alexander Pytts Falconer, Esq. The fossil femur of the Gavial from Bracklesham (fig. 9) may therefore be referred, with the utmost probability, to the same species as the portions of jaw, teeth, and vertebræ above described; and as these clearly demonstrate a species distinct from any known Gavial, I propose to call the extinct species of the Eocene deposits at Bracklesham, *Gavialis Dixoni,* after my esteemed friend, by whose scientific and zealous investigations so much valuable additional knowledge has been obtained respecting the fossils of that rich, but, previously to his researches, little known locality.

The tooth represented of the natural size in fig. 10, T. X, was also discovered at Bracklesham, and forms part of the collection of G. Coombe, Esq. It resembles, in its proportions and obtuse extremity, the teeth of the Crocodiles rather than those of the Gavials, and at first sight reminded me of those of the *Goniopholis* or amphicœlian Crocodile of the Wealden period. On comparing it closely with similar-sized teeth of that species, the enamel ridges were more numerous and decided in the *Goniopholis;* and the delicate reticular surface in the interspaces of the more widely separated and feebler longitudinal ridges in the Bracklesham tooth was wanting in the *Goniopholis.* The minute superficial characters of the enamel of the large and strong Crocodilian tooth from Bracklesham, closely agree with those of the *Gavialis Dixoni.* It is just possible that this may be a posterior tooth of a very large individual of that Gavial, as the teeth become at that part of the jaw shorter in proportion to their thickness in the modern Gavials. If it should not belong to that Gavial, it must be referred to a Crocodile distinct from those species of the secondary strata, or those existing Crocodiles which have teeth of a similar form; since they present a different superficial pattern of markings on the enamel.

On reviewing the information which we have derived from the study of the fossil remains of the procœlian *Crocodilia,* that have been discovered in the Eocene deposits of England, the great degree of climatal and geographical change, which this part of Europe must have undergone since the period when every known generic form of that group of reptiles flourished here, must be forcibly impressed upon the mind.

At the present day the conditions of earth, air, water, and warmth, which are

* Ossemens Fossiles, 4to, tom. v, pt. ii, p. 108.

indispensable to the existence and propagation of these most gigantic of living Saurians, concur only in the tropical or warmer temperate latitudes of the globe. Crocodiles, Gavials, and Alligators now require, in order to put forth in full vigour the powers of their cold-blooded constitution, the stimulus of a large amount of solar heat, with ample verge of watery space for the evolutions which they practise in the capture and disposal of their prey. Marshes with lakes, extensive estuaries, large rivers, such as the Gambia and Niger that traverse the pestilential tracts of Africa, or those that inundate the country through which they run, either periodically, as the Nile for example, or with less regularity, like the Ganges; or which bear a broader current of tepid water along boundless forests and savannahs, like those ploughed in ever-varying channels by the force of the mighty Amazon or Oronooko;—such form the theatres of the destructive existence of the carnivorous and predacious Crocodilian reptiles. And what, then, must have been the extent and configuration of the eocene continent which was drained by the rivers that deposited the masses of clay and sand, accumulated in some parts of the London and Hampshire basins to the height of one thousand feet, and forming the graveyard of countless Crocodiles and Gavials? Whither trended that great stream, once the haunt of Alligators and the resort of tapir-like quadrupeds, the sandy bed of which is now exposed on the upheaved face of Hordwell Cliff?

Had any of the human kind existed and traversed the land where now the base of Britain rises from the ocean, he might have witnessed the Gavial cleaving the waters of its native river with the velocity of an arrow, and ever and anon rearing its long and slender snout above the waves, and making the banks re-echo with the loud and sharp snappings of its formidably-armed jaws. He might have watched the deadly struggle between the Crocodile and Palæothere, and have been himself warned by the hoarse and deep bellowings of the Alligator from the dangerous vicinity of its retreat. Our fossil evidences supply us with ample materials for this most strange picture of the animal life of ancient Britain, and what adds to the singularity and interest of the restored 'tableau vivant,' is the fact that it could not now be presented in any part of the world. The same forms of Crocodilian Reptile, it is true, still exist, but the habitats of the Gavial and the Alligator are wide asunder, thousands of miles of land and ocean intervening: one is peculiar to the tropical rivers of continental Asia, the other is restricted to the warmer latitudes of North and South America; both forms are excluded from Africa, in the rivers of which continent true Crocodiles alone are found. Not one representative of the Crocodilian order naturally exists in any part of Europe; yet every form of the order once flourished in close proximity to each other in a territory which now forms part of England.

Order—Lacertilia.

Pleurodont Lizard (?) Tab. XIV, figs. 43, 44.

Although members of the present order, with the modern procœlian type of vertebræ, existed in England during the Wealden and Chalk periods, and the greater part of the actual class of Reptiles, in all parts of the world, is composed of the same order, yet but one solitary example of true Lacertian from the formations of the Eocene tertiary period has hitherto come under my observation—a fact which has often excited my surprise. Future researches may bring to light farther and better evidence of the class.

Among the fossils obtained by Mr. Colchester from the Eocene sand, underlying the Red Crag at Kyson, or Kingston, in Suffolk, the existence of a Lizard, about the size of the Iguana, is indicated by a part of a lower jaw, armed with close-set, slender, subcylindrical, antero-posteriorly compressed teeth, attached to shallow alveoli, and with their bases protected by an external parapet of bone. The fragment of jaw is traversed by a longitudinal groove on the inside (fig. 44), and is perforated, as in most modern Lizards, and as in some Fishes, by numerous vascular foramina along the outside (fig. 43). The teeth are hollow at their base.

PART III.

Order *OPHIDIA.*

SERPENTS.

Prior to the publication of my Memoir on the *Palæophis* in the 'Geological Transactions,'* and my 'Report on British Fossil Reptiles,'† the sole notice of any fossil belonging to the order of Serpents was contained in the following passage from the Appendix to the concluding volume of the second edition of Baron Cuvier's great and comprehensive work, the 'Recherches sur les Ossemens Fossiles.' After alluding to the scarcity of the fossil remains of birds, the immortal author of that work proceeds to say: "The bones of Serpents are still rarer, if it be possible. I have seen no specimens of them, save the vertebræ from the osseous breccia of Cette, of which I have spoken in the article on those breccia, and a single one from the fresh-water deposits of the Isle of Sheppy."‡

We may perhaps gather the reason for the silence of Cuvier respecting the relations of that vertebra and of the fossil vertebræ of Serpents in general to each other, and to those of the existing species, from his brief notice of the Ophidian fossils from the breccia of Cette; where, after stating in general terms their resemblance in form and figure to the vertebræ of the common harmless snake (*Coluber natrix*), he proceeds to remark, "but it may well be conceived, that in a genus where the osteology of the species has so much similitude, it is not in isolated vertebræ that one can discover specific characters."§ If, however, this discouraging conclusion of the great comparative anatomist should be countenanced by the results of a rigorous comparison of the vertebræ of the different species of *Coluber*, as that genus may be restricted by modern naturalists, it is by no means borne out by such comparison of the vertebræ of the species of the wider Linnean genus *Coluber*, and gives place to a very different estimate of the value of vertebral characters, when these are studied in species of the different Linnean genera of the '*Amphibia* Serpentes' in the 'Systema Naturæ.'

Baron Cuvier having, conformably with his convictions, deemed it unnecessary to give figures or to describe the vertebræ of Serpents, recent or fossil, in his 'Ossemens

* Vol. vi, 2d series (1839), p. 209, pl. xxii.

† Report of the British Association for the Advancement of Science, for 1841.

‡ "Les os de serpens sont encore plus rares, s'il est possible. Je n'en ai vu que des vertèbres des brèches osseuses de Cette, dont j'ai parlé à l'article de ces brèches, et une seule des terrains d'eau douce de l'île de Sheppy." (Tom. v, pt. ii, p. 526, 1824.)

§ "Mais on sent bien que, dans un genre ou l'ostéologie des espèces a tant de ressemblance, ce n'est pas dans les vertèbres isolées que l'on peut trouver les caractères spécifiques." (Op. cit., tom. iv, p. 180.)

Fossiles,' I am compelled to premise such observations on the anatomical construction of this part of the skeleton of those Reptiles as will render intelligible my description of the fossil ophidian vertebræ, and vindicate the grounds on which some of these are referred to distinct species, and others to genera of which we have no evidence of the actual existence in living Nature.

I have selected as the type of an ophidian vertebra that of a large, terrestrial, constricting Serpent (*Python Sebæ*), an African species, which makes the nearest approach in size to some of the fossil ophidian vertebræ from British tertiary strata. The vertebra figured in T. XIII, figs. 1-4, is from about the middle of the back of a specimen which was twenty feet in length. In the Pythons, as in other known *Ophidia*, all the autogenous elements, except the pleurapophyses (*pl*, figs. 2', 3'), coalesce with one another in the vertebræ of the trunk; and the pleurapophyses (T. XIV, fig. 42, *pl*) also become anchylosed to the diapophyses (ib. *d*) in those of the tail. There is no trace of suture between the neural arch (T. XIII, figs. 1-4 *n*) and centrum (*c*). The outer substance of the vertebra is compact, with a smooth or polished surface. The vertebræ are procœlian, the cup (fig. 2 *c*) being deep, with its rim sharply defined and most produced at the sides; the cavity looking not directly forwards, but a little downwards, from the greater prominence of the upper over the lower border: the well-turned prominent ball (fig. 3 *c*) terminates the back part of the centrum rather more obliquely, its aspect being backwards and upwards. The hypapophysis (*h*) is developed in different degrees from different vertebræ, but throughout the greater part of the trunk presents the form and proportions shown in figs. 1, 4 *h*. A vascular canal perforates the under surface of the centrum (fig. 4), and there are sometimes two or even three smaller foramina. A large, vertically oblong, but short diapophysis (*d*) extends from the fore part of the side of the centrum obliquely upwards and backwards. It is covered by the articular surface for the rib, which is convex lengthwise, and convex vertically at its upper half, but slightly concave at its lower half. The base of the neural arch swells outward from its confluence with the centrum, and developes from each angle a transversely elongated zygapophysis; that from the anterior angle (*z*) looking upwards, that (*z'*) from the posterior angle downwards, both surfaces being flat, and almost horizontal. A thick rounded ridge connects the anterior with the posterior zygapophysis on each side, extending along the base of the neural arch. The neural canal (fig. 2, *n*) is narrow, with a subtriedral area, and with a narrow longitudinal ridge on each side. The neural spine (*ns*) is of moderate height, which scarcely equals its antero-posterior extent; it is compressed and truncate. A wedge-shaped process—the 'zygosphene'* (*zs*, fig. 2)—is developed from the fore part of the base of the spine; the lower apex of the wedge being, as it were, cut off, and its sloping sides presenting two smooth, flat, articular surfaces. This wedge is received into a cavity—the 'zygantrum'†

* Ζυγόν, a yoke, σφήν, a wedge. † Ζυγόν, and ἄντρον, a cavity.

(fig. 3, *za*)—excavated in the posterior expansion of the neural arch, and having two smooth articular surfaces to which the zygosphenal surfaces are adapted.

Thus the vertebræ of Serpents articulate with each other by eight joints in addition to those of the cup and ball on the centrum; and interlock by parts reciprocally receiving and entering one another, like the joints called tenon-and-mortise in carpentry.

This is the most conspicuous, but is not the peculiar characteristic of an ophidian vertebra; the zygosphene (*zs*) and zygantrum (*za*) being developed in certain Lacertians, e. g. the genus *Iguana* (T. XIII, figs. 34, 35), but here the articular diapophysis (fig. 33, *d*) is much smaller, and forms a simple, convex, sessile tubercle; the hypapophysis is wanting: the zygosphene (fig. 34, *zs*) is deeply notched anteriorly, and the zygantra (fig. 35, *za, za*) are shallow, and separated from each other behind: a thick rounded eminence extends backwards from the diapophysis to the ball on the back part of the centrum (fig. 36); and that ball is a transverse ellipse (fig. 35), not hemispheroid, as in the *Ophidia*.

With regard to the specific distinctions which may be deduced from the characters of the vertebræ of Serpents, it is requisite first to determine the extent to which those characters vary in the vertebral column of the same species.

The atlas and axis are modified in the same degree as in the *Crocodilia*, with the addition of the entire suppression of their pleurapophyses. The atlas (T. XIV, figs. 38, 39) has two hypapophyses, one behind the other, as we shall find to be the case in other vertebræ of one of the great fossil Serpents. The normal hypapophysis (*h*, fig. 39), answering to that marked *ca, ex* in the woodcut, fig. 8, p. 85, is autogenous and wedge-shaped, as usual in the Reptilia; and is articulated on each side to a small portion of the neurapophysis (*n*); it also presents a concave articular surface anteriorly (fig. 38, *h*) for the lower part of the basioccipital tubercle, and a similar surface behind for the detached central part of the body of the atlas (fig. 40, *ca*), which is here confluent with that of the axis (fig. 40, *cx*), forming the so-called odontoid process of that vertebra; its Ophidian peculiarity being the development of an exogenous hypapophysis (*h′*) from its under and back part, like the posterior hypapophysis of the succeeding vertebræ.

The base of each neurapophysis of the atlas (fig. 38, *n*) has an antero-internal articular surface for the exoccipital tubercle, and a postero-internal surface for the upper and lateral parts of the odontoid (*ca*), besides the small median inferior facet for the detached hypapophysis (*h*): they thus rest on both the separated parts of their proper centrum. The neurapophyses expand and arch over the neural canal, but meet without coalescing. There is no neural spine. Each neurapophysis developes from its upper and hinder border a short zygapophysis (*z*): and from its side a still shorter diapophysis (*d*).

The axis or second vertebra of the trunk with the partially coalesced body of the atlas or 'odontoid,' is represented at fig. 40, T. XIV.

The odontoid presents a convex tubercle anteriorly, which fills up the articular cavity in the atlas for the occipital tubercle: below this is the surface for the detached hypapophysial part of the atlas (fig. 39, *h*) and above and behind it are the two surfaces for the atlantal neurapophyses; the whole posterior surface of the odontoid is anchylosed to the proper centrum of the axis.

The neural arch of the axis developes a short ribless diapophysis from each side of its base; a short zygapophysis (*z*), from each side of its anterior border; a thick sub-bifid zygapophysis (*z'*) from each side of the posterior border, and a moderately long retroverted spine (*ns*) from its upper part. The centrum terminates in a ball behind, and below this sends downwards and backwards a long hypapophysis (*hx*).

In the skeleton of an African Constrictor (*Python regius*, Dum.), which measured 15 feet 6 inches in length, there are 348 vertebræ, of which the 279 following the atlas and axis support simple moveable ribs; of these vertebræ about 70 anterior ones have long hypapophyses, as in fig. 4, *h*, T. XIV, which in the rest subside to the obtuse ridge and tubercle, as in fig. 1, *h*, T. XIII: the caudal vertebræ have not the ribs moveably articulated; they are 67 in number; of these vertebræ 56 have bifurcate hypapophyses as in fig. 42, *h*, T. XIV; the six anterior caudals have bifurcate ribs (ib., fig. 41, *pl*), in the rest they are simple (ib., fig. 42, *pl*), and lengthen out the diapophyses (ib. *d*,) to which they are anchylosed.

The ribs of the trunk-vertebræ, like those of the tail, are 'pleurapophyses' or 'vertebral ribs;' there are no 'hæmapophyses' or sternal ribs; the exogenous hypapophyses (*h*, fig. 42) take the place of the hæmapophyses in the tail. The pleurapophyses of the trunk (T. XIII, figs. 2', 3'), are long, slender, curved, subcompressed, expanded at the proximal end, which presents an articular surface chiefly concave, and adapted to the diapophysial tubercle (*d*, figs. 2, 3,) above described; there is a rough depression on the fore part of the expansion for the insertion of a ligament, and a tuberosity projects from the upper and back part; the distal end of the rib is truncate, with a terminal pit; a medullary cavity extends through a great part of the length of the rib, as shown in fig. 3''.

There is a small cavity in the substance of each neurapophysis, which communicates by a smaller foramen with the zygantrum. A vascular cavity in the centrum communicates with the neural canal.

In the skeleton of a Tiger-boa (*Python tigris*), in the Museum of the Royal College of Surgeons, measuring eleven feet in length, and having 291 vertebræ, the 253 following the axis support simple moveable pleurapophyses, articulated to concavo-convex sessile diapophyses, and constitute the dorsal, abdominal, or trunk-vertebræ; 70 of the anterior of these vertebræ have long hypapophyses, as in fig. 4, *h*, T. XIV, they then begin to shorten, and subside to the ridge and tubercle, as shown in fig. 1 and 4, T. XIII, in the rest of the trunk-vertebræ. The first caudal vertebra has free pleurapophyses, but they are short and bifurcate, the upper prong being the shortest; in the second caudal the left bifurcate rib is free, but the right is anchylosed to the diapophyses; the prongs are of equal length in this and the two following vertebræ.

In the fifth caudal the outer prong is again shorter, and in the sixth it is a mere tubercle; at this part of the tail the hypapophyses begin to lengthen, bifurcate, and progressively increase in length to the sixteenth caudal, and thence gradually diminish and subside; yet the general configuration of the neural arch, the contour and degree of production of its posterior border, and the shape of the zygosphene, remain almost unaltered throughout.

In a true *Boa constrictor*, with 305 vertebræ, 71 at the anterior part of the trunk have long hypapophyses; and of the 60 caudal vertebræ, 44 have bifid hypapophyses. The first caudal is characterised by the sudden shortening of its ribs, and by a short process from the middle of their outer surface: this process is longer and nearer the head in the next rib; and in the third caudal vertebra the rib seems to bifurcate from its proximal end, which has become anchylosed to the diapophysis. Beyond the eighth caudal the outer costal prong or process disappears, and the anchylosed rib represents a long deflected diapophysis to within three or four vertebræ from the end of the tail. The last imperforate obtuse bone of the tail is obviously a coalescence of three vertebræ.

In the Rattlesnake (*Crotalus*, T. XIII, figs. 9-12) the hypapophyses (*h*) continue to be developed singly, and of equal length with the neural spines (*ns*), throughout the trunk; and any single vertebra might be distinguished from an anterior trunk-vertebra of a *Boa* or *Python* by the following characters: the diapophysis (*d*) developes a small, circumscribed, articular tubercle from its upper convexity, and a short process (*d′*) from its under part, extending downwards and forwards below the level of the centrum (*c*); the anterior zygapophysis (*z*) seems to be supported by a similar process (*d″*) from the upper end of the diapophysis, the point of which projects a little beyond the end of the zygapophysis (fig. 10); the zygapophyses are less produced outwards than in the Python; the zygantra (*za*, fig. 11) are more distinct excavations.

In the Cobra di Capello (*Naja*, T. XIII, figs. 13-16), the diapophysis presents the same well-marked tubercle (*d*) upon its upper part, but its lower end (*d′*) is much less produced than in the Rattlesnake; the process of bone (*d″*) underpropping the zygapophysis projects proportionally further beyond the articular surface (*z*): the neural spine (*ns*) is much lower, and beyond the anterior third of the trunk the hypapophysis (*h*) subsides into a ridge, with its point produced backwards beneath the articular ball of the centrum; the zygantra (*za*, fig. 15) are distinct cavities.

In the *Coluber elaphus* (T. XIII, figs. 17-20) the trunk-vertebræ are distinguished by the great extent to which the part of the diapophysis (*d″*, fig. 18) which underprops the zygapophysis (*z*) is produced beyond the articular surface, the lower end of the diapophysis (*d′*) is less produced; the hypapophysis, beyond the anterior fourth part of the vertebral column, is reduced to a straight ridge, (fig. 20, *h*), extending along the middle of the under surface of the centrum, and not produced posteriorly: a groove separates the ridge on each side from the diapophysis and the posterior ball of the centrum. Both the cup and ball and the articular part of the diapophysis are relatively smaller than in the *Naja;* the neural spine (*ns*, fig. 17) is lower in proportion to its antero-posterior extent. The pleurapophysis (*pl*) is shown articulated to the tubercle in figs. 19 and 20.

The vertebræ of the common harmless Snake, *Coluber natrix*, differ only in size from those of the larger continental species above described.

In an African *Eryx* (T. XIII, figs. 21-24) the diapophysis (*d*) does not extend beyond the articular surface of the anterior zygapophysis (*z*), but is exclusively devoted to forming a low, subconvex, articular tubercle, which has a longitudinal depression anteriorly; the posterior margin of the neurapophysis (fig. 21, *n*) forms an angle above the zygantrum, which angle, though slight, is more marked than in any of the foregoing Ophidians; the hinder end of the hypapophysial ridge (*h*) is slightly produced; the zygapophyses (*z*, *z′*, fig. 24) are less extended outwards than in the Pythons.

In a Sea-snake (*Hydrophis bicolor*, T. XIII, figs. 25-28) I find the height of the neural spine (fig. 25, *ns*) greater in proportion to its antero-posterior extent than in any of the foregoing Ophidians. The diapophysis (*d*) sends a point (*d″*) outwards a little beyond the articular surface of the anterior zygapophysis (*z*); a very small hypapophysis (*h*) projects below the articular ball of the centrum, and a low ridge is continued forwards from it (fig. 28); the posterior border of the neurapophysis (fig. 25, *n*) forms no angle, but is moderately convex, as in all the foregoing Ophidians, excepting the *Eryx*.

With this indication of the kind and extent of the vertebral characters of the different species of Serpent which I have been able to study in reference to the fossils to be described, I proceed to the comparisons by which the following extinct genera and species have been established.

Genus—Palæophis.

Palæophis Typhæus, *Owen.* Tab. XIII, figs. 5-8, Tab. XIV, figs. 1-3, 7-9, 16, 17, 26, 27, 28. (Fig. 6, 10-12)?

Amongst the numerous vertebræ of this species of Serpent which have come under my examination, a few, of small size, have shown the hypapophysis long and compressed, as in the specimen in Mr. Bowerbank's collection, figured in T. XIV, figs. 1-3, *h*, indicating that the vertebræ at the anterior part of the trunk had that character, as in the large existing Serpents; whilst all the larger vertebræ, with the hypapophysis perfect, manifest shorter proportions of that process, as in the typical example, apparently from the middle of the abdomen (T. XIII, figs. 5-8, *h*); whence I infer that the *Palæophis* resembled the *Python*, *Boa*, *Coluber*, and *Hydrus*, in having different proportions of the hypapophysis at different parts of the vertebral column. Had every fossil vertebra shown a long hypapophysis like that in T. XIV, fig. 1, we might have suspected that the species had been of the venomous family, like the Rattlesnake.

The veritable Ophidian nature of the fossils in question is demonstrated, not only by the superadded zygosphenal (*zs*, fig. 6) and zygantral (*za*, fig. 7) articulations, but by the solidity of the zygosphene, by the size and form of the centrum, by those of its articular cup (*c*, fig. 6) and ball (*c*, fig. 7), and of its hypapophysis (*h*); and also by the size and prominence of the diapophysis (*d*). The largest vertebræ (e. g. T. XIII, figs. 5-8, and T. XIV, figs. 16, 26, 27, 28) probably from about the middle of the body, as compared with the vertebræ from the same part of the skeleton of a *Python Sebæ*, twenty feet in length, are longer in proportion to their breadth, and the cup and ball of the centrum are larger; the hypapophysis (*h*) is more produced, and there is a second smaller hypapophysis close to the anterior part of the under surface of the centrum, which in most of the large vertebræ is connected by a ridge with the hinder and normal hypapophysis; but in a few vertebræ is not so connected. The articular cup and ball are less obliquely placed upon the extremities of the centrum, being nearly vertical (compare fig. 5 and fig. 1, *c′*). The rim of the cup is sharply defined, and is more produced from between the bases of the diapophyses; a deeper and narrower chink intervening than in the *Python*. The transverse diameter of the cup (*c*, fig. 6) is greater than that of the zygosphene (ib., *zs*)—a proportion which I have not found in the vertebræ of any existing genus of Serpent, in which the base of the zygosphene always equals at least the parallel diameter of the articular cup. The articular part of the diapophysis is more produced outwards and less extended vertically in *Palæophis* than in *Python*, and it is uniformly convex; a ridge is continued from its upper end obliquely forwards to, but not beyond, the apex of the anterior zygapophysis (*z*), forming the angle between the lateral and anterior surfaces, whilst the horizontal articular facet forms the third surface of that three-sided conical process. In the Python the non-articular part of the same zygapophysis is convex, and the process is much more extended outwardly; the proportions of the zygapophysis in the *Palæophis* more resemble those in the *Coluber* and *Hydrus*, but differ from these, as also from *Naja* and *Crotalus*, in the non-extension of the diapophysial point beyond the articular surface.

A ridge or horizontal rising of the bone extends from the anterior to the posterior zygapophysis, but is more or less blunted or subsides midway, and is by no means so produced outwards as in Python; in this respect more resembling that in *Coluber* and *Hydrus*. Below the middle of this ridge, on a level with the upper surface of the centrum, there is a short, nearly parallel rising in *Palæophis* (fig. 5). The zygosphene (fig. 6, *zs*) is slightly excavated anteriorly, and shows no trace of the tubercle which characterises the middle of that surface in the Python (fig. 2); it is also broader in proportion to its height. But perhaps the most characteristic feature of the vertebra of the *Palæophis* is the peculiar production of the posterior border of the neurapophysis into an angle (*n*, fig. 5) directed upwards, outwards, and backwards, and this is common to all the species; there is no trace of this process in the *Hydrus* (fig. 25), and the nearest approach to it which I have hitherto met with among existing

Serpents, is that low, tuberous angle at the corresponding part of the vertebra of the *Eryx* (fig. 21). The posterior zygapophysis resembles, of course, the anterior one in its much less extent, especially transversely, as compared with that in the Python, and the posterior border of the neurapophysis (fig. 5, *z′*, *n*) rises from its apex vertically, or a little inclined outwards and backwards, giving a squarish form to the surface of the neural arch in which the zygantra (*za*, fig. 7) are excavated; these cavities, in proportion to the articular ball beneath, are smaller and less deep than in the Python, or any other existing genus of Serpent. The sloping sides of the neural arch above the zygapophysial ridge are more concave than in Python, and so resemble those parts in *Coluber* and *Hydrus*. The latter genus (fig. 25) and *Crotalus* (fig. 9) most resemble *Palæophis* in the proportions of the neural spine (*ns*); this part, however, in *Palæophis* differs from that of *Hydrus* in having its base coextensive with the supporting arch, springing up from the fore part of the zygosphene, whilst this part entirely projects forwards, clear of the base of the spine in *Hydrus*, as in *Python*, *Coluber*, and *Naja;* but in *Crotalus* the base of the spine has the same antero-posterior extent as in *Palæophis*, and it comes very near to the fore part of the zygosphene in *Eryx*. The neural spine has been more or less fractured in every specimen of the brittle crumbling vertebræ of the *Palæophis Typhæus* from the Bracklesham Clay; only one specimen, which I carefully worked out in relief from a mass of matrix, after imparting some of its original tenacity to the substance of the bone, affords a true idea of the peculiar character of these Ophidian vertebræ, which is afforded by the great height of the neural spine (see T. XIV, fig. 27, *ns*); but even here, although the fore part of the spine equals in vertical extent that of the rest of the vertebra beneath it, I am not sure that its entire extent is preserved, the part having been obliquely broken away behind this point before the specimen came into my hands. Some vertebræ of another species of *Palæophis* from Sheppy, show this elevated spine to be a generic characteristic of the fossil vertebræ.

	Inches.	Lines.
The entire vertical extent of the vertebra, fig. 27, from the end of the hypapophysis to the summit of the neural spine is .	2	5
The length of the same vertebra is	1	2
The length of a larger vertebra of the same species . .	1	4
The length of the smallest free vertebra	0	5

I have specified this last vertebra as being 'free,' because in Mr. Dixon's collection, by far the richest in the remains of the great *Palæophis* of Bracklesham, there are two smaller vertebræ anchylosed together by both their bodies and neural arches (T. XIV, figs. 32, 33, 34), which, therefore, are not 'atlas and axis,' but from their compressed form I should judge rather to have come from the opposite end of the vertebral column: they have not formed, however, the very extremity of the tail, like the terminal anchylosed vertebræ in the *Boa constrictor*, or those supporting the rattle in the *Crotalus;* for the ball of the centrum, the posterior zygapophyses, and the zygantral articulations, are present on the back part of the second of these anchylosed vertebræ. But before further pursuing the description of this remarkable specimen, I shall premise a brief notice of the vertebræ which have presented other modifications.

In the series of Palæophidian vertebræ from Bracklesham, which I have had the opportunity of comparing, a few, as has been already remarked, appear to have come from the fore part of the body by the length of the hypapophysis, as compared with the size of the vertebræ, which is small; a character that adds to the likelihood of their having come from that extremity of the series. Fig. 1, T. XIV, shows one of these vertebræ in which the hypapophysis (*h*) is entire; it is shorter and much more compressed than that process is in the anterior trunk-vertebræ of the Python, fig. 4, and its base extends forwards, as a sharp ridge, to between the diapophyses (fig. 3), where like them, it has been mutilated by fracture. The zygapophyses are small, and there is no ridge continued from the anterior to the posterior one; the neurapophysis presents the characteristic angular production (fig. 1, *n*), and the neural spine (ib., *ns*) is coextensive with the supporting arch.

The second form of vertebra is characterised by a single and moderately-developed hypapophysis, the base of which is confined to the hinder half of the under surface of the centrum, leaving the fore part of that surface concave where it expands between the bases of the diapophyses. I have received twelve such vertebræ from Bracklesham, varying in size between the two extremes given in figs. 5, 6, and 10, 11, 12, T. XIV. The hypapophysis (*h*) which is best preserved in the vertebra fig. 10, is shorter but thicker than in fig. 1; the articular cup and ball are relatively smaller; the zygosphene (*zs*) is larger, and its surfaces larger and more vertical (fig. 5); the neural spine has a less antero-posterior extent. These may be vertebræ from the hinder part of the abdomen, near the beginning of the tail. Some of them have a minute ridge at the middle of the anterior inferior concavity (fig. 9).

A third modification of vertebra shows the same limited extent of the base of the posterior hypapophysis, but a second shorter hypapophysis is constantly developed from the middle of the space between the bases of the diapophyses. I have examined twenty of such vertebræ ranging in size between the extremes given in figs. 14, 15, and 17, T. XIV. As compared with fig. 5, the articular cup of fig. 14 is larger, the zygosphene less, and of a different shape, concave anteriorly and not straight above, but forming an obtuse angle there. A ridge is continued from the posterior to the anterior zygapophysis (fig. 13).

This ridge is more strongly developed in the larger vertebræ with the same modification of the under surface (figs. 20, 21). The articular ball of the diapophysis would seem not to have descended so low down as in the typical vertebræ referred to *Pal. Typhæus.* The neural spine does not extend to the fore part of the zygosphene; there is a short but well-defined space above zygosphene in front of the spine.

Figs. 18, 19, 20, 21, give views of two of the best-preserved vertebræ of the present form, which I have attributed to a distinct species under the name of *Palæophis porcatus.*

The fourth modification of the Palæophidian vertebræ from Bracklesham is the most common, and is characterised by the coextension of the base of the hypapophysis with the under surface of the centrum, or by the whole of the middle of that under surface forming a ridge: both ends of the ridge being produced, the posterior one the most, and forming the normal hypapophysis. These vertebræ are usually of large size; I have examined upwards of thirty, ranging between the extremes given in figs. 25 and 26, T. XIV; and it is from this series that I have selected the type vertebra of the genus *Palæophis,* T. XIII, figs. 5-8.

The ridge between the anterior and posterior zygapophyses in these vertebræ is absent (T. XIII, fig. 5) or interrupted (T. XIV, figs. 27, 28). There is no well-defined space above the zygosphene anterior to the base of the neural spine. These vertebræ I regard as typical of the species *Palæophis Typhæus:* they are rather longer in proportion to their breadth than those of the *Palæophis porcatus.*

To this category belongs the vertebra with the unusually well-preserved neural spine (fig. 27), and likewise the two vertebræ which are preserved in their natural connexion, showing the reciprocal interlocking of their complex articular processes (fig. 28).

The fifth form of the vertebræ from Bracklesham is characterised by the compression of the centrum and the convergence of its almost flattened sides to the ridge on the inferior surface, from which a single hypapophysis is developed. I have examined not more than four such vertebræ, including the two which are anchylosed together, those (figs. 32-34, T. XIV) being the smallest in size, and the vertebra (figs. 29-31, T. XIV) the largest. The ridge between the anterior and posterior zygapophyses is suppressed; the neural arch gently swells out as it descends from the base of the neural spine, and from between the zygapophyses it bends in to coalesce with the converging sides of the centrum. This vertebra has not that character of a caudal vertebra, which is manifested in the *Python* and most modern *Ophidia* by the transverse pair of hypapophyses; it shows plainly the base of a single median hypapophysis from near the posterior surface of the centrum (fig. 34). The diapophyses of fig. 29 are broken away, together with the anterior concave end of the centrum; had they been entire, we might have derived from them evidence of the more constant character of the caudal vertebræ of Serpents, which is derived from the coalescence of a short and straight pleurapophysis with the diapophysis, lengthening out that transverse process, as in fig. 42. The zygosphene and zygantra are developed, as, indeed, they continue to be to near the end of the tail in modern Serpents; and the produced angle of the posterior border of the neurapophysis is as characteristic of the small compressed vertebræ of the *Palæophis* (fig. 29) as of the larger specimens.

The two anchylosed vertebræ belonging to the compressed series have been already alluded to. The base of the neural spine is limited to the posterior half of the neural arch in both (fig. 33). The hindmost of the two vertebræ is the longest, measuring five lines, the length of the two being nine lines. In each, the sides of the centrum are nearly plane, and converge at an acute angle to a ridge, which forms the under surface; a very small hypapophysis was continued from the back end of the ridge. This process is broken away from each vertebra, as are also the diapophyses, which are indicated by their rough fractured base; they are situated near the lower part of the side of the centrum, like the long diapophyses of the posterior caudal vertebræ of the Pythons; had they been preserved, their proportions would have determined whether the anchylosed vertebræ were caudal or not.

In the skeleton of a Tiger-boa (*Python tigris*) in the museum of the Royal College of Surgeons, anchylosis of the 148th to the 149th vertebra has taken place; and the 166th and 167th vertebræ have been more completely and abnormally fused together, so as to appear like a single vertebra on the left side, and a double one on the right side, where there are two diapophyses and two ribs. The compressed form, however, and diminutive size of the two anchylosed vertebræ of *Palæophis*, strongly indicate them to be from near the end of the tail, in which case it must be concluded that that part was compressed, as in the smaller modern *Hydrophides*, and that the present extinct Ophidian was a Sea-serpent of at least twenty feet in length.

All the vertebræ with the characters specified in the description of the large specimens from the trunk, and referable to the *Palæophis Typhæus*, have been obtained from the Eocene clay at Bracklesham, Sussex: they form part of the collections of the late Frederic Dixon, Esq., F.G.S., of Worthing; of James S. Bowerbank, Esq., F.R.S.; and of George Augustus Combe, Esq., of Preston, near Arundel, to whom I have been indebted for some beautiful examples, including the two vertebræ in natural conjunction (T. XIV, fig. 28), and the vertebra with the best preserved neural spine (ib., fig. 27.)

PALÆOPHIS PORCATUS, *Owen*. Tab. XIV, figs. 13-15, 18, 20, 21.

On comparing together eighteen Palæophidian vertebræ of different sizes from Bracklesham, the smallest of the dimensions represented in figs. 14, 15, and thence gradually increasing to the size of the specimen fig. 20, I find the following differences: in fig. 14, e. g. the articular cup and ball at the ends of the centrum are larger in proportion to the length of the centrum, as compared with the next-sized vertebra, fig. 5: the under surface of fig. 15 is convex transversely between the diapophyses and sends down a short median ridge; in fig. 6 it is concave at the same part, and without the median ridge; but both vertebræ have the median process or 'hypapophysis' at the back part of the under surface. In fig. 14 the fore part of the zygosphene is concave, in fig. 5 it is flat; in fig. 5 the upper border is straight, in fig. 14 it forms an open angle; the space between the zygosphene and zygapophysis is greater in fig. 5 than in fig. 14.

Twelve vertebræ of progressively increasing size repeat the characters of the vertebræ (fig. 6); i. e. they have the fore part of the under surface between the diapophyses excavated, and have only one inferior spine, viz. the hypapophysis developed from the hind part of the under surface; they have also the zygosphenal articulations nearly vertical, and raised high above those of the zygapophyses (fig. 8). A vertebra (figs. 22, 23, 24) of the same size as the largest of these twelve differs from them, and repeats the general characters of the small vertebra (fig. 14): it has the anterior as well as the posterior hypapophysis; larger terminal cup-and-ball surfaces in proportion to its size; smaller intervals between the zygosphenal and zygapophysial articulations (fig. 24); less lofty posterior aliform extensions of the neural arch, and the base of the neural spine extending nearly to the fore part of that arch. These vertebræ, and especially the larger specimens (figs. 18, 20) have a strong external ridge extending from the anterior to the posterior zygapophyses on each side of the neural arch. On comparing one of these vertebræ with another of the ordinary character and of the same size, the following further differences presented themselves: in the ridged vertebræ, which are provisionally referred for the convenience of description and comparison to a distinct species, with the name of *Palæophis porcatus*, the articular ball is broader in proportion to its height (compare fig. 23 with fig. 27); the anterior zygapophyses are more produced outwards and less produced forwards, so that they do not extend beyond the border of the articular cup, so far as in the non-ridged vertebræ of *Palæophis Typhæus;* the fore part of the zygosphene in the ridged vertebræ is broader, and less excavated. The breadth of the base of the neurapophysis is greater in the ridged vertebræ than in the unridged ones, in proportion to its length. The articular surfaces of the zygapophyses are smaller in the ridged than in the unridged vertebræ.

Figs. 13, 18, 20, 22, T. XIV, show the ridged character of the sides of the neural arch in *Palæophis porcatus*, and fig. 19 shows the consequent superior breadth of the base of that arch in relation to the length of the vertebra as compared with fig. 8, T. XIII, a corresponding vertebra of the *Palæophis Typhæus.* Fig. 14 in the same Plate shows the striking difference in the proportions of the same part of the vertebra in the *Python tigris.*

Such are the observed differences which seemed worthy of mention in the series of Palæophidian vertebræ from the Eocene deposits at Bracklesham which I have had the opportunity of comparing. The nature of the differences may be interpreted in different ways: with regard to the small vertebræ, for example, those with a single spine from the posterior part of the under surface (figs. 1, 2, 3, T. XIII) may be small cervical vertebræ of the same species as that to which the large vertebræ with the two inferior spines belong; and the small vertebræ with two inferior spines (figs. 14, 15) may have belonged to a smaller and younger individual of the same species, and have come from a more posterior part of the vertebral column of such individual. The anterior vertebræ of both Pythons and Boas, for example, are distinguished by an inferior spine, the remaining vertebræ to the tail being merely ridged beneath: but I have not met with such modifications in the trunk-vertebræ of the same existing Serpent, as those that have been pointed out in the vertebræ (figs. 5, 6, and figs. 14, 15); and in no specimen of Python or Boa, have I found the vertebræ presenting such differences of character as those indicated in the larger fossil Palæophidian vertebræ which I have described as 'ridged' and 'not ridged.' Leaving therefore the question of the nature of the differences in the smaller vertebræ (figs. 1 and 14) open, and as possibly depending upon difference of age and position in the series, I believe the characters of the ridged vertebra to be those of a distinct species of *Palæophis*.

Masses of mutilated vertebræ and ribs, irregularly cemented together by their matrix, are occasionally though rarely discovered in the Eocene clay at Bracklesham. The specimens of such aggregates which I have as yet seen have not exhibited any vertebræ sufficiently complete to yield more than the means of determining the generic relations. That of which a small portion is figured in T. XVI, fig. 4, is the most instructive, since it shows the form and structure of the ribs. The proximal half of the pleurapophysis (*pl*) equals in size the corresponding part in the *Python regius* of twenty feet; it shows the same fine cancellous structure of the articular end, and a similar medullary cavity, with thin compact walls, forming the body of the vertebra. The more slender distal portion of another rib is preserved, with the medullary cavity exposed at its fractured parts.

PALÆOPHIS TOLIAPICUS, *Owen*. Tab. XV and XVI.

Transactions of the Geological Society of London, vol. vi, part ii, p. 209.
Report on British Fossil Reptiles, in the Report of the British Association, 1841, p. 180.

The fossil Ophidian vertebræ which have been discovered in the London clay at Sheppy are, for the most part, smaller than those from Bracklesham; their common dimensions equalling those of a *Boa constrictor* of from ten to twelve feet in length. They all repeat, however, the generic modifications characteristic of *Palæophis;* the hinder margin of the neurapophyses (T. XV, fig. 5) is produced into a pointed or angular plate; the articular prominence for the rib (ib., fig. 3, *d*) is wholly convex; the zygapophyses are short, and no diapophysial point extends beyond the anterior ones; the height of the neural spine (T. XV, fig. 1, and T. XVI, fig. 2, *ns*) exceeds its antero-posterior extent. The veritable Ophidian character of the Reptile to which these fossil vertebræ belonged, is not only shown by their individual structure, but is well illustrated by the number of them in natural articulation which have occasionally been found cemented together in the petrified clay.

One of these Ophidiolites from the clay of Sheppy, in Mr. Bowerbank's collection, exhibits a portion of the vertebral column of the *Palæophis* suddenly bent upon itself, and indicating the usual lateral flexibility of the spine: in another specimen, including about thirty vertebræ, the vertebræ have been partially dislocated and are bent in a semicircle, Tab. XVI.

As compared with either of the species of *Palæophis* from Bracklesham, the vertebræ from Sheppy have the centrum proportionally longer and more slender, with a smaller terminal cup and ball. In vertebræ from Sheppy and Bracklesham in which those articulations were of equal size, the length of the neural arch at and including the zygapophyses, was two centimetres in the *Palæophis toliapicus,* and one centimetre, seven millimetres in the *Palæophis Typhæus.*

The hypapophysial ridge is more constant and better marked; it is produced at both extremities, and most so at the hinder one, but here in a less degree than in the *Palæophis Typhæus,* or *Pal. porcatus,* and the ridge is not interrupted between the two hypapophyses, as in most of the large vertebræ of the *Palæophis porcatus.* On the other hand, the rising of the bone continued from the anterior to the posterior zygapophysis does subside midway more completely than in the *Palæophis Typhæus;* and the ridge, which in that species extends to the apex of the produced posterior border of the neurapophysis along the outside of that aliform production, is less developed in the *Palæophis toliapicus:* the neural arch is less suddenly compressed above, or inclines more gradually to the base of the spine; this spine, also, although its base is extended to near the anterior border of the zygosphene, appears to be higher in proportion to its antero-posterior extent than in the *Palæophis Typhæus.* The diapophysis is less produced outwards and downwards than in the *Palæophis Typhæus* or *Palæophis porcatus.* In a group of thirty vertebræ of this species cemented together by the indurated clay from Sheppy, in the Hunterian Collection, and which, in the original MS. Catalogue of that part of John Hunter's Collection, were called 'vertebræ of a Crocodile,' T. XV, fig. 1, several of the long and slender subcylindrical ribs are also preserved, in the fractured parts of which the medullary cavity is shown. The articular surface at the proximal end presents the uniform concavity suited to the convexity of the diapophysis. I have seen no evidence of the process from the upper and back part of the proximal end of the rib which is present in the Python.

The finest and most strikingly Ophidian example of the great fossil snake of Sheppy has been obtained from that locality by Mr. Bowerbank since the publication of the Memoir in which his earlier specimens of the *Palæophis toliapicus* were determined and described. It consists of a series of thirty vertebræ, from about the middle of the abdomen, bent into an oval form upon their dorsal aspect, and measuring twenty inches in length (T. XVI, figs. 1, 2).

As the strong and complex articulations of these vertebræ in Serpents opposes any inflection of the column except from side to side, their unnatural bend in the fossil is attended with just the amount of mutual dislocation that was requisite to admit of it; but beyond this amount of dislocation, which chiefly affects the terminal ball and socket-joints, the vertebræ have been preserved in their natural juxtaposition and succession. The dead body of this eocene serpent has apparently sunk or been washed into the great stream or estuary, where it has been driven about to and fro, and variously contorted as it was swept along by the current; the portion here preserved has been by some external influences obstructed and bent upon itself in its present unnatural curve, as it finally sank in the sediment in that state of decomposition when the ligaments were ready to give way to the strain upon them; but the tough integuments, which have longer resisted dissolution, have served to retain the partially-dislocated vertebræ together until they became fixed in the matrix in the position in which they are now fossilized. We have in this condition very good evidence of that long and slender form of body which would admit of such an extent of inflection from external pressure in a direction contrary to that which the natural articulations of the vertebræ would allow; but since in Serpents those articulations are so strong, when fresh, as to offer considerable obstacles to any vertical inflection upwards or downwards, we may infer that the body of the *Palæophis*, of which the example in question formed a part, must have floated long enough to have undergone that degree of internal decomposition, which allowed it easily to yield to external pressure in any direction.

The characteristically long and comparatively slender spine is well preserved in the vertebræ at *ns*, fig. 2; and the equally characteristic angular production of the hinder border of the neural arch is shown in some other of the vertebræ. In many vertebræ the ribs are preserved just in that degree of juxtaposition in which they would remain after yielding to the pressure and movements of the overlying and accumulating sediment upon the integument of the body. Fig. 3 shows a portion of the coil, in which a few of the ribs offer to our view the concave articular surface (*pl*), which was articulated with the diapophysial tubercle (*d*): in fractured portions of the ribs their medullary cavity is shown. The hypapophysis which terminates the thick and low inferior ridge of the vertebræ of the present species offers that small degree of development characteristic of the middle and posterior part of the long abdominal region.

In T. XVI, fig. 1 shows this remarkable chain of vertebræ from the right side; fig. 2 the middle portion of the same chain from the left side; and fig. 3 the under surface of the vertebræ with the juxtaposed ends of the ribs.

In T. XV, fig. 1 shows a group of the vertebræ of *Palæophis toliapicus*, in some of which the long and slender spine (*ns*) characteristic of the genus is well preserved. In fig. 3 of the same plate, the position and form of the diapophysial tubercle (*d, d*) are shown. The character of the under surface of the vertebræ is shown in fig. 4, and the angular aliform production of the neural arch is shown in fig. 5.

One of these characteristic examples of the *Palæophis toliapicus* is preserved in the Hunterian Museum*, the others in that of James S. Bowerbank, Esq., F.R.S. In the Museum of Mr. Saull, F.G.S., a few vertebræ, and a fragment of the skull of probably the same species of *Palæophis*, likewise from Sheppy, are preserved.

* This was figured, by the permission of the President and Council of the College, in illustration of my original Memoir on the Genus *Palæophis* in the Geological Transactions.

On a general review of these numerous and rich accessions to our previously scanty evidence of extinct Serpents, I may sum up by stating that the generic character of *Palæophis* is chiefly manifested in the length of the neural spine, in the pointed aliform productions of the back part of the neurapophyses, in the uniform convexity of the diapophysial tubercles, and the minor transverse production of the zygapophyses.

The *Palæophis toliapicus* is distinguished by its longer vertebræ in proportion to their breadth, by its sessile diapophyses, and by the carinate character of the lower part of the centrum in the vertebræ of the abdomen.

The *Palæophis Typhæus* is distinguished by its shorter and broader vertebræ, by its pedunculate diapophysis, and by the anterior and posterior hypapophyses of the vertebræ of the abdomen; its neural arch is narrower, and its sides not longitudinally ridged.

The *Palæophis porcatus* is characterised by the longitudinal ridges connecting the anterior with the posterior zygapophyses, by its broader and squarer neural arch; but it has the two hæmal spines below like the other large species from Bracklesham.

PALÆOPHIS (?) LONGUS, *Owen*. Tab. XIV, figs. 35, 36, 37, 45, 46.

Vertebræ of a serpent agreeing in character with those of the London clay at Sheppy, but smaller, have been obtained by Mr. Colchester, from the sand of the Eocene formation underlying the Red Crag at Kyson or Kingston in Suffolk. In these, as in most of the trunk vertebræ of *Palæophis Typhæus*, the hypapophysis is a small sub-compressed tubercle at the under and back part of the body of the vertebra; but there is no repetition of a smaller process at the fore part; and no ridge is continued backward from the hypapophysis, as in the *Palæophis toliapicus*. The tubercle for the rib is single; in *Naja* it is almost divided into two, the upper being convex, the lower moiety concave; in the *Python* the upper half of the tubercle is convex, and the lower half concave, but the two facets are not marked off. In the fossil serpent from Kingston, as in the *Palæophis* from Sheppy and Bracklesham, the costal tubercle is simply convex. The chief characteristic of the Ophidian vertebræ from Kingston is the length and slenderness of their bodies, in which respect they exceed those of the *Palæophis toliapicus*, and resemble some of the existing tree-snakes (*Dendrophis*) with elongated vertebræ. The origin of the neural spine is limited to the posterior half of the arch (fig. 36); but the mutilation of the neural arch in the specimens I have yet had the opportunity of examining, prevents a prosecution of the comparison with any adequate advantage.

Genus—Paleryx.

The vertebræ of this extinct genus of Serpent (T. XIII, figs. 29-32, and figs. 37-38) differ from those of *Palæophis,* in the absence of the pointed aliform production of the hinder border of the neurapophyses, that border (fig. 29, *n*) descending from the neural spine to the posterior zygapophyses, with a convex curve as in most modern Serpents. The neural spine (*ns*) is low, the antero-posterior extent of its truncated summit exceeding the height. There is no point of bone extending outwards beyond the articular surface of the anterior zygapophysis (*z*), as in *Coluber, Vipera, Naja, Crotalus,* and *Hydrus;* in this character *Paleryx* resembles *Eryx, Python, Boa,* and *Palæophis.* The middle and posterior trunk-vertebræ of *Paleryx* differ from those of *Python* and *Boa,* and resemble those of *Eryx* in having a sharp and well-developed hypapophysial ridge (*h*) coextensive with the under surface of the centrum, and deepest at its posterior half; but the border here is gently convex, not angular as in *Eryx;* and the posterior border of the neurapophysis is less produced than in *Eryx;* the articular cup and ball are relatively larger, especially transversely; the cup is a full transverse ellipse, not circular as in *Eryx;* in this respect it resembles that of *Python* and *Palæophis.*

Paleryx rhombifer. Tab. XIII, figs. 29-32.

In the vertebræ of this species the hypapophysial ridge (*h*) is sharp and well produced; the neural spine (*ns*) is rhomboid, not rounded off anteriorly; the zygosphene (*zs,* fig. 30) has the same relative vertical extent as in the Python. The diapophysial tubercle (*d*) is less elongated vertically than in *Python* and *Boa,* presenting proportions like those of the vertebra of the Eryx (fig. 22, *d*); the zygapophyses (*zz'*) are more pointed at their terminations. The figures 29-32, Pl. 2 represent the largest of the trunk-vertebræ upon which has been founded the genus and species above defined: they indicate a land Serpent of about four feet in length. They were obtained from the Eocene sand at Hordwell by Alex. Pytts Falconer, Esq., of Christchurch, Hants., to whose liberality I am indebted for the specimen figured.

Paleryx depressus, *Owen.* Tab. XIII, figs. 37 and 38.

The smaller Ophidian vertebræ, indicative of the above species, agree in their generic characters with the foregoing; that is to say, in the shape and development of the hinder border of the neural arch in the relations of the diapophysis to the anterior zygapophysis, in the shape and size of the articular cup and ball of the centrum, and in the shape of the diapophysial tubercle for the rib. But the whole vertebra is more depressed; the hypapophysial ridge is relatively thicker and less produced; the zygosphene has much less vertical thickness, and there is a corresponding modification of the zygantra; the neural spine is relatively lower and of a different shape, having its anterior angle rounded off, and its posterior one more produced backwards.

As I have failed to discover modifications of the kind and degree above described in the dorsal or free rib-bearing vertebræ of the same species in any of the existing genera of Serpents, I am left to interpret such characters as indicative of a distinct species, probably of the extinct genus of Eocene Serpent above defined. The specimens of the vertebræ of the present species, which indicate a serpent of between two and three feet in length, were obtained from the Eocene sand at Hordwell Cliff, by Searles Wood, Esq., F.G.S., in whose museum they are preserved.

A few bones of serpents have been found in the superficial stalagmite, and in clefts of caves, in peat bogs, and the like localities, which bring their occurrence and deposition within the period of human history. None of these Ophidian remains, however, have offered any differences in size or other character from the corresponding parts of the skeleton of our common harmless snake (*Coluber natrix*). As yet no Ophidian fossils have been found in British fresh-water formations of the pre-adamitic or pleistocene period, from which formations the remains of the Mammoth, tichorrhine Rhinoceros, great Hippopotamus, and other extinct species of existing genera of *Mammalia* have been so abundantly obtained. Between the newest and the oldest deposits of the tertiary period in Geology, there is a great gap in England, the middle or miocene formations being very incompletely represented by some confused and dubious parts of the crag of fluviomarine origin in which teeth of a Mastodon have been found.

The deposits in which the remains of the large serpents of the genus *Palæophis* occur so abundantly, carry back the date of their existence to a period much more remote from that at which human history commences. Yet, as the strange and gigantic Reptiles that have been restored, and, as it were, called again to life, from times vastly more ancient, realise in some measure the fabulous dragons of mediæval romance; so the locality on our shore of the English channel in which the Eocene serpents have been found in most abundance and of largest size, recalls to mind, by a similar coincidence, the passage cited by an accomplished and popular historian, in his masterly sketch of the rise and progress of the English nation. "There was one province of our Island in which, as Procopius had been told, the ground was covered with serpents, and the air was such that no man could inhale it and live. To this desolate region the spirits of the departed were ferried over from the land of the Franks at midnight." (Macaulay's History of England, vol. i, p. 5.)

C. AND J. ADLARD, PRINTERS, BARTHOLOMEW CLOSE.

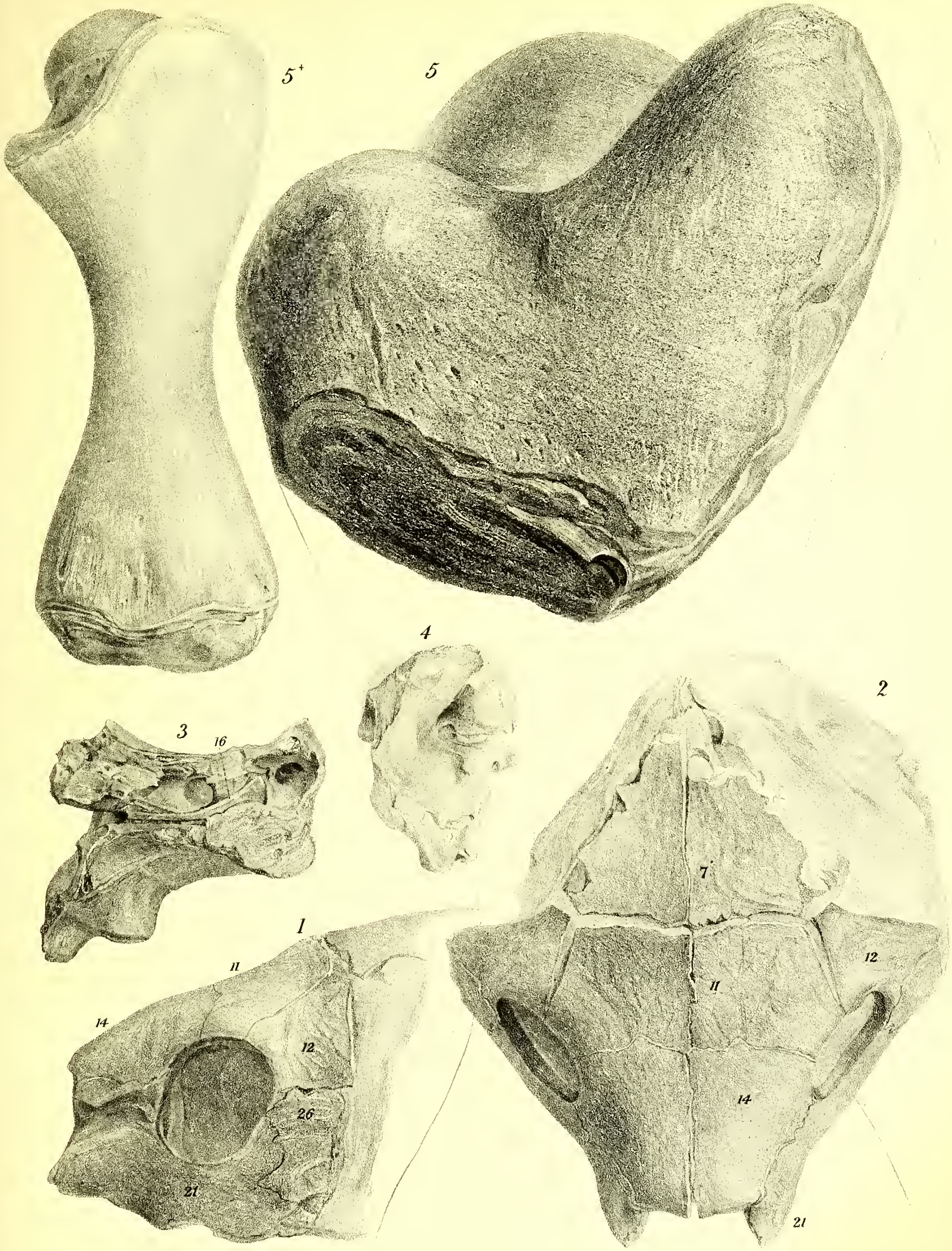
TAB. XXIX.

Chelonia.

Fig.

1. Side view of the fore part of the skull of the *Platemys Bowerbankii,* nat. size.
2. Upper view of the same fossil.
3. Side view of a fractured tympanic bone of a large Turtle (*Chelone*), from Bracklesham, showing the long and slender ossicle or 'columella' (16) *in situ;* nat. size.
4. Extremity of the same tympanic bone, to which the 'membrana tympani' was attached.
5. Proximal end of the femur of a very large Chelonian from the Isle of Sheppy, nat. size.

5′. Left femur of a Turtle (*Chelone mydas*) which weighed 150 lbs., nat. size.



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TAB. I.

Crocodilus Suchus, half the nat. size.

Fig.

1. Upper view of the skull.
2. Under view of ditto. Both ends of the bony palate have suffered fracture and loss, apparently in the process of mummifying the body of the Crocodile.

J. Erxleben

Day & Son lith.

Crocodilus Suchus. (From an Egyptian Mummy)

TAB. II.

Fig.

1. Upper view of the skull of the *Crocodilus toliapicus,* one third the nat. size.

2. Under view of the hinder portion of the skull of the *Crocodilus champsoïdes,* on which Dr. Buckland founded his species of 'Crocodile with a short and broad snout,' called *Crocodilus Spenceri;* half the nat. size.

3. Upper view of the cranial platform of a young *Crocodilus Hastingsiæ,* nat. size.

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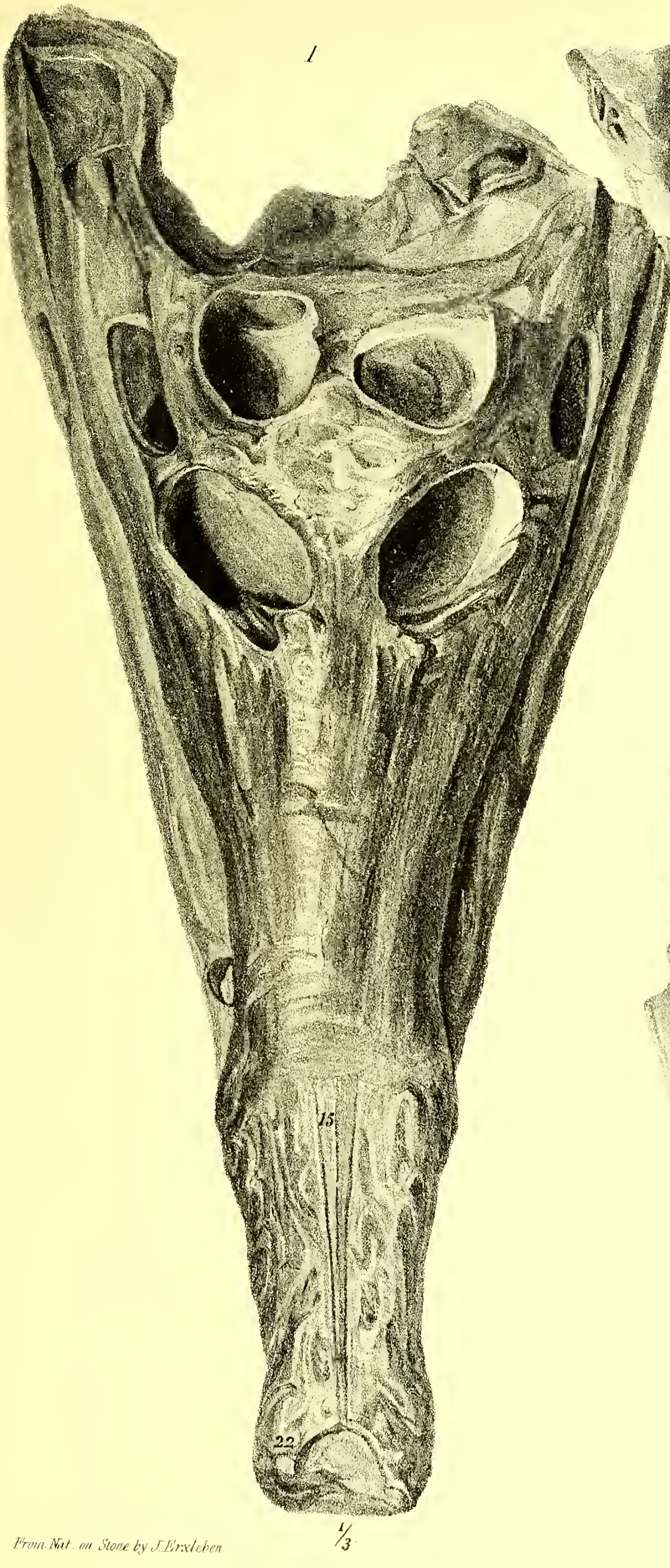

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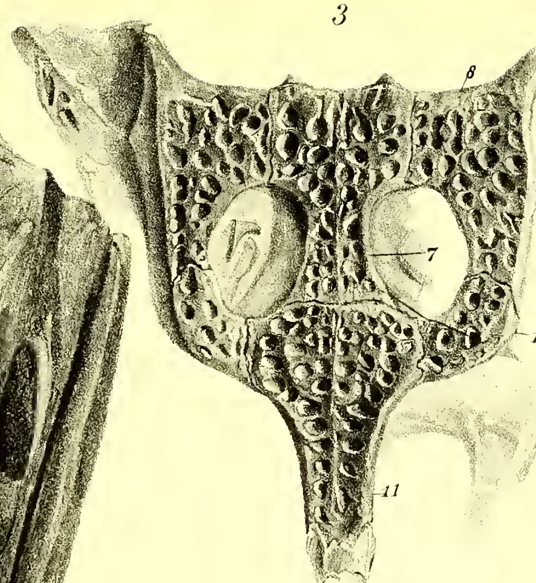

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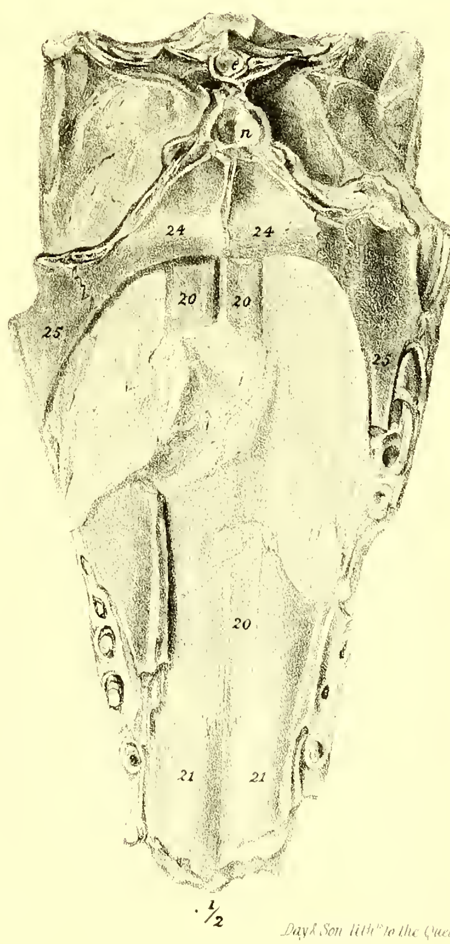

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TAB. II *A*.

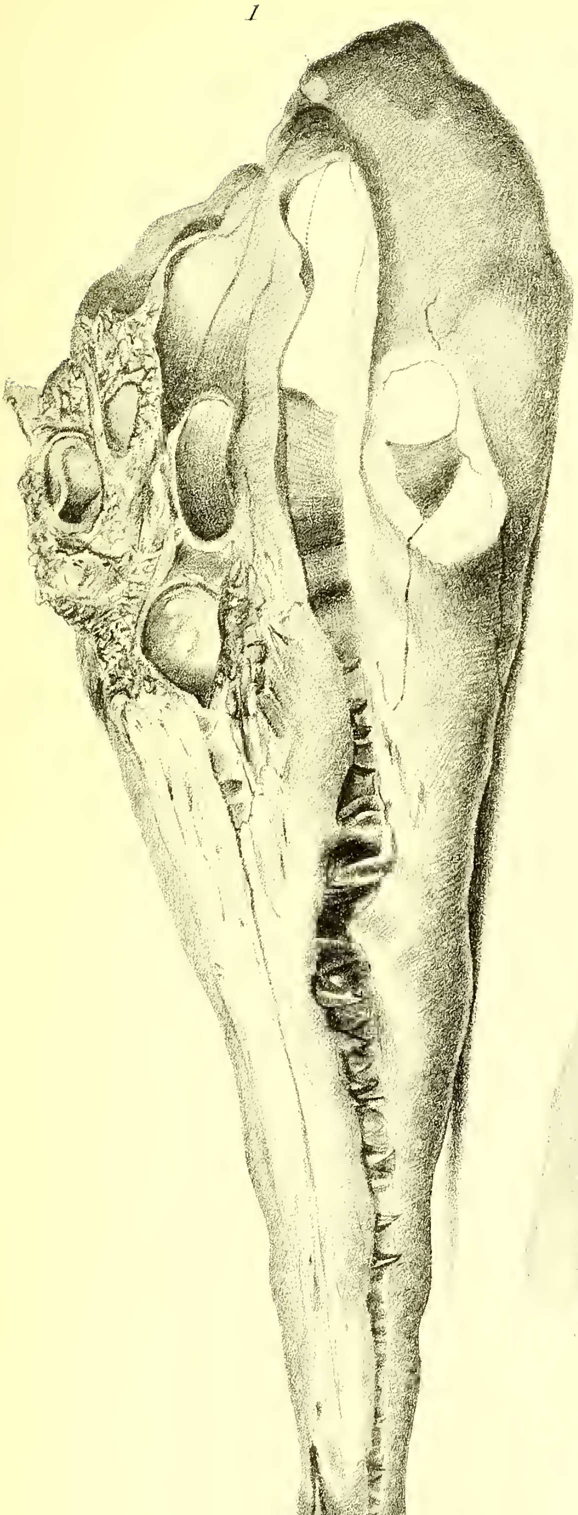
Crocodilus toliapicus, one third the nat. size.

Fig.

1. Oblique side view of the skull.
2. Under view of the skull.

T. II. A.

1



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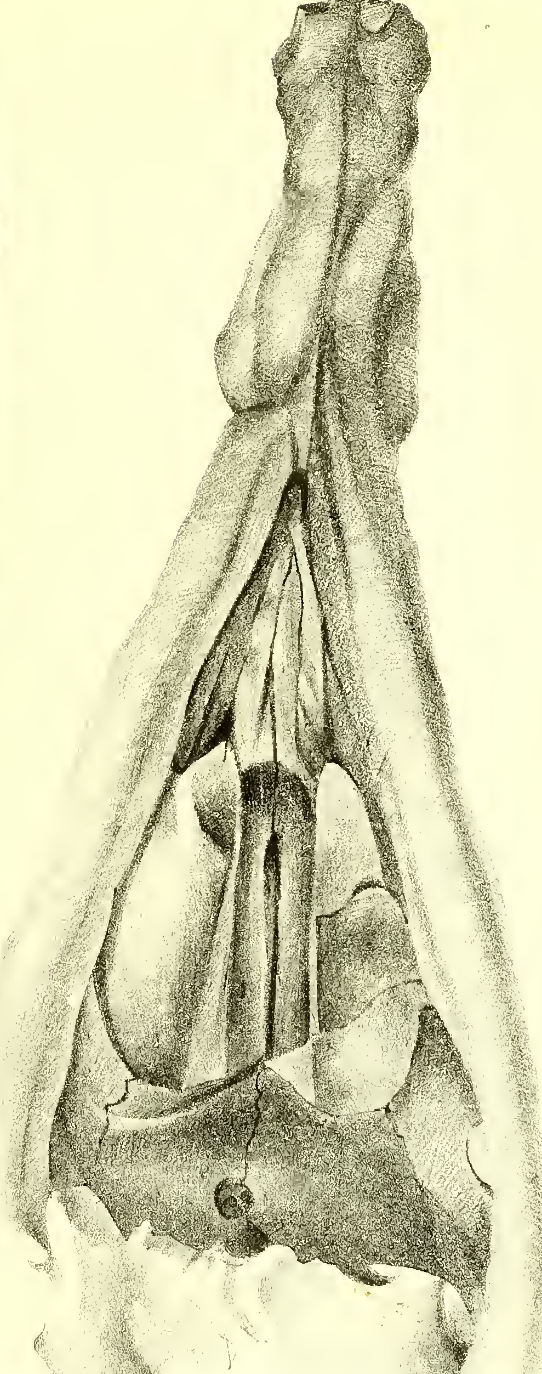


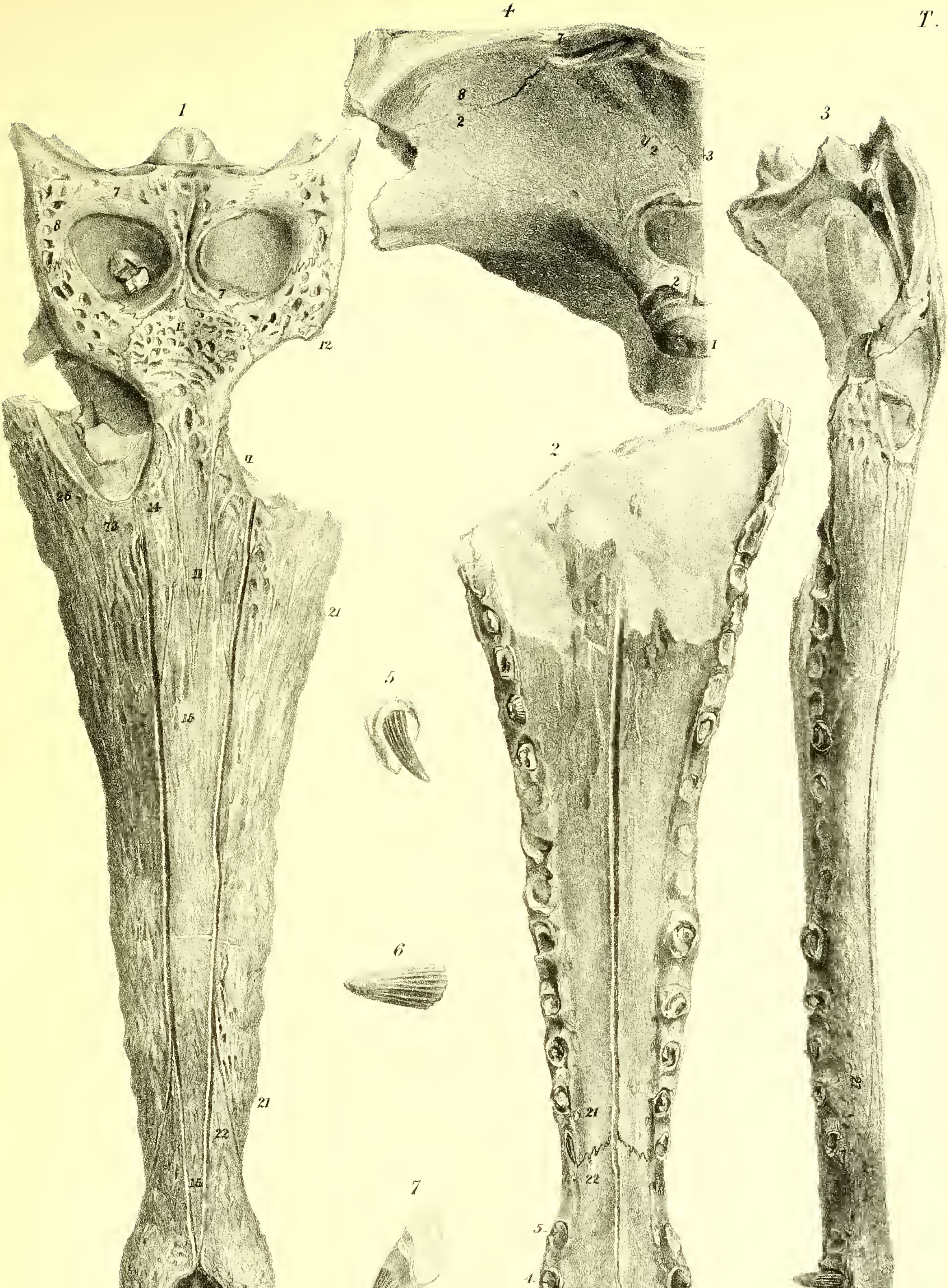
TAB. III.

Crocodilus champsoïdes, half the nat. size.

Fig.

1. Upper view of the skull.
2. Under view of the fore part of ditto.
3. Side view of ditto.
4. The left half of the back part of the skull of ditto, nat. size.
5. The point of an anterior young tooth coming into place, nat. size.
6. Half of the crown of one of the large conical teeth, nat. size.
7. One of the shorter and more obtuse posterior teeth, nat. size.

T. III.

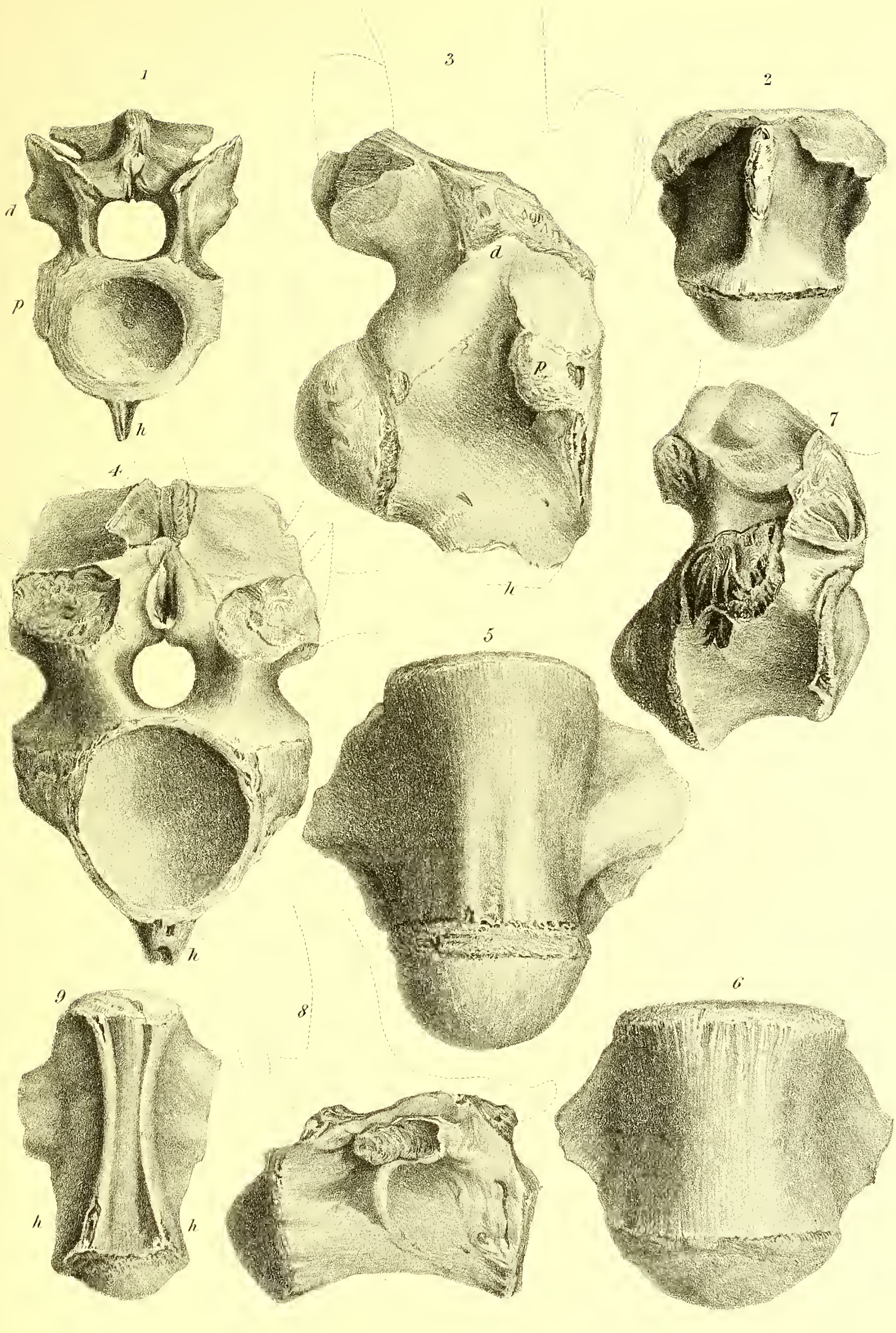


TAB. IV.

Vertebræ of the *Crocodilus toliapicus,* nat. size.

Fig.

1. Fore part of a mutilated seventh cervical vertebra.
2. Under part of ditto.
3. Side view of a mutilated eighth cervical vertebra.
4. Front view of the same vertebra.
5. Under view of the centrum of a lumbar vertebra.
6. Under view of the centrum of the fourth or fifth dorsal vertebra.
7. Side view of the first caudal vertebra.
8. Side view of a middle caudal vertebra.
9. Under view of the same vertebra.



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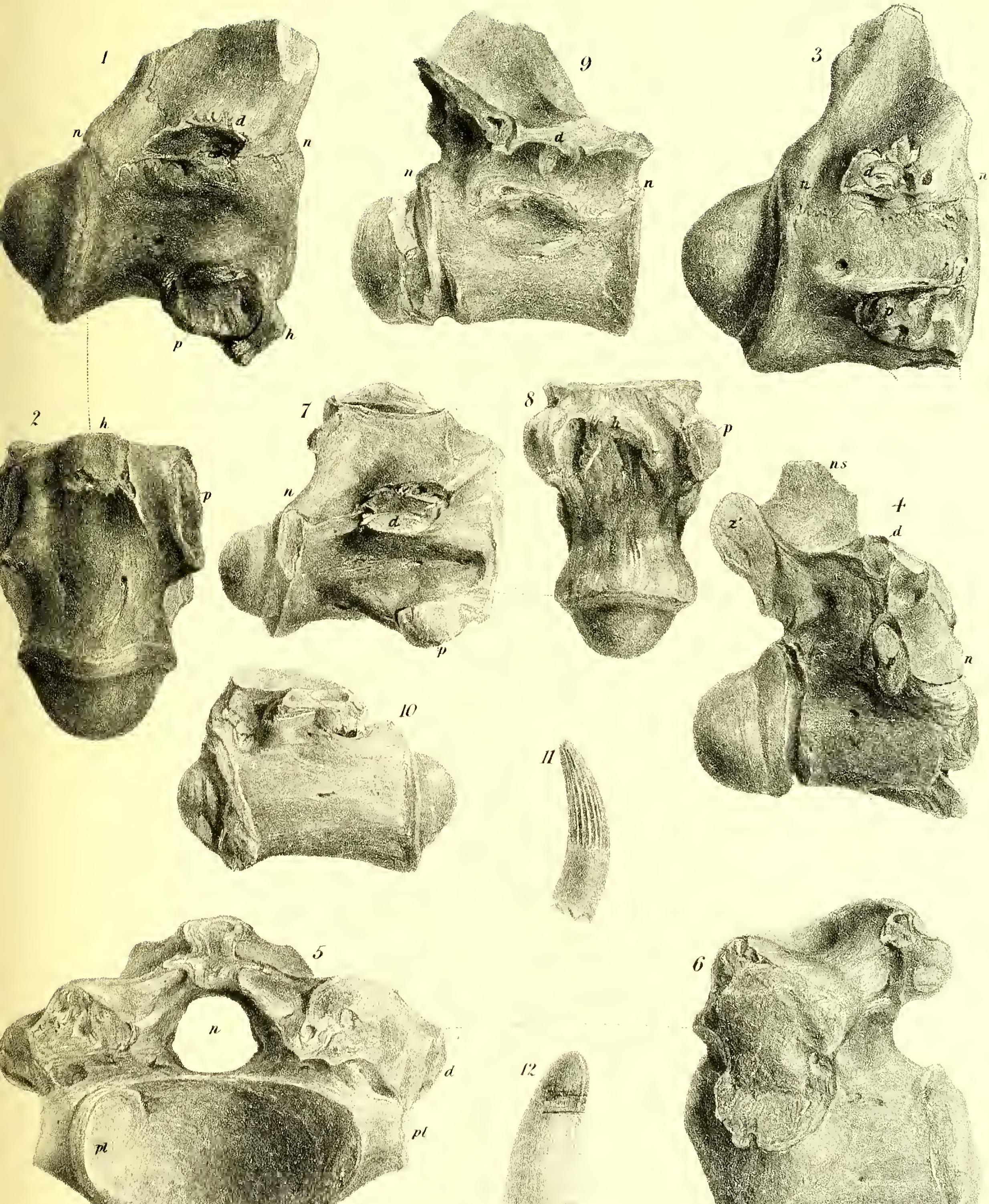
TAB. V.

Fig.

1. Side view of the fourth cervical vertebra (mutilated) of the *Crocodilus toliapicus.*
2. Under view of the same, showing the shape of the *hypapophysis h.*
3. Side view of the sixth cervical vertebra (mutilated) of ditto.
4. Side view of the first dorsal vertebra (mutilated) of the *Crocodilus champsoïdes.*
5. Front view of the anterior sacral vertebra (mutilated) of the *Crocodilus toliapicus.*
6. Side view of the same vertebra.
7. Side view of the third cervical vertebra (mutilated) of the *Crocodilus champsoïdes.*
8. Under view of the same vertebra.
9. Side view of a posterior dorsal vertebra (mutilated) of the *Crocodilus champsoïdes.*
10. Side view of the centrum of the first caudal vertebra of ditto.
11. An anterior tooth of the *Crocodilus champsoïdes.*
12. A posterior tooth of the *Crocodilus toliapicus.*

All the figures are of the natural size.



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TAB. VI.

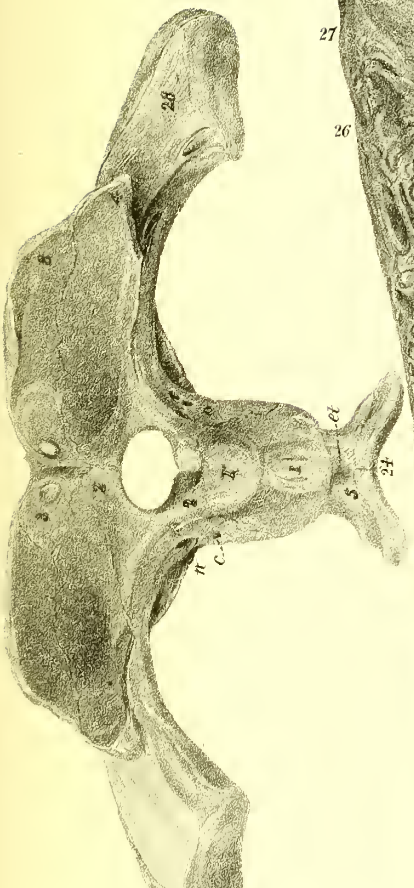
CROCODILIA—*Crocodilus Hastingsiæ*, half the nat. size.

Fig.

1. Upper view of the skull.
2. Back view of ditto.
3. Ectopterygoids (25) and pterygoids (24), with the posterior aperture of the nostril.

1

2



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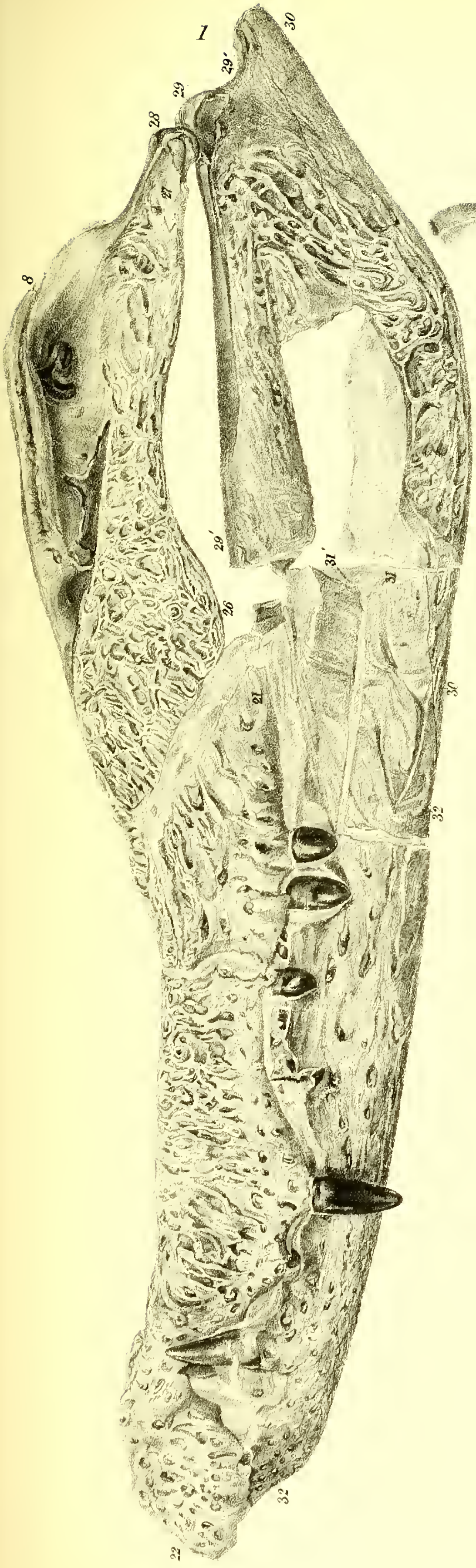
TAB. VII.

CROCODILIA—*Crocodilus Hastingsiæ,* half the nat. size.

Fig.

1. Side view of the skull.

2. Under view of the cranial and facial parts of ditto.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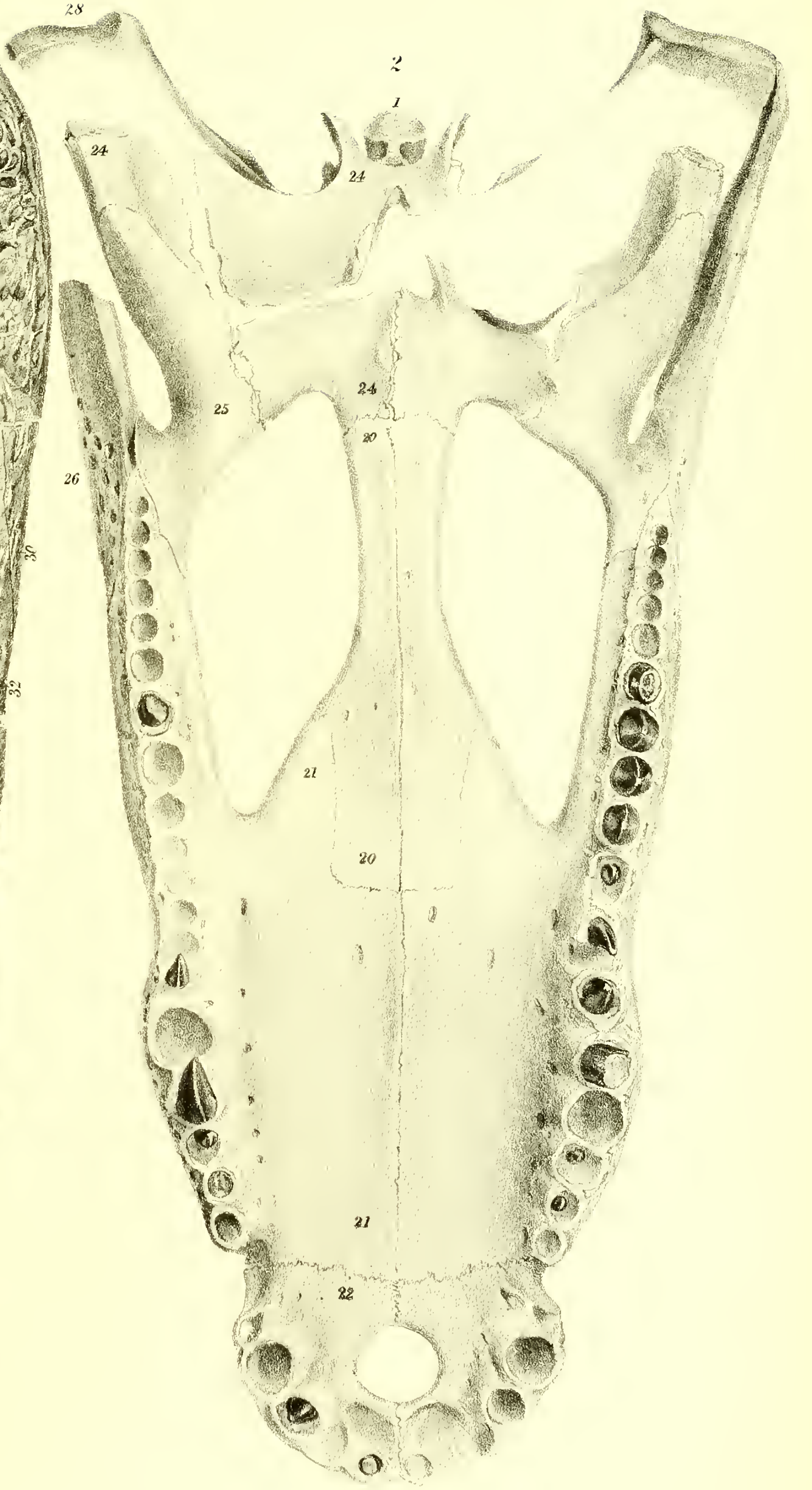
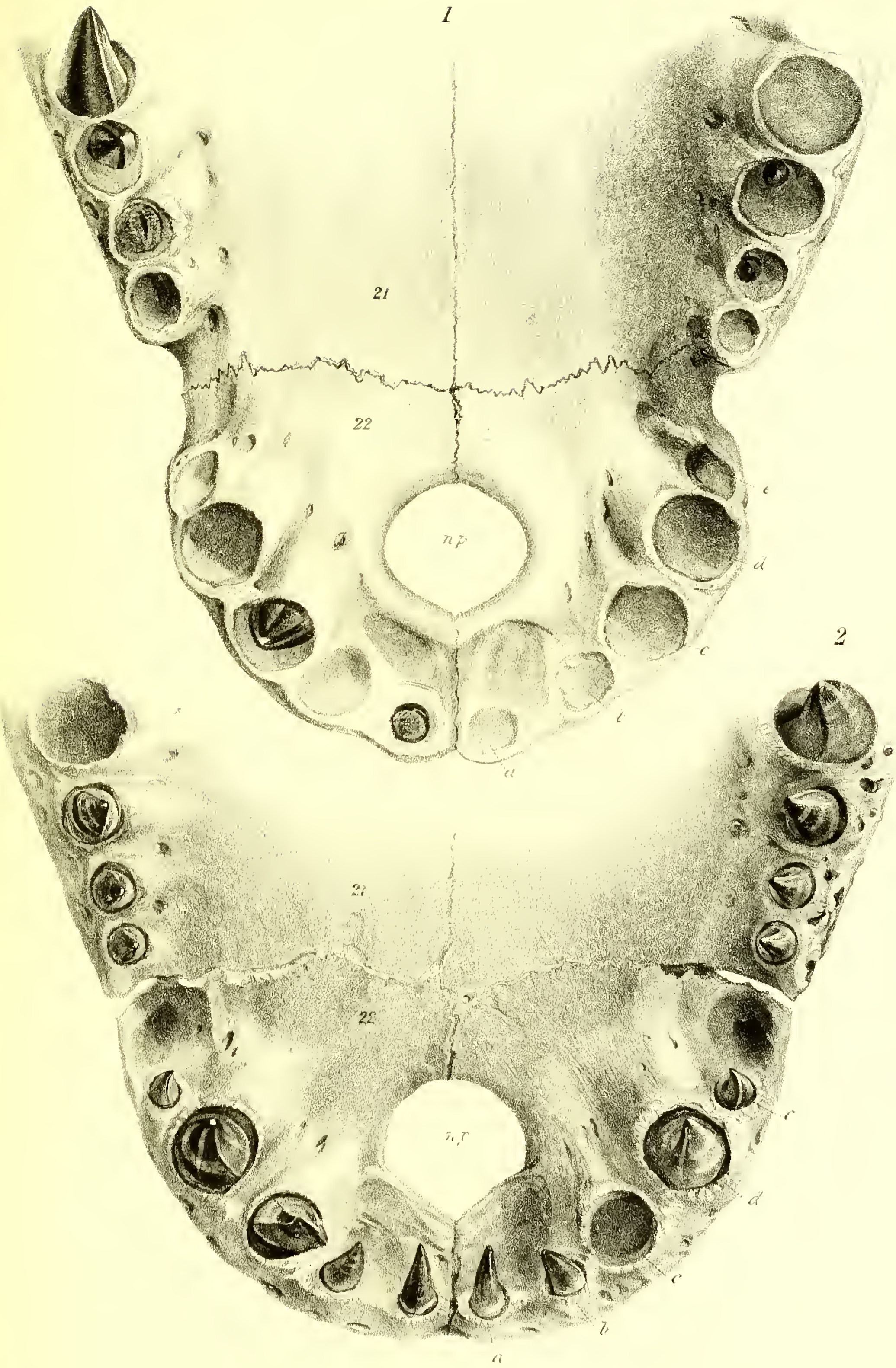

2
28
1
24
24
24
25
20
26
21
20
21
22

TAB. VIII.

Fig.

1. Under view of the fore part of the upper jaw of the *Crocodilus Hastingsiæ*, nat. size.

2. The same view of the *Alligator Hantoniensis*, nat. size.



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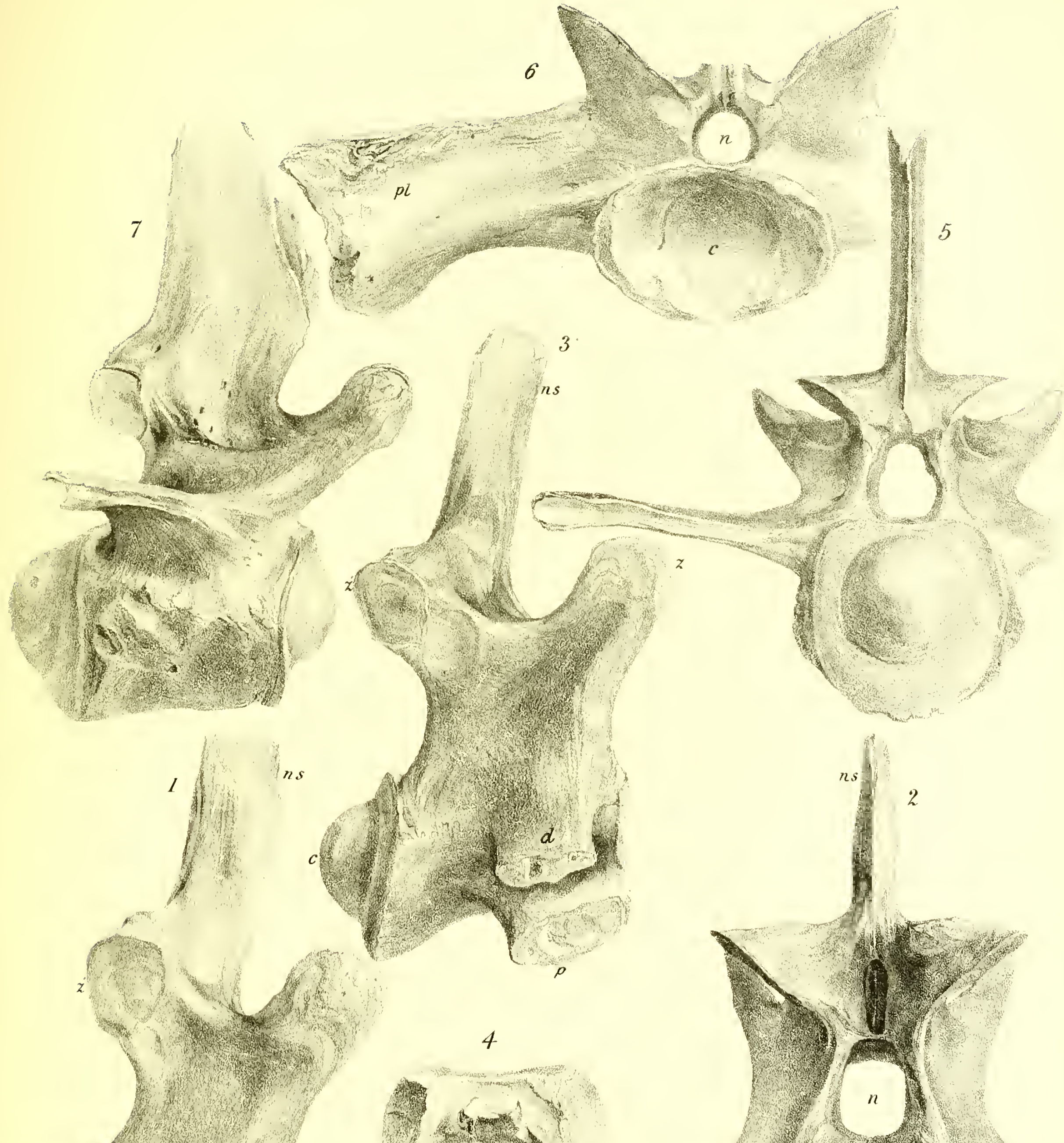
1. Crocodilus Hastingsiæ. 2. Alligator Hantoniensis.

TAB. IX.

Crocodilus Hastingsiæ, nat. size

Fig.

1. Side view of the fourth cervical vertebra.
2. Back view of the same vertebra.
3. Side view of a similar vertebra, *minus* the pleurapophyses.
4. Under view of the third cervical vertebra.
5. Back view of a lumbar vertebra.
6. Front view of the first sacral vertebra.
7. Side view of the first caudal vertebra.



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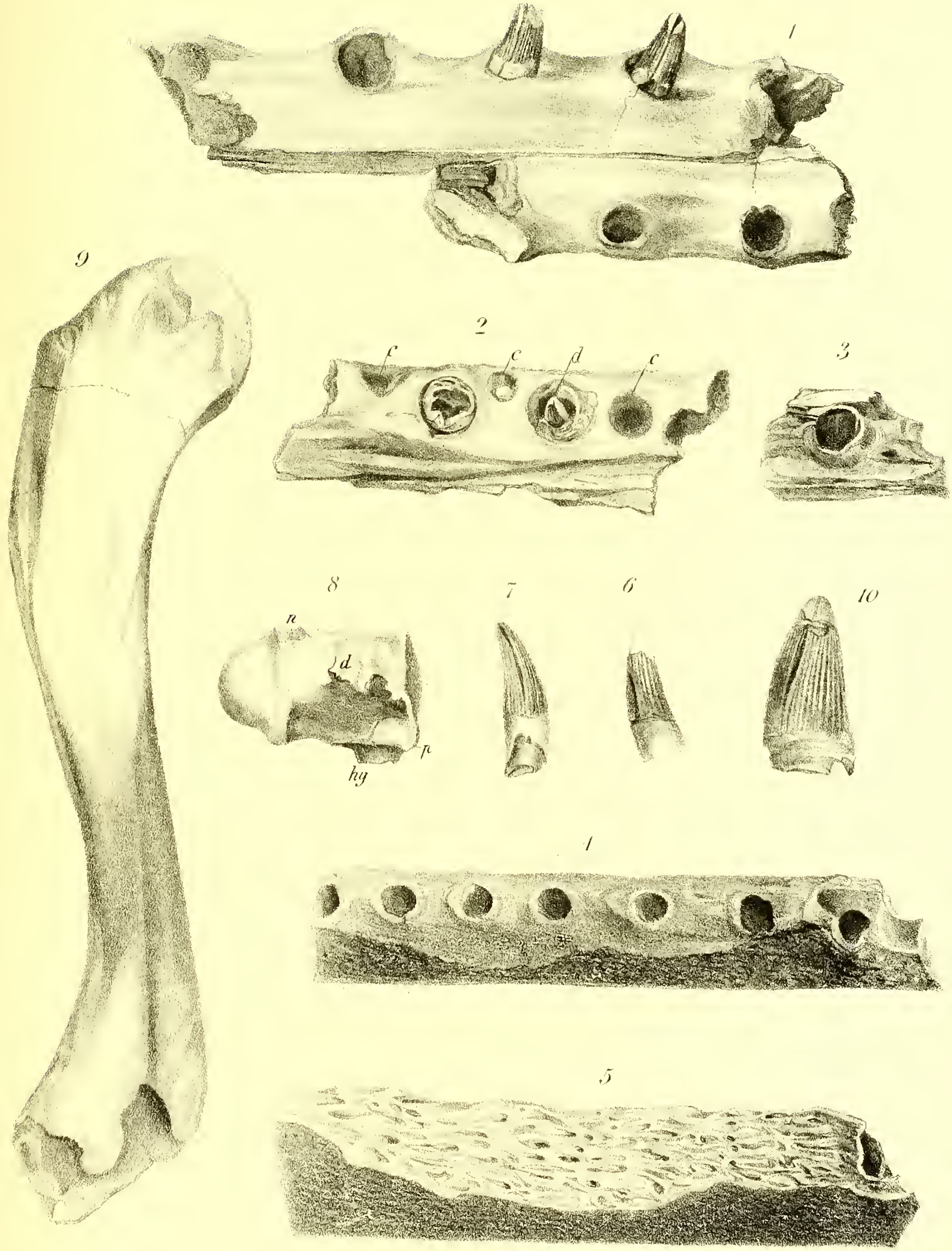
TAB. X.

Gavialis Dixoni, nat. size.

Fig.

1. A fragment of the symphysis of the lower jaw.
2. A fragment of one of the rami from the back part of the symphysis, showing the depressions *cc*, in the interspaces of the alveoli.
3. The fractured under part of a fragment of the same (*d*) jaw, exposing the hollow base of a young tooth.
4. A fragment of a ramus forming the long symphysis of the under jaw of a younger individual of the same species; upper surface.
5. Under side of the same fragment.
6. A portion of a tooth of the same species of Gavial.
7. A tooth with the germ of its successor, which has entered its base, of the same Gavial.
8. The centrum of a cervical vertebra of the same Gavial.
9. The femur of the same Gavial.
10. The crown of a tooth of a large Crocodilian from Bracklesham.



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TAB. XI.

Crocodilia.

Fig.

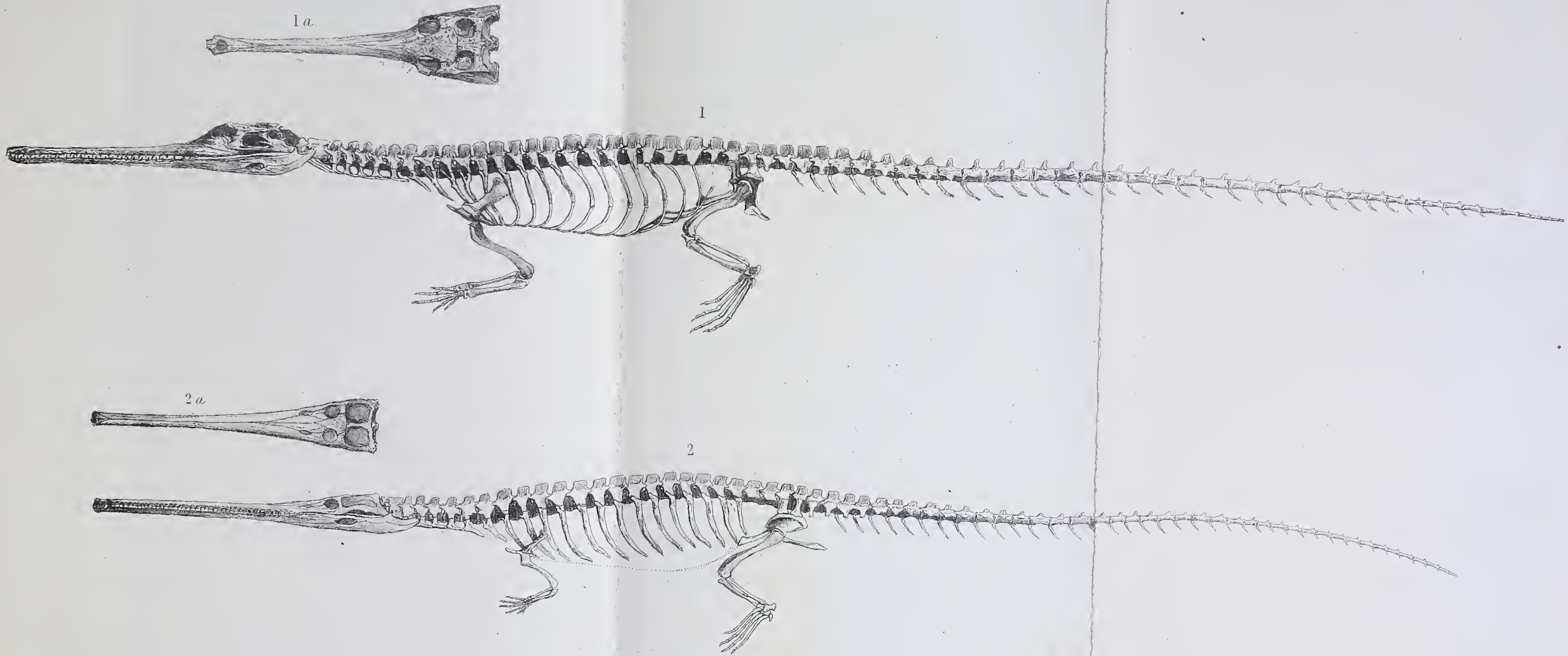
1. Side view of the skeleton of a Gavial.

1 *a*. Upper view of the skull of ditto.

2. Side view of the skeleton of a Teleosaur.

2 *a*. Upper view of the skull of ditto.

On the scale of one inch to a foot.



J. Erxleben Zinc.

Day & Haghe Lith^rs to the Queen

1. *Modern Gavial of the Ganges* — 2. *Ancient Gavial, or Teleosaur, of the Whitby lias.*

TAB. XII.

Fig.

1. Upper surface of the symphysial end of the right ramus of the lower jaw of *Crocodilus biporcatus.*

2. The same part of *Crocodilus Hastingsiæ.*

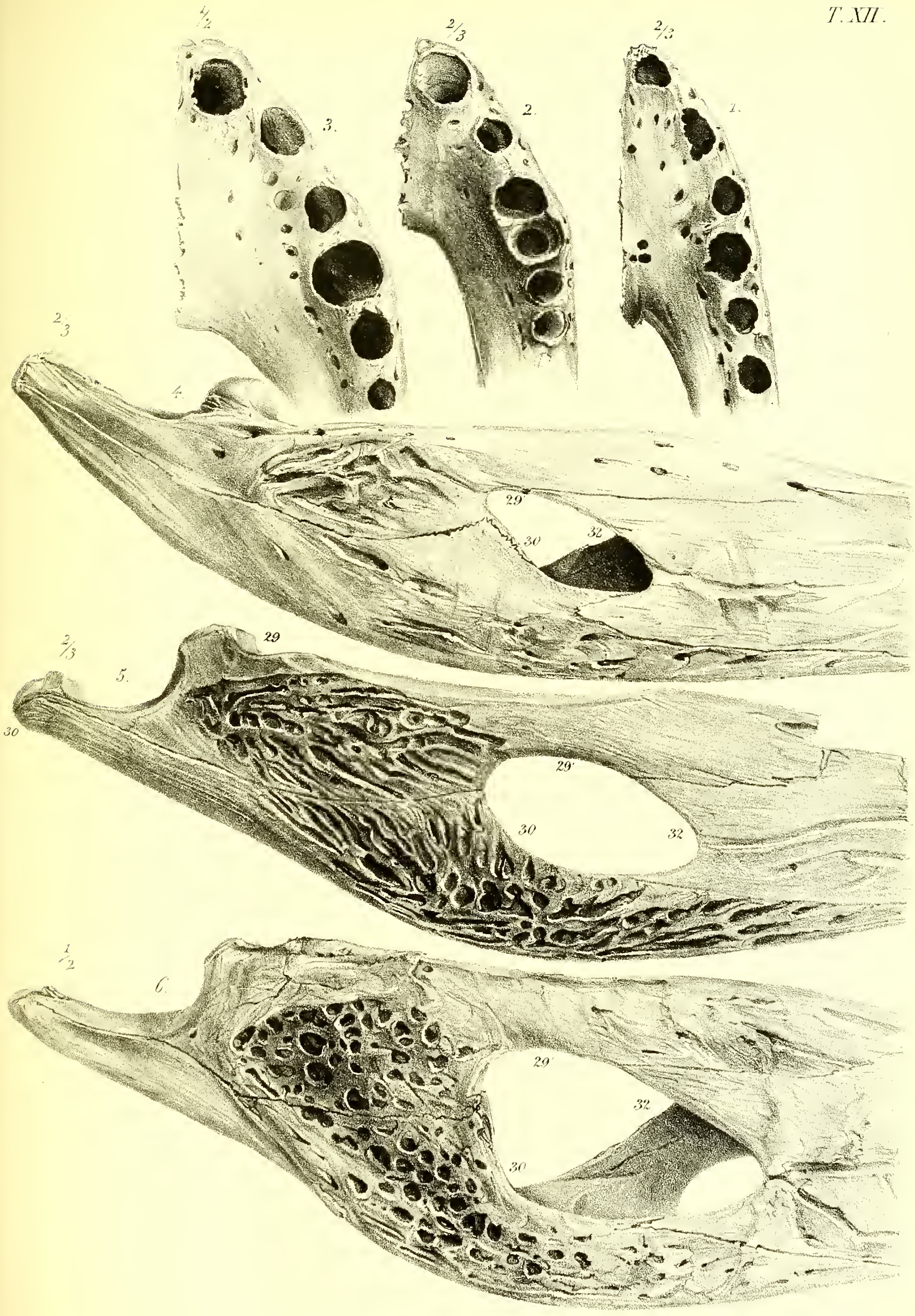
3. The same part of *Alligator niger.*

4. The hinder part of the right ramus of the lower jaw of *Crocodilus biporcatus.*

5. The same part of *Crocodilus Hastingsiæ.*

6. The same part of *Alligator niger.*

Figures 1, 2, 4, 5, two-thirds, 3 and 6 one half the nat. size.



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Day & Son, Lith^rs to The Queen

TAB. XIII.

Ophidia.—Recent and Fossil Ophidian Vertebræ; nat. size.

Fig.

1—4. Vertebræ from the middle of the body of a *Python Sebæ*, twenty feet in length.

2,′ 3′. A rib of the same Python.

3″. Section of the proximal end of a rib of the same Python, showing the medullary cavity.

5—8. Vertebræ from the middle of the body of the *Palæophis typhæus*.

9—12. Corresponding vertebræ of a rattle-snake. (*Crotalus.*)

13—16. Corresponding vertebræ of a hooded-snake. (*Naja.*)

17—20. Corresponding vertebræ of a harmless snake. (*Coluber elaphus.*)

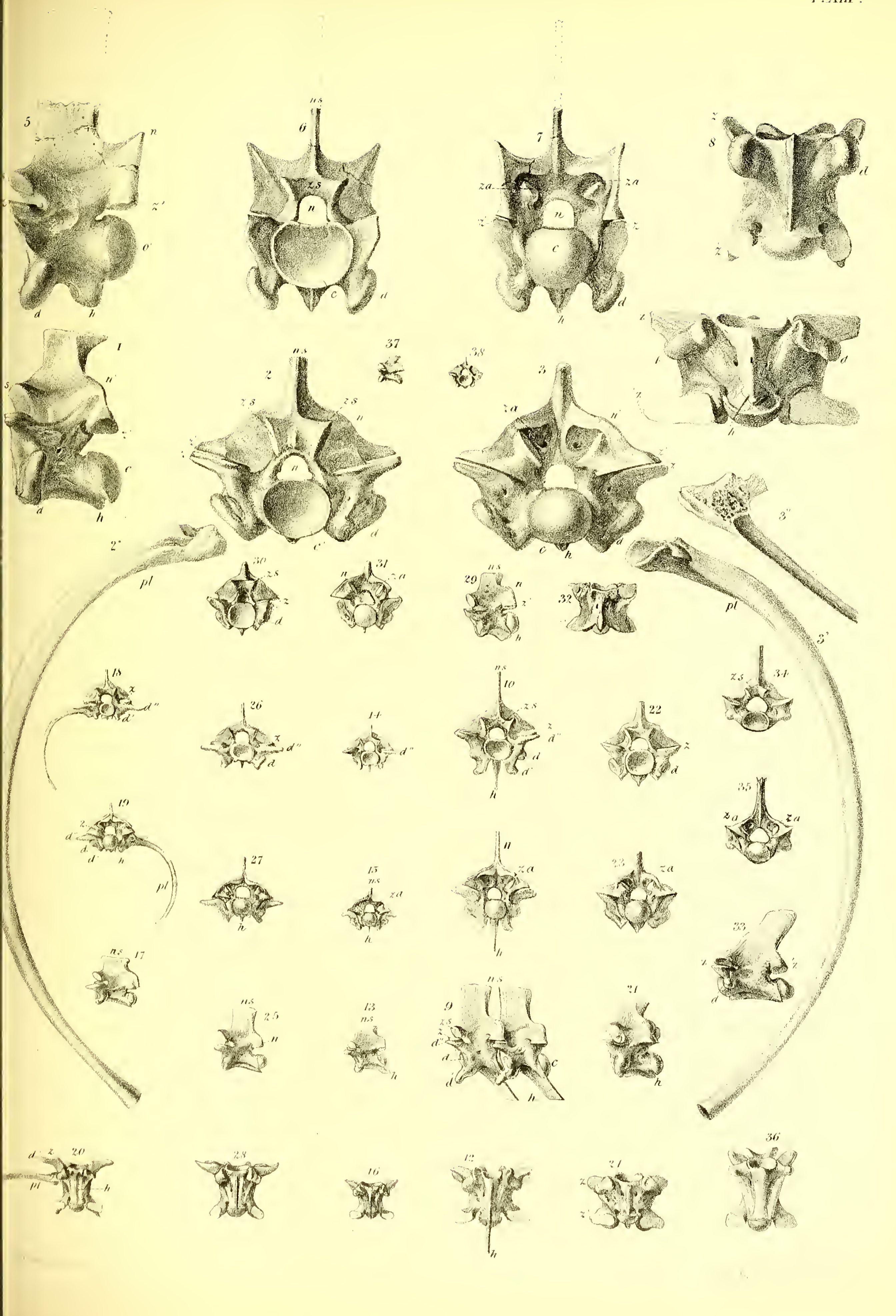
21—24. Corresponding vertebræ of an African *Eryx.*

25—28. Corresponding vertebræ of a sea-snake. (*Hydrus bicolor.*)

29—32. Corresponding vertebræ of *Paleryx rhombifer.*

33—36. Corresponding vertebræ of an Iguana.

37—38. Corresponding vertebræ of *Paleryx depressus.*



TAB. XIV.

OPHIDIA.—Fossil and Recent Ophidian Vertebræ; nat. size.

Fig.

1—3. A cervical or anterior trunk vertebra of a *Palæophis.*

4. A corresponding vertebra of a *Python tigris.*

5—6. A small vertebra of a Palæophis with one hypapophysis.

7—9. A larger vertebra of the same species.

10—12. A similar vertebra of the same species.

13—15. A small vertebra of *Palæophis porcatus.*

16—17. A large vertebra of Palæophis, longer in proportion to its breadth than

18—20. A type vertebra of *Palæophis porcatus.*

21. A vertebra of *Palæophis porcatus.*

22—24. A middle trunk vertebra of the same species of *Palæophis*, as figs. 1—3.

25. A small vertebra of a *Palæophis,* with an inferior ridge.

26. A large vertebra of do. do.

27. Two views of a vertebra of *Palæophis typhæus*, with the major part of the long neural spine preserved.

28. Two vertebræ of *Palæophis typhæus*, in natural articulation.

29—31. A vertebra of a *Palæophis,* of the compressed kind.

32—34. Two similar but smaller vertebræ of the same kind anchylosed, perhaps from the tail.

35—37. A trunk vertebra of the *Palæophis longus.*

38. Front view of the atlas vertebra of the *Python Sebæ.*

39. Side view of the same vertebra.

40. Side view of the axis vertebra of the same *Python.*

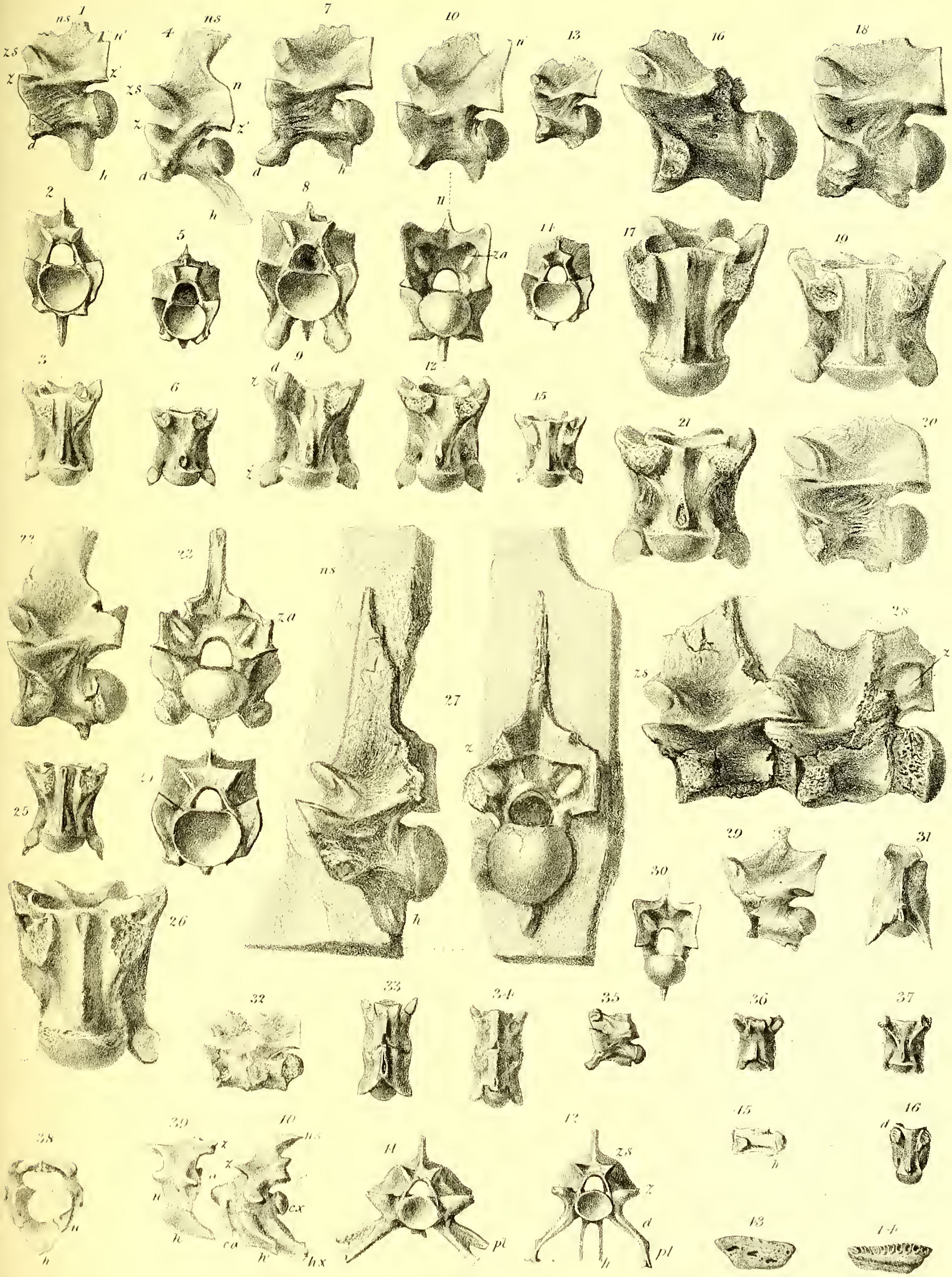
41. Front view of an anterior caudal vertebra of a *Python tigris.*

42. Front view of a middle caudal vertebra of the same Python.

43—44. Two views of a portion of the lower jaw of a lizard or sauroid fish.

45—46. The centrum of a vertebra of the *Palæophis longus.*

With the exception of figs. 35—37 and 45—46, which are from Kingston in Suffolk, all the specimens of *Palæophis* figured in this plate are from Bracklesham, Sussex.

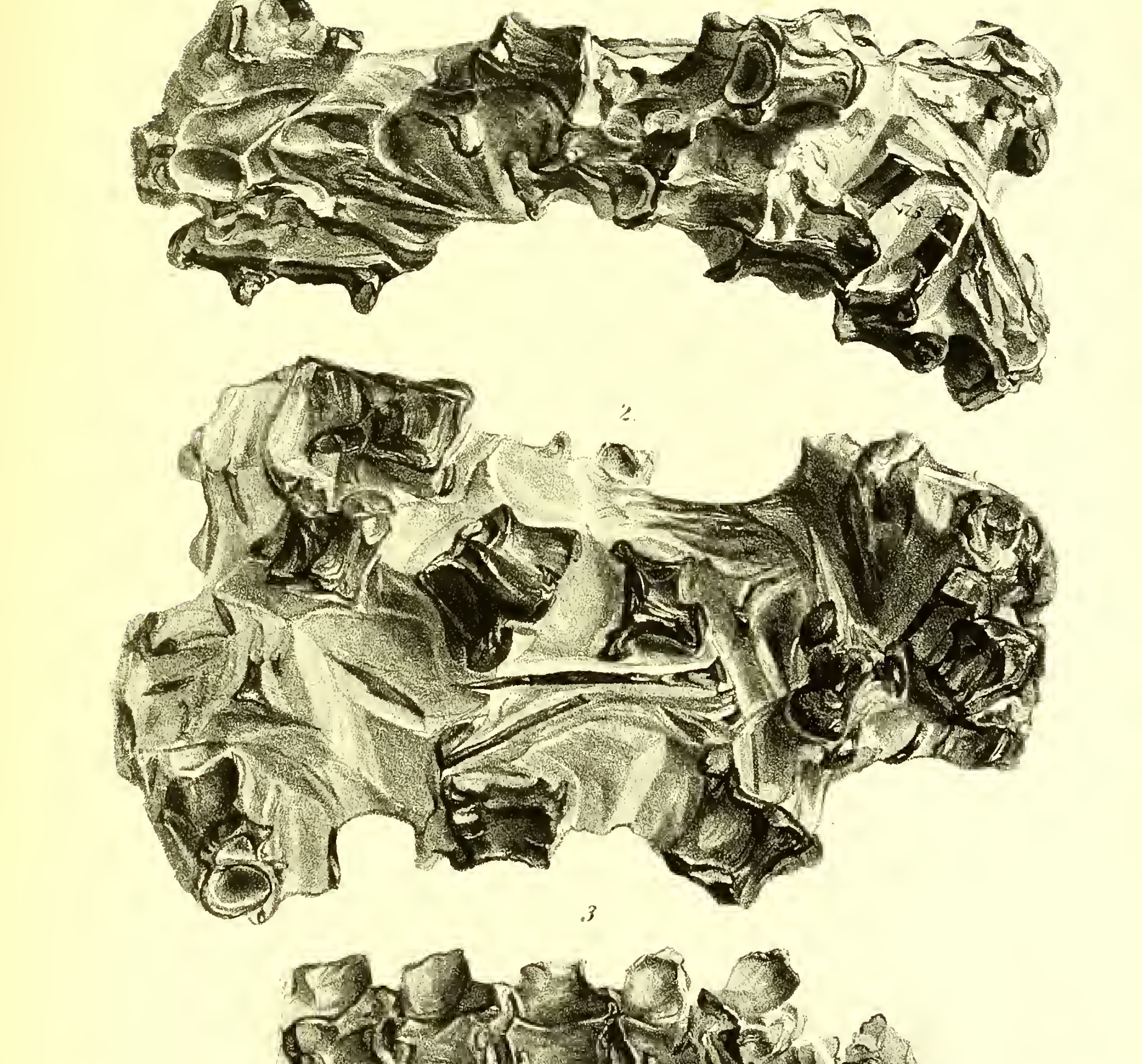


TAB. XV.

Ophidia.—*Palæophis toliapicus;* nat. size.

Fig.

1. A group of vertebræ, some of which show the long neural spine entire.
2. A group of vertebræ and ribs.
3. Five vertebræ in natural articulation with the diapophysis well preserved.
4. Under surface of four partially dislocated vertebræ.
5. Side view of the same vertebræ; natural size.



J. Erxleben

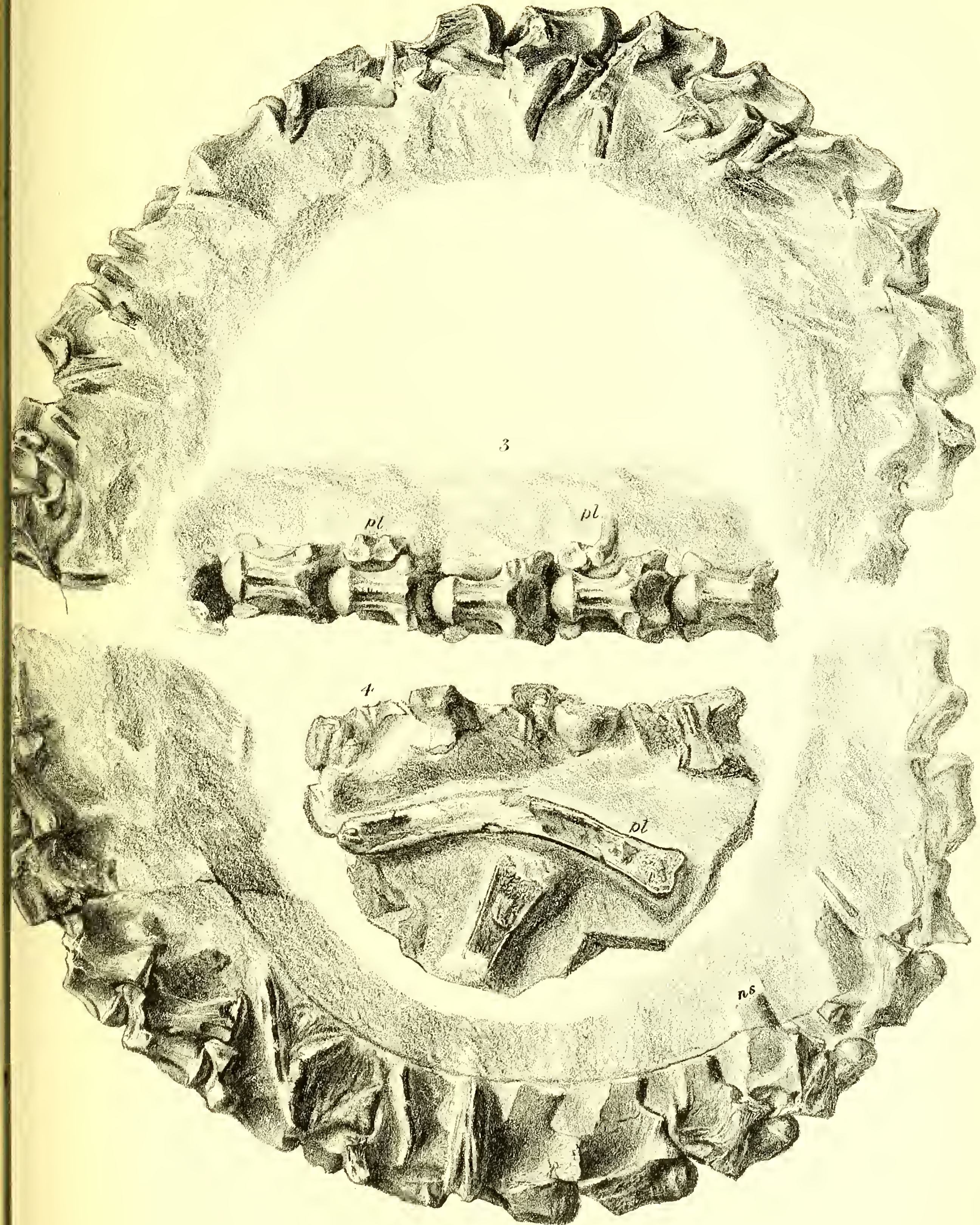
TAB. XVI.

Ophidia.

Fig.

1. Left side view of a chain of thirty trunk vertebræ of the *Palæophis toliapicus*, from Sheppy.
2. Right side view of the same vertebræ.
3. Under view of five vertebræ of the same chain, with the articular ends of some of of the ribs.
4. Portion of a group of Palæophis vertebræ from Bracklesham, showing the size and structure of the ribs; natural size

Fig. 1



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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

MDCCCL.

A MONOGRAPH

OF THE

BRITISH FOSSIL CORALS.

BY

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DEAN OF THE FACULTY OF SCIENCES OF PARIS; PROFESSOR AT THE MUSEUM OF NATURAL HISTORY;
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AND

JULES HAIME.

FIRST PART.

INTRODUCTION; CORALS FROM THE TERTIARY AND CRETACEOUS FORMATIONS.

LONDON:

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A MONOGRAPH

OF

THE BRITISH FOSSIL CORALS.

INTRODUCTION.

§ I.[1]

Naturalists often designate under the general name of *Coral,* not only the stony substance of a vivid red which is found on the coast of Barbary, and has been long used for ornamental purposes, but also a vast number of other marine productions, which have a calcareous structure, and are considered as appertaining to Zoophytes, more or less analogous to the Polypi that form the *Isis nobilis* of Linnæus, or real Mediterranean Coral. The remains of the minute plant-like animals which abound in most tropical seas, and constitute in some parts of the globe extensive reefs, or even large clusters of islands, have thus been very properly called *Corals.* But the same appellation has been erroneously given to the lapidified teguments of many beings which differ most essentially from all Zoophytes, and belong some to the great Mollusca tribe, some to the family of Sponges, and others to the Vegetable kingdom. In all Natural classifications it is necessary to separate that which is fundamentally different, and to unite that which is in reality similar. Zoologists must, therefore, be more reserved in the use of this expression, and cannot, without impropriety, continue to comprehend under the same name all the natural productions which are com-

[1] In writing this Monograph in English, a language with which I am not so familiar as I could wish, I much fear that the incorrectness of the phraseology will often strike the reader. I preferred, however, not having recourse to a translator, for the meaning of an author is often misrepresented by those who lend him their pen, and I thought that in a work of this kind accuracy of description would be preferable to elegance of style. Before commencing the task I have undertaken, I must also beg leave to express publicly my grateful feelings for the kind and liberal manner in which Sir H. De la Beche, Mr. Stokes, Mr. J. S. Bowerbank, Professor John Phillips, Mr. Frederick Edwards, Mr. Searles Wood, Mr. Dixon, Mr. Pratt, Mr. Sharpe, Dr. Battersby, Mr. F. W. Fletcher, Mr. J. Gray, and the Council of the Geological Society of London, have communicated to me the palæontological treasures belonging to their respective collections.—H. Milne Edwards.

monly thus blended together. For us the word *Coral*, or *Corallum*, must be synonymous with *Polypidom*,[1] and signify the hard or ossified parts of the body of a Polyp.

In treating of the "Fossil Corals of Great Britain," we must, therefore, exclude from our investigation the various organic remains which bear a certain resemblance to Polypidoms, but which do not in reality belong to beings of the same structure, and we must circumscribe our researches within the boundaries of the group of Zoophytes, which, in a Natural arrangement of the Animal Kingdom, is represented by the Class of Polypi.[2]

These Zoophytes are closely allied to Medusæ, and in the actual state of science there is some uncertainty respecting the natural limits which separate these two groups; but the mode of organization common to both is so characteristic, that the most superficial anatomical investigation will always enable the zoologist to distinguish a Polyp or an Acaleph from the Bryozoa and the Spongidæ, which, till lately, have been erroneously considered as belonging to the class of Corals. Polypi have a radiate structure; a protractile mouth, surrounded by non-ciliate tentacula; a large and well-organized digestive cavity; but have no anus. In Spongidæ no appearance of tentacula or of a stomach is ever met with; and in Bryozoa an intestinal canal, much resembling that of ordinary Mollusca, is always provided with two distinct openings, a mouth and an anus, the first of which is encircled by ciliated tentacula. The structure of the digestive organs is, therefore, characteristic in all these animals, and in most instances the radiate form of the tegumentary system will alone suffice to render the diagnosis of Polypi an easy task. But when the Polypidom is reduced to its most simple condition, it sometimes bears great resemblance to the calcareous or horny covering of certain Bryozoa, or to the reticulate skeleton of some of the Spongidæ; and the Polypidom being the only part of these animals which is found in the fossil state, it is sometimes hard for the palæontologist to decide whether the organic remains that assume this form are in reality Corals, or whether they do not belong to one of the other above-mentioned Zoological divisions.

Polypidoms may present two very distinct forms. Some, belonging to aggregate Polypi, are developed on the basal surface of these Zoophytes, and constitute a sort of stem in the

[1] In translating the French expression *Polypier* by the word *Polypidom*, which has of late been adopted by some of the most eminent English zoophytologists, we deem it necessary to guard the reader against the erroneous ideas which the etymology of that name might lead to. Till of late the nature of Corals was in general misunderstood; they were supposed to be produced by a plastic exudation moulded round the body of the Polyp, and serving as a dwelling for these singular beings, but not forming a part of their organism. Such is far from being the case; the corallum is a part of the animal, in the same way as the coating of the armadillo or the shell of the lobster belong to the structure of these beings. The words "Polypidom," *Polypier*, &c., might therefore be objected to, if their meaning was not generally known, and had not become independent of their etymology.

[2] The class of Polypi, reduced to its natural limits, corresponds to the *Anthozoa* of M. Ehrenberg, and to the sub-class of *Radiated Zoophytes* of Mr. Johnston. In the excellent work recently published by Mr. Dana, the same group is designated by the name of *Zoophytes*, which is usually employed in a much wider acceptation, and had long ago been given by Cuvier to the great division of radiate animals, comprising Echinoderma and Acalephæ, as well as Polypi, etc.

centre of the ramified mass produced by the multiplication of these plant-like animals. The dendroid red Coral of the Mediterranean Sea and the horny skeleton of Gorgonia are thus inclosed in the axis of cylindrical branches, formed by the thick coriaceous tegumentary tissue belonging to the whole community of aggregate Polypi, and studded, as it were, by the radiate protractile heads of the many individual Zoophytes thus united. Other Corals, appertaining either to simple or to compound Polypi, are, on the contrary, produced by the ossification of this tegumentary tissue itself, and instead of forming a sort of stem, constitute a sheath, or an assemblage of calcareous tubes, each of which belong to an individual Zoophyte, correspond to the lower part of its digestive cavity, and serve as a kind of cell or lodge into which the anterior portion of the animal's body recedes when in a contracted state.

The basal or stalk-like Corals are in general well characterised by their dendroid form, compact tissue, and concentric layers. At first sight they may bear a slight resemblance to certain Bryozoa that have attained a very advanced age;[1] but even then the remains of some non-obliterated cells will always enable an attentive observer to recognise the latter, and the absence of all trace of any such cavities can easily be ascertained, by grinding down or fracturing the stem of the above-mentioned Zoophytes. In some few instances these basal Polypidoms are more like the reticulated skeleton of certain foliaceous Spongidæ; but the concentric lamellæ of their stem contrasting with the fibrous structure of the tissue of the Sponge, will still render them recognisable.

Dermal Corals are in general characterised by features of a more striking aspect, and it is only when these Polypidoms are reduced to their most simple and degraded form, that they can be mistaken for the tegumentary skeleton of some of the lowest Bryozoa, or the reticulate, stony tissue of some highly-organized Spongidæ. In all well-developed Corals of this kind, the central cavity or visceral chamber is more or less completely divided by a certain number of vertical plates, which project from its walls towards its axis, and produce that radiate structure which is so remarkable in the Astrean tribe. In most Bryozoa the mouth, or cephalic aperture of the tegumentary cell, is provided with a horny operculum,[2] but no such organ ever exists in a true Coral; and, on the other hand, the radiate septa which we have just alluded to as being conspicuous in most Polypidoms, never exist in the cells of Bryozoa. The absence of an operculum, or of vertical septa, will not, however, enable the observer to decide whether the coral-like organic remains submitted to his investigation belong to the one or to the other of the two great zoological divisions, for it is a well-known fact that, in many of the inferior forms among recent Bryozoa, the tegumentary skeleton is reduced to a simple non-operculated tubular sheath, and that in certain Polypi (the Tubipora for example), no longitudinal septa are to be found; and the Polypidom is equally reduced to a calcareous tube, tapering and closed at its base, open and more or less enlarged at its upper end.

[1] The *Millepora truncata* of Ellis and Solander, for example.

[2] See "Recherches sur les Eschares," Annales des Sciences Naturelles, 2[me] série, t. vi, pl. i.

In cases of this kind the distinction between the Polypi and the Bryozoa is always rendered easy by the most superficial examination of the soft parts of the animal; but it is sometimes a matter of great difficulty for the palæontologist, who is necessarily deprived of all such resources, and can only be guided by the peculiarities observable in the ossified tissues.

In general, the distinction between Corals and Spongidæ is also very easy, for the lamellar structure, so prevalent among the former, is never met with in the latter; but in some Polypidoms (certain Milleporidæ for example), the vertical plates disappear, and the mural tissue becomes extremely porous, irregular, and abundant, so as to resemble much the reticulated mass formed by the stony skeleton of some Spongidæ, where the oscula and aquiferous canals are on the contrary more regular than usual. In cases of this kind it may be necessary to seek for distinctive characters in the internal structure of the Zoophyte; and, independently of the benefit to be obtained by the microscopical investigation of the tissue itself, it will sometimes be found useful to examine the form of the tubular cavities which pervade the mass, and correspond either to the visceral chambers of the Polypi, or to the great aquiferous ducts of the Spongidæ; for in the first instance they are always simple, whereas in the latter they are more or less ramified.

§ II.

The external forms of Corals vary considerably, but are in general more dependent on the mode of aggregation of the different individuals produced by a common parent than on the mode of organization peculiar to the animals to which these tegumentary skeletons belong. Characters derived from these forms can therefore be but of little avail for the natural arrangement of Polypi; and the classification of these Zoophytes, like that of the higher animals, must be founded on the principal modifications observable in their structure. It would lead us too far from the special object of this Monograph, if we were to enter on the investigation of the anatomical facts which alone can furnish satisfactory elements for such a classification; but in order to facilitate the study of the Corals about to be described, it may be useful for us to revert to a few of the leading points in the structure of Polypi, and to define some of the expressions which we shall often have to employ.[1]

The Sclerenchyma, or hardened tissue of Polypi, by which Corals are formed, is always a portion of the tegumentary system of these Zoophytes, but, as we have already stated, it may be produced in two very different ways. In some cases it is the result of a sort of ossification of the chorion or principal tunic of the Polypi; in others it grows on

[1] For more ample details on this subject we must refer to our "Memoir on the Structure and Development of Corals," published in the Annales des Sciences Naturelles, 3[me] série, t. ix.

certain parts of the surface of that membrane in a manner somewhat similar to that in which calciferous epidermis covers the skin of Crustacea and Mollusca. This *epidermic sclerenchyma* constitutes the tissue which Mr. Dana has designated by the name of " foot-secretion," and is the only anatomical element employed by nature in the formation of the common red Coral, and the horny tubes of Sertulariæ; but in most Polypidoms it is of secondary importance, and the structure is essentially made up with the *dermic sclerenchyma*, or ossified chorion. The calcification of this tegumentary tissue always commences in the centre of the inferior part of the Polyp, and, spreading gradually, rises as the animal grows, so as to inclose the lower part of the gastric cavity, and to constitute a sort of cup or cell, which is sometimes broad and shallow, sometimes long and tubular.

In general the fundamental part of these Corals corresponds to the parietes of the great gastric or visceral cavity of the Polyp, and forms what may be called the *walls* of the Polypidom. The basal disc, the spreading cup, or the columnar sheath so produced, very seldom remains in this simple condition, and in general soon gives rise to a certain number of laminate processes, which converge towards the axis of the body, and divide the central cavity into so many radiating *loculi*. These vertical laminæ, to which we shall exclusively apply the name of *septa*, cover the upper surface of the wall when this spreads out in the form of a disc (as in Fungiæ); but in general they are more or less completely inclosed in the cup-shaped or tubular cell produced by the growth of this wall around the visceral cavity, which pervades the body of the Polyp from top to bottom. In some Corals the septa remain free all along their inner edge; in other species they adhere to a sort of central style or plate, which rises from the bottom of the same cavity, and which M. Ehrenberg has proposed calling the *columella*. The loculi, or interseptal spaces, are then completely separated; and in many Polypidoms, where there is no true columella, the same result is produced by a greater development of the septa, which become united by means of irregular trabiculæ branching off from their inner edge, and forming a *spurious columella*, the structure of which is usually loose and spongy.

Other lamellar or styliform processes, quite distinct from the septa and the columella, are in some Corals interposed between these organs, and form around the central style a sort of circular palisade, somewhat like the staminæ which in most flowers surround the pistil. These additional elements of the Polypidom have been designated by the name of *pali*, and form sometimes one, sometimes two or three, circular rows or *coronets*.

In most Corals other lamellar or spiniform processes extend from the walls outward, and constitute the parts which we propose calling the *costæ* of the Polypidom. In general they correspond exactly to the septa; and in many cases they seem to be mere prolongations of these organs through the sort of sheath formed by the walls. Sometimes, indeed, the walls themselves are no longer composed of a distinct, independent, calcified lamina, and are made up by a slight thickening and cementing of the septa along the line corresponding to the boundaries of the gastric cavity and the inner margin of the costæ.

The cavity thus circumscribed by the walls of the corallum, and subdivided by the septa, the pali, and the columella, is always closed at its bottom and open at its upper extremity, where it usually presents the appearance of a sort of radiated cup, and constitutes the *calice.* In some species, this central cavity, or *visceral chamber,* remains completely pervious from one extremity of the corallum to the other; and the membranous appendices containing the reproductive organs, and situated in the loculi, extend to its basis, without encountering any obstacle; but in other species a certain number of transverse *trabiculæ* or *synapticulæ* extend from one septum to another at various heights, and fill up, more or less completely, the inferior part of the loculi. In other cases, horizontal or oblique laminæ occupy the same position, and subdivide the loculi into a series of small, irregular cells; and sometimes these partitions are developed to such an extent that no direct communication is preserved between the lower and the upper parts of the visceral chamber, so that the calice, instead of resembling a deep tubular cup, is reduced to the form of a shallow basin. In general, these transversal laminæ, to which the name of *dissepiments* has been given, grow from the sides of the septa in an irregular manner, and do not unite so as to constitute complete horizontal tabulæ, extending from wall to wall; but in some Corals, where the septal apparatus is even rudimentary, the bottom of the visceral chamber is incessantly raised by the formation of new floors or *tabulæ,* which extend horizontally through the centre of the Polypidom, and constitute, under the calices, a vertical series of secondary chambers.

Intercostal dissepiments are frequently met with on the outside of the walls of the corallum and in compound Polypidoms, where the costæ are highly developed, a thick cellular mass is thus formed, and often assumes the appearance of a *cœnenchyma,* or common tissue. In other instances, the calcified derm continues to extend exteriorly without constituting distinct costæ, and forms a dense or a reticulate tissue, which, in certain aggregate Corals, is nowhere referable to any individual Polyp, and produces a sort of intermediate mass or true cœnenchyma.

It is also to be remarked, that the exterior surface of most Corals is covered by a layer of epithelic sclerenchyma, which is sometimes thick and spongy, but in general thin and dense, and then constitutes a species of coating, which may be called the *epitheca.*

These different constitutive parts of the Polypidom furnish the principal characters employed in the classification of Corals; but the mode of multiplication of the Polypi must also be attended to in the methodical arrangement of these Zoophytes. In some species, the young are only produced by the ova, and each corallum is formed by the skeleton of a single individual; but in most, reproduction also takes place by fissiparity or by gemmation, and in those cases the young usually remain adherent to the body of their parent, and thus produce *compound Polypidoms.* The manner in which the different individual Polypidoms, or *corallites* thus united, are grouped together, varies very much, and furnishes also useful zoological characters. It is equally necessary not to neglect studying the changes which take place in the structure of Polypidoms by the progress of age. Corals, when young, are in general much less complicated than in the adult state, and the manner in which the multiplication of their constituent parts is effected is often a subject of great interest for classifiers as well as for physiologists.

The natural affinities of recent Corals can, in general, be easily recognised by means of facts obtained from these different sources; but the study of fossil Polypidoms presents greater difficulties, and the palæontologist must also direct his attention to the modifications which may have taken place after the death of the Zoophyte, and have been produced by the slow, but long-continued action of solvent or lapidescent fluids. Changes of this kind sometimes efface the most important features of these organic remains, for it often happens that the different parts of a corallum are not modified with an equal degree of facility, and the complete destruction of certain organs in specimens, where other parts are well preserved, may give rise to most delusive appearances. Even generic divisions have thus been established by some palæontologists, on accidental changes due to fossilization alone, and it is indeed often very difficult to avoid errors of this kind in the distinction of species, when the observer is not able to compare a sufficient number of specimens.

§ III.

This Monograph being intended principally for the use of Geologists, we have thought it advisable not to follow the Zoological classification of Corals in describing the species belonging to the Fossil Fauna of Great Britain, but to distribute them in reference to the different Formations in which they are found. We must, however, not lose sight of the Natural arrangement of these Zoophytes, and before entering on the specific history of the organic remains which we have to study, it is necessary that we should make known to the reader the system of classification which we have adopted for Polypi in general. The following Synopsis will suffice for that purpose, and will serve as a sort of framework illustrative of the divers Zoological divisions to which we shall often have to revert as we proceed in the descriptive part of our work.

CLASSIFICATION OF POLYPI.

SUB-KINGDOM ZOOPHYTA; SECTION RADIATA.

CLASS
POLYPI.

Animals of the sub-kingdom of ZOOPHYTA, and of the section of RADIATA,[1] organized for a sedentary mode of life, having no locomotive organs, and being provided with a circle of retractile tentaculæ around the mouth, and a central gastric cavity, not communicating with an anus, and containing the reproductive organs when these exist; in general fissiparous, or multiplying by buds as well as by ovules.

The systems adopted by Cuvier, Lamarck, Lamouroux, and their contemporaries, for the subdivision of the class of Polypi, were founded on external characters of very little value, and were quite artificial. In a Memoir, published about twenty years ago,[2] a first attempt was made to establish this classification on anatomical facts, and the Zoophytes presenting the above-mentioned structure were distributed in two groups, characterised by the presence or the absence of internal ovaria, and a membranaceous tube leading from the mouth to the great gastric cavity. Subsequent observations have confirmed these views, and Mr. Dana, whose recent work[3] is one of the most valuable contributions which America has yet made to Natural History, divides in a similar manner the class of Polypi into two secondary groups. We shall continue adopting this classification here; but the name of *Actinoidea,* which Mr. Dana applies to the first of the two sub-classes thus established, having been previously employed by other zoologists in a much narrower acceptation, we have thought it advisable not to make use of it here, and we propose substituting for it that of *Corallaria.* The second group comprises the *Sertularian Polypi* (Milne Edw.), and may be designated by the name of *Hydraria.*

[1] The sub-kingdom of Zoophytes may be divided into two natural groups: the one comprising all the true Radiate animals (Echinoderma, Acalephæ, and Polypi); the other containing the spheroidal or amorphous Zoophytes (such as Spongidæ and certain Infusoria). The first may retain the name of *Radiata;* the second has been designated by that of *Sarcodaria* (Milne Edwards, Cours élémentaire de Zoologie).

[2] Recherches sur les Animaux sans Vertèbres, faites aux îles Chausay, par MM. Audouin et Milne Edwards (Annales des Sciences Naturelles, première série, t. xv, p. 18, Septembre, 1828).

[3] United States Exploring Expedition; Zoophytes. Philadelphia, 1846.

Sub-class 1.
CORALLARIA.

Actinoidea, Dana. Op. cit., p. 16, 1846.

Polypi possessing distinct internal reproductive organs, and having the gastric or visceral cavity surrounded by vertical, radiating, membranaceous lamellæ.

In this division of the class of Polypi, the Corallum is in general calcareous, and may be either tubular, cyathoid, discoidal, or basal; but never assumes the form of cylindrical, tubular, horny sprigs, bearing simple bell-shaped cells, for the reception of the contracted tentacula, as we usually find in the sub-class of Hydraria.

Corallaria present three principal structural modifications, and must therefore be subdivided into three corresponding groups or orders: Zoantharia, Alcyonaria, and Podactinaria.

Order 1.
ZOANTHARIA.

Zoanthaires (*Zoantha*), Blainville. Manuel d'Actinologie, p. 308, 1834.
Zoanthaires (*Zoantharia*), Milne Edwards. Elém. de Zoologie, p. 1045, 1835; Annot. de Lamarck, Anim. sans Vertèb., tom. ii, p. 106, 1836.
Zoophyta helianthoidea, Johnston; in Mag. of Zool. and Bot., vol. i, p. 448, 1837; Hist. of British Zoophytes, p. 207, 1838.
Zoantharia, J. E. Gray. Synop. Brit. Mus., 1842.
Actinaria, Dana. United States Exploring Expedition, Zoophytes, p. 112, 1846.
Anthozoa helianthoidea, Johnston. Hist. of Brit. Zooph., 2d ed., vol. i, p. 181, 1847.

Polypi with conical, tubular, simple or arborescent, but not bipinnate, tentacula, and with numerous perigastric membranaceous laminæ, containing the reproductive organs.

Zoantharia are in general coralligenous, and almost all the known fossil Polypidoms belong to this natural group of Zoophytes.

These Corals are very seldom essentially composed of epidermic tissues, nor do they scarcely ever constitute basal stems, as is usually the case in Alcyonaria. They are almost always formed of calcified dermic sclerenchyma, and inclose, more or less completely, the inferior portion of the great visceral or gastric cavity of the Polyp. Each individual has in general the form of a deep cup or a tubular sheath, the cavity of which is subdivided into a circle of loculi, by vertical septa affecting a radiate disposition. No trace of any such septa is ever met with in Corals belonging to other animals of the same class, and although these parts are sometimes rudimentary in Zoantharia, the starlike appearance of the calice produced by their existence must be considered as one of the most striking features of this zoological division. The septa are developed successively, as the Polyp grows, and in general six of these vertical laminæ constitute the primary or fundamental cyclum. Shortly afterwards a second circle, equally composed of six septa, appears, and the twelve loculi situated between these secondary septa and the primary ones are next subdivided by a third row or cyclum of twelve younger septa. The number of the septa often augments still more, and is sometimes carried very high; but in general the primary septa continue to be more developed than the others, and thus divide the whole of the radiate structure into six distinct groups or systems. In some instances, however, the secondary, or even the tertiary, septa grow so rapidly, that they soon exactly resemble those of the first cyclum, and in such cases the number of the systems is apparently much greater.[1] Sometimes the number of the primary septa is, on the contrary, reduced to four, or perhaps even to two, but never reaches eight, as would be the case if the Polypi of this order had ever eight tentacula and eight perigastric lamellæ, a structure which is always met with in the order of Alcyonaria. It is also to be noted, that the septa vary considerably in their structure, and thus furnish most important characters, not only for the distinction of species and genera, but even for the formation of higher zoological divisions in this order of Polypi.

Zoantharia may be divided into two principal groups, characterised by the structure of the parietes of their body. One of these sections comprises the species in which the dermal tissue remains soft and flexible; the other contains those the teguments of which assume an osseous structure and constitute a calcareous Polypidom.

The Sclerenchymatous Zoantharia are the only Zoophytes of this order which we shall have to mention in the sequel of this work; it would, therefore, be superfluous for us to treat of the classification of Malacodermous Zoantharia; but it is necessary that we should give a detailed account of the methodical arrangement of the first of these groups. Little is known concerning the anatomical modifications of the soft parts in the different representatives of this zoological form; but the structure of the Polypidom offers great variety, and furnishes, to an attentive observer, data which appear sufficient for the natural classification of Sclerenchymatous Zoantharia. The principal characters which we have made use of for that purpose, are derived from the dense or porous structure of the sclerenchyma; the predominance of the septal apparatus, the mural tissue or the tabular system in the formation of the corallum; the existence or the absence of dissepiments uniting the septa and subdividing the loculi, and the mode of development of the Polypi. Five principal divisions may be thus established in this section, and may be designated by the following appellations: *Zoantharia aporosa*, *Zoantharia perforata*, *Zoantharia tabulata*, *Zoantharia rugosa*, and *Zoantharia caulicutata*.

[1] The laws by which the development of the septal apparatus appears to be regulated, have been laid down in our memoir on the Structure of Corals, published in the Annales des Sciences Naturelles, 3me série, tom. ix, 1848.

Sub-order 1.
ZOANTHARIA APOROSA.

Corallum composed essentially of lamellar dermic sclerenchyma, with the septal apparatus highly developed, completely lamellar, and primitively composed of six elements; no tabulæ.

The foliaceous or lamellar structure of the calcified tissue, which furnishes one of the principal characters of these Corals, is always recognisable in the exterior part of the septa; these organs are never composed of irregular trabiculæ, as is the case in Porites, or even perforated, excepting near their inner margin. The walls are also very seldom porous, and usually constitute an uninterrupted theca, so as to admit of no communication between the visceral chamber and the exterior, except by the calice. The septa form the most important part of the Polypidom; they augment more or less in number as the Polyp rises, but in general remain unequally developed, and are disposed in groups corresponding to the six primitive radii, or to a multiple of that number, but never present a quaternary arrangement, as is often the case in Cyathophyllidæ. The visceral chamber remains open from top to bottom, or is only subdivided by synapticulæ, or by irregular dissepiments, which extend from one septum to another without joining together, so as to form a series of distinct tabulæ or discoid floors; a mode of structure which is on the contrary prevalent, and very remarkable in most of the Corals belonging to our third and fourth sections.

The *Zoantharia aporosa* are the most lamelliferous and stelliform of all the Corallaria; they are very numerous, and belong to four principal families: the *Turbinolidæ*, the *Oculinidæ*, the *Astreidæ*, and the *Fungidæ;* but some few of them cannot find a proper place in any of these natural divisions, and appear to constitute a certain number of satellite or transitional minor groups, which partake of some of the characters of two or more of the above-mentioned principal forms, without possessing any structural peculiarity of sufficient importance to make us consider them as the representatives of a special type; these groups are therefore not of the same zoological value as the preceding, and in order to point out their aberrant nature, we shall designate them by names indicative at once of their principal affinities and their dependent character: *Pseudastreidæ* and *Pseudoturbinolidæ* for example.

Family I.
TURBINOLIDÆ.

Milne Edwards and Jules Haime, Recherches sur les Polypiers; Annales des Sciences Naturelles, 3me série, tom. ix, p. 211, 1848.

Corallum in general simple, never fissiparous, and multiplying by lateral gemmation in compound species. Interseptal loculi extending from the top to the bottom of the visceral chamber, and containing neither dissepiments, as in the Astreidæ, nor synapticulæ, as in the Fungidæ. *Walls* thin, lamellar, and imperforated. *Septa* highly developed, simple, compact, in general regularly granulated on each side, and never denticulated or lobulated at their apex. *Costæ* in general well marked and straight. No cœnenchyma in the compound Polypidoms.

First Tribe—CYATHININÆ.

Milne Edwards and J. Haime, loc. cit., p. 289, 1848.

Calicule presenting one or more rows of pali, placed between the columella and the septa.

§ 1. A single coronet of pali.

1. *Genus* Cyathina.

Caryophyllia, Stokes. Zool. Journ., vol. iii, p. 486, 1828.

Cyathina, Ehrenberg. Corall. des Rothen Meeres, p. 76, 1834; Milne Edwards and J. Haime, op. cit., p. 285.

Corallum simple, never gemmiparous, subturbinate and adherent. *Calice* circular or nearly so, with a broad but not very deep central fossula. *Columella* fasciculate, composed of a certain number (3 to 20) of vertical, narrow, and twisted lamellar processes, and terminated by a convex, crispate surface. *Pali* broad, entire, free in a considerable part of their length, and equally developed. *Septa* straight, broad, exsert, and forming six systems, which are in general unequally developed, and become in appearance much more numerous. *Costæ* straight, slightly prominent near the calice, more or less obsolete lower down, delicately granulated, and never armed with tubercles, crests, or spines.

Typical species, *Cyathina cyathus*, Ehrenb., loc. cit.; Milne Edwards and J. Haime, Ann. des Sc. Nat., 3me série, tom. ix, tab. iv, fig. 1.

2. *Genus* Cœnocyathus.

Milne Edwards and J. Haime, Ann. des Sc. Nat., 3me série, tom. ix, p. 297, 1848.

Corallum composite and adherent; the *corallites* sub-cylindrical, rather tall, segregate (united near their basis, but free in the greatest part of their length), and not grouped in rows. *Calice* circular; fossula not very deep. *Columella* composed of a few twisted, lamellar, vertical processes. *Pali* entire, equidistant from the centre, and similar in size. *Septa* rather broad, not projecting much above the walls, and forming four cycla, the last of which is incomplete in one of the six systems. *Costæ* distinct near the calice only, straight, flat, broad, and delicately granulated.

These Corals have great affinity to Cyathina, from which they differ principally by their gemmiparous mode of multiplication, and the permanent union of the young to the parent.

Typ. sp., *Cœnocyathus cylindricus*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 8.

3. *Genus* Acanthocyathus.

Milne Edw. and J. Haime, loc. cit., p. 292, 1848.

Corallum simple, free, subturbinate, slightly compressed, and subpedicellate. *Calice* more or less oval. *Columella* and *pali* as in Cyathina. *Septa* broad, exsert, and forming five cycla; systems unequally developed, so as to form sixteen groups. *Costæ* partly armed with crests or spines.

Typ. sp., *Acanthocyathus Grayi*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 2.

4. *Genus* Bathycyathus.

Milne Edw. and J. Haime, loc. cit., p. 294, 1848.

Corallum simple, adherent by a broad basis, tall, subturbinate, and slightly compressed. *Calice* subelliptical, with a broad and very deep fossula. *Columella* small and crispate. *Pali* narrow, feeble, entire, and closely united to the septa. *Septa* exsert, thin, closely set, and forming apparently twelve equally developed systems; five cycla, the last of which is more developed than the penultimate one, the septa of which are closely approximated towards the wall, or even cemented to those of the primary, secondary, and ternary cycla. *Costæ* very narrow, straight, unarmed, delicately granulated, and distinct down to the basis of the corallum.

Typ. sp., *Bathycyathus chilensis*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 5.

5. *Genus* Brachycyathus.

Milne Edw. and J. Haime, loc. cit., p. 295, 1848.

Corallum simple, extremely short, widening very rapidly, and becoming free in the adult state. *Calice* circular, and very slightly excavated. *Columella* very thick, fasciculate, and terminated by circular papillæ. *Pali* very broad, entire. *Septa* exsert, narrow, and forming four cycla; the systems equally developed, and apparently twelve in number. *Costæ* unarmed.

Typ. sp., *Brachycyathus Orbignyanus*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 6.

6. *Genus* Discocyathus.

Milne Edw. and J. Haime, loc. cit., p. 296, 1848.

Corallum simple, free, and discoidal. *Calice* circular and slightly convex. *Columella* formed by a single vertical lamina; its apex smooth and undivided. *Pali* free and corresponding to the septa of the antepenultimate cyclum. *Septa* very exsert, broad, and striated laterally near their apex. *Wall* horizontal, and covered with an *epitheca* presenting some concentric striæ.

Typ. sp., *Discocyathus Eudesii*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 7.

7. *Genus* Cyclocyathus.

Corallum simple, discoidal, and having the same characters as the preceding genus, except that the *columella* is fasciculate and papillous.

Typ. sp., *Cyclocyathus Fittonii*, nob.

§ 2. Pali of divers orders, forming two or more coronets.

8. *Genus* Trochocyathus.

Milne Edw. and J. Haime, loc. cit., p. 300, 1848.

Corallum simple, pediculate or sub-pediculate, but free in the adult state. *Calice* with a broad but not very deep fossula. *Columella* well developed, and composed of prismatic or twisted processes disposed fascicularly or in a single row. *Pali* well developed, entire, free on both edges, and differing in breadth according to the coronet to which they belong. *Septa* very exsert, broad, thick near the wall, striated laterally, and forming from four to six cycla. *Costæ* often armed.

Typ. sp., *Trochocyathus mitratus*, nob. (*T. mitratus* et *T. plicatus*, Milne Edw. and J. Haime, loc. cit., p. 303); *Turbinolia mitrata*, Goldfuss, op. cit., pl. xv, fig. 5; *Turbinolia plicata*, Michelotti, Specim. Zooph. dil., tab. ii, fig. 9.

9. *Genus* Leptocyathus.

Corallum presenting most of the characters of the preceding genus, from which it differs by its subdiscoid form, and its not showing any trace of adherence.

Typ. sp., *Leptocyathus elegans*, nob.

10. *Genus* Thecocyathus.

Milne Edw. and J. Haime, loc. cit., p. 317, 1848.

Corallum simple, very short, and adherent, at least when young. *Calice* circular, with the fossula shallow. *Columella* very large, fasciculate, formed by a great number of prismatic processes, and terminated by a flat papillous apex. *Pali* thick, narrow, short, and entire, those corresponding to the penultimate cyclum of septa the most developed. *Septa* not exsert, thick, closely set, and almost equally developed; systems equally developed. *Wall* covered by a complete *epitheca*, slightly striated transversely, and constituting around the calice a small projecting ring.

Typ. sp., *Thecocyathus tintinnabulum*, Milne Edw. and J. Haime, loc. cit., p. 317; *Cyathophyllum tintinnabulum*, Goldfuss, Petref. Germ., tab. xvi, fig. 6.

11. *Genus* Paracyathus.

Milne Edw. and J. Haime, loc. cit., p. 318, 1848.

Corallum simple, subturbinate, and having a broad adherent basis. *Calice* with a large but not very deep fossula. *Columella* very broad, terminated by a papillous surface, and formed by processes that appear to arise from the lower part of the inner edge of the septa. *Pali* in general lobulated at their apex, narrow, tall, and appearing also to proceed from the inferior part of the margin of the septa, their size diminishing as they approach nearer to the columella. *Septa* nearly equal, very slightly exsert, and closely set, their lateral surface strongly granulated, and presenting sometimes traces of imperfect dissepiments; four or five cycla; systems equally developed. *Costæ* nearly equal, straight, closely set, projecting very little, and delicately granulated.

Typ. sp., *Paracyathus procumbens*, Milne Edw. and J. Haime, loc. cit., tab. x, fig. 6.

12. *Genus* Heterocyathus.

Milne Edw. and J. Haime, loc. cit., p. 323, 1848.

Corallum simple, sub-cylindrical, extremely short, and adherent by a basis at least as broad as the calice, but appearing free, because in the adult state it imbeds in its tissue the small shell to which it is fixed. *Calice* circular, or nearly so, with a broad, deep fossula; *Columella* small, and composed of very slender vertical styli. *Pali* broad, thin, and denticulate. *Septa* very exsert, broad, thick, and covered with conical granulations arranged in radiate series; four or five cycla, the last of which is more developed than the penultimate one, and composed of septa that diverge from the older septa as they advance towards the centre of the visceral chamber. *Costæ* straight, thick, closely set, and strongly granulated.

Typ. sp., *Heterocyathus æquicostatus*, Milne Edw. and J. Haime, loc. cit., tab. x, fig. 8.

13. *Genus* Deltocyathus.

Milne Edw. and J. Haime, loc. cit., p. 325, 1848.

Corallum short, conical, free, and presenting no trace indicating its having been adherent when young. *Calice* circular, and almost flat. *Columella* multipartite. *Pali* highly developed, and very unequal, those of the penultimate circle the largest, and turned towards those of the antepenultimate row, so as to form with them a series of deltæ. *Septa* slightly exsert. *Costæ* straight, unequal, distinct down to the basis of the corallum, and strongly granulated, so as to assume a moniliform appearance.

Typ. sp., *Deltocyathus italicus*, Milne Edw. and J. Haime, op. cit., tab. x, fig. 11; *Stephanophyllia italica*, Michelin, Icon. Zooph., tab. viii, fig. 3.

14. *Genus* Tropidocyathus.

Milne Edw. and J. Haime, loc. cit., p. 326, 1848.

Corallum simple, free, presenting no trace of former adherence, compressed, and having at its basis a large, thick, transverse, vertical crest, or two projecting lobes, resembling wings, or the fins of sepia. *Calice* elliptic and arched, its small axis being much higher than its long axis; fossula not very deep. *Columella* oblong and multipartite. *Pali* entire; those corresponding to the penultimate cyclum of septa taller and broader than the others. *Septa* exsert; the six systems equally developed. *Costæ* well marked, especially at the upper part of the wall, and covered with small granulations.

Typ. sp., *Tropidocyathus Lessonii*, Milne Edw. and J. Haime, loc. cit.; *Flabellum Lessonii*, Michelin, in Guerin's Mag. de Zool., 1843, tab. vi.

15. *Genus* PLACOCYATHUS.

Milne Edw. and J. Haime, loc. cit., p. 327, 1848.

Corallum simple, pedicellate, and slightly compressed. *Columella* lamellar, with its apical margin straight. *Pali* thin, resembling lobes of the septa, and corresponding only to the septa of the penultimate and antipenultimate cycla; those facing the latter more developed than the others (a disposition which forms an exception to the common rule). *Septa* numerous, thin, broad, and slightly exsert. *Costæ* distinct from the top to the bottom of the walls, but projecting very little, nearly equal, and appearing to bifurcate towards the upper part of the corallum.

Typ. sp., *Placocyathus apertus*, Milne Edw. and J. Haime, loc. cit., tab. x, fig. 10.

Second Tribe—TURBINOLINÆ.

Milne Edw. and J. Haime, loc. cit., p. 235, 1848.

Corallum destitute of pali; the septa extending to the columella, or meeting in the centre of the visceral chamber.

§ 1. Wall naked, or having only an incomplete epitheca.

16. *Genus* TURBINOLIA.

Turbinolia (*in parte*), Lamarck, An. sans Vert., vol. ii, p. 359, 1816; *Turbinolia* (*in parte*), Ehrenberg, op. cit., p. 53, 1834; Dana, op. cit., p. 374; *Turbinolia*, Milne Edw. and J. Haime, loc. cit., p. 235, 1848.

Corallum simple, conical, straight, and presenting no trace of adherence. *Calice* circular. *Columella* styliform. *Septa* exsert, those of the last cyclum bent toward the neighbouring ones and united to them. *Costæ* lamellar, straight, entire, and very projecting; the intercostal grooves presenting a double series of small dimples, resembling pores.

Typ. sp., *Turbinolia sulcata*, Lamarck, Hist. Anim. sans Vert., vol. ii, p. 231; Cuvier and Brongniart, Géographie Minéral. des Envir. de Paris, tab. ii, fig. 3.

17. *Genus* SPHENOTROCHUS.

Milne Edw. and J. Haime, loc. cit., p. 240, 1848.

Corallum simple, presenting no trace of adherence, straight, and cuneiform. *Calice* elliptical. *Columella* lamellar, and occupying the great axis of the calice; its upper margin flexuous and bilobate. *Septa* broad, slightly exsert, and forming three cycla; apparently twelve systems in the adult. *Costæ* broad, not very prominent, in general crispate, or represented by series of papillous tubercles.

Typ. sp., *Sphenotrochus crispus*, Milne Edw. and J. Haime, loc. cit., p. 241; *Turbinolia crispa*, Lamarck, op. cit., vol. ii, p. 231; Milne Edwards, Atlas du Règne Animal de Cuvier, Zooph., pl. lxxxii, fig. 4.

18. *Genus* Platytrochus.

Milne Edw. and J. Haime, loc. cit., p. 246, 1848.

Corallum simple, straight, cuneiform, and presenting no trace of adherence. *Calice* elliptical. *Columella* fasciculate, and terminated by papillæ. *Septa* exsert, very broad, nearly equal, and very strongly granulated; three cycla; systems equally developed. *Costæ* of two sorts, those that occupy the middle of each side of the corallum enlarging as they ascend; the lateral ones larger and much broader at their bases than near the calice, so as to render the lateral edges of the corallum almost parallel.

Typ. sp., *Platytrochus Stokesii,* Milne Edw. and J. Haime, loc. cit. tab. vii, fig. 7; *Turbinolia Stokesii,* Lea, Contrib. to Geol., tab. vi, fig. 207.

19. *Genus* Ceratotrochus.

Milne Edw. and J. Haime, loc. cit., p. 248, 1848.

Corallum simple, subpedicellate, free in the adult state, and recurved towards its basis. *Calice* circular, or nearly so. *Columella* fasciculate, and highly developed. *Septa* straight, broad, and exsert. *Costæ* partly armed with spines, crests, or small lobular processes.

Typ. sp., *Ceratotrochus multiserialis,* Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 5; *Turbinolia multiserialis,* Michelotti, Spec. Zool. tab. ii, fig. 7.

20. *Genus* Discotrochus.

Milne Edw. and J. Haime, loc. cit., p. 251, 1848.

Corallum simple, discoidal, and presenting no trace of adherence. *Calice* circular, and almost flat. *Columella* fasciculate, and terminated by papillæ equal in size. *Septa* straight, very broad, and projecting but little laterally. *Wall* horizontal. *Costæ* straight and simple.

Typ. sp., *Discotrochus Orbignyanus,* Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 6.

21. *Genus* Desmophyllum.

Ehrenberg, op. cit., p. 75, 1834.

Corallum simple, and adherent by a broad basis. *Calice* with a very deep fossula. No *columella* (a character which distinguishes this group from all the preceding Turbinolinæ). *Septa* broad, very exsert, free almost all along their inner edge, and grouped in fasciculæ; those of the last cyclum taller than those of the penultimate cyclum, and cemented exteriorly to the older septa. *Costæ* distinct near the calice, but obsolete on the lower part of the wall, where there are only a few granulations.

Typ. sp., *Desmophyllum crista-galli,* Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 10.

§ 2. Wall completely covered by a pellicular epitheca.

22. *Genus* Flabellum.

Lesson, Illustr. de Zoologie, 1831; *Phyllodes*, Philippi, Neues Jahrbuch für Miner. Geol. 1841.

Corallum simple, compressed, and in general free in the adult state. *Calice* usually elliptic, very strongly arched in the direction of its long axis; fossula narrow, and very deep. *Columella* spurious, and formed by marginal trabiculæ of the septa; very little developed, or even quite rudimentary. *Septa* in general very numerous, appertaining in reality to six primitive systems, but forming in appearance a much greater number of systems; not projecting above the margin of the wall, and presenting laterally regular rows of well-developed granulations. *Walls* completely covered with a thin, slightly-striated epitheca, and in general armed laterally with long spiniform processes, corresponding with the direction of the long axis of the calice. No radiciform appendices.

Typ. sp., *Flabellum pavoninum*, Lesson, op. cit., pl. xiv.

23. *Genus* Placotrochus.

Milne Edw. and J. Haime, loc. cit., p. 282, 1848.

Corallum resembling much those of the preceding genus, but having a lamellar *columella.*

Typ. sp., *Placotrochus lævis*, Milne Edw. and J. Haime, loc. cit., tab. viii, fig. 15.

24. *Genus* Blastotrochus.

Milne Edw. and J. Haime, p. 282, 1848.

Corallum resembling those of the genus Flabellum, but gemmiparous; the young produced by buds placed along the lateral edges of the corallum, and becoming free by the progress of their development.

Typ. sp., *Blastotrochus nutrix*, Milne Edw. and J. Haime, loc. cit., tab. viii, fig. 14.

25. *Genus* Rhizotrochus.

Milne Edw. and J. Haime, loc. cit., p. 281, 1848.

Corallum simple, trochoid, and adherent by means of cylindrical radiciform appendices, which proceed from the wall, at different heights, and descend to embrace the extraneous body on which the Zoophyte lives. *Calice* almost oval, with a very narrow and very deep fossula. No *columella*. *Septa* extending to the middle of the visceral chamber, where they unite without presenting any trabiculæ.

Typ. sp., *Rhizotrochus typus*, Milne Edw. and J. Haime, loc. cit., tab. 8, fig. 16.

Aberrant Group.

PSEUDOTURBINOLIDÆ.

Corallum simple, with the loculi open and devoid of synapticulæ or dissepiments, as in Turbinolidæ, but having the septa represented by groups of three vertical laminæ, not adhering together, excepting near their external margin, where they are united by a common costa; a mode of structure, which is quite anormal in the whole order of Zoantharia.

Genus Dasmia.

Milne Edw. and J. Haime, op. cit., p. 328, 1848.

Corallum subturbinate, and appearing not to be free. *Septa* strongly granulated. *Costæ* thick, equal, not numerous, and separated by deep grooves.

Typ. sp., *Dasmia Sowerbyi*, Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 8.

Family II.

OCULINIDÆ.

Corallum composite, produced by gemmation, and presenting in general an abundant, compact cœnenchyma or common tissue, the surface of which is smooth, delicately striate near the calices, or slightly granular, but never echinulate. *Walls* of the corallites complete (that is to say, presenting no perforations), not distinct from the cœnenchyma, and increasing by their internal surface, so as to invade progressively the inferior part of the visceral cavity, and to fill it up more or less completely in old age. Loculi imperfectly divided by a few dissepiments; no synapticulæ. *Septa* entire, or having their upper edge slightly divided.

§ 1. Septa of various sizes, forming distinct cycla.

1. *Genus* Oculina.

(*Pars*) Lamarck, Hist. des An. sans Vert., t. ii, p. 283, 1816; Milne Edw. and J. Haime, Comptes rend. de l'Ac. des Sc., t. xxix, p. 68, 1849.

Corallum in general arborescent; gemmation irregular or affecting a spiral disposition; cœnenchyma highly developed; its surface smooth, excepting near the calices, where it presents slight radiating striæ. *Corallites* with the calice very deep; a *columella* well developed, papillose at its apex, and becoming compact towards its basis. *Pali* corresponding to all the septa, excepting those of the last cyclum. *Septa* almost entire, slightly exsert, and very unequally developed.

Typ. sp., *Oculina virginea*, Lamarck, An. sans Vert., p. 289; *Madrepora virginea*, Ellis and Sol., tab. xxxvi.

2. *Genus* Trymhelia.

Milne Edw. and J. Haime, Comptes rend. de l'Académie des Sciences, t. xxix, p. 68, 1849.

Corallum arborescent, differing from Oculina by the non-existence of a *columella*, and the great development of the *pali*, which are cemented together, so as to form a vertical tube.

Typ. sp., *Trymhelia eburnea*, Milne Edw. and J. Haime, loc. cit., p. 68.

3. *Genus* Cyathelia.

Milne Edw. and J. Haime, loc. cit., p. 68, 1849.

Corallum arborescent; gemmation terminal and regularly opposite. *Corallites* free to a considerable distance from the calice, which are grouped in a way similar to that of flowers constituting a dichotomous cyme. *Columella* large and papillose. *Pali* well developed. *Septa* entire, exsert, and strongly granulated.

Typ. sp., *Cyathelia axillaris*, nob.; *Madrepora axillaris*, Ellis and Solander, tab. xiii, fig. 5.

4. *Genus* Astrhelia.

Milne Edw. and J. Haime, loc. cit., p. 68, 1849.

Corallum in general arborescent, and resembling Oculina by its form and its mode of gemmation, but differing from the three preceding genera by the non-existence of *pali*. *Calice* with a deep central fossula. *Columella* septal; edges of the *septa* denticulated.

Typ. sp., *Astrhelia palmata*, nob.; *Madrepora palmata*, Goldfuss, tab. xxv, fig, 6.

5. *Genus* Synhelia.

Milne Edw. and J. Haime, loc. cit., p. 68, 1849.

Corallum arborescent, with thick branches; gemmation irregular. *Calices* very shallow, their border scarcely projecting above the surface of the cœnenchyma, and united by common striæ. *Columella* compact, styliform, and terminated by a small tubercle. *Septa* scarcely exsert.

Typ. sp., *Synhelia gibbosa*, nob.; *Lithodendron gibbosum*, Goldfuss, op. cit., tab. xxxvii, fig. 9.

6. *Genus* Acrhelia.

Milne Edw. and J. Haime, op. cit., p. 69, 1849.

Corallum arborescent, or forming a ramified cluster; gemmation pretty regularly spiral. Surface of the cœnenchyma smooth, excepting in the immediate vicinity of the calices, where slight traces of radiating costæ are perceptible. *Septa* extremely exsert, lanceolate, and entire; the principal ones uniting towards the lower part of their inner edge, without there being either a columella or pali in the centre of the visceral chamber.

Typ. sp., *Acrhelia Sebæ*, Milne Edw. and J. Haime, loc. cit., p. 69; Seba, Thes., vol. iii, tab. cxvii, fig. 5.

7. *Genus* Lophelia.

Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Corallum arborescent, segregate, with coalescent branches; no true cœnenchyma, but walls very thick; gemmation irregularly alternate and subterminal. *Calices* with a reverted lamellar border. *Septa* entire, exsert, and uniting at the bottom of the visceral chamber as in the preceding genus. No *columella* nor *pali*.

Typ. sp., *Lophelia prolifera*, nob.; Ellis and Sol., tab. xxxii, fig. 2; *Oculina prolifera*, Lamarck, An. sans Vert., vol. ii, p. 286.

8. *Genus* Amphelia.

Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Corallum arborescent, with coalescent branches, and well-developed cœnenchyma in aged parts; gemmation subterminal, regularly alternate. *Calice* deep. *Columella* rudimentary. *Septa* slightly exsert, entire, and small. No distinct *costæ*; the surface of the corallum smooth or very delicately striated.

Typ. sp., *Amphelia oculata*, nob.; *Madrepora oculata*, Esper, tab. xii.

9. *Genus* Diplhelia.

Corallum resembling Amphelia, but having a large *columella* and denticulated *septa*.

Typ. sp., *Diplhelia raristella*, nob. *Oculina raristella*, Defrance, Dict. des Sc. Nat., vol. xxxv, p. 356.

10. *Genus* Enallhelia.

D'Orbigny MSS.; Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Differs from Amphelia by the shallowness of the calices, a greater development of the septa, and the existence of long costal striæ.

Typ. sp., *Enallhelia compressa*, D'Orbigny; *Lithodendron compressum*, Goldfuss, op. cit., tab. xxxvii, fig. 11.

§ 2. Septa equally developed, and forming apparently a single cyclum.

11. *Genus* Axhelia.

Milne Edw. and J. Haime, Compt. rend., t. xxix, p. 69, 1849.

Corallum arborescent, with coalescent branches, and a well-developed cœnenchyma, the surface of which is entirely covered with sub-granulose striæ. *Calices* very shallow. *Columella* compact, very thick, and terminated by a rounded tubercle. No *pali*. *Septa* exsert, entire.

Typ. sp., *Axhelia myriaster*, nob.; *Oculina myriaster*, Valenciennes MSS., Catal. of the Museum of Nat. Hist. of Paris.

12. *Genus* Crypthelia.

Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Corallum arborescent, flabellate, and unifacial, all the corallites opening on one of the surfaces of the flabellum; surface of the branches quite smooth. *Calices* very prominent, pediculate, explanate, and folded in two. No *columella* nor *pali*.

Typ. sp., *Crypthelia pudica*, Milne Edw. and J. Haime, loc. cit., p. 69.

13. *Genus* Endhelia.

Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Corallum of the same general form as in the preceding genus, but with the corallites alternate on the branches, which are thick and coalescent. *Calices* immersed; their border not projecting, but armed with a tongue-shaped process. No *columella* nor *pali*.

Typ. sp., *Endhelia Japonica*, Milne Edw. and J. Haime, loc. cit., p. 69 (Mus. of Leyden).

14. *Genus* Stylaster.

Gray, Zool. Miscel., p. 36, 1831; *Allopora*, Ehrenb., Cor. Roth. Meeres, p. 147, 1834; Dana, op. cit., p. 693, 1846; Milne Edw. and J. Haime, loc. cit., p. 69, 1849.

Corallum arborescent and subflabellate; cœnenchyma highly developed, smooth, and presenting certain excrescences or tubercles, the nature of which is problematic. *Calices* rare and not projecting much. Neither *columella* nor *pali*.

Typ. sp., *Stylaster rosea*, Gray, loc. cit.; *Oculina rosea*, Lamarck, op. cit., t. xi, p. 287; Esper., tab. xxxvi.

Transitional Group.
PSEUDOCULINIDÆ.

Corallum composite, with a highly developed, spongy, or cellulose, echinulate, dermic, cœnenchyma. Costal apparatus rudimentary. Walls imperforate, and never invading the visceral cavity. Septal apparatus well developed; dissepiments few in number.

This small group participates of the characters belonging to the *Oculinidæ* and the *Astreidæ*, but differs essentially from both. It does not, however, present any important structural peculiarity, and does not appear to be derived from a special zoological type.

1. *Genus* Madracis.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., t. xxix, p. 70, 1849.

Corallum arborescent; cœnenchyma almost compact, and highly echinulated. *Calices* unarmed. *Columella* styliform. *Septa* exsert and equally developed.

Typ. sp., *Madracis asperula*, Milne Edw. and J. Haime, loc. cit., p. 70; *Dentipora asperula*, Gray, MSS. British Museum.

2. *Genus* Stylophora.

Schweigger, Beobacht. auf Natur., t. v, 1819; *Sideropora* and *Stylopora*, Blainville, Manuel d'Actinologie, p. 348, 1830; *Sideropora*, Milne Edw. and J. Haime, loc. cit., p. 70, 1849.

Corallum arborescent; cœnenchyma sub-compact, with a granulated surface. *Calices* armed with a labial process near the upper part of their margin. *Columella* styliform.

Typ. sp., *Stylophora pistillaris*, Schweigger, loc. cit.; *Madrepora pistillaris*, Esper., tab. lx.

3. *Genus* DENDRACIS.

Milne Edw. and J. Haime, Comp. rend., t. xxix, p. 70, 1849.

Corallum arborescent; cœnenchyma almost compact, with its surface granulated. *Calices* sub-mammiform. No *columella*. *Septa* not exsert, or only very slightly so; nearly equal.

Typ. sp., *Dendracis Gervillii*, nob.; *Madrepora Gervillii*, Defrance, Dict. des Sc. Nat., vol. xxviii, p. 8; Michelin, Icon., Zooph., pl. xlix, fig. 8.

4. *Genus* ARÆACIS.

Milne Edw. and J. Haime, loc. cit., p. 70, 1849.

Corallum massive; cœnenchyma spongy, with its surface echinulate. *Calices* with a thin projecting margin. No *columella*. *Septa* unequally developed, entire.

Typ. sp. *Aræacis sphæroidalis*, nob.; *Astrea sphæroidalis*, Michelin, pl. xliv, fig. 9.

Family III.

ASTREIDÆ.

Dana, Exploring Expedition, Zooph., p. 194, 1846.

Corallum composite or simple, circumscribed by imperforated walls, and often increasing by fissiparity. Corallites becoming tall by the progress of their growth; each individual or series of individuals well defined, and separated from the others by perfect walls. Cœnenchyma not existing, or being formed either by the development of the costæ and their dissepiments, or by the epithecal tissue alone, and not forming a compact mass as in the Oculinidæ. The visceral chamber never obliterated inferiorly by the growth of the walls, but subdivided and more or less completely closed up by the interseptal dissepiments, which are in general very abundant; never any synapticulæ like those of the Fungidæ.

First Tribe—EUSMILINÆ.

Septa completely developed and entire (that is to say, with their apical margin neither lobate nor denticulate). *Costæ* always unarmed. *Columella* often compact, or even styliform.

Section I.—EUSMILINÆ PROPRIÆ.

Corallum simple or composite, and in that case formed by distinct corallites, affecting an arborescent disposition, fasciculate, or presenting a linear arrangement; free laterally, at least in a great part of their length, and never having their calices blended together. Reproduction usually fissiparous in the compound species.

1. *Genus* Cylicosmilia.

Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, t. x, p. 232, 1848.

Corallum simple, adherent. *Columella* well developed, and of a spongy structure. *Septa* thin, slightly exsert, covered laterally with small granulations, and closely set. *Dissepiments* very abundant. *Wall* thin, with a rudimentary epitheca. *Costæ* simple, not ramified, and distinct down to the basis of the corallum.

Typ. sp., *Cylicosmilia altavillinsis*, Milne Edw. and J. Haime, loc. cit., p. 233 ; *Caryophyllia altavillinsis*, Defrance; Michelin, Icon. Zooph., tab. lxxiv, fig. 2.

2. *Genus* Placosmilia.

Milne Edw. and J. Haime, loc. cit., p. 233, 1848.

Corallum simple, compressed, free, and subpediculate. *Calice* more or less elliptical. *Columella* lamellar. *Septa* numerous, closely set, slightly exsert, and not much granulated; systems apparently very numerous. *Dissepiments* abundant. *Wall* naked, or with a rudimentary epitheca. *Costæ* simple, not ramified, and distinct from the basis of the corallum.

Typ. sp., *Placosmilia cymbula*, Milne Edw. and J. Haime, loc. cit., p. 234 ; *Turbinolia cymbula*, Michelin, Icon., pl. lxvii, fig. 1.

3. *Genus* Trochosmilia.

Milne Edw. and J. Haime, loc. cit., p. 236, 1848.

Corallum simple, subpedicellate or adherent. *Calice* nearly horizontal. No *columella*. *Septa* meeting in the centre of the visceral chamber, numerous, and closely set; systems apparently very numerous. *Dissepiments* abundant. *Wall* naked, or with a rudimentary epitheca. *Costæ* simple, granulated, delicate, usually distinct from the basis, and never ramified.

Typ. sp., *Trochosmilia Faujasii*, Milne Edw. and J. Haime, loc. cit., tab. v, fig. 6.

4. *Genus* Parasmilia.

Milne Edw. and J. Haime, loc. cit., p. 243, 1848.

Corallum simple, adherent or pedicellate, tall, subturbinate, and presenting in general indications of an intermittent growth. *Calice* nearly circular; fossula not very deep. *Columella* spongy. *Septa* exsert, very granular laterally, and arched at their apex. *Dissepiments* not abundant, and existing only in the inferior part of the loculi. *Wall* naked, or with a rudimentary epitheca. *Costæ* straight, simple, not ramified, somewhat granulated, and in general projecting more near the calice than in the lower part of the coral.

Typ. sp., *Parasmilia centralis*, Milne Edw. and J. Haime, loc. cit.; *Madrepora centralis*, Mantell, Geol. of Sussex, tab. xvi, figs. 2, 4.

5. *Genus* Cœlosmilia.

Differs from Parasmilia by not having any rudiments of a columella.

Typ. sp., *Cœlosmilia poculum; Parasmilia poculum*, Milne Edw. and J. Haime, loc. cit., tab. v, fig. 5.

6. *Genus* Lophosmilia.

Milne Edw. and J. Haime, loc. cit., p. 246, 1848.

Corallum simple, subturbinate, adherent. *Calice* almost circular. *Columella* lamellar, small. *Septa* very exsert, unequal; their apical margin highly arched, and their sides granular; the six systems equally developed. *Wall* naked. *Costæ* simple, and but slightly marked; growth not intermittent.

Typ. sp., *Lophosmilia rotundifolia*, Milne Edw. and J. Haime, loc. cit., tab. v, fig. 3.

7. *Genus* Diploctenium.

Goldfuss, Petref. Germ., p. 50, 1826-30.

Corallum simple, extremely compressed, flabelliform, free, but retaining a thick peduncle. *Calice* representing a very long ellipse, arched so strongly that the extremities of its long axis descend much below the level of its small axis; fossula very narrow, very long, and shallow. No *columella*. *Septa* extremely numerous, nearly equal, thin, very closely set, and slightly exsert. *Dissepiments* simple and numerous. *Walls* naked. *Costæ* extremely numerous, narrow, crowded, nearly equal, distinct from the basis, and dichotomosing, or even dividing into three branches as they rise.

Typ. sp., *Diploctenium lunatum*, Michelin, Icon. Zooph., tab. lxv, fig. 8; *Madrepora lunata*, Bruguière, Journ. d'Hist. Nat., vol. i, tab. xxiv, figs. 5, 6.

8. *Genus* Montlivaltia.

Lamouroux, Exposit. Méthod. des Genres de Polypiers, p. 78; Milne Edw. and J. Haime, loc. cit., p. 250.

Corallum simple, adherent, or sub-pedicellate. No *columella*. *Septa* exsert, in general numerous and crowded, very broad, and forming apparently twelve or more cycla. *Wall* covered by a highly-developed membraniform epitheca; growth not intermittent.

Typ. sp., *Montlivaltia caryophyllata*, Lamouroux, op. cit., tab. lxxix, figs. 8, 9, 10; Michelin, op. cit., tab. liv, fig. 2.

9. *Genus* Peplosmilia.

Corallum resembling Montlivaltia, but having a large, lamelliform columella.

Typ. sp., *Peplosmilia Austenii*, nob.

10. *Genus* Axosmilia.

Milne Edw. and J. Haime, loc. cit., p. 261, 1848.

Corallum simple, free in the adult state, tall, turbinate. *Calice* circular; fossula large and deep. *Columella* styliform, large, and slightly compressed. *Septa* neither exsert nor crowded, delicately granulated, and all, excepting those of the youngest cyclum, cemented to the columella; loculi deep. *Walls* entirely covered by a membraniform epitheca, presenting strong transverse folds, and extending to the edge of the calice.

Typ. sp., *Axosmilia extinctorium,* Milne Edw. and J. Haime, loc. cit.; *Caryophyllia extinctorium,* Michelin, op. cit., tab. ix, fig. 3[a].

11. *Genus* Eusmilia.

Milne Edw. and J. Haime, loc. cit., p. 262, 1848.

Corallum composite, cespitose, with dichotomous or trichotomous branches, and a stem that does not thicken much by the progress of age. *Corallites* multiplying by fissiparity, becoming rapidly segregate, and not remaining disposed in series at their calicular extremity. *Calices* rather irregular in form, but in general nearly circular; fossula deep. *Columella* of a loose lamello-spongiate texture. *Septa* exsert, broad, thin, straight, not crowded, with their apex strongly arched, and their surface almost smooth. *Dissepiments* well formed, but not very abundant. *Walls* naked or covered inferiorly by a slight pellicular epitheca. *Costæ* indistinct towards the basis of the corallites, but becoming sub-cristiform near the calice.

Typ. sp., *Eusmilia fastigiata,* Milne Edw. and J. Haime, loc. cit., tab. v, fig. 1; *Madrepora fastigiata,* Pallas, Eleuch. Zooph., p. 301.

12. *Genus* Aplosmilia.

D'Orbigny MSS.

Corallum composite, and having the characters of Eusmilia, excepting that the *columella* is lamellar.

Typ. sp., *Aplosmilia aspera,* D'Orbigny MSS.; *Lobophyllia aspera,* Michelin, Icon., tab. xx, fig. 4; *Eusmilia* (?) *aspera,* Milne Edw. and J. Haime, loc. cit., p. 266.

13. *Genus* Leptosmilia.

Milne Edw. and J. Haime, loc. cit., p. 267, 1848.

Corallum composite, cespitose, fissiparous, and presenting the same general disposition as in the preceding genus. No *columella. Septa* extremely thin, crowded, broad, very slightly exsert, with their apex slightly arched, and their lateral surfaces sub-glabrous. *Dissepiments* very abundant. *Walls* very thin, plain towards the basis, and costulate near the calices.

Typ. sp., *Leptosmilia ramosa,* Milne Edw. and J. Haime, loc. cit., tab. vi, fig. 1.

14. *Genus* Thecosmilia.

Milne Edw. and J. Haime, loc. cit., p. 270, 1848.

Corallum composite, cespitose, fissiparous, and affecting the same general disposition as in the two preceding genera. No *columella. Septa* closely set, not remarkably thin, slightly exsert, and granulate. *Walls* covered with a strong epitheca, reaching almost to the margin of the calices.

Typ. sp., *Thecosmilia trichotoma*, Milne Edw. and J. Haime, loc. cit.; *Lithodendron trichotomum*, Goldfuss, Petref. Germ., tab. xiii, fig. 6.

15. *Genus* Barysmilia.

Milne Edw. and J. Haime, loc. cit., p. 273, 1848.

Corallum composite, increasing by fissiparity, and forming a very thick stem, on the apex of which the corallites become distinct, and are disposed in transverse series. *Columella* rudimentary or not existing. *Septa* closely set. *Walls* very thick, naked, and covered with delicate costal lines, which are nearly equal and granulate.

Typ. sp., *Barysmilia Cordieri*, Milne Edw. and J. Haime, loc. cit., tab. v, fig. 4.

16. *Genus* Dendrosmilia.

Milne Edw. and J. Haime, loc. cit., p. 274, 1848.

Corallum composite, somewhat arborescent, and increasing by lateral gemmation. *Corallites* with large *septa*, and a spongious *columella.*

Typ. sp., *Dendrosmilia Duvaliana*, Milne Edw. and J. Haime, loc. cit., p. 274.

17. *Genus* Stylosmilia.

Milne Edw. and J. Haime, loc. cit., p. 275, 1848.

Corallum composite, fasciculate, and increasing by lateral gemmation. *Corallites* tall, with a small number of thick *septa*, and a styliform *columella. Walls* thick, with obsolete *costæ.*

Typ. sp., *Stylosmilia Michelinii*, Milne Edw. and J. Haime, loc. cit., p. 275, pl. vi, figs. 2, 2[a].

18. *Genus* Placophyllia.

D'Orbigny MSS.

Corallum composite, segregate, and increasing by gemmation, which is almost basal. *Corallites* cylindrical and low. *Columella* well developed. *Septa* probably entire. *Walls* completely covered with a membraniform epitheca, presenting thick transverse folds.

Typ. sp., *Placophyllia dianthus*, D'Orbigny MSS.; *Lithodendron dianthus*, Goldfuss, Petref. Germ., tab. xiii, fig. 8.

Section II.—EUSMILINÆ CONFLUENTES.

Corallum composite, and presenting no separation between the corallites, united in rows, so as to assume a meandriform disposition; multiplication essentially fissiparous.

19. *Genus* Ctenophyllia.

Dana, Zoophytes, p. 169, 1846.

Corallum pedunculate, but increasing very little by its basis, and terminated by a large oval, almost flat, calicular surface; the different series of corallites intimately united together by means of their common walls, and without there being in general any cœnenchyma; the gyri or calicular grooves very long, and the mural ridges thin. *Columella* lamellar, and almost uninterrupted from one end of the gyrus to the other. In general, some traces of *pali*. *Septa* rather closely set, slightly exsert, and delicately granulated. *Dissepiments* very abundant, arched, and oblique; sometimes simple, but in general producing a vesicular mass. The common epitheca rudimentary, and covering only the inferior part of the common exterior walls, in the upper part of which are *costæ*, nearly equal, and more or less cristiform near the margin of the calicular surface.

Typ. sp., *Ctenophyllia mæandrites*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, p. 277; *Meandrina pectinata*, Lamarck; *Madrep. mæandrites*, Solander and Ellis, Zooph., tab. xlviii, fig. 1.

20. *Genus* Dendrogyra.

Ehrenberg, Corall. des Roth. Meeres, p. 100, 1834.

Corallum composite, having the form of a thick, massive, vertical column, in which the corallites are placed perpendicularly to the axis, and constitute very tortuous gyri, completely united by their walls; mural ridges broad, flat, and compact; grooves shallow. *Columella* highly developed, and formed by a series of very compact, enlarged processes. *Septa* very thick and closely set. *Dissepiments* large, but not crowded.

Typ. sp., *Dendrogyra cylindrus*, Ehrenb., op. cit.; Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, Zool., t. x, pl. vi, fig. 9.

21. *Genus* Rhipidogyra.

Milne Edw. and J. Haime, loc. cit., p. 281, 1848.

Corallum composed of a single series of corallites and constituting a flabelliform or tall tortuous mass, the lateral walls of which are always free from top to bottom. *Columella* lamellar, but almost rudimentary. *Septa* exsert and crowded. *Dissepiments* abundant. *Costæ* delicate, in general subcristate near the margin of the calice. No *epitheca*, or only a rudimentary one.

Typ. sp., *Rhipidogyra flabellum*, Milne Edw. and J. Haime, loc. cit.; *Lobophyllia flabellum*, Michelin, Icon., tab. xviii, fig. 1.

22. *Genus* Pachygyra.

Milne Edw. and J. Haime, loc. cit., p. 468, 1848.

Corallum adherent by a very thick peduncle; gyri with a narrow calicular groove, and united by a very broad mass of dense cœnenchyma. *Columella* lamellar. *Septa* crowded. *Costæ* delicate and granulated; little or no epitheca.

Typ. sp., *Pachygyra labyrinthica*, Milne Edw. and J. Haime, loc. cit.; *Lobophyllia labyrinthica*, Michelin, Icon., pl. lxvi, fig. 3.

23. *Genus* Plerogyra.

Milne Edw. and J. Haime, loc. cit., p. 284, 1848.

Corallum composed of long, thick, slightly ramified gyri, united laterally by their lower part, and free only near the calicular margin. No *columella*. *Septa* exsert, and broad; interseptal loculi very broad, and almost entirely filled up with large vesicular dissepiments, constituting a cellular mass. *Walls* presenting some *costal* striæ near the calicular margin, but covered in all the other parts by a vesicular structure, which becomes highly developed between the gyri.

Typ. sp., *Plerogyra laxa*, Milne Edw. and J. Haime, loc. cit., tab. vi, fig. 8.

Section III.—EUSMILINÆ AGGREGATÆ.

Corallum composite and massive, in which the corallites are not arranged in series, and although remaining quite distinct, are united together by their walls, by a costal cœnenchyma, or by mural annular expansions.

This group corresponds to the division of the *Astreinæ aggregatæ* of the second tribe of this family, and constitutes with these the great genus *Astrea* of most authors.

24. *Genus* Stylina.

Lamarck, Hist. des Anim. sans Vert., t. ii, p. 220, 1816; *Fascicularia*, Lamarck, Extrait du Cours, 1812.

Corallum glomerate, astreiform. *Corallites* very tall, united by means of the costal system and its dissepiments, and having the appearance of small truncate cones at their upper end. *Calices* circular, with their margin free; usually distant from each other. *Columella* styliform and projecting. *Septa* exsert, arched at their apex; in general not numerous, and forming as usual six systems. No *pali*. *Walls* thick.

Typ. sp., *Stylina echinulata*, Lamarck, loc. cit.; Milne Edw., Atlas du Règne Animal de Cuvier, Zooph., pl. lxxxv, fig. 3.

25. *Genus* Stylocœnia.

Milne Edw. and J. Haime, An. des Sc. Nat., 3me série, t. x, p. 298, 1848.

Corallum having the form of a very thick sheet, convex or bent in different ways; covered inferiorly by a finely-striated epitheca; and increasing by marginal gemmation. *Corallites* united by their walls, which are thin and prismatic. *Calices* polygonal, their margins simple, and bearing at their angles small, columnar, grooved processes. *Columella* styliform, projecting. *Septa* very thin, not exsert, nor numerous, and forming six systems.

Typ. sp., *Stylocœnia emarciata*, Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 2; *Astrea emarciata*, Lamarck, op. cit., t. ii, p. 266.

26. *Genus* Astrocœnia.

Milne Edw. and J. Haime, loc. cit., p. 296, 1848.

Corallum very dense, and not bearing columnar processes, as in the preceding genus. *Calices* polygonal. *Columella* styliform, not projecting much. No *pali*. *Septa* thick; apparently eight or ten systems, two or four of the secondary septa being as much developed as the six primary ones. *Walls* thick and united, as in Stylocœnia.

Typ. sp., *Astrocœnia Orbignyana*, Milne Edw. and J. Haime, loc. cit., p. 297; *Astrea formosissima*, Michelin, Icon., pl. lxxii, fig. 9.

27. *Genus* Stephanocœnia.

Milne Edw. and J. Haime, loc. cit., p. 300, 1848.

Corallum glomerulate; the *corallites* united by their walls, which are thick and compact; gemmation lateral and marginal. *Calices* subpolygonal. *Columella* styliform, and not projecting much. A coronet of *pali*, corresponding to the septa of the older cycla. *Septa* scarcely exsert, granulated on their sides, and forming six systems, which are in general equally developed.

Typ. sp., *Stephanocœnia intersepta*, Milne Edw. and J. Haime, loc. cit., tab. vii, fig. 1; *Astrea intersepta*, Lamarck, Anim. sans Vert., t. ii, p. 266.

28. *Genus* Phyllocœnia.

Milne Edw. and J. Haime, loc. cit., p. 469, 1848.

Corallum glomerate, astreiform. *Corallites* united by the costæ and the exotheca, which are highly developed. *Calices* with a free margin, slightly elevated. No *columella*, or only traces of a rudimentary one. No *pali*. *Septa* very broad, exsert, and forming six systems; gemmation lateral.

Typ. sp., *Phyllocœnia irradians*, Milne Edw. and J. Haime, loc. cit.; *Astrea radiata*, Michelin, pl. xii, fig. 4.

29. *Genus* Dichocœnia.

Milne Edw. and J. Haime, loc. cit., p. 305, 1848.

Corallum glomerate, astreiform. *Corallites* united by a very abundant and dense costal cœnenchyma, the upper surface of which is subgranulate. *Calices* circular or elliptical, with a projecting margin. *Columella* small. *Pali* corresponding to most of the *septa*, which are exsert and granulated. Multiplication fissiparous.

Typ. sp., *Dichocœnia porcata*, Milne Edw. and J. Haime, loc. cit.; *Astrea porcata*, Lamarck, Anim. sans Vert., t. ii, p. 260.

30. *Genus* Heterocœnia.

Milne Edw. and J. Haime, loc. cit., p. 308, 1848.

Corallum resembling that of Sarcinula, but differing from all the preceding genera by the small number and the unequal development of the *septa*, which form in appearance only three systems. In general, one of the three large primary septa is more developed than the others, and remains sometimes alone in fossil species. *Calices* circular, with a projecting free margin. No *columella* nor *pali*. *Septa* exsert; cœnenchyma abundant, of a foliate structure, and having a granular surface.

Typ. sp., *Heterocœnia exiguis*, Milne Edw. and J. Haime, loc. cit., tab. ix, fig. 13; *Lithodendron exigue*, Michelin, Icon., Zooph. tab. lxxii, fig. 7.

Section IV.—EUSMILINÆ IMMERSÆ.

Corallum composite. *Corallites* disposed as in the preceding Section, but imbedded in an epithecal cellular tissue, and not united by costal laminæ or mural annular expansions; gemmation lateral and basal; reproduction never fissiparous.

31. *Genus* Sarcinula.

(*In parte*) Lamarck, Hist. des Anim. sans Vert., t. ii, p. 222, 1816; *Anthophyllum*, Ehrenb., op. cit., p. 89, 1834.

Corallum fasciculate, and almost massive. *Corallites* tall, free towards their upper end, which projects more or less above the surface of the cellular exotheca. *Walls* strong, with costæ but little developed. No *columella*, or only a rudimentary one. *Septa* very exsert. *Dissepiments* in general simple, and not abundant.

Typ. sp., *Sarcinula organum*, Lamarck, loc. cit., p. 223; Milne Edw., Atlas du Règne Animal de Cuvier, Zooph., pl. lxxxv, fig. 1.

Second Tribe—ASTREINÆ.

Septa having their upper edge lobulated, dentate, or armed with spines, and often imperfect near their inner edge. *Costæ* also spinulous, dentate or crenulate, but never forming simple cristæ, as is often the case in Eusmilinæ. *Columella* in general spongy, rarely lamellar, and never styliform. Corallum in general massive.

Section I.—ASTREINÆ HIRTÆ.

Corallum simple or composite, and then formed by perfectly delineated corallites, produced by fissiparity, or by calicular gemmation.

32. *Genus* Caryophyllia.

(*In parte*) Lamarck, Hist. des Anim. sans Vert., t. ii, p. 224, 1816; Milne Edw. and J. Haime, Comptes rend. de l'Ac. des Sc., t. xxvii, p. 491, 1848.

Corallum simple, and adherent by a broad basis. *Calice* circular, or almost so. *Columella* well developed, spongy, and composed of twisted lamellæ, that advance one over the other. *Septa* broad, exsert, numerous, close set, and armed with spines, the size of which augments from the centre of the calice towards its margin. *Dissepiments* vesicular and abundant. *Wall* presenting *costæ*, formed by a series of spines; epitheca rudimentary.

Typ. sp., *Caryophyllia lacera*, Milne Edw. and J. Haime, An. des Sc. Nat., 3me série, t. xi, p. 237; *Madrepora lacera*, Esper, Pflanz., tab. xxv, fig. 2.

33. *Genus* Circophyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 491, 1848.

Corallum simple, subturbinate. *Columella* large and papillose. *Septa* broad, numerous, exsert, with their calicular edge divided in small obtuse lobes. *Dissepiments* abundant, vesicular, and arranged in spiral concentric lines. *Costæ* thin, nearly equal, simple, and delicately granulated.

Typ. sp., *Circophyllia truncata*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, t. x, tab. viii, fig. 3; *Anthophyllum truncatum*, Goldfuss, Petref., tab. xiii, fig. 9.

34. *Genus* Thecophyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 491, 1848.

Corallum simple, adherent, or sub-pedicellate. *Calice* circular, or nearly so. No *columella*. *Septa* very broad, in general slightly exsert, numerous, and armed with nearly equal spiniform teeth. *Wall* covered with a thick, membraniform epitheca.

Typ. sp., *Thecophyllia decipiens*, Milne Edw. and J. Haime, Ann., t. xi, p. 241; *Anthophyllum decipiens*, Goldfuss, Petref., tab. lxv, fig. 3.

35. *Genus* Lobophyllia.

(*Pars*) Blainville, Dict. des Sc. Nat., t. lx, 1830; Milne Edw. and J. Haime, Ann., t. xi, p. 244.

Corallum composite, tall, and increasing by fissiparity. *Corallites* segregate, or united in series, which are always simple, and free laterally. *Calice* with a deep fossula. *Columella* spongy. *Septa* numerous, exsert, very granular, and armed with strong marginal teeth, the most external of which are the largest; loculi shallow. *Walls* striated longitudinally, and armed with spines; epitheca rudimentary.

§ 1. *Lobophyllia cymosæ*. Typ. sp., *Lobophyllia angulosa*, Blainv.; *Caryophyllia angulosa*, Lamarck.—§ 2. *Lobophyllia gyrosæ*. Typ. sp., *Lobophyllia multilobata*, Milne Edw. and J. Haime, loc. cit., p. 250; *Fungus marinus*, Seba, Rer. Nat. Thes., vol. iii, tab. cix, No. 4.

36. *Genus* Symphyllia.

Milne Edw. and J. Haime, Comptes rend. de l'Ac. des Sc., t. xxvii, p. 491, 1848.

Corallum composite, massive, short, and increasing by fissiparity. *Corallites* having distinct calicula, but united in linear series, which are cemented together laterally. The other characters as in the preceding genus.

Typ. sp., *Symphyllia sinuosa*, Milne Edw. and J. Haime, Ann. des Sc. Nat., vol. x, tab. viii, fig. 7.

37. *Genus* Mycetophyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 491, 1848.

Corallum massive, composed of corallites intimately united in series by their walls, which are very thin. *Exterior common walls* lobulate, spinulous, and presenting but rudiments of an epitheca. Calicular grooves, very shallow. No *columella*, or only rudiments of one. *Septa* not numerous, scarcely exsert, strongly dentate, and confluent. *Dissepiments* vesicular, large, and abundant; loculi closed almost to their top.

Typ. sp., *Mycetophyllia Lamarckiana*, Milne Edw. and J. Haime, Ann. des Sc. Nat., vol. x, tab. viii, fig. 6.

38. *Genus* Eunomia.

Lamouroux, Exposit. Méthod. des Polypiers, p. 83, 1824.

Corallum cespitose, fissiparous; *Corallites* segregate, tall, cylindroid. *Calices* almost circular. *Columella* rudimentary. *Septa* not very numerous. *Walls* covered with a complete membraniform epitheca, strongly striated transversely.

Typ. sp., *Eunomia radiata*, Lamouroux, op. cit., p. 83; *Lithodendron Eunomia*, Michelin, Icon., pl. xxxiv, fig. 6; *Eunomia lævis*, Milne Edw. and J. Haime, Ann., t. xi, p. 260; *Lithod. læve*, Michelin, loc. cit., pl. xix, fig. 8.

39. *Genus* Calamophyllia.

Calamites, Guettard, Mém. sur les Sc. et les Arts, vol. ii, p. 404, 1770; *Calamophyllia*, Blainville, Dict. des Sc. Nat., t. lx, p. 312, 1830.

Corallum fasciculate, cespitose, and dichotomous. *Corallites* very long and segregate. *Calices* not very deep. *Columella* rudimentary or not existing. *Septa* thin, numerous, crowded, and armed with apical teeth, the size of which increases from the margin towards the centre of the calice. *Dissepiments* very oblique and crowded. *Walls* delicately striated, devoid of epitheca, but presenting at certain points circular foliaceous expansions.

Typ. sp., *Calamophyllia striata*, Blainville, Dict. des Sc. Nat., pl. cccxii; *Calamite strié*, Guettard, Mém. sur les Sc., t. iii, pl. xxxiv.

40. *Genus* Dasyphyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 492, 1848.

Corallum fasciculate, cespitose, and dichotomous. *Corallites* very long and segregate. *Columella* spongy. *Septa* thin, slightly exsert, and armed with apical teeth, the size of which is much greater near the columella than towards the margin of the calice.

Typ. sp., *Dasyphyllia echinulata*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, t. x, pl. viii, fig. 5.

41. *Genus* Colpophyllia.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., t. xxvii, p. 492, 1848.

Corallum sub-glomerate, remarkably light and fragile, composed of series of corallites cemented together laterally, without their respective walls ceasing to be distinct on the calicular surface, where they are parallel, very thin, and constitute a double ridge on each side of the calicular trench. *Calices* individualized by the direction of their septa. *Columella* rudimentary, or not existing. *Septa* extremely thin, broad, and slightly exsert; their apical edge armed with small delicate teeth, and emarginate near the middle. *Dissepiments* very abundant, and closing up the loculi almost to the margin of the calice, and forming a vesicular mass. *Common exterior walls* of the corallum or plate presenting small, lamellar, nearly equal, denticulate costæ; *epitheca* rudimentary.

Typ. sp., *Colpophyllia gyrosa*, Milne Edw. and J. Haime, Ann., t. xi, p. 266; *Madrepora gyrosa*, Ellis and Solander, op. cit.; tab. li, fig. 2; *Manicina gyrosa*, Ehrenberg, op. cit.; *Mussa gyrosa*, Dana, op. cit., p. 186.

42. *Genus* Oulophyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 492, 1848.

Corallum composed of a series of corallites, intimately united by their lateral walls, which constitute simple ridges between the trenches formed by the aggregate calices. *Columella* spongy, and in general not highly developed. *Septa* thin, slightly exsert, closely set, and armed with numerous long, sharp, apical teeth, the size of which augments towards the centre of the corallite. *Common exterior walls* sometimes covered with a thin epitheca; multiplication fissiparous.

Typ. sp., *Oulophyllia Stokesiana*, Milne Edw. and J. Haime, Ann. des Sc. Nat., vol. x, tab. viii, fig. 10.

43. *Genus* Latomeandra.

D'Orbigny MSS.; Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, t. xi, p. 270, 1849.

Corallum having most of the characters of the preceding genus, but increasing by calicular gemmation. The gyri in general short, the marginal ones distinct, and not forming a common rim. No epitheca.

Typ. sp., *Latomeandra plicata*, Milne Edw. and J. Haime, loc. cit., p. 271; *Lithodendron plicatum*, Goldfuss, Petref. Germ., tab. xiii, fig. 5.

44. *Genus* Tridacophyllia.

Blainville, Dict. des Sc. Nat., vol. lx, p. 327, 1830.

Corallum short, and composed of corallites, arranged in series intimately united by their lateral walls, which, instead of forming a simple ridge as in the preceding genera, constitute very tall, foliaceous expansions, variously twisted, and terminated by a sub-crenulate margin; the calicular trenches broad, very deep, and winding. *Columella* quite rudimentary, but the calicular centres very distinct. *Septa* projecting very little, thin, nearly equal, and serrate. *Dissepiments* abundant, very oblique, convex, and forming long vesicules. *Plate* or exterior surface of the common wall of the corallum covered with lamellar costæ, which extend from the basis of the mass, project slightly, and are irregularly denticulate.

Typ. sp., *Tridacophyllia lactuca*, Blainville, loc. cit.; *Concha fungiformis*, Seba, Thes., v. iii, tab. cxxxix, No. 10; *Pavonia lactuca*, Lamarck, An. sans Vert., vol. ii, p. 239; *Manicina lactuca*, Ehrenberg, op. cit., p. 103.

45. *Genus* Trachyphyllia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 492, 1848.

Corallum short, increasing by fissiparity, and composed of very flexuous series of corallites, free laterally. Common *walls* strongly echinulate. *Epitheca* rudimentary. *Columella* well developed, but of a very loose, spongy texture. *Septa* numerous, crowded, exsert, and strongly granulated laterally.

Typ. sp., *Trachyphyllia amarantum*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me sér., vol. xi, p. 275; *Amarantum saxum*, &c. Rumph. Amb. Hort. vi, tab. lxxxvii, fig. 1.

46. *Genus* Aspidiscus.

König, Icon. Foss. Sect., p. 1, 1825; *Cyclophyllia*, Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., vol. xxvii, p. 492, 1848.

Corallum discoidal, with its inferior surface flat, and its upper surface convex. *Corallites* arranged in radiating series, separated by thick and simple, crest-like mural ridges, excepting towards the margin of the calicular surface, where the young individuals spread out so as to form a broad, continuous, lamello-striate border. *Columella* rudimentary, but the calicules well individualized. *Septa* very thin and crowded, but not numerous in each corallite. common *plate* covered with a thick epitheca, presenting concentric striæ or folds.

Typ. sp., *Aspidiscus cristatus*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. xi, p. 277; *Aspidiscus Shawi*, König, Icon. Foss. Sect., pl. i, fig. 6; *Cyclolites cristata*, Lamarck, Anim. sans Vert., t. ii, p. 234.

47. *Genus* Scapophyllia.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., t. xxvii, p. 492, 1848.

Corallum columnar, erect, very dense, and formed of corallites arranged in series, completely united laterally. *Columella* tubercular, somewhat compact. *Septa* very thick, neither closely set nor numerous; with their sides very echinulate, and the apex denticulate. *Dissepiments* simple and distant.

Typ. sp., *Scapophyllia cylindrica*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. viii, fig. 8.

Section II.—ASTREINÆ CONFLUENTES.

Corallum massive, increasing by fissiparity, and formed by a series of corallites, the individuality of which is not distinct. The calices, thus united in a common trench, have their septa arranged in a parallel manner in two lines; and the columella, when existing, is continuous in the whole length of the series.

These meandriform Corals much resemble the confluent Eusmilinæ, and in fossils where the apical teeth of the septa may be worn away, it is often difficult to distinguish them. It may therefore be useful to mention that, in the confluent Astreinæ, the gyri are always completely united laterally, and never more or less segregate, which is sometimes the case with the confluent Eusmilinæ; that the columella, which is generally spongy in the latter, never presents that loose structure in this section; and when it is lamellar, the septa are united to it by an undivided margin in the confluent Eusmilinæ, and by a series of trabiculæ or processes in the confluent Astreinæ; lastly, that the sides of the septa are more or less granulated in all these Astreinæ, and are on the contrary almost glabrous in the meandroid Eusmilinæ.

48. *Genus* Meandrina.

(*Pars*) Lamarck, Hist. des Anim. sans Vert., t. ii, p. 244, 1816; Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 493.

Corallum glomerate, adherent by a very broad basis, and having a very dense structure. *Gyri* intimately united by their lateral walls, which constitute simple, compact ridges, with a cristate apex. Calicular trenches very long. *Columella* much developed, spongy and essential (that is to say, not arising from the septa, and distinct from the bottom of the visceral chamber). *Septa* crowded, enlarging near the columella, and not presenting any appearance of a paliform lobe. *Plate* or exterior common walls of the corallum covered with a complete delicate epitheca.

Typ. sp., *Meandrina filograna*, Lamarck, loc. cit., vol. ii, p. 248; Michelin, Icon., pl. xi, fig. 7.

49. *Genus* Manicina.

(*In parte*) Ehrenberg, Corall. des Roth. Meeres, p. 101, 1834; Dana, op. cit., p. 188, 1846; Milne Edw. and J. Haime, Ann. des Sc. Nat., vol. xi, p. 285, 1849.

Corallum free or sub-pedicellate, in the adult state; sub-turbinate when young, but becoming convex, and massive. *Gyri* very long, and united by their walls, so as to form simple ridges, as in the preceding genus; the apex of the ridge cristate or sulcate. Calicular trench broad and deep. *Columella* spongy, and even more developed than in Meandrina. *Septa* thin, crowded, strongly granulated, and armed with delicate, equal teeth; a well-characterised paliform lobe arising from the edge of the principal septa near the columella. *Plate* or exterior common wall covered with thin and very delicately-serrated costæ; its inferior part having an incomplete epitheca.

Typ. sp., *Manicina areolata*, Ehrenberg, loc. cit.; *Madrepora areolata*, Ellis and Solander, op. cit., tab. xlvii, fig. 5.

50. *Genus* Diploria.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 493, 1848.

Corallum glomerate, adherent by a broad basis, and of a dense structure. *Gyri* long, very sinuous, and united by highly-developed costæ, and not by the walls themselves; ridges complex, presenting on each side a mural crest, and in the middle a broad concave groove or ambulacrum, formed by the costæ and their dissepiments. *Columella* spongy, essential, and well developed. *Septa* strong, exsert, and armed with closely-set teeth, the largest of which are near the walls.

Typ. sp., *Diploria cerebriformis,* Milne Edw. and J. Haime, Ann., t. xi, p. 289; *Meandrina cerebriformis,* Lamarck, op. cit., vol. ii, p. 246; Seba Thes., vol. iii, tab. cxii, No. 6.

51. *Genus* Leptoria.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 493, 1848.

Corallum glomerate, of a light spongy structure. *Gyri* very long, and limited by their walls, which are thin or cellulose, and form simple intercalicular ridges. *Columella* lamellar; its upper edge projecting slightly, and regularly lobated. *Septa* united to the columella by means of marginal trabiculæ; their upper edge slightly exsert, and armed with very small irregular teeth. *Plate* covered with a thin but complete common epitheca.

Typ. sp., *Leptoria tenuis,* Milne Edw. and Haime, Ann. des Sc. Nat., 3me sér., vol. x, tab. viii, fig. 11; *Meandrina cerebriformis,* Quoy and Gaimard, Voy. de l'Astrol., Zooph., pl. xviii, figs. 2, 3; *Meandrina tenuis,* Dana, op. cit., p. 262; Milne Edw., Atlas du Règne An. de Cuvier, Zooph., pl. lxxxiv ter, fig. 2.

52. *Genus* Cœloria.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 493, 1848.

Corallum resembling much the true Meandrina, but differing from the four preceding genera by its rudimentary *columella,* which is not essential, but septal, and formed by trabiculæ, springing from the margin of the septa. *Gyri* long, and united by their *walls,* the tissue of which is cellular; ridges simple and continuous. *Septa* delicate, and having neither a paliform lobe nor a lateral expansion near the columella.

Typ. sp., *Cœloria labyrinthica,* Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, t. xi, p. 194; *Madrepora labyrinthica,* Ellis and Solander, op. cit., tab. xlvi, figs. 3, 4.

53. *Genus* Astroria.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 493, 1848.

Corallum having the same structure as in the preceding genus, but formed of very short gyri, the corallites tending to individualization. This form is intermediate between the ordinary confluent Astreidæ (or Meandrinæ) and the agglomerated Astreidæ, such as true Astrea.

Typ. sp., *Astroria dædalea,* Milne Edw. and J. Haime, Ann. des Sc. Nat., t. xi, p. 297; *Madrepora dædalea,* Ellis and Solander, op. cit., tab. xlvi, figs. 1, 2.

54. *Genus* Hydnophora.

Fischer de Waldheim, Descrip. du Mus. Démidoff, vol. iii, p. 295, 1810; *Monticularia*, Lamarck, Hist. des Anim. sans Vert., t. ii, p. 248, 1816.

Corallum formed of irregular series of corallites, united by their walls, which are thick, compact, and constitute ridges, divided longitudinally, so as to represent rows of conical prominences, or monticulæ. The calicular trenches are transversal as well as longitudinal, and there is no columella. *Septa* nearly equal, and rising to the apex of the conical mural monticulæ. General form sometimes massive and sub-globose or gibbous; sometimes sub-explanate.

Typ. sp., *Hydnophora Demidovii*, Fischer, Oryct. du Gouv. de Moscou, pl. xxxii.

Section III.—ASTREINÆ DENDROIDÆ.

Corallum always increasing by lateral gemmation. The corallites segregate, and having an arborescent or fasciculate arrangement. *Septa* regularly and delicately serrated; those of the principal cycla always bearing pali.

55. *Genus* Cladocora.

(*In parte*) Ehrenberg, Corall. des Roth. Meeres, p. 85, 1834; *Caryophyllia*, Dana, Zoophytes, p. 378, 1846.

Corallum arborescent, forming branched clumps. *Corallites* cylindrical, very long, and completely free laterally. *Calices* circular, or almost so. *Columella* papillose. *Pali* well developed, and corresponding to all the septa, except those of the last cyclum. *Septa* slightly exsert, nearly equal, granulated, and having their apex arched and delicately serrated. *Walls* compact, with simple, granulated, or echinulated costæ, and an incomplete epitheca, which often expands into circular, horizontal leaves, extending to the neighbouring corallites.

Typ. sp., *Cladocora cespitosa*, Milne Edw. and J. Haime; *Madrepora flexuosa*, Solander and Ellis, tab. xxxi, figs. 5, 6.

56. *Genus* Pleurocora.

Milne Edw. and J. Haime, Comptes rend. de l'Ac. des Sc., t. xxvii, p. 494, 1848.

Corallum sub-dendroid. *Corallites* cylindrical, very short; united by their basal part, and free towards their upper end. *Columella, pali,* and *septa* much as in the preceding genus. *Walls* compact, extremely thick, and never presenting any traces of an epitheca. *Costæ* distinct from one end of the corallites to the other, and vermiculate.

This genus approximates in some degree to Dendrophyllia and to Oculina.

Typ. sp., *Pleurocora explanata*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3^{me} série, vol. x, tab. vii, fig. 10.

Section IV.—ASTREINÆ AGGREGATÆ.

Corallum composite, massive, increasing by gemmation or by fissiparity, and in that case not presenting a linear mode of arrangement of the corallites, which are always completely united laterally, but remain well defined, and never lose their individuality, as in the confluent Astreina.

57. *Genus* Astrea.

(*In parte*) Lamarck, Syst. des Anim. sans Vert., p. 371, 1801; Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 494, 1848.

Corallum massive, in general convex or sub-globose. Gemmation extra-calicular. *Corallites* tall. *Calicules* having a free, exsert, obtuse, circular margin; fossula not very deep. *Columella* spongy, and not projecting at the bottom of the calicule. No *pali*. *Septa* complete, exsert, broad, and strongly dentated or lobated; the largest of their apical teeth near the columella; their sides strongly granulated. *Costæ* highly developed, and composed of lamellæ; in general perforated, and united by numerous dissepiments.

Typ. sp., *Astrea cavernosa*, Milne Edw. and J. Haime, loc. cit., vol. x, tab. ix, fig. 1; *Madrepora cavernosa*, Esper, Pflanz. Suppl. Mad., tab. xxxvii; *Astrea argus*, Lamarck, Hist. des Anim. sans Vert., t. xi, p. 259.

58. *Genus* Cyphastrea.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., vol. xxvii, p. 494, 1848.

Corallum massive, convex, and globose. Gemmation extra-calicular. *Corallites* united by a compact septal cœnenchyma, the surface of which is strongly granulated, or even echinulated. *Calicular* rims as in the preceding genus. *Columella* papillose, and well developed. *Septa* lamellar near the wall, but cribriform towards the columella, where they are formed by a series of oblique processes, representing a sort of lattice; their calicular teeth rather larger towards the calice than near the walls.

Typ. sp., *Cyphastrea microphtholma*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. ix, fig. 5; *Astrea microphthalma*, Lamarck, op. cit.

59. *Genus* Oulastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum massive and incrustating. Gemmation extra-calicular. *Corallites* low. *Calices* circular, with a free margin. *Columella* papillose, and appearing to be formed by the inner apical teeth of the septa. No *pali*. *Septa* with a crispate, denticulated, apical margin, and echinulate sides. *Costæ* also echinulate and crispate.

Typ. sp., *Oulastrea crispata*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. ix, fig. 4; *Astrea crispata*, Lamarck, Hist. des Anim. sans Vert., vol. ii, p. 265.

60. *Genus* Plesiastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 494, 1848.

Corallum globose; its under surface having the form of a naked costulated plate. Gemmation extra-calicular. *Calices* with a free margin, and a fossula rather shallow. *Columella* spongy. *Pali* well developed, and corresponding to all the septa except those of the last cyclum. *Septa* exsert, formed by a well-developed lamina, and having a delicately-serrated apex. *Costæ* and their dissepiments in general well developed.

Typ. sp., *Plesiastrea Urvillii*, Milne Edw. and J. Haime, Ann. des Sc. Nat., vol. x, tab. ix, fig. 2; *Astrea galaxea*, Quoy and Gaim., Voyage de l'Astrolabe, Zooph., pl. xvii, figs. 10-14.

61. *Genus* Leptastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 494, 1848.

Corallum very dense and incrusting, and increasing by fissiparity, as well as by extra-calicular gemmation. Costal cœnenchyma quite compact. *Calices* in general much crowded together, but preserving their margins distinct. *Columella* papillose. *Septa* thin, closely set, exsert, delicately granulated, and having their apical margin almost entire near the walls, but delicately denticulated towards the columella. *Dissepiments* not very abundant. *Costæ* rather indistinct.

Typ. sp., *Leptastrea Roissyana*, Milne Edw. and J. Haime, Ann. Sc. Nat., 3me série, vol. x, tab. ix, fig. 6.

62. *Genus* Solenastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 494, 1848.

Corallum forming in general a convex mass, of a light and cellular structure. Gemmation extra-calicular. *Corallites* long, slender, and united by an exothecal structure, and not by the *costæ*, which do not meet, and are often rudimentary. *Calices* circular, with an exsert margin. *Columella* spongy, and in general small. *Septa* very thin; their margin denticulated. *Dissepiments* simple, numerous, and closely set.

Typ. sp., *Solenastrea Turonensis*, nob.; *Astrea Turonensis*, Michelin, Icon., pl. lxxv, figs. 1, 2.

63. *Genus* Phymastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 494, 1848.

Corallum forming a convex or a horizontal mass. *Corallites* prismatical; surrounded from top to bottom by a thin epitheca; very nearly approximated to each other, but not united by their walls, and cemented together by means of a certain number of large wart-like processes, so as to leave an empty space between them. Gemmation extra-calicular. *Calices* sub-polygonal, with a free margin. *Columella* spongy, well developed. *Septa* large, slightly exsert, and strongly dentated. *Walls* thick; no trace of costæ.

Typ. sp., *Phymastrea Valenciennesii*, Milne Edw. and J. Haime, Ann. Sc. Nat., 3me série, vol. x, tab. ix, fig. 3.

64. *Genus* Astroides.

Quoy and Gaimard, Ann. des Sc. Nat., 1re série, vol. x, p. 187, 1827; *Astroitis,* Dana, Zooph., p. 405, 1846.

Corallum incrusting, and formed of corallites very unequally approximated; some almost entirely free, others crowded so as to become polygonal, but always separated by a more or less developed epitheca. Gemmation extra-calicular. *Calices* deep. *Columella* spongy, large, and projecting very much at the bottom of the fossula, a character which does not exist in any of the preceding Astreinæ. *Septa* not much developed, very thin, not exsert, irregularly and delicately denticulated. *Dissepiments* very abundant. *Walls* composed of a dense spongy tissue. Epitheca complete.

Typ. sp., *Astroides calicularis,* Blainville, Dict. des Sc. Nat., vol. lx.; *Caryophyllia calicularis,* Lamarck, op. cit., vol. ii, p. 226; Milne Edwards, Atlas du Règne Anim. de Cuvier, Zooph., tab. lxxxiii, fig. 2.

65. *Genus* Prionastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum forming a convex or gibbose mass, the under surface of which constitutes a common plate, covered with a thin, complete epitheca. Gemmation sub-marginal. *Calices* distinct, polygonal; fossula deep; margins united so as to form a simple crest between the different corallites. *Columella* spongy. *Septa* thin, crowded, delicately granulated on their sides, and strongly dentated at their apex; the largest of these teeth are those nearest the columella. *Dissepiments* well developed. *Walls* in general independent towards the basis of the coral, but uniting to the adjacent ones near the calices, so that the visceral chambers appear to be separated only by a single simple lamina.

Typ. sp., *Prionastrea abdita,* Milne Edw. and J. Haime, loc. cit.; *Astræa abdita,* Lamarck, Hist. des Anim. sans Vert., t. ii, p. 265, 1816; *Madrepora abdita,* Soland. and Ellis, t. 50, f. 2.

66. *Genus* Siderastrea.

(*In parte*) Blainville, Dict. des Sc. Nat., t. lx, p. 335, 1830; *Siderina,* Dana, Zooph., p. 218, 1846.

Corallum incrusting, forming a convex mass of a very dense tissue. Gemmation sub-marginal. *Corallites* united by their walls, which are thin, and sometimes indistinct. *Calices* sub-pentagonal, with a deep fossula, and their margins rendered thick by the prolongation of the septa. *Columella* papillose, in general not much developed, but having a tendency to become compact. *Septa* very closely set, thin, and regularly denticulated; their lateral surfaces covered with large granulations, which come in contact with those of the adjoining septa, but are not united to them. *Dissepiments* rudimentary.

Typ. sp., *Siderastrea galaxea,* Blainville, loc. cit.; *Madrepora galaxea,* Ellis and Solander, Hist. of Zooph., tab. xlvii, fig. 7.

67. *Genus* Baryastrea.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., t. xxvii, p. 495, 1848.

Corallum incrusting; its tissue very dense and compact. Gemmation marginal or sub-marginal. *Corallites* very intimately united by their walls. *Calices* polygonal and indistinctly separated by superficial, narrow grooves. *Columella* not much developed at its apex; but having a tendency to become compact, and to fill up the visceral chamber towards its basis. *Septa* very thick, closely set, scarcely granulated, and very feebly denticulated. *Dissepiments* little developed.

Typ. sp., *Baryastrea solida*, Milne Edw. and J. Haime, loc. cit.

68. *Genus* Acanthastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum forming a slightly convex mass, with its upper surface strongly echinulate, and its under surface constituting a plate, covered with a complete, thin epitheca. Gemmation sub-marginal or marginal. *Corallites* united by their walls, which are somewhat cellular. *Calices* sub-polygonal, with broad, spiniferous, simple, common margins. *Columella* rudimentary or septal. *Septa* exsert, strong, and armed with projecting spiniform teeth, the largest of which are situated near the walls, instead of being the central ones, as in the preceding genera. *Dissepiments* very numerous.

Typ. sp., *Acanthastrea spinosa*, Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495.

69. *Genus* Synastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum pediculate, and increasing in breadth more than in height. Gemmation sub-marginal. *Corallites* intimately united by their walls. *Calices* superficial, distinct at their centre, but not so towards their circumference. *Columella* very small. *Septa* confluent, progressing from one calicular centre to another without interruption, exsert, and hiding the walls, over which they extend; their calicular margin almost horizontal, and armed with nearly equal teeth.

Typ. sp., *Synastrea Savignyi*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. ix, fig. 12.

70. *Genus* Thamnastrea.

Thamnasteria (*in parte*), Le Sauvage, Mém. de la Soc. d'Hist. Nat. de Paris, vol. i, p. 241, 1822; *Thamnastrea*, ejusd., Ann. des Sc. Nat., 1re série, vol. xxvi, p. 328.

Corallum having confluent septa, and most of the other characters of Synastrea, but forming a fasciculus of columns or thick branches, erect, and of a more or less arborescent aspect.

Typ. sp., *Thamnastrea dendroidea*, Le Sauvage, Mém. de la Soc. d'Hist. Nat., vol. i, tab. xiv.

71. *Genus* Goniastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum always increasing by successive fissiparity, and forming a convex or lobulated mass, of a dense structure. *Corallites* intimately united from top to bottom by their walls, which thus form simple partitions between the visceral cavities, and are thick and compact. *Calices* polygonal; fossula rather deep. *Columella* spongy. *Septa* slightly exsert, their apex arched and denticulated. Well-characterised, denticulated *pali*, corresponding to all the septa, except those of the last cyclum.

Typ. sp., *Goniastrea solida*, Milne Edw. and J. Haime, Ann., 3[me] série, t. x, pl. ix, fig. 7; *Madrepora solida*, var. *b*, Forskal, Descr. Anim. in Itin. Orient., p. 131.

72. *Genus* Aphrastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum increasing by fissiparity, and forming a convex mass of a light cellular structure, presenting on its under surface a complete, common epitheca. *Calices* intimately united by their margins, which thus assume the appearance of simple partitions. *Columella* spongy. *Pali* or paliform lobes of the septa corresponding to all the cycla, except the last. *Septa* denticulated, slightly exsert. *Dissepiments* vesicular, and highly developed. *Walls* extremely thick, and completely vesicular.

Typ. sp., *Aphrastrea deformis*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3[me] série, vol. x, tab. ix, fig. 11; *Astrea deformis*, Lamarck, Hist. des An. sans Vert., t. xi, p. 264.

73. *Genus* Parastrea.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 495, 1848.

Corallum increasing by fissiparity, and having the same general form as in the preceding genus, but differing from it by the mode of union of the corallites, which takes place by means of the costæ and their dissepiments, so that the calices, instead of being separated only by a common simple margin, have each a distinct margin independent of those surrounding it. *Septa* exsert, and armed with teeth, the largest of which are placed near the centre of the calice, and often assume the appearance of pali. *Dissepiments* well developed.

Typ. sp., *Parastrea amicorum*, Milne Edw. and J. Haime, Ann., 3[me] série, vol. x, pl. ix, fig. 9.

Section V.—ASTREINÆ REPTANTES.

Corallum increasing by the development of buds on stolons, or on membraniform basal expansions. The *corallites* not united by their sides, excepting accidentally by means of their walls, and remaining short. *Septa* feebly denticulated. *Dissepiments* almost rudimentary.

74. *Genus* Angia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 496, 1848.

Corallum composed of short, cylindrical corallites, united by a common gemmiferous basal expansion, and completely free laterally. *Calices* sub-circular; fossula broad and deep. *Columella* papillose, well developed. *Septa* thin, not exsert; the principal ones having their upper margin almost entire, the others strongly dentated. *Walls* covered with a complete epitheca.

Typ. sp., *Angia rubeola*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. vii, fig. 6; *Dendrophyllia rubeola*, Quoy and Gaimard, Astrolabe, Zooph., tab. xv, figs. 12-15.

75. *Genus* CRYPTANGIA.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 496, 1848.

Corallum composed of agglomerate, cylindro-turbinate corallites, which appear to multiply by gemmation on a non-persistent, soft stolon, so that they cease to be organically united when in the adult state, but remain imbedded in an extraneous mass composed of Cellepora. *Calices* circular, with a well-formed fossula. *Columella* papillose, well developed. *Septa* thin, not very closely set; the upper edge of all of them dentate. *Walls* covered with a complete epithcea.

Typ. sp., *Cryptangia Woodii*, Milne Edw. and J. Haime, loc. cit.; *Cladocora cariosa*, Wood, Ann. of Nat. Hist., vol. xiii, p. 12.

76. *Genus* RHIZANGIA.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 496, 1848.

Corallum increasing by the gemmation of stolons, which sometimes become calcified, and are persistent. *Corallites* agglomerate, sub-cylindrical. *Calices* circular; fossula shallow. *Columella* papillose, and not very distinct from the neighbouring denticulations of the septa. *Septa* thin, scarcely exsert, nearly equal, very closely set, with the upper edge slightly arched, and armed with small, regular teeth. *Walls* covered with a complete epitheca, which extends almost as high as the apex of the septa.

Typ. sp., *Rhizangia brevissima*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, t. vii, figs. 7, 8; *Astrea brevissima*, Deshayes, in Ladoucette, Hist. des Hautes Alpes, tab. xiii, fig. 13.

77. *Genus* ASTRANGIA.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 496, 1848.

Corallum incrusting. *Corallites* very short, produced by gemmation on a thin, common, basal expansion, the surface of which is granulated. *Calices* circular, with a deep fossula. *Columella* papillose, sub-echinulate and not distinctly delimitated. *Septa* thin, exsert, nearly equal, granulate, and armed with teeth much resembling those of the columella; the tertiary septa bent towards those of the second cycla, and united to them. *Dissepiments* in general simple and distant. *Walls* naked, with broad, delicately-granulated costæ.

Typ. sp., *Astrangia Michelinii*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, t. vii, f. 5.

78. *Genus* PHYLLANGIA.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 497, 1848.

Corallum differing from those of the preceding genus by the structure of the *septa*, the upper edge of which is almost entire in the principal cycla, and slightly denticulated in the others. *Columella* rudimentary.

Typ. sp., *Phyllangia americana*, nob.

79. *Genus* Oulangia.

Milne Edw. and J. Haime, Comptes rend., t. xxvii, p. 497, 1848.

Corallum composed of very low, cylindrical corallites, which appear to arise by gemmation on a basal incrusting expansion, and having their walls naked and costate, as in the preceding genus, but with a highly-developed, papillose columella. *Septa* very exsert, closely set; those of the principal cycla having their upper edge almost entire.

Typ. sp., *Oulangia Stokesiana*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. vii, fig. 4.

Aberrant Group.

PSEUDASTREIDÆ.

Corallum composite, thin, and foliaceous, and increasing by extra-calicular gemmation. *Corallites* short, well circumscribed, and dispersed on the surface of a common lamellar plate. Cœnenchyma echinulate. *Septa* well developed, very echinulate. *Dissepiments* not numerous. No synapticulæ. Common basal wall imperforate, sub-costulate, and naked.

Genus Echinopora.

Lamarck, Hist. des An. sans Vert., vol. ii, p. 252, 1816; *Echinastrea*, Blainville, Dict. des Sc. Nat., vol. lx, p. 343, 1830.

Corallum adherent, near the centre, and expanding into large foliaceous, lobated laminæ. *Calices* circular, with an exsert margin.

Typ. sp., *Echinopora rosularia*, Lamarck, loc. cit., p. 253; Milne Edw., Atlas du Règne Anim. de Cuvier, Zooph., tab. lxxxiii ter, fig. 1.

Transitional Group.

PSEUDOFUNGIDÆ.

Corallum composite and foliaceous, having a perforated plate or basal wall (as in Fungidæ) and interseptal dissepiments (as in Astreidæ). *Calices* forming radiating series, separated by lobes or ridges. No synapticulæ.

Genus Merulina.

Ehrenberg, Corall. des Roth. Meeres, p. 104, 1834. Typ. sp., *Merulina ampliata*, Ehrenberg, loc. cit.

Family IV.

FUNGIDÆ.

Dana, Expl. Exped., Zooph., p. 283, 1846.

Corallum simple or composite, very short and expanding, so as to constitute a disc or foliaceous lamina. *Calice* very shallow, and open laterally in simple species;

confluent, and not circumscribed in the compound species. *Septa* not distinct from the costæ, and formed by complete, imperforate laminæ, with the edge dentate, and the sides covered with styliform or echinulate processes, which, in general, meet so as to constitute numerous *synapaticulæ,* or transverse props, extending across the loculi like the bars of a grate. No dissepiments or tabulæ, so that no part of the visceral chamber is completely closed. *Walls* basal, in general porous. The compound species increasing by submarginal gemmation, and not by fissiparity.

First Tribe—CYCLOLITINÆ.

Corallum simple. *Plate* or basal wall having a well-developed *epitheca,* presenting concentric folds.

1. *Genus* Cyclolites.

Lamarck, Syst. des Anim. sans Vert., p. 369, 1801.

Corallum circular, or nearly so, and covered with an immense number of very thin septa. Fossula oblong, narrow, and shallow. The small septa in general united to those of the older cycla.

Typ. sp., *Cyclolites elliptica,* Lamarck, loc. cit., p. 234.

2. *Genus* Palæocyclus.

Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., vol. xxix, p. 71, 1849.

Corallum circular. Fossula deep, very broad, and circular. *Septa* thick and not numerous; none of them cemented together.

Typ. sp., *Palæocyclus porpita,* Milne Edw. and J. Haime, loc. cit.; *Madrepora porpita,* Fougt, Lin. Amœn. Acad., t. i, tab. iv, fig. 5.

Second Tribe—FUNGINÆ.

Corallum simple or composite. *Plate* or basal wall without an epitheca, in general strongly echinulate, and porous.

3. *Genus* Fungia.

(*In parte*) Lamarck, Syst. des An. sans Vert., p. 369, 1801; Dana, Zooph., p. 287, 1846; Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 71, 1849.

Corallum simple, subdiscoidal. *Septa* very numerous, and united so as to appear ramified. Basal *wall* strongly echinulate, and perforated in an irregular manner.

Typ. sp., *Fungia patellaris,* Lamarck, loc. cit., p. 236; Milne Edw. and J. Haime, Ann. des Sc. Nat., t. ix, pl. vi, fig. 1.

4. *Genus* Micrabacia.

Milne Edw. and J. Haime, Comptes rendus, vol. xxix, p. 71, 1849.

Corallum simple, lenticular, plano-convex. *Septa* not extremely numerous, straight. *Wall* scarcely echinulate, and perforated in a regular manner.

Typ. sp., *Micrabacia coronula*, nob.; *Fungia coronula*, Goldfuss, Petref. Germ., vol. i, tab. xiv, fig. 10.

5. *Genus* Anabacia.

D'Orbigny MSS.; Milne Edw. and J. Haime, loc. cit., p. 71, 1849.

Corallum simple and lenticular. *Septa* extremely numerous, thin, and projecting on the under side of the corallum without forming a distinct basal wall or plate. Fossula shallow.

Typ. sp., *Anabacia orbulites*, nob.; *Fungia orbulites*, Lamouroux, Exp. Méth., tab. lxxxiii, figs. 1, 2, 3.

6. *Genus* Genabacia.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 71, 1849.

Corallum composite, formed by a parent corallite similar to Anabacia, bearing young calicula arranged circularly.

Typ. sp., *Genabacia stellata*, nob.; *Fungia stellata*, D'Archiac, Mém. Soc. Géol. France.

7. *Genus* Herpolitha.

Eschscholtz, Isis, 1825; *Haliglossa*, Ehrenberg, Corall., p. 50, 1834; *Herpetolithus*, Leuckart; Dana, Zooph., p. 306, 1846.

Corallum composite, free. *Calicula* sub-radiate, and of two sorts; the central ones multi-lamellate, and arranged in a line; the others pauci-lamellate, and dispersed irregularly. *Septa* strong, and alternately thick and thin. Under surface of the common basal wall very echinulate.

Typ. sp., *Herpolitha limacina*, nob.; *Madrepora pileus*, Ellis and Solander, op. cit., tab. xlv.

8. *Genus* Cryptabacia.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 71, 1849.

Corallum composite, free and convex above. *Calices* distinctly radiate; the central ones arranged in a line, and more distinct than the others. *Septa* short, and not numerous. Under surface of the common basal walls strongly echinulated.

Typ. sp., *Cryptabatia talpa*, nob.; *Fungia talpa*, Lamarck, Hist. des An. sans Vert., t. ii, p. 237.

9. *Genus* Halomitra.

Dana, Zooph., p. 311, 1846.

Corallum composite, differing from the preceding genus by its very long and numerous septa.

Typ. sp., *Halomitra pileus*, Dana, loc. cit., p. 311; *Fungia pileus*, Lamarck, Hist. des An. sans Vert., t. ii, p. 237.

10. *Genus* Podobacia.

Milne Edw. and J. Haime, loc. cit., p. 71, 1849.

Corallum composite, cyathiform, and adherent by its basis. *Calices* as in Halomitra.

Typ. sp., *Podobacia cyathoides*, nob.; *Agaricia cyathoides*, Valenciennes MSS., in the Gallery of the Paris Museum.

11. *Genus* Lithactinia.

Lesson, Illustr. Zool., 1833.

Corallum composite, free. *Calices* of one sort only, and not radiate. *Septa* short, and separated by very thin, transverse laminæ, which appear to be analogous to columellæ.

Typ. sp., *Lithactinia novæhyberniæ*, Lesson, loc. cit., vi, figs. 1, 2.

12. *Genus* Polyphyllia.

Quoy and Gaimard, Voy. de l'Astrolabe, Zooph., p. 184, 1833.

Corallum composite, free, and having calices of two sorts; the central ones sub-radiate, and arranged in a line.

Typ. sp., *Polyphyllia pelvis*, Quoy and Gaimard, loc. cit., pl. xx, figs. 8—10.

13. *Genus* Zoopilus.

Dana, Zooph., p. 318, 1846.

Corallum composite. *Septa* of two sorts; the large ones radiately prolonged quite to the margin; the intermediate much smaller, and those only interrupted by the calicular fossulæ or oririms.

Typ. sp., *Zoopilus echinatus*, Dana, op. cit., p. 319.

Third Tribe—LOPHOSERINÆ.

Plate (or basal wall) not perforate nor echinulate. No *epitheca*.

14. *Genus* Cycloseris.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 72, 1849.

Corallum simple, free, and discoidal. *Septa* very numerous, and united by their inner edge. *Wall* completely horizontal.

Typ. sp., *Cycloseris cyclolites,* nob.; *Fungia cyclolites,* Lamarck., Hist. des Anim. sans Vert., t. ii, p. 236.

15. *Genus* Diaseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum simple, free, and discoidal; when young, composed of a certain number of separate, radiating lobes, which, in the adult state, become cemented together. General structure as in Cycloseris.

Typ. sp., *Diaseris distorta,* nob.; *Fungia distorta,* Michelin, in Guerin's Mag. Zool., t. v, Zooph., pl. v, 1843.

16. *Genus* Trochoseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum simple, trochoidal, adherent. *Septa* very numerous, and strongly granulated.

Typ. sp., *Trochoseris distorta,* nob.; *Anthophyllum distortum,* Michelin, Icon. Zooph., pl. xliii, fig. 8.

17. *Genus* Cyathoseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum composite, trochoid, adherent. *Calices* rather distinctly radiate. *Septa* long and thick. Common basal walls, sometimes forming folds, which rise up so as to constitute lobes or ridges on the upper surface of the corallum.

Typ. sp., *Cyathoseris infundibuliformis,* nob.; *Agaricia infundibuliformis,* Michelin, op. cit., tab. xliii, fig. 12.

18. *Genus* Lophoseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849; *Pavonia* (*ex parte*), Lamarck, op. cit., t. ii, p. 238, 1816.

Corallum composite, foliaceous, and adherent, rising in the form of irregular cristæ or of lobes, with confluent, radiate calicules on each side. *Columella* tubercular.

Typ. sp., *Lophoseris boletiformis,* nob.; *Pavonia boletiformis,* Lamarck, loc. cit., p. 240.

19. *Genus* Agaricia.

(*Pars*) Lamarck, Syst. des Anim. sans Vert., p. 375, 1801.

Corallum composite, foliaceous, and irregular. *Calices* arranged in concentric series, separated by unequal ridges. *Columella* tubercular.

Typ. sp., *Agaricia undata,* Lamarck, loc. cit.; *Madrepora undata,* Solander and Ellis, Zooph., tab. xl.

20. *Genus* Pachyseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum similar to Agaricia, excepting that the corallites belonging to the same trench are completely blended together. *Columella* well developed and dense.

Typ. sp., *Pachyseris rugosa,* nob.; *Agaricia rugosa,* Lamarck, Hist. des An. sans Vert., t. ii, p. 243.

21. *Genus* Phyllastrea.

Helioseris, Dana, Zooph., p. 269; Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum composite, composed of frondiform expansions. *Calices* circumscribed, submammillate, and arranged around the parent corallite, which remains larger than the others. *Columella* tubercular.

Typ. sp., *Phyllastrea tubifex,* Dana, loc. cit., tab. xvi, fig. 4.

22. *Genus* Haloseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum composite, forming foliaceous, crispate, lobulate expansions, the upper surface of which is covered with very long radii, and shows only obsolete calices. *Columella* rudimentary.

Typ. sp., *Haloseris lactuca,* Milne Edw. and J. Haime, loc. cit.

23. *Genus* Leptoseris.

Milne Edw. and J. Haime, loc. cit., p. 72, 1849.

Corallum composite and adherent; the basal walls rising so as to constitute a subcrateriform disc, in the centre of which is situated a large parent corallite, surrounded by smaller ones. *Calices* very imperfectly circumscribed, but well radiated. *Septa* very long. *Columella* rudimentary.

Typ. sp., *Leptoseris fragilis,* Milne Edw. and J. Haime, loc. cit.

Sub-order 2.

ZOANTHARIA PERFORATA.

Corallum composed essentially of porous sclerenchyma; with the septal apparatus well characterised, and consisting of six primitive elements, but being sometimes represented only by series of trabiculæ. *Dissepiments* rudimentary; no tabulæ.

The principal character of this section of Zoantharia is furnished by the structure of the sclerenchyma, which, instead of forming imperforated lamella as in the preceding groups, is always porous, or even reticulate. In general the mural apparatus constitutes here the greatest part of the corallum, and does not consist of costal laminæ; the walls are always perforated, and completely or nearly completely naked. It is also to be remarked, that the visceral chamber is almost completely open from top to bottom, and never filled up with dissepiments or synapticulæ, as in most of the *Zoantharia aporosa*, or with tabulæ, as will be seen in the next two sections of this order.

The perforated Zoantharia form three natural families: Eupsammidæ, Madreporidæ, and Poritidæ.

Family V.
EUPSAMMIDÆ.

Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, p. 65, 1848.

Corallum simple or complex, with well-developed lamellar septa, a spongiose columella, and perforated, granular, subcostulated walls.

The septa are always numerous, and those of the last cyclum are never situated in the direction of a line drawn from the centre of the calice to its circumference, but are bent towards those of the penultimate cyclum, so as to produce the appearance of a six- or twelve-branched star. The interseptal loculi are completely open from top to bottom, or divided only by a few incomplete trabiculæ. The walls have a granulate vermiculate surface, and become often very thick in advanced age, but never constitute a loose spongy mass, as in Madreporidæ and Poritidæ, or a compact cœnenchyma, as in Oculinidæ.

The star-like arrangement of the septa, which is visible in transverse sections of these corallums, as well as in the calice, is not met with in any other family. The principal septa are sometimes imperforate, but those of the succeeding cycla are more or less porous. It is also to be noted that there are never any pali, and that the costæ are always rudimentary; sometimes there is a rudimentary epitheca.

1. *Genus* EUPSAMMIA.

Milne Edw. and J. Haime, Ann. Sc. Nat., 3me série, vol. x, p. 77, 1848.

Corallum simple, subturbinate, free, and not presenting any lateral mural expansions. *Calice* oval and rather deep. *Septa* broad, slightly exsert, granulate, closely set, and forming four or five cycla. *Costæ* simple, distinct from the basis of the corallum, nearly equal, slightly vermiculate, and composed of a series of distinct, projecting granulæ.

Typ. sp., *Eupsammia trochiformis*, Milne Edw. and J. Haime, loc. cit., tab. i, fig. 3; *Madrepora trochiformis*, Pallas; *Turbinolia elliptica*, Brongniart.

2. *Genus* Endopachys.

(*Pars*) Lonsdale, Journ. of the Geol. Soc. of London, vol. i, p. 214, 1845.

Corallum simple, free, and organized as in the preceding genus, but much compressed towards its basis, which is carinate, and continued laterally into two vertical lobiform or cristate expansions. *Calice* arched; fossula long and narrow.

Typ. sp., *Endopachys Maclurii*, Milne Edw. and J. Haime, Ann. Sc. Nat., vol. x, tab. i, fig. 1; *Turbinolia Maclurii*, Lea, Contrib. to Geol., tab. vi, fig. 206.

3. *Genus* Balanophyllia.

Searles Wood, Ann. and Mag. of Nat. Hist., vol. xiii, p. 11, 1844.

Corallum simple and adherent, sub-pediculate, or sub-cylindrical, with a very broad basis. *Columella* well developed, but not projecting at the bottom of the fossula. *Septa* thin, and closely set; those of the last cyclum well developed, and complete in number. *Costæ* narrow, crowded, and nearly equal; no mural expansions.

Typ. sp., *Balanophyllia caliculus*, Searles Wood, loc. cit.

4. *Genus* Heteropsammia.

Milne Edw. and J. Haime, Ann. Sc. Nat., 3^{me} série, vol. x, p. 89, 1848.

Corallum simple, adherent, and growing by its basis so as to cover completely the shell on which it is fixed, and to assume the appearance of being free. *Calice* smaller than the basal part of the corallum. *Columella* well developed. *Septa* thick, slightly exsert, and closely set. *Walls* not having distinct costæ, but presenting small striæ or small papillæ, composed of minute granulæ, and arranged in an irregular manner.

Typ. sp., *Heteropsammia Michelinii*, Milne Edw. and J. Haime, loc. cit., p. 89.

5. *Genus* Leptopsammia.

Milne Edw. and J. Haime, loc. cit., p. 90, 1848.

Corallum simple, adherent. *Calice* elliptical. *Columella* much developed, and projecting at the bottom of the fossula. *Septa* neither exsert nor crowded, very thin, and presenting scarcely any granulations; those of the fifth order rudimentary. *Walls* thin and translucid. *Costæ* distinct from the basis, and formed by series of small granulæ.

Typ. sp., *Leptopsammia Stokesiana*, Milne Edw. and J. Haime, loc. cit., tab. i, fig. 4.

6. *Genus* Endopsammia.

Milne Edw. and J. Haime, loc. cit., p. 91, 1848.

Corallum simple, erect, and adherent. *Calice* circular. *Columella* much developed, but not projecting. *Septa* thick, strongly granulated, and slighty exsert, forming four cycla, the last of which is almost rudimentary. *Walls* covered with an indistinct pellicular epitheca, and having broad, straight costæ.

Typ. sp., *Endopsammia Philippensis*, Milne Edw. and J. Haime, loc. cit., tab. i, fig. 5.

7. *Genus* Stephanophyllia.

Michelin, Dict. des Sc. Nat., Suppl., vol. i, p. 484, 1841.

Corallum simple, free, and presenting no trace of adherence. *Wall* discoidal, horizontal. *Calice* circular and open. *Septa* tall, thin, crowded, not projecting laterally beyond the edge of the mural disc, covered with conical granulations on each side, and all, excepting those of the first cyclum, united by the inner edge. *Costæ* delicate, straight, composed of simple series of obscure granulations, and radiating regularly from the centre of the mural disc to its circumference. No epitheca.

Typ. sp., *Stephanophyllia elegans*, Michelin, Icon. Zooph., pl. viii, fig. 2. Milne Edw. and J. Haime, loc. cit., tab. i, fig. 10.

8. *Genus* Dendrophyllia.

Blainville, Dict. des Sc. Nat., vol. lx, p. 319, 1830.

Corallum composite, and in general arborescent. Corallites cylindrical, or cylindrico-turbinate, and formed by lateral gemmation. *Calices* circular, or nearly so ; fossula deep. *Columella* well developed, and in general projecting much at the bottom of the fossula. *Septa* not exsert, thin, and closely set ; those of the fourth cyclum well developed. *Walls* becoming very thick, and presenting narrow vermiculate *costæ*, formed by series of granulæ.

Typ. sp., *Dendrophyllia ramea*, Blainville, loc. cit. ; Milne Edw., Atlas du Règne Animal de Cuvier, Zooph., pl. lxxxiii, fig. 1.

9. *Genus* Lobopsammia.

Milne Edw. and J. Haime, Ann. des Sc. Nat., 3^me^ série, vol. x, p. 105, 1848.

Corallum composite, arborescent, increasing by successive fissiparity. *Calices* irregular in form. *Septa* forming four complete and well-developed cycla. In other respects similar to Dendrophyllia.

Typ. sp., *Lobopsammia cariosa*, Milne Edw. and J. Haime, loc. cit. ; *Lithodendron cariosum*, Goldfuss, Petref. Germ., vol. i, tab. xiii, fig. 7.

10. *Genus* Cœnopsammia.

Milne Edw. and J. Haime, loc. cit., p. 106, 1848 ; *Tubastrea*, Lesson, Voyage aux Indes orient. par Belanger, 1834.

Corallum composite, dendroid, or sub-globose, increasing by lateral or sub-basal gemmation. *Corallites* cylindrical. *Calices* circular, or nearly so. *Columella* tubercular, well developed. *Septa* not exsert, distant, and forming three cycla ; those of the fifth order rudimentary. *Costæ* narrow, sub-vermiculate towards the bases, simple, and formed of a series of granulæ near the calice.

Typ. sp., *Cœnopsammia coccinea*, Milne Edw. and J. Haime, loc. cit., p. 107 ; *Tubastrea coccinea*, Lesson, op. cit., Zooph., tab. i ; *Astrea calicularis*, Blainville, Manuel d'Actinol., tab. liv, fig. 2.

11. *Genus* Stereopsammia.

Corallum presenting most of the characters of Cœnopsammia, but not having any *Columella*.

Typ. sp., *Stereopsammia humilis*, nob., tab. v, fig. 4.

Family VI.

MADREPORIDÆ.

Corallum composite, increasing by gemmation and not by fissiparity. *Cœnenchyma* abundant, spongy, and reticulate. *Walls* very porous, and not distinct from the cœnenchyma. *Septa* lamellose, and well developed; loculi free.

First Tribe—MADREPORINÆ.

Visceral chambers divided into two equal parts by two of the principal septa, which are more developed than the others, and meet by their inner edge.

1. *Genus* Madrepora.

Lamarck, Hist. des Anim. sans Vert., t. xi, p. 277, 1816.

Corallum composite, forming ramified, lobate, or fasciculate masses. *Cœnenchyma* loose, and delicately echinulate. *Calices* projecting, with a thick margin. No *columella*.

Typ. sp., *Madrepora muricata*, Ellis and Solander, Zooph., tab. lvii; *Madrepora abrotanoides*, Lamarck, loc. cit., p. 280.

Second Tribe—EXPLANARINÆ.

Visceral chamber presenting at least six equally developed principal septa.

2. *Genus* Explanaria.

(*Pars*) Lamarck, Hist. des Anim. sans Vert., vol. ii, p. 254, 1816; *Gemmipora*, Blainville, Dict. des Sc. Nat., vol. lx, p. 352, 1830.

Corallum in general foliaceous. *Cœnenchyma* abundant, rather dense, and delicately echinulate. *Septa* almost all of the same size. *Columella* spongy.

Typ. sp., *Explanaria crater*, nob.; *Madrepora crater*, Pallas, Elench. Zooph., p. 332.

3. *Genus* Astreopora.

Blainville, Dict. des Sc. Nat., vol. lx, p. 348, 1830.

Corallum massive. *Cœnenchyma* of a loose texture, and strongly echinulated. *Septa* unequally developed. No *columella*.

Typ. sp., *Astreopora myriophthalma*, Blainville, loc. cit.; *Astrea myriophthalma*, Lamarck, op. cit., p. 260.

Family VII.
PORITIDÆ.

Corallum entirely composed of reticulate sclerenchyma. Septal apparatus well developed, but never lamellar, and composed only of series of styliform processes or trabiculæ, constituting by their junction a sort of irregular trellis. *Walls* presenting the same structure, and not distinct from the cœnenchyma. Visceral chamber containing some small dissepiments, but never divided by tabulæ.

First Tribe—PORITINÆ.

Cœnenchyma rudimentary, or not existing.

1. *Genus* Porites.

(*Pars*) Lamarck, Hist. des An. sans Vert., t. ii, p. 267, 1816; Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 258, 1849.

Corallum composed of sclerenchyma, very irregularly reticulated. *Calices* shallow. *Septa* not numerous, rudimentary, and appearing to be represented by a circle of *pali*, the apex of which is papillose.

Typ. sp., *Porites conglomerata*, Lamarck, loc. cit., p. 269.

2. *Genus* Litharæa.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 258, 1849.

Sclerenchyma very irregularly reticulated. *Calices* not very deep. *Columella* spongy. *Pali* rudimentary, or not existing. *Septa* well developed, particularly towards the wall.

Typ. sp., *Litharæa Websteri*, nob.; *Astrea Websteri*, Bowerbank, Mag. of Nat. Hist., new series, vol. iv, p. 27, figs. A, B, 1840.

3. *Genus* Coscinaræa.

Milne Edw. and J. Haime, Comptes rend. de l'Ac. des Sc., t. xxvii, p. 496, 1848.

Corallum of a dense structure. *Calices* rather deep; neither pali, nor distinct walls. *Septa* crowded, very regularly fenestrate, and with crispate edges, passing without any interruption from one visceral chamber to the adjacent one. No *epitheca*.

Typ. sp., *Coscinaræa Bottæ*, Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. ix, tab. v, fig. 2.

4. *Genus* Microsolena.

Lamouroux, Exp. méth., p. 65, 1821.

Corallum differing from the preceding genus by the structure of the septa, the perforations of which are much larger than in Coscinaræa, and by the existence of a strong, common epitheca.

Typ. sp., *Microsolena porosa,* Lamouroux, op. cit., tab. lxxiv, fig. 24.

5. *Genus* Goniopora.

Quoy and Gaimard, Voy. de l'Astr., Zooph., p. 218, 1833; *Goniopora* and *Porastrea,* Milne Edw. and J. Haime, Comptes rend. de l'Acad. des Sc., t. xxvii, p. 496, 1848.

Corallum having distinct, elevated walls, of a fenestrate structure. *Calices* deep. *Columella* spongy. *Septa* well developed, and fenestrate. No *pali.*

Typ. sp., *Goniopora pedunculata,* Quoy and Gaimard, Voyage de l'Astrolabe, Zooph., tab. xvi, figs. 9-11.

6. *Genus* Rhodaræa.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 259, 1849.

Corallum with thick walls, rather high. *Septa* rudimentary. *Pali* greatly developed, and forming a rosette in the centre of the calice.

Typ. sp., *Rhodaræa calicularis,* nob.; *Astrea calicularis,* Lamarck, Hist. des An. sans Vert., t. ii, p. 266.

7. *Genus* Poraræa.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 259, 1849.

Walls thin, and widely fenestrated. *Septa* formed by a series of spiniform processes, which sometimes ramify towards the centre of the visceral cavity, so as to constitute a sort of spurious columella.

Typ. sp., *Poraræa fenestrata,* nob.; *Pocillopora fenestrata,* Lamarck, Hist. des An. sans Vert., t. ii, p. 275; Milne Edw. and J. Haime, Ann. des Sc. Nat., 3me série, vol. ix, fig. 1.

8. *Genus* Holaræa.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 259, 1849.

Calices with distinct polygonal margins, rather deep. Septal apparatus composed of irregular trabiculæ, completely blended with the walls, and constituting thus a delicate spongy mass. *Columella* fasciculate and short.

Typ. sp., *Holaræa Parisiensis,* nob.; *Alveolites Parisiensis,* Michelin, Icon. Zooph., pl. xlv, fig. 10.

Second Tribe—MONTIPORINÆ.

Cœnenchyma abundant and spongy.

9. *Genus* Alveopora.

Quoy and Gaimard, Voyage de l'Astrolabe, Zooph., p. 240, 1833.

Corallum arborescent. *Cœnenchyma* very porous and echinulate, but not bearing large excrescences. Margins of the *calices* scarcely distinct. *Septa* not numerous, and formed by series of spiniform processes. No *columella*.

Typ. sp., *Alveopora rubra*, Quoy and Gaim., loc. cit., Zooph., tab. xix, figs. 11-14.

10. *Genus* Montipora.

Quoy and Gaimard, op. cit., p. 247, 1833; *Manopora*, Dana, Zooph., p. 489, 1846.

Corallum of various forms, differing from Alveopora by the existence of large projections of the cœnenchyma between the calicules. *Cœnenchyma* much more abundant, and more delicately spongy.

Typ. sp., *Montipora verrucosa*, Quoy and Gaim., op. cit., Zooph., pl. xx, fig. 11.

11. *Genus* Psammocora.

Dana, Zooph., p. 344, 1846.

Cœnenchyma somewhat compact, of a fasciculate structure, and having its surface papillose. *Calices* very shallow, confluent, and without distinct walls. *Septa* thick, and formed by strong spiniform processes.

Typ. sp., *Psammocora obtusata*, Dana, loc. cit., p. 345; *Pavonia obtusangula*, Lamarck, Hist. des An. sans Vert., t. ii, p. 240.

Sub-order 3.
ZOANTHARIA TABULATA.

Corallum essentially composed of a well-developed mural system, and having the visceral chambers divided into a series of stories by complete transverse tabulæ or diaphragms. Septal apparatus rudimentary.

The principal character of this sub-order is founded on the existence of the lamellar diaphragms that close the visceral chamber of the corallites at different heights, and differ from the dissepiments of the Astreidæ by not being dependent on the septa, and forming as many complete horizontal divisions extending from side to side of the general cavity, instead of occupying only the one or two loculi. It is also to be remembered that the septal apparatus, although more or less rudimentary, has the same general mode of arrangement as in the preceding sub-orders, and never presents the crucial character which we shall find in *Zoantharia rugosa*.

This section comprises four families: Favositidæ, Milleporidæ, Seriatoporidæ, and Theeidæ.

Family VIII.
MILLEPORIDÆ.

Corallum principally composed of a very abundant cœnenchyma, distinct from the walls of the corallites, and of a tubular or cellular structure. *Septa* not numerous; tabulæ numerous, and well formed.

1. *Genus* Millepora.

(*Pars*) Lamarck, Syst. des An. sans Vert., p. 373, 1801; *Palmipora*, Blainville, Dict. des Sc. Nat., t. lx, p. 356, 1830.

Corallum of various forms, but more or less foliaceous. *Cœnenchyma* extremely abundant, of an irregular subtubular structure. *Calices* of very different dimensions in the same corallum. No distinct septa. *Tabulæ* horizontal.

Typ. sp., *Millepora alcicornis*, Lamarck, loc. cit.; Milne Edw., Atlas du Règne Anim. de Cuvier, Zooph., tab. lxxxix, fig. 1.

2. *Genus* Heliopora.

(*Pars*) Blainville, Dict. des Sc. Nat., vol. lx, p. 357, 1830; Dana, Zooph., p. 539, 1846.

Corallum lobulate, somewhat massive, and differing from Millepora by the regular tubular structure of the cœnenchyma, and the existence of small but distinct septa.

Typ. sp., *Heliopora cærulea*, Blainville, loc. cit., p. 357.

3. *Genus* Heliolites.

Dana, Zooph., p. 541, 1846; *Palæopora*, M'Coy, Ann. and Mag. of Nat. Hist., 2d series, vol. iii, p. 129, 1849; *Geoporites*, D'Orbigny, Prodr. de Palæont. stratif. Univers., t. i, p. 49, 1849.

Corallum sub-globose. *Cœnenchyma* regularly tubular. Septal radii advancing almost to the centre of the visceral chamber on the upper surface of the tabulæ, which are horizontal.

Typ. sp., *Heliolites pyriformis*, Dana, loc. cit., p. 542; *Heliolite pyriforme*, etc., Guettard, Mém. sur les Sc. et les Arts, vol. iii, pl. xxii, figs. 13, 14.

4. *Genus* Fistulipora.

M'Coy, Ann. and Mag. of Nat. Hist., 2d series, vol. iii, p. 130, 1849.

Corallum with vesicular cœnenchyma; thick walls and infundibuliform tabulæ.

Typ. sp., *Fistulipora minor*, M'Coy, loc. cit., figs. *a*, *b*.

5. *Genus* Plasmopora.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 262, 1849.

Corallum free, sub-hemispheric, with a basal plate covered with an epitheca presenting concentric folds. *Calices* immersed. *Septa* rudimentary. *Tabulæ* horizontal. *Walls* thin. *Cœnenchyma* composed of large, vertical, radiate laminæ, united by smaller horizontal plates, and resembling much the costal cœnenchyma of the Astreidæ.

Typ. sp., *Plasmopora petaliformis*, nob.; *Porites petaliformis*, Lonsdale, in Murchison, Sil. Syst., pl. xvi, fig. 4.

6. *Genus* Propora.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 262, 1849.

Corallum differing from the preceding genus by the calices having exsert margins; the septa being more developed, and extending outwards so as to constitute small costæ.

Typ. sp., *Propora tubulata*, nob.; *Porites tubulata*, Lonsdale, Sil. Syst., pl. xvi, figs. 3, 3^a, 3^b (cæteris exclusis).

7. *Genus* Axopora.

Corallum composite, incrusting, and forming thin expansions, which are often superposed. *Cœnenchyma* abundant, and forming irregular ridges between the calices, which are small and deep. *Septa* rudimentary. *Columella* well developed, fasciculate, and expanding at its passage through each of the tabulæ.

Typ. sp., *Axopora pyriformis*, nob.; *Geodia pyriformis*, Michelin, Icon., tab. xlvi, fig. 2.

8. *Genus* Lobopora.

Corallum having the same structure as in the preceding genus, but forming large, thick, foliaceous expansions, the two surfaces of which are covered with calices.

Typ. sp., *Lobopora Solanderi*, nob.; *Palmipora Solanderi*, Michelin, op. cit., tab. xlv, fig. 9.

Family IX.
FAVOSITIDÆ.

Corallum essentially formed by lamellar walls, with little or no cœnenchyma. Visceral chambers divided by numerous and well-developed complete tabulæ.

First Tribe—FAVOSITIDÆ.

Corallum massive. *Walls* perforated. *Septa* rudimentary. No *cœnenchyma.*

1. *Genus* Favosites.

Lamarck, Hist. des An. sans Vert., vol. ii, p. 204, 1816; *Calamopora,* Goldfuss, Petref. Germ., vol. i, p. 77, 1826-30.

Corallum composed of basaltiform corallites, and having a basal plate covered with an epitheca, and no radiciform appendices. *Calices* at right angle with the axis of the corallite, and in general hexagonal. *Walls* perforated in a very regular manner. *Tabulæ* horizontal, and very regularly superposed. No *cœnenchyma.*

Typ. sp., *Favosites Gothlandica,* Lamarck, loc. cit., p. 206.

2. *Genus* Michelinia.

De Koninck, Descr. des Anim. foss. des Terr. houilliers de la Belgique, p. 30, 1842-44.

Corallum having a basal plate with radiciform prolongations. *Tabulæ* very irregular, and subvesicular. The other characters as in Favosites.

Typ. sp., *Michelinia tenuisepta,* De Koninck, loc. cit., pl. c, fig. 3 *a, b.*

3. *Genus* Koninckia.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 260, 1849.

Corallum resembling Favosites, but having the walls larger and less regular, and the septa constituted by series of distinct and spiniform processes, interrupted at certain distances by the tabulæ, which are horizontal.

Typ. sp., *Koninckia fragilis,* Milne Edw. and J. Haime, loc. cit.

4. *Genus* Alveolites.

(*Pars*) Lamarck, Syst. des An. sans Vert., p. 375, 1801; Steininger, Mém. Soc. Géol. France, vol. i.

Corallum composed of superposed strata of corallites very similar to those of Favosites, but much shorter, and terminated by an oblique semicircular or subtriangular calice, the edge of which projects on one side.

Typ. sp., *Alveolites spongites*, Steininger, Mém. de la Soc. Géol. de France, vol. i; *Calamopora spongites*, Goldfuss, Petref. Germ., pl. xxviii, figs. 1[a], 1[b], 1[c].

Second Tribe—CHÆTETINÆ.

Corallum massive. *Walls* not perforated. Neither septa nor cœnenchyma.

5. *Genus* Chætetes.

Fischer, Oryct. du Gouv. de Moscou, p. 159, 1837.

Corallum glomerate. *Corallites* very long, basaltiform, and in general more or less bent. *Calices* polygonal. *Tabulæ* independent, not connected in the adjoining corallites, nor placed on the same level throughout the corallum.

Typ. sp., *Chætetes radians*, Fischer, loc. cit., pl. xxxvi, fig. 6.

6. *Genus* Dania.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 261, 1849.

Corallum having most of the characters of Chætetes, but with the tabulæ connected through the different corallites so as to constitute a series of common plates, and to divide the whole mass into a great number of parallel strata.

Typ. sp., *Dania Huronica*, Milne Edw. and J. Haime, loc. cit.

7. *Genus* Stenopora.

(*Pars*) Lonsdale, Geol. of Russia and Ural Mount., vol. i, p. 631, 1845.

Corallum very similar to Chætetes, but having small styliform processes at the angles of the calices.

Typ. sp., *Stenopora spinigera*, Lonsdale, loc. cit., pl. A, fig. 2.

8. *Genus* Constellaria.

Dana, Zooph., p. 537, 1846.

Third Tribe—HALYSITINÆ.

Corallum composed of corallites constituting vertical laminæ or fasciculi, but more or less free laterally, and united by means of connecting tubes or mural expansions. *Walls* well developed, and not porous. *Septa* distinct, but small.

8. *Genus* Halysites.

Fischer, Zoognosia, 3d edit., vol. i, p. 387, 1813; *Catenipora,* Lamarck, Hist. des An. sans Vert., t. ii, p. 206, 1816.

Corallites extremely long, arranged in a single series, and united laterally, so as to constitute large flabelliform expansions, which remain free laterally, but often meet, and thus form a lacunous mass. *Epitheca* very thick. *Septa* almost rudimentary, but very distinct in perfect specimens. *Tabulæ* horizontal.

Typ. sp., *Halysites escharoides,* Fischer; *Catenipora escharoides,* Lamarck, loc. cit., p. 207.

9. *Genus* Harmodites.

Fischer, Notice sur les Tubipores fossiles, 1828; *Syringopora,* Goldfuss, Petref. Germ., vol. i, p. 75, 1826-33.

Corallum fasciculate. Corallites irregularly cylindrical, very long, and united by horizontal connecting tubes. *Tabulæ* infundibuliform.

Typ. sp., *Harmodites ramulosa,* nob.; *Syringopora ramulosa,* Goldfuss, loc. cit., pl. xxv, fig. 7.

10. *Genus* Thecostegites.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 261, 1849.

Corallites cylindrical, short, and united by strong mural expansions situated at various heights. *Tabulæ* horizontal.

Typ. sp., *Thecostegites Bouchardi,* nob.; *Harmodites Bouchardi,* Michelin, Icon. Zooph., pl. xlviii, fig. 3.

Fourth Tribe—POCILLOPORINÆ.

Corallum massive, gibbous, or subdendroid, with thick imperforated walls, forming, towards the surface, an abundant compact cœnenchyma. *Septa* quite rudimentary.

11. *Genus* Pocillopora.

(*Pars*) Lamarck, Hist. des An. sans Vert., t. ii, p. 273, 1816; Dana, Zooph., p. 523, 1846.

Calices shallow, and presenting, at their bottom, a transverse, thick, projecting ring, resembling a columella.

Typ. sp., *Pocillopora acuta,* Lamarck, loc. cit., p. 274; Milne Edw., Atlas du Règne Animal de Cuvier, Zooph., pl. lxxxi, fig. 3.

Family X.

SERIATOPORIDÆ.

Corallum arborescent or bushy, with an abundant compact cœnenchyma. Visceral chambers filling up by the growth of the columella and the walls, and showing but few traces of tabulæ.

1. *Genus* Seriatopora.

Lamarck, Hist. des An. sans Vert., vol. ii, p. 282, 1816.

Corallum arborescent, with echinulated branches. *Calices* arranged in ascending series. *Septa* scarcely visible. *Columella* large and compact.

Typ. sp., *Seriatopora subulata*, Lamarck, loc. cit., p. 282.

2. *Genus* Dendropora.

Michelin, Icon. Zooph., p. 187, 1845.

Corallum arborescent, with very delicate smooth branches. *Calices* distant, and surrounded by a narrow, obtuse margin. *Septa* small, but distinct.

Typ. sp., *Dendropora explicita*, Michelin, op. cit., pl. xlviii, fig. 6.

3. *Genus* Rhabdopora.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 262, 1849.

Corallum with prismatic echinulate branches. *Calices* arranged in series. *Septa* very distinct.

Typ. sp., *Rhabdopora megastoma; Dendropora megastoma*, M'Coy, Ann. and Mag. of Nat. Hist., 2d series, vol. iii, p. 129.

Family XI.

THECIDÆ.

Corallum massive, with an abundant, compact, spurious cœnenchyma, produced by the septa becoming cemented together laterally. *Tabulæ* numerous.

Genus Thecia.

Milne Edw. and J. Haime, Comptes rend., t. xxix, p. 263, 1849.

Septal system highly developed. *Calices* shallow, with a very small deep fossula.

Typ. sp., *Thecia Swinderniana; Agaricia Swinderniana*, Goldfuss, Petref. Germ., pl. xxxviii, fig. 3; *Porites expatiata*, Lonsdale, ap. Murchison, Sil. Syst., p. 678, tab. xv, fig. 3.

Sub-order 4.

ZOANTHARIA RUGOSA.

Corallum simple or composite, with a septal apparatus never forming six distinct systems, as in all the preceding Zoantharia, but appearing to be derived from four primary elements. Sometimes this disposition is rendered manifest by the existence of four well-characterised primary septa, or of an equal number of depressions occupying the bottom of the calice, and assuming a crucial appearance: in other cases only one of these primary septa or excavations is well developed so as to interrupt the radiate form of the system; and in others, again, no trace of septal groups can be discovered, and the whole apparatus is represented by numerous equally developed radiate striæ rising on the surface of the tabulæ, and extending up the inner side of the walls. The corallites are always perfectly distinct, and are never united by means of a cœnenchyma; nor do they ever form linear series, which is often the case in the preceding sections. They multiply by gemmation, and the reproductive buds are in general developed on the surface of the calices of the parents: this often arrests the growth of the latter, and gives rise to a superposition of generations. It is also to be noted that the septa, although in general very incomplete, are never porous, and never bear synapticulæ, but that the visceral chamber is in general filled up from the bottom by a series of transverse tabulæ, or by a vesicular structure, which often constitutes the principal part of the corallum.

Family XII.

STAURIDÆ.

Corallum with well-developed septa, extending without any interruption from the bottom to the top of the visceral chamber, united by lamellar dissepiments, and arranged in four systems, characterised by an equal number of large primary septa.

1. *Genus* Stauria.

Corallum composite, massive, astreiform, and increasing by calicular gemmation. *Corallites* united by their walls, or free in part, and not presenting any *costæ*. *Septa* large, and with undivided edges, united along the axis of the visceral chamber. No *columella*.

Typ. sp., *Stauria astreiformis*, nob.

2. *Genus* Holocystis.

Lonsdale, in the Quarterly Journal of the Geol. Soc. of London, vol. v, part i, p. 83, 1849.

Corallum composite, massive, astreiform, and increasing by extra-calicular gemmation. *Corallites* united by means of well-developed *costæ*. *Columella* styliform.

Typ. sp., *Holocystis elegans; Cyathophora elegans*, Lonsdale, loc. cit., tab. iv, figs. 12, 13, 14, 15.

Family XIII.

CYATHAXONIDÆ.

Corallum with well-developed, complete *septa*, which extend without interruption from the bottom to the top of the visceral chamber, and not forming a regular radiate circle; those of the primary cyclum not much larger than the others, and not forming a four-branched cross, as in the Stauridæ; one well-characterised septal fossula. No dissepiments nor tabulæ.

Genus Cyathaxonia.

Michelin, Icon. Zooph., p. 258, 1846.

Corallum simple. *Calice* deep. *Columella* styliform, strong, and very prominent. *Septa* extending to the columella; the place of one of them occupied by a deep depression or septal fossula.

Typ. sp., *Cyathaxonia cornu*, Michelin, loc. cit., p. 258, pl. lix, fig. 9.

Family XIV.

CYATHOPHYLLIDÆ.

Corallum with incomplete *septa*, that do not extend from the bottom to the top of the visceral chamber, in the form of uninterrupted laminæ; those of the primary cyclum similar to the others, and not forming a central four-branched cross. Septal fossulæ varying in number and in size. Visceral chamber divided by a series of superposed tabulæ.

First Tribe—ZAPHRENTINÆ.

A single septal fossula, well developed, or replaced by a sulcus or a crestiform process, and occasioning more or less irregularity in the radiate arrangement of the septal apparatus. The corallum is simple, and free in all the known species.

1. *Genus* Zaphrentis.

Rafinesque and Clifford, Ann. des Sciences physiques de Bruxelles, vol. v, p. 234, 1820; *Caninia*, Michelin, Dict. des Sc. Nat., Supplém., vol. i, p. 485; *Siphonophyllia*, Scouler, in M'Coy's Carbonif. Foss. of Ireland, p. 187, 1844.

Corallum simple and trochoid. *Calice* deep. Septal fossula strongly developed, and occupying the place of one of the septa. No *columella*. *Tabulæ* moderately developed, and bearing on their upper surface a series of septa, which extend from the wall to the centre of the visceral chamber, and are denticulate all along their calicular edge.

Typ. sp., *Zaphrentis patula; Caninia patula*, Michelin, Icon. Zooph., tab. lix, fig. 4.

2. *Genus* Amplexus.

Sowerby, Miner. Conchol., vol. i, p. 165; *Amplexus* and *Cyathopsis*, D'Orbigny, Prodrome de Paléontol., vol. i, p. 105, 1850.

Corallum resembling Zaphrentis, excepting that the *septa* do not extend to the centre of the visceral chamber, and leave the upper surface of the tabulæ naked and smooth in that part. The *septal fossula* well characterised in the upper portion of the corallum, but not so on the lower floors. *Tabulæ* highly developed.

Typ. sp., *Amplexus coralloides*, Sowerby, loc. cit., tab. lxxii.

3. *Genus* Menophyllum.

Corallum resembling Zaphrentis, excepting that a small septal fossula is situated on each side of the large one, and that one half of the central part of the calice is occupied by an elevated, smooth portion of the tabula, which resembles a crescent.

Typ. sp., *Menophyllum tenui-marginatum*, nob.

4. *Genus* Lophophyllum.

Corallum resembling Zaphrentis, excepting that a crestiform *columella* occupies the centre of the calice, and is in continuity by one of its ends with a small septum, placed in the middle of the septal fossula, and by the other end with the opposite primary septum.

Typ. sp., *Lophophyllum Konincki*, nob.

5. *Genus* Anisophyllum.

Corallum resembling Zaphrentis, excepting by the great development of three primary *septa*, one of which is placed facing the septal fossula; this *fossula* extending much towards the centre of the visceral chamber, and ceasing there to be distinct from the bottom of the calice.

Typ. sp., *Anisophyllum Agassizi*, nob.

6. *Genus* Baryphyllum.

Corallum very short. *Calice* quite superficial. A slightly developed septal fossula, corresponding to one of the branches of a cross, the three other branches of which are constituted by well-developed primary septa. The younger septa not arranged in a regular radiate circle, but inclined obliquely towards the primary ones.

Typ. sp., *Baryphyllum Verneuilanum*, nob.

7. *Genus* Hallia.

Corallum tall, turbinate. *Septa* highly developed, and extending to the centre of the tabulæ. No *columella.* One remarkably large primary septum occupying the place of the septal fossula, and the neighbouring septa directed towards it, so as to assume a pinnate arrangement; the septa belonging to the two other systems presenting the usual regular radiate position.

Typ. sp., *Hallia insignis*, nob.

8. *Genus* Aulacophyllum.

Corallum resembling Hallia by the mode of arrangement of the septa, but having the septal fossula not replaced by a primary septum, and affecting the form of a narrow groove, at the bottom of which the septa of the two adjoining systems meet, and even cross each other.

Typ. sp., *Aulacophyllum sulcatum; Caninia sulcata*, D'Orbigny, Prod. de Paléont., vol. i, p. 105.

9. *Genus* Trochophyllum.

Corallum simple, trochoid. *Calice* rather shallow. Septal fossula rudimentary, and occupied by a small septum. The other *septa* thick, not denticulate, presenting a regular radiate mode of arrangement, and extending almost to the centre of the visceral chamber, where a small tabula is visible.

Typ. sp., *Trochophyllum Verneuili*, nob.

10. *Genus* Hadrophyllum.

Corallum short. *Calice* superficial. One very large septal fossula, and three small ones, representing a cross. The radiate arrangement of the septa somewhat irregular.

Typ. sp., *Hadrophyllum Orbignyi*, nob.

11. *Genus* Combophyllum.

Corallum presenting the general form of a Cyclolites. A single septal fossula. *Septa* exsert, and regularly radiate.

Typ. sp., *Combophyllum osismorum*, nob.

Second Tribe—CYATHOPHYLLINÆ.

Septal apparatus regularly radiate, and uninterrupted, or equally divided into four groups by four superficial septal fossulæ. No true *columella*, but sometimes a spurious one formed by the inner edge of the septa.

12. *Genus* Cyathophyllum.

Goldfuss (in parte), Petref. Germ., vol. i, p. 54, 1826.

Corallum simple or composite. No *costæ*. *Septa* well developed, extending to the centre of the calice, and twisted together so as to produce the appearance of a small columella. *Tabulæ* occupying only the centre of the visceral chamber; the outer portion of which is filled up with numerous vesicular dissepiments. A single wall, situated exteriorly, and provided with a complete epitheca.

Typ. sp., *Cyathophyllum helianthoides*, Goldfuss, loc. cit., tab. xx, fig. 2.

13. *Genus* Pachyphyllum.

Corallum composite, and increasing by lateral gemmation. *Corallites* united in their lower portion by means of the great development of the costæ and the exotheca, and not delimitated by an individual epitheca. *Tabulæ* well characterised.

Typ. sp., *Pachyphyllum Bouchardi*, nob.

14. *Genus* Campophyllum.

Corallum simple, very tall, and protected by an epitheca. *Septa* well developed. *Tabulæ* very large, and smooth towards the centre. Interseptal loculi filled with small vesiculæ.

Typ. sp., *Campophyllum flexuosum; Cyathophyllum flexuosum*, Goldfuss, Petref. Germ., vol. i, tab. xvii, fig. 3.

15. *Genus* Streptelasma.

Hall, Palæont. of New York, p. 17, 1847.

Corallum simple, and differing from Cyathophyllum by the structure of the wall, which is destitute of epitheca, and covered with sublamellar costæ.

Typ. sp., *Streptelasma corniculum*, Hall, loc. cit., tab. xxv, fig. 1.

16. *Genus* Omphyma.

Rafinesque and Clifford, in Ann. des Sc. Phys. de Bruxelles, vol. v, p. 234, 1820.

Corallum simple, turbinate. Wall provided with a rudimentary epitheca, and producing radiciform appendices. *Septa* very numerous, equally developed, and divided into four groups by an equal number of shallow septal fossulæ. *Tabulæ* well developed, and smooth towards the centre.

Typ. sp., *Omphyma turbinata; Madrepora turbinata*, Lin. Amœn. Acad., vol. i, tab. iv, fig. 2.

17. *Genus* Goniophyllum.

Corallum simple, and affecting the form of a quadrangular pyramid. *Calice* deep and square. *Septa* thick and well developed. *Tabulæ* central, and but little developed.

Typ. sp., *Goniophyllum pyramidale; Turbinolia pyramidalis*, Hisinger, Lethæa Suecica, tab. xviii, fig. 12.

18. *Genus* Chonophyllum.

Corallum simple, and constituted principally by a series of infundibuliform *tabulæ*, superposed and invaginated, the surface of which presents numerous septal radii equally developed, and extending from the centre to the circumference. No *columella* nor *walls*.

Typ. sp., *Chonophyllum perfoliatum; Cyathophyllum perfoliatum*, Goldfuss, tab. xviii, fig. 5.

19. *Genus* Ptychophyllum.

Strombodes (*pars*), Lonsdale, Sil. Syst., p. 691, 1839 (not Schweigger.).

Corallum simple, and organized as in the preceding genus, but having the septal radii strongly twisted towards the centre of the tabulæ, so as to constitute a spurious *columella*.

Typ. sp., *Ptychophyllum Stokesi*, nob.; C. Stokes, Trans. of the Geol. Soc., 2d series, vol. i, tab. xxix, fig. 1. (N.B. The second figure bearing this number, but not the first.)

20. *Genus* Heliophyllum.

Hall, in Dana, Zooph., p. 396. 1846.

Corallum simple. Septal apparatus well developed, and producing lateral lamellar prolongations, which extend from the wall towards the centre of the visceral chamber, so as to represent ascending arches and to constitute irregular central *tabulæ*, and which are united towards the circumference by means of vertical dissepiments.

Typ. sp., *Heliophyllum Halli*, nob.; *Strombodes helianthoides*, Hall, Geol. of New York, No. 48, fig. 3 (not *S. helianthoides* of Phillips).

21. *Genus* Metriophyllum.

Corallum simple, turbinate. *Septa* well developed, slightly twisted, and extending to the centre of the visceral chamber, through well-developed *tabulæ*.

Typ. sp., *Metriophyllum Bouchardi*, nob.; *Cyathophyllum mitratum*, Michelin, Icon. Zooph., tab. xlvii, fig. 7 (not *C. mitratum* of Schlotheim).

22. *Genus* Clisiophyllum.

(*Pars*) Dana, Exploring Exped., Zoophytes, p. 361, 1846.

Corallum simple, turbinate. *Septa* well developed, and rising towards the centre of the calice so as to form a spurious *columella*, but not twisted.

Typ. sp., *Clisiophyllum Danianum*, nob.

23. *Genus* Aulophyllum.

Corallum simple. *Septa* well developed. A double mural investment; the interior wall dividing the visceral chamber into two portions—one central and columnar, the other exterior and annular. No *columella*. *Tabulæ* but little developed.

Typ. sp., *Aulophyllum prolapsum; Clisiophyllum prolapsum*, M'Coy, in Ann. and Mag. of Nat. Hist., 2d series, vol. iii, p. 3.

24. *Genus* Acervularia.

Schweigger, Handb. der Naturg., p. 418, 1820.

Corallum composite, increasing by calicular gemmation. *Corallites* provided with a double mural investment; the inner wall disposed as in the preceding genus. Septal apparatus well developed between the outer and the inner walls, but much less so in the central area. No *columella*. *Tabulæ* not well developed.

Typ. sp., *Acervularia Rœmeri; Astrea Hennahi*, Rœmer, Verst. der Hartzgeb., tab. ii, fig. 13 (not Lonsdale).

25. *Genus* Strombodes.

(*Pars*) Schweigger, Handb. der Naturg., p. 418, 1820; Goldfuss, Petref. Germ., vol. i, p. 62, 1826; *Acervularia*, Lonsdale, Sil. Syst., p. 689, 1839; *Arachnophyllum*, Dana, Zooph., p. 360, 1846; *Strombodes* and *Actinocyathus*, D'Orbigny, Prod. de Paléont. stratigr., vol. i, p. 107, 1849.

Corallum composite, increasing by calicular gemmation. *Corallites* constituted principally by a series of superposed, invaginated, infundibuliform *tabulæ*, united by ascending trabiculæ, so as to form a columnar mass. *Calices* pentagonal, well circumscribed, and completely covered with the septal radii. *Outer walls* not well developed; the inner mural investment rudimentary.

Typ. sp., *Strombodes pentagonus*, Goldf., Petref. Germ., vol. i, tab. xxi, fig. 3.

26. *Genus* Phillipsastrea.

D'Orbigny, Note sur des Polypiers fossiles, p. 2, 1849.

Corallum composite, resembling Strombodes, but differing from them by the septal or costal radii of the neighbouring corallites, being confluent, and consequently the calices not being definitely circumscribed. No exterior *walls;* the interior mural investment well characterised. The centre of the *tabulæ* presenting a columellarian tubercle.

Typ. sp., *Phillipsastrea Hennahi,* D'Orbigny, loc. cit.; *Astrea Hennahi,* Lonsdale, in Geol. Trans., 2d series, vol. v, tab. lviii, fig. 3.

27. *Genus* Eridophyllum.

Corallum composite, and increasing by lateral gemmation. *Corallites* tall, cylindroid, and provided with a thick epitheca, which gives rise to a vertical series of short and thick subradiciform productions that extend to the next individual and unite them together. *Tabulæ* well developed, and occupying the central area circumscribed by the inner wall. Septal apparatus occupying the annular area situated between the outer and inner mural investment, but not extending into the inner or central area.

Typ. sp., *Eridophyllum seriale,* nob.

Third Tribe—LITHODENDRONINÆ.

Axis of the visceral chamber of the corallites occupied by a styliform or lamellar columella.

28. *Genus* Lithodendron.

Phillips, Geol. of Yorkshire, vol. ii, p. 200, 1835 (but not *Lithodendron* of Schweigger, which is not an admissible genus); *Siphonodendron,* M'Coy, in Ann. and Mag. of Nat. Hist., 2d series, vol. iii, 1849.

Corallum composite, arborescent, or massive. *Corallites* cylindrical or prismatic. *Columella* styliform, compact. *Septa* well developed, but not reaching to the columella. *Tabulæ* well developed. Interior wall rudimentary.

Typ. sp., *Lithodendron irregulare,* Phillips, loc. cit., pl. ii, figs. 14, 15.

29. *Genus* Nematophyllum.

Nematophyllum and *Stylaxis,* M'Coy, loc. cit., 1849.

Corallum composite, massive. *Corallites* prismatic, with a well-developed interior *wall.* *Columella* lamellar. *Septa* well developed, and united by transverse dissepiments, which extend to the columella, but do not constitute true tabulæ. Exterior area vesicular.

Typ. sp., *Nematophyllum arachnoideum,* M'Coy, loc. cit., p. 16.

30. *Genus* Lithostrotion.

(*Pars*) Fleming, British Animals, p. 508, 1828; *Strombodes* and *Lonsdaleia*, M'Coy, in Ann. of Nat. Hist., 2d series, vol. iii, pp. 10, 11, 1849.

Corallum resembling *Nematophyllum*, but having the *columella* formed by a fasciculus of twisted bands, and the *septa* subvesicular exteriorly, and joining the columella along their inner edge.

Typ. sp., *Lithostrotion floriforme*, Fleming, loc. cit., p. 508.

31. *Genus* Axophyllum.

Corallum simple, trochoid, and resembling Lithostrotion by its structure.

Typ. sp., *Axophyllum expansum*, nob.

32. *Genus* Syringophyllum.

Sarcinula, Dana, Zooph., p. 363, 1846 (not *Sarcinula*, Lamarck).

Corallum composite, astreiform. *Corallites* provided with strong *walls*, and much developed costæ. *Septa* large. *Tabulæ* but little developed. *Columella* styliform.

Typ. sp., *Syringophyllum organum; Madrepora organum*, Linnæus, Syst. Nat., ed. xii, vol. i, p. 1278.

Family XV.

CYSTIPHYLLIDÆ.

Corallum essentially composed of a vesicular tissue, and presenting little or no traces of septa or radiate striæ.

1. *Genus* Cystiphyllum.

Lonsdale, in Murchison's Silurian Syst., p. 691, 1839.

Corallum simple, turbinate; the visceral chamber filled with small vesicular laminæ. *Calice* shallow. *Walls* vesicular.

Typ. sp., *Cystiphyllum Siluriense*, Lonsdale, loc. cit., tab xvi bis, fig. 1 (but not fig. 2).

Sub-order 5.

ZOANTHARIA CAULICULATA.

Antipathacea, Dana, Zooph., p. 574.

Polypi supported on a *sclerobasis* or epidermic stem-like corallum.

The general form of the corallum is similar to that of the Isis, Gorgonia, &c., in the order of Alcyonaria; but may be distinguished from these by its surface being spinulous or smooth, whereas it is always sulcated in Alcyonaria.

Family ANTIPATHIDÆ.

Gray, Synop. of the Brit. Mus., p. 135, 1842; Dana, Zooph., p. 574, 1846.

1. *Genus* Antipathes.

(In parte) Pallas, Elench. Zooph., p. 209, 1766.

Corallum arborescent; its surface spinulous.

Typ. sp., *Antipathes myriophylla*, Ellis and Solander, Zooph., tab. xix, figs. 11, 12.

2. *Genus* Cirrhipathes.

De Blainville, in Dict. des Sc. Nat., vol. lx, p. 475, 1830.

Corallum not arborescent, and having the form of a simple cylindrical stem; its surface spinulous.

Typ. sp., *Cirrhipathes spiralis*, Blainv., loc. cit.; *Antipathes spiralis*, Ellis and Soland., Zooph., tab. xix, fig. 1.

3. *Genus* Leiopathes.

Gray, Synops. of the Brit. Mus., p. 135, 1842.

Corallum arborescent; its surface smooth.

Typ. sp. *Leiopathes glaberrima; Antipathes glaberrima*, Esper, Pflanz., Antipathes, tab. ix.

ZOANTHARIA INCERTÆ SEDIS.

1. *Genus* Heterophyllia.

M'Coy, Palæozoic Corals, in Ann. and Mag. of Nat. Hist., 2d series, vol. iii, p. 126, 1849.

Corallum composed of a tall, subcylindrical, irregularly fluted, stem (or tube), containing a few laminæ, irregularly branching and coalescing, but not presenting a radiate appearance.

Typ. sp., *Heterophyllia grandis*, M'Coy, loc. cit., figs. A, B.

2. *Genus* Mortieria.

De Koninck, Anim. foss. du Terr. carbon. de Belgique, p. 12, 1842.

Corallum having the form of a bi-concave disc, presenting a radiate structure and numerous costæ.

Typ. sp., *Mortieria vertebralis,* De Koninck, loc. cit., pl. B, fig. 3.

3. *Genus* Cyclocrinites.

Eichwald, Uber das Silurische Schichten-System in Esthland, p. 192, 1840.

Corallum composite, astreiform. *Calices* hexagonal and shallow. *Septa* well characterised, but not extending to the centre of the visceral chamber, which appears to be occupied by small tabulæ. (?)

Typ. sp., *Cyclocrinites Spaskii,* Eichwald, Die Urwelt Russlands durch abbildungen erlaeutert, p. 48, tab. i, fig. 8, 1842.

Order 11.

ALCYONARIA.

Alcyoniens, Audouin and Milne Edwards, Recherches sur les Anim. sans Vertèbres faites aux iles Chausay, Ann. des Sc. Nat., 1st series,, vol. xv, p. 18, 1828; *Zoophytaria,* Blainville, Manuel d'Actinologie, p. 496, 1834; *Zoophyta asteroïdea,* Johnston, Brit. Zooph., p. 164, 1838; *Alcyonaria* Dana, Exploring Expedition, Zooph., p. 586, 1846; *Anthozoa asteroïdea,* Johnston, Brit. Zooph., 2d edit., p. 138, 1847.

Polypi with bi-pinnate tentacula, and only eight perigastric membranaceous laminæ, containing the reproductive organs.

Alcyonaria have, in general, their dermal tissue consolidated by isolated spiculæ or nodular concretions only, and very rarely present a vaginal polypidom similar to that of the Zoantharia; but even when that is the case, the visceral chamber is never subdivided by any longitudinal septa, and consequently the calice never presents any appearance of radii. In general, the corallum is entirely composed of epidermic tissue, (or basal secretion, Dana,) and constitutes a sort of stem or axis in the centre of the compound mass formed by the gemmation of the Polypi. This sclerobasis is always covered by soft dermic tissue, and increases by the addition of concentric layers.

This order is far from being as numerous as the preceding division of Corallaria, and comprises three natural families,—Alcyonidæ, Gorgonidæ, and Pennatulidæ.

Family I.

ALCYONIDÆ.

Polypi adherent and not provided with an epidermic sclerenchyma.

In this family, the dermic tissue is usually consolidated by a great number of sclerenchymous spicula imbedded in its substance, and constitutes sometimes a tubular corallum, but there is never any trace of a central stem or axis, like that which is constituted by the sclerobasis in Gorgonidæ and in most of the Pennatulidæ.

First Tribe—CORNULARINÆ.

Polypi simple or segregate, and produced by gemmation on creeping stolons, or basal membranaceous expansions, and having no lateral buds or connecting appendices.

1. *Genus* Cornularia.

Lamarck, Hist. des An. sans Vert., vol. ii, p. 111, 1816.

Polypi rising by gemmation from creeping filiform stolons, and provided with a tough or subcorneous tubiform polypidom, the surface of which is not costulated.

Typ. sp., *Cornularia cornucopiæ*, Cuvier; *Tubularia cornucopiæ*, Cavolini, Mem. per Servire alla Storia de Polipi Marini, tab. ix, figs. 11, 12; *Cornularia rugosa*, Lamarck, loc. cit.

2. *Genus* Clavularia.

Quoy and Gaimard, ap. Blainville, Dict. des Sc. Nat., vol. lx, p. 499, 1830; *Actinantha*, Lesson, Zool. de la Coquille, Zooph., p. 89, 1831.

Polypi resembling Cornularia, but having their tubular polypidoms costulated and incrustated with long spicula.

Typ. sp., *Clavularia viridis*, Quoy and Gaim., Voyage de l'Astrolabe, Zooph., tab. xxi, fig. 10.

3. *Genus* Rhizoxenia.

Ehrenberg, Corall. Roth. Meer., p. 55, 1834.

Polypi resembling those of the preceding genus, but not retractile.

Typ. sp., *Rhizoxenia thalassantha*, Ehr.; *Zoantha thalassantha*, Lesson, Voyage de la Coquille, Zooph., tab. i, fig. 2.

4. *Genus* Sarcodictyon.

E. Forbes ap. Johnston, Brit. Zooph., 2d ed., p. 179.

Polypi rising from creeping, filiform, anastomosing stolons, distant, uniserial, and appearing verruciform (not tubular) when retracted. Differ from Cornularia by the shortness of the polypidoms.

Typ. sp., *Sarcodictyon catenatum*, Forbes, loc. cit., tab. xxxiii, figs. 4, 7.

5. *Genus* Anthelia.

Savigny, ap. Lamarck, An. sans Verteb., vol. ii, p. 407, 1816.

Polypi not retractile, and rising from a thin fleshy incrustating plate.

Typ. sp., *Anthelia glauca*, Savigny, Egypte, Polypes, tab. i, fig. 7.

6. *Genus* Sympodium.

Ehrenberg, Corall., p. 61, 1834.

Polypi resembling Anthelia, but being retractile.

Typ. sp., *Sympodium fuliginosum*, Ehrenb., Savigny, Egypte, Polypes, tab. i, fig. 6.

7. *Genus* Aulopora.

Goldfuss, Petref. Germ., vol. i, p. 82.

The fossil corals forming this genus greatly resemble Cornularia and Sarcodictyon, but differ from all the preceding genera by their thick, calcareous polypidom.

Typ. sp., *Aulopora serpens*, Goldfuss, loc. cit., tab. xxix, fig. 1.

8. *Genus* Cladochonus.

M'Coy, in Ann. and Mag. of Nat. Hist. 1st series, vol. xx, p. 227.

Corallum resembling Aulopora, but composed of cup-shaped calices, arranged in a regularly alternate manner, and bent in nearly opposite directions.

Typ. sp., *Cladochonus tenuicollis*, M'Coy, loc. cit., tab. xi. fig. 8.

Second Tribe—TUBIPORINÆ.

Polypi fasciculate, and provided with independent tubular polypidoms, united at various heights by means of horizontal connecting plates, the surface of which produces the reproductive buds.

9. *Genus* Tubipora.

Lamarck, Hist. des Anim. sans Verteb., vol. ii, p. 207, 1816.

Typ. sp. *Tubipora musica,* Lamarck, loc. cit., p. 209.

Third Tribe—TELESTHINÆ.

Polypi segregate and multiplying by lateral gemmation, so as to form arborescent tufts.

10. *Genus* Telestho.

Lamouroux, Polypiers Flexibles, p. 232.

Polypidom composed of ramified tubes of a subcalcareous structure.

Typ. sp., *Telestho aurantiaca,* Lamouroux, loc. cit., tab. vii, fig. 6.

Fourth Tribe—ALCYONINÆ.

Polypi aggregate and multiplying by lateral gemmation, so as to constitute a ramified, lobate or simple mass.

11. *Genus* Alcyonium.

Pallas, Elenchus Zooph., p. 342, 1766; *Lobularia,* Savigny, ap. Lamarck, Hist. des Anim. sans Verteb. vol. ii, p. 412, 1816.

Polypi retractile, and united by a thick tough common tissue, so as to form gibbose or subramified masses.

Typ. sp., *Alcyonium digitatum,* Lin. Solander and Ellis, op. cit., p. 175.

12. *Genus* Xenia.

Savigny, Egypte, Atlas and op., Lamarck, op. cit., vol. ii, p. 629, 1816.

Polypi forming subramified masses, as in Alcyonium, but not retractile, and not having a thick coating of spiculæ at the basis of the tentacula.

Typ. sp. *Xenia umbellata*, Savigny, Egypte, Polyp., tab. i, fig. 3.

13. *Genus* Nephthya.

Savigny, Atlas de l'Egypte; Blainville, Manuel d'Actinol, p. 523; *Spoggodes*, Lesson, Illustr. de Zoologie, 1831.

Polypi forming arborescent masses, incompletely retractile, and having the borders of the calice thick and incrustated with large navicular spiculæ.

Typ. sp,, *Nephthya Chabroli*, Audouin, ap. Savigny, Egypte, Pol. tab. ii. fig. 5.

14. *Genus* Paralcyonium.

Alcyonidia, Milne Edwards, Ann. des Sc. Nat. 2d series, vol. iv, p. 323.

Polypi resembling Nephthya, but being completely retractile, and having the lower part of the common mass incrustated with a thick coating of long navicular spiculæ, but the upper part membranaceous and retractile.

Typ. sp., *Paralcyonium elegans; Alcyonidia elegans*, Milne Edwards, loc. cit., tab. xii and xiii.

15. *Genus* Sarcophyton.

Lesson, Zoologie du Voyage de la Coquille, Zooph., p. 92, 1831.

Differs from the genus Alcyonium by the great abundance and the peculiar structure of the common tissue, the cells of which are tubular, and arranged with great regularity in fasciculi, perpendicularly to the upper surface of the mass.

Typ. sp., *Sarcophyton plicatum*, Valenciennes MSS.; *Sarcophyton lobulatum*, Lesson, loc. cit.; *Alcyonium plicatum*, Lamarck, Hist. des An. sans Verteb., vol. ii, p. 395.

16. *Genus* Cespitularia.

Valenciennes MSS.

Polypi non-retractile, arranged in fasciculi, and united in the greatest part of their length by a dense, tough, common tissue, as in Alcyonium.

Typ. sp., *Cespitularia multipinnata*, Valen.; *Cornularia multipinnata*, Quoy and Gaimard, Voyage de l'Astrolabe, Zooph., tab. xxii, figs. 1-4.

17. *Genus* Distichopora?

Lamarck, loc. cit., p. 197.

This singular zoophyte appears to have more affinity to Alcyonium than to any other form of polypi; but the place belonging to it in a natural system of classification is as yet very uncertain. It is characterised by a calcareous, dendroid corallum, composed of long tubular cells, that present no traces of septa or tubulæ, and are disposed in a flabellate manner, so as to constitute a vertical plane, the two sides of which are covered with a thick and compact cœnenchyma, and the edge assumes the appearance of a calicular groove, limited laterally by two rows of circular pores. Nothing is known concerning the structure of the soft parts.

Typ. sp., *Distichopora violacea*, Lamarck, op. cit., p. 305. (For the structure of the Corallum, see Milne Edwards, Atlas du Regne Animal de Cuvier, Zooph., tab. lxxxv, fig. 4.)

Family II.

GORGONIDÆ.

Polypiers corticiferes, Lamarck, Hist. des Anim. sans Verteb. vol. ii, p. 288, 1816; *Polypes corticaux*, Cuvier, Regne Animal, vol. iv, p. 78, 1817; *Corallia*, Blainville, Manuel d'Actinologie, p. 501, 1834; *Cerato-corallia*, Ehrenberg, Corall. des Roth. Meeres, 1834; *Coralliadæ*, Gray, Synop. Brit. Mus. p. 134; *Gorgoniadæ*, Johnston, British Zooph., p. 182, 1838; *Gorgonidæ*, Dana, Exploring Expedition, Zooph., p. 637, 1846; *Gorgoniadæ*, Gray, List of British Anim. of the British Museum, p. 55, 1848.

Polypi provided with a thick, suberous cœnenchyma, surrounding a central stem that is adherent to an extraneous body by its basis, and is formed of epidermic sclerenchyma.

First Tribe—GORGONINÆ.

Gorgonia, Pallas, Elenchus Zoophytorum, p. 160, 1766; Cuvier, Regne Animal, 1st ed., vol. iv, p. 80; Lamarck, Hist. des Anim. sans Verteb., vol. ii, p. 309; *Gorgoninæ*, Dana, Exploring Expedition, Zooph., p. 641, 1846.

Common axis inarticulate, horny or fasciculate, but not calcareous.

1. *Genus* Gorgonia.

Pallas, loc. cit., (in parte.)

Axis corneous. *Calices* disposed irregularly round the ramified cylinders formed by the cœnenchyma, and not encircled by imbricated squammæ. *Polypi* retractile.

Typ. sp., *Gorgonia tuberculata*, Esper. Pflanz., Gorg., tab. xxxvii.

2. *Genus* Pterogorgia.

Ehrenberg, Corall. des Rothen Meeres, p. 144, 1834; Dana, op. cit., p. 647, 1846.

Differs from Gorgonia by the polypi being bifarious.

Typ. sp., *Pterogorgia anceps*, Ehrenb., loc. cit., p. 145.

3. *Genus* Bebryce.

Philippi, Zoologesche Beobachtungen, in Archiv. fur Naturgeschichte, von Erichson, vol. viii, p. 35, 1842.

Arborescent compound polypi, resembling Gorgonia by their corneous sclerobasis, but differing from the preceding genera by not being retractile.

Typ. sp., *Bebryce mollis*, Philippi, loc. cit.

4. *Genus* Phyllogorgia.

Differs from Gorgonia by the cœnenchyma not constituting a cylindrical sheath around the ramifications of the sclerobasis, but extending between them so as to constitute large foliaceous, frondiform laminæ, the two surfaces of which are studded with the calices of the individual polypi.

Typ. sp., *Phyllogorgia dilatata; Gorgonia dilatata*, Esper, Pflanz. Gorg. tab. xli.

5. *Genus* Phycogorgia.

Sclerobasis flabelliform, divided into digitated lobes, and composed of delicate corneous fibres united into laminæ, the two sides of which are covered with the cœnenchyma, and densely studded with numerous non-prominent calices.

Typ. sp., *Phycogorgia fucata; Gorgonia fucata*, Valenciennes, Voyage de la Venus, tab. xi, fig. 2.

6. *Genus* Muricea.

Lamouroux, Exposit. Method. des Polyp. p. 36, 1821.

Differs from Gorgonia by the calices being surrounded with imbricated squammulæ, but not supported on long, verruciform, moveable appendices, as in Primnoa.

Typ. sp., *Muricea spicifera*, Lamouroux, op. eit., tab. lxxi, figs. 1, 2.

7. *Genus* Primnoa.

Lamouroux, Hist. des Polypiers Flexibles, p. 440, 1816.

Differs from the preceding genus by the polypi constituting long verruciform subpediculated appendices, which are capable of motion at their bases.

8. *Genus* Solanderia.

Duchassaing and Michelin, in Guerin's Revue Zoologique, June, 1846.

Differs from Gorgonia by the suberous texture of the sclerobasal axis, which resembles the non-calcified joints of Melitæa.

Typ. sp., *Solanderia gracilis,* Duchassaing and Michelin, loc. cit.

9. *Genus* Briareum.

Blainville, Manuel d'Actinologie, p. 520, 1830.

Axis soft, suberous, or composed of spicula. This genus is intermediate between Alcyonium and Gorgonia.

Typ. sp., *Briareum gorgonoideum,* Blainv.; *Gorgonia briareus,* Lin.; Ellis and Solander, tab. xiv, figs. 1, 2.

The genus Hyalonema established by M. Gray, ('Proceed. of the Zool. Soc.' 1835, p. 63,) is also referred by some zoologists to the tribe of Gorgoninæ; but the recent observations of M. Valenciennes tend to establish that the fasciculi of siliceous threads, which constitute the axis of this singular production, belong to the class of Spongidæ, and the polypi which we have observed in a dried state on different parts of the axis appear to be parasites, belonging to the order of Zoantharia.

Second Tribe—ISINÆ.

Dana, Exploring Exped., Zooph., p. 677, 1846.

Common axis articulated, or composed of segments, the structure of which differ alternately.

10. *Genus* Isis.

Linnæus, Syst. Nat., 12th ed., p. 1287, 1767.

Axal sclerobasis composed of joints, alternately corneous and calcareous; branches proceeding from the calcareous joints.

Typ. sp., *Isis hippuris,* Lin., loc. cit.

11. *Genus* Mopsea.

Lamouroux, Polyp. Flex., p. 466, 1816.

Axis presenting the same structure as in the preceding genus, but with the branches proceeding from the corneous joints.

Typ. sp., *Mopsea dichotoma,* Lamouroux, loc. cit., p. 467.

12. *Genus* Melitæa.

Lamouroux, Polyp. Flex., p. 461, 1816.

Axis composed of joints, which are alternately calcareous and suberous.

Typ. sp., *Melitæa ochracea*, Lamouroux, loc. cit., p. 462.

Third Tribe—CORALLINÆ.

Dana, loc. cit., p. 639, 1846.

Common axis inarticulate, solid and calcareous.

13. *Genus* Corallium.

Lamarck, Hist. des Anim. sans Vert., t. ii, p. 295, 1816.

Typ. sp., *Corallium rubrum*, Cavolini, Mem. per Servire all. Hist. des Polypi Marini, tab. ii.

Family III.
PENNATULIDÆ.

Pennatula, Linnæus, Syst. Nat., 10th ed., p. 818; Pallas, Elen. Zooph., p. 362, 1766; *Polypi natantes*, Lamarck, op. cit., p. 415; *Pennatulidæ*, Fleming, Brit. Animals, p. 507, 1828; *Pennatularia*, Blainville, Manuel, p. 512, 1830; *Calomides*, Latreille, Fam. du Reg. Anim. p. 543; *Pennatulina*, Ehrenberg, loc. cit., p. 63, 1834; *Pennatulidæ*, Johnston, Brit. Zooph., p. 175; Dana, Explor. Exped. p. 587, 1846.

Polypi aggregate, and having a common peduncle, the centre of which is occupied by a peculiar cavity, and usually contains a solid axis; this sclerobasis styliform, and never expanding at its under extremity, so as to adhere to extraneous bodies. The polypi mass is consequently free.

1. *Genus* Pennatula.

(In parte.) Linnæus, Syst. Nat., 10th ed., p. 818, 1760; Lamarck, Syst. des An. sans Vert., p. 380, 1801.

Polype mass plume-shaped, with the shaft composed of contractile common tissue, containing a short subosseous axis, and bearing on each side of its upper part a series of large spreading pinnules, on the upper edge of which, the retractile exhalic portion of the polypi protudes. The axis is cylindrical at its upper part, and more or less quadrangular towards its lower end; its structure is somewhat fibrous, and its tissue is not very brittle.

Typ. sp., *Pennatula setacea*, Esper, Pflanz., Pennat. tab. vii.

2. *Genus* VIRGULARIA.

Lamarck, Hist. des Anim. sans Verteb. vol. ii, p. 429, 1816.

Differs from Pennatula by the length of its shaft and the shortness of its pinnules, which assume the form of lunate lobes, or simple transverse striæ. Axis cylindrieal, ealcareous, very long, slender, tapering, and presenting in its transverse section a radiate structure.

Typ. sp., *Virgularia mirabilis*, Lamk.; *Pennatula mirabilis*, Müller, Zool. Danica, vol. i, tab. xi.

3. *Genus* PAVONARIA.

Cuvier, Regne Animal, vol. iv, p. 85, 1816; *Funicularia*, Lamarck, op. cit., p. 423, 1816.

Polype mass virgate; the polypi not retractile, arranged on one side of the stem. Axis quadrangular, long, and very tapering.

Typ. sp., *Pavonaria quadrangularis*, Cuv.; *Pennatula antennina*, Lin.; Johnston, Brit. Zooph., tab. xxxi.

4. *Genus* GRAPHULARIA.

Corallum styliform, straight, very long, cylindroid towards the lower extremity, subtetrahedral at the upper part, and presenting on one side a broad shallow furrow. Transverse section showing the existence of a thin coating, and a radiate structure in the body of the eoral.

Typ. sp., *Graphularia Wetherelli*, nob.; *Pennatula*, Sowerby and Wetherell, in Geol. Trans. 2d series, vol. v, part i, p. 136, tab. viii. fig. 2.

5. *Genus* UMBELLULARIA.

Cuvier, Regne Animal, vol. iv, 1807.

Resembling Pavonaria, but having all the polypi eolleeted in a terminal bunch at the extremity of the stem. Axis quadrangular and twisted.

Typ. sp., *Umbellularia Groenlandica*, Cuv.; *Hydra Marina arctica*, Ellis, Corallines, tab. xxxvii.

6. *Genus* VERETILLUM.

Cuvier, Regne Animal, vol. iv.

Resembling Pennatula, but not having any lateral pinnules, with the polypi arranged all round the upper part of the stem. Axis rudimentary, and of a form almost navicular.

Typ. sp., *Veretillum cynomorium*, Cuvier; *Pennatula digitiformis*, Ellis.

7. *Genus* Lituaria.

Valenciennes MSS., Cat. of the Zoophytes in the Museum of Paris.

Resembling Veretillum, but having a long well-developed axis, quadrangular and tapering towards its lower part, inflated, claviform, pitted and echinulate at its upper end.

Typ. sp., *Lituaria phalloides,* Valenciennes, loc. cit.; *Pennatula phalloides,* Pallas, Miscel. Zool., tab. xiii.

8. *Genus* Cavernularia.

Valenciennes, loc. cit., MSS.

Resembling Veretillum, but having in its centre a large fibrous tube divided longitudinally into four cavities, and not containing any calcareous or horny axis.

Typ. sp., *Cavernularia obesa,* Valenciennes MSS.

9. *Genus* Renilla.

Lamarck, Hist. des Anim. sans. Verteb., vol. ii, p. 428, 1816.

Polyp-mass explanate, unifacial, reniform, with a short, slender peduncle, containing a central cavity as in Pennatula, but not having any solid axis.

Typ. sp., *Renilla Americana,* Lamarck; *Pennatula reniformis,* Ellis and Solander, p. 67; Shaw, Miscel. iv, tab. cxxxix.

The genus Graptolithus (Linnæus, *Iter Scan.* 1751,) appears to have more affinity with Virgularia than with any other recent zoophyte. The polype mass is slender, virgate, and often becomes bifurcate by the progress of growth. The axis projects at the inferior extremity of the stem, and is often bifurcate.

Example, *Graptolithus ramosus,* Hall, Palæont. of New York, tab. lxxiii, fig. 3.

The genus Websteria, nob. appears to be very similar to Graptolithus by its general structure, but offers also a certain resemblance to some Sertularidæ and to certain Bryozoa. In the present state of our knowledge, the natural affinities of these fossil zoophytes are indeed so obscure, that we hesitate to place them in any of the preceding zoological divisions, and prefer leaving them in the *incertæ sedis.*

Typ. sp., *Websteria Crisioïdes,* nob., tab. vii, fig. 5.

Order 3.

PODACTINARIA.

Polypi having the gastric cavity surrounded by four vertical membranaceous *septa*, at the upper end of which are placed four pairs of intestiniform reproductive organs. The tentacula discoidal, pedunculated, not tubular as in Zoantharia and Alcyonaria, but organized much in the same way as in Echinoderma. The mouth proboscidiform, and the fauces surrounded by numerous internal, filiform, contractile appendices.

The genus Lucernaria is the only known representative of this zoological type, and comprises no coralligenous polypi.

Sub-class 2.

HYDRARIA.

Polypes sertulariens, Audouin and Milne Edwards, Recherches sur les Anim. sans Verteb., faites aux îles Chausay, in Ann. des Sc. Nat., 1st series, vol. xv, p. 18, 1828, ap. Lamarck, Hist. des An. sans Verteb. 2d ed., vol. ii., p. 105; *Sertulariacæa* (*in parte*), Blainville, Manuel d'Actinologie, p. 465, 1834; *Zoocorallia oligactinia*, Ehrenberg, Coral. Roth. Meeres, p. 67, 1834; *Zoophyta Hydroida*, Johnston, in Mag. of Zool. and Bot., vol. i, p. 447, 1837; *Polyparia*, Gray, Synop. Brit. Mus.; *Nudibranchiata*, Farre, on the Structure of Polypi, Phil. Trans. 1837; *Hydrozoa*, R. Owen, Lectures on the Comp. Anat. of the Inverteb. Animals, p. 82, 1843; *Hydroidea*, Dana, Exploring Expedition, Zooph. p. 685, 1846; *Anthozoa Hydroidea*, Johnston, British Zooph, 2d ed. p. 5, 1847.

Polypi with a simple, non-lamelliferous, digestive cavity. No internal generative organs. Tentacula filiform and subverrucose.

The naked, fresh-water zoophytes of the genus Hydra constitute the type of this group, and till very lately were considered as being closely allied to Sertularia, Campanularia, &c.; but the recent observations of divers zoologists tend to establish that all the coralligenous animals of this form belong to the class of Medusa. Till this question is decided, it would therefore be idle to make any modifications in the systematic arrangement of these problematic polypi, and it will suffice for us to refer the reader to Dr. Johnston's valuable work on 'British Zoophytes,' for the characters of the generic divisions generally adopted.

DESCRIPTION

OF

THE BRITISH FOSSIL CORALS.

CHAPTER I.

CORALS OF THE CRAG.

The Crag formation of the East of England is generally reputed very rich in Fossil Corals; and the name given to the lower strata of this system is even derived from the abundance of various organic remains of coralloid appearance which occur in some localities. But this opinion arises from the confusion which has till lately been made between Bryozoa and Polypi; in reality true Corals are far from being common in any of these beds. The four species mentioned by Mr. Searles Wood, in the Catalogue of the Zoophytes of the Crag, published in 1844 in the 'Annals of Natural History,' are the only known Polypidoms belonging to this geological division.

These fossils are found in the Red Crag as well as in the Coralline Crag, and most of them are as yet peculiar to England; only one species has been met with on the Continent, in the Crag of Antwerp, a strata belonging to the same geological horizon; and none of them are known to live in the seas of the present period. The *Sphenotrochus intermedius* has, it is true, been considered as existing on the coast of England as well as in the Crag; but the recent species, which has lately received the name of *Sphenotrochus Andrewianus*,[1] is perfectly distinct from the fossil Coral to which it was at first referred. It is also worthy of remark that the Crag Corals belong to four distinct genera, each of which is represented by different species in the other Miocene formations; that three of these genera are also represented by peculiar species in our actual Fauna, and that none of them have been discovered in strata anterior to the older tertiary formations.

[1] Milne Edwards and J. Haime, Monographie des Turbinolides, Ann. des Sc. Nat., 3me série, vol. ix, p. 245, tab. vii, fig. 4.

Order ZOANTHARIA (p. ix).

Family TURBINOLIDÆ (p. xi).

Tribe TURBINOLINÆ (p. xvi).

Genus Sphenotrochus (p. xvi).

1. Sphenotrochus intermedius. Tab. I, figs. 1, 1 *a*—1 *i*.

Turbinolia intermedia, *Münster*, ap. Goldfuss, Petref. Germ., vol. i, p. 108, tab. xxxvii, fig. 19, 1826. (This figure is good, excepting that the basis of the Coral appears too truncate.)

— — *Ch. Morren*, Descrip. Corall. foss., in Belgio Repertorum, p. 52, 1828.

— . . . . *R. C. Taylor*, in Mag. of Nat. Hist., vol. iii, p. 272, fig. 2, 1830. (A rough figure.)

— intermedia, *Milne Edwards*, Notes in the second ed. of Lamarck's Anim. sans Vert., vol. ii, p. 361, 1836.

— — *Galeotti*, Mém. couron. par l'Acad. de Bruxelles, vol. xii, p. 188, 1837.

— — *Hagenow*, in Neues Jarhb. für Miner. Geol., 1839, p. 291.

— — *Nyst*, Coquilles et Poly. foss. des Terr. Tert. de la Belgique, p. 631, tab. xlviii, fig. 14, 1843. (This figure is incomplete, and does not show the columella.)

— Milletiana, *Searles Wood*, Ann. and Mag. of Nat. Hist., vol. xiii, p. 12, 1844.

Sphenotrochus intermedius, *Milne Edwards* and *Jules Haime*, Monogr. des Turbinolides, Ann. des Sc. Nat., 3me série, vol. ix, p. 243, 1848.

Corallum simple, straight, free, presenting no trace of adherence, cuneiform, strongly compressed in its lower part, and truncate at its basis, which is very broad (fig. 1); sometimes even as much so as the calice (fig. 1*a*). This last character exists also in the *Sphenotrochus Milletianus;* but this Coral, instead of being much compressed in the lower part, is, on the contrary, very thick down to its extremity.

Costæ smooth, rather thick, especially near the calicular edge, closely set, but separated by deep grooves (fig. 1*b*). They all occupy almost the whole length of the corallum; and it is therefore difficult to recognise their relative age by the height at which they begin. This difficulty is also augmented by the form of those situated near the middle of the flattened sides, which in their lower part are constituted by small, rather irregular papillæ. The median costæ are nearly straight, nearly equal, not very prominent, and narrowing as they approach the base; the lateral costæ, and those situated near them, are, on the contrary, larger, separated by deeper grooves, slightly curved towards their lower end, sometimes rather undulate, and thicker at their base than higher up.

It may also be worth remarking that similar smooth and simple costæ exist in all the species of this genus belonging to the present period or to the Miocene deposits; whereas the older species, found in the Eocene formation, have the costæ crispate, and composed of series of papillæ.[1]

The *calice* (fig. 1*a*) is regularly elliptic and slightly arched, the extremities of its great axis being lower than those of its small axis. The proportion between the two diameters is nearly constant, and the form of the ellipse, represented by the calicular margin, is intermediate between that of *Sphenotrochus granulosus,* which is much shorter, and that of *Sphenotrochus Andrewianus,* which is more elongated; it is approximately as 100 : 150. The size of the calice is also subject to very slight variations in individuals which have attained their definitive form, whether they be short or tall.

The *fossula* is very shallow.

The *columella* (figs. 1*a* and 1*c*) has the form of a rather thin, vertical lamina, situated in the direction of the long axis of the calice and of the basal edge of the corallum. Its upper edge is nearly horizontal, and reaches almost to the level of the apex of the septa; it is obtuse at its angles, and divided into two equal lobes by a small notch; sometimes three of the lobes are visible. The structure of this part of the polypidom may be very well shown by a vertical section corresponding to the small axis of the calice; it is formed by two delicate parallel laminæ, applied together, thickened near its upper edge, and united, towards its base, to the wall, so as to form with the mural sclerenchyma one compact mass.

The *septa,* as in all the other species of this genus, form three complete and well-developed cycla (fig. 1*a*); they are consequently twenty-four in number, and they are closely set, straight, thick exteriorly, and becoming gradually thinner towards the centre of the calice, exsert, arched at their apex, truncate at the upper end of their inner edge, and granulated on their surface. These granulations are easily brought to view by a vertical section of the corallum (fig. 1*c*); they are small, unequal in size, pointed, not numerous, and not disposed in a regular manner, excepting near the upper edge of the septa, where they form a curved line nearly parallel to the edge. The septa of the first and second cycla are nearly similar; and, as is often the case in Corals with an elliptic calice, the two primary septa, corresponding to the long axis of the calice, are a little smaller than the four others of the same cyclum, and the six secondary ones. The tertiary septa are

[1] The fossil Coral figured by Mr. Isaac Lea, under the name of *Turbinolia nana,* and mentioned by that author as belonging to the Eocene strata of Alabama, would appear to be an exception to this rule, for it resembles much the *Sphenotrochus Milletianus,* and seems to have smooth costæ; but the figure given by Mr. Lea is not sufficiently explicit for us to be able to decide the question, or even to be quite sure that this Turbinolida really belongs to the genus Sphenotrochus, and in the text the author says that he could see no trace of a columella (Lea, Contrib. to Geol., p. 195, tab. vi, fig. 209). In the present state of palæontology, we may, therefore, consider the above-mentioned observation as still holding good; and the distinction between the Eocene species of Sphenotrochus and the more recent representatives of the same generic type is a result not devoid of interest for geologists as well as for zoologists.

not quite as much developed as the older ones, but are broad enough to reach the columella, to which they are united, at least towards their base. The union between the septa and the columella is not complete, but is effected by means of a double series of trabiculæ extending from the inner edge of the septa, bent alternately to the right and to the left; so that in a vertical section of the visceral chamber a series of pores is seen along the line of junction of each septa with the columella (fig. 1*c*). This mode of arrangement of the marginal trabiculæ gives also to the septa, when viewed from above (fig. 1*a*), or by means of a horizontal section, the appearance of bifurcation along their inner margin, and may easily be mistaken for a disjunction of their two constituent laminæ, an error which has been committed by Goldfuss and by ourselves in our first observations.

Sphenotrochus intermedius is the largest known species of this genus; sometimes, however, *S. Milletianus* and *S. granulatus* are almost as long. Its usual length is about three lines, but there are individuals half an inch long. The long axis of the calice is about two lines and a half.

Mr. Searles Wood, to whose kindness we are indebted for the specimens here described, has collected an interesting series of these Corals, showing the changes of form which they experience before arriving at the adult state, and has thus enabled us to study their mode of growth, as we had already done for Fungia in a preceding memoir.[1] We have not met with any of these young Turbinolidæ with only six septa and the same number of costæ; the youngest in Mr. Searles Wood's collection (fig. 1*e*) has twelve well-marked costæ, distinct from the top to the bottom of the corallum; but the six primary septa are the only ones which are pretty well developed, and those of the second cyclum are still in a rudimentary state. There is no trace of the columella, which appears at a later period and the general form of the corallum is almost cylindrical; its height is then not more than two thirds of a line, and its calice is circular. The base of the corallum is circular; it is truncate, but not spread out, and its adherence must have been of very short duration.

Before the tertiary costæ make their appearance, the calice begins to enlarge in one direction more than in the other, so as to assume an oval form; a slight coarctation becomes visible towards the middle of the corallum, its upper part swells out laterally, and the peduncle enlarges and becomes smooth. Soon after this the tertiary costæ begin to be formed (fig. 1*f*), and the calice becomes completely elliptical, but is still quite horizontal. The coarctation above the peduncle still exists, and we at first supposed that the upper part of the corallum became free by rupture, as is the case in Flabellum;[2] but the series of specimens collected by Mr. Searles Wood shows that such is not the case, and that the peduncle does not lose its vitality, but is gradually absorbed. Its truncate extremity is first

[1] Observations sur la Structure et le Mode de Développement des Polypiers, Ann. des Sc. Nat., 3me série, vol. ix, p. 76, tab. vi.

[2] Loc. cit.

cicatrized, and becomes rounded, at the same time that it expands laterally, as does the rest of the corallum, which ceases to be cylindrical, and assumes a compressed form (figs. 1*g* and 1*h*). Soon after the peduncle begins to become thin, and to shorten (fig. 1*i*); the absorption continues till it disappears completely, and the under edge of the corallum becomes long and obtuse. While these modifications are going on, other changes are produced in the internal structure of the corallum. As soon as the tertiary septa appear, the columella begins to rise, and the primary and the secondary septa, which have become rather broad, give off some spiniform trabiculæ, that unite with the columella. The simultaneous development of the twelve tertiary costæ also determines considerable change in the general form of the corallum; the calice, instead of being horizontal, becomes arched (figs. 1*g*, 1*h*, 1*i*), and the sides of the wall corresponding to the long axis of the calice not having yet expanded towards the basis, the corallum has the form of a small battledore; but when the tertiary costæ increase in size, the convexity of the calice diminishes, and the base of the corallum spreads out, till it assumes the form of a broad, obtuse wedge (figs. 1, 1*a*), which it retains in the adult state.

The *Sphenotrochus intermedius* is easily distinguished from *Sphenotrochus crispus*, *S. mixtus*, *S. pulchellus*, *S. granulosus*, and *S. semigranosus* (species which all belong to the Eocene period), by the costæ being smooth, and not formed by a series of large granules. It resembles *S. granulosus* by its general form, and *S. crispus* by its calice. We are acquainted with only three other species, which have also smooth costæ, and have often been confounded with *S. intermedius.* One of these lævicostate species is the *S. Andrewianus*, which lives on the coasts of Cornwall and of the Isle of Arran, but is easily distinguished by its narrow subconical base, and the slight elongation of its calice, the two diameters of which are as 100 : 120. The second lævicostate species, which we designate by the name of *Sphenotrochus Rœmeri*,[1] differs also from *S. intermedius* by its narrow base. The third species, *S. Milletianus*, bears great resemblance to the latter, and belongs to strata occupying the same geological formation, a circumstance that has also contributed to create confusion between them. But the *S. Milletianus* found in the Faluns of Anjou is characterised by its lateral costæ being much less prominent, and its base being more rounded and less compressed than in the *S. intermedius.*

This fossil is common in the Coralline Crag, and the Red Crag at Sutton. We have ascertained its identity with the species found in the Crag of Antwerp, by comparing it with the specimens belonging to the collection of M. H. Nyst, at Louvain, and with that of Goldfuss, in the Poppelsdorf Museum, at Bonn. Specimens of this species exist in the

[1] This undescribed species has most of the characters of *S. mixtus*, but the costæ are all similar and smooth. The lateral ones are not notably larger than the others, and those adjacent are slightly curved near their lower end, and sometimes interrupted. The primary and secondary septa are equal, and those of the third cyclum are narrow; all are thick towards the outer edge, and but slightly granulate. Calice twice as long as it is broad. Length two lines; breadth one line and a half; thickness one line. A fossil of the Miocene strata of Cassel and Hildesheim, belonging to the Museum of Bonn. M. Nyst possesses a specimen of the same species found in the Crag of Antwerp.

collections of the Geological Society of London, and of MM. Searles Wood, Bowerbank, and Frederick Edwards, in London; of the Museum of Natural History, and of MM. d'Archiac, Michelin, and Milne Edwards, in Paris; M. Nyst, at Louvain; M. de Koninck, at Liége, &c.

Genus FLABELLUM (p. xviii).

1. FLABELLUM WOODII. Tab. I, figs. 2, 2 *a*, 2 *b*.

FUNGIA SEMILUNATA,[1] *Searles Wood*, Ann. and Mag of Nat. Hist., vol. xiii, p. 12, 1844.
FLABELLUM WOODII, *Milne Edwards* and *J. Haime*, Monogr. des Turbinolides, Ann. des Sc. Nat., 3me série, vol. ix, p. 267, 1848.

Corallum simple, erect, rather short, much compressed, especially towards its base, cuneiform, subdeltoid, with a peduncle short and rather thick, and lateral edges straight, and diverging at an angle of rather less than 90°. All the *costæ*, even the lateral ones, simple, flat, equal, indistinct, and crossed by scarcely developed rugæ and slight folds of the epitheca, which is very thin. The surface of the wall is also marked by small longitudinal sulci, corresponding to the outer edge of the septa; those referable to the small septa but slightly marked.

Calice having the form of a very long ellipse, and rather arched. In one specimen the proportion of its two axes was as 100 : 280, and in another as 100 : 300; the extremities of the ellipse corresponding to the great axis are obtuse, and on a level rather lower than that of the small axis. The *fossula* is long, narrow, and deep.

The *columella* represented only by few large granulæ adhering to the inner edge of the septa, and assuming the form of short, thick trabiculæ.

The *septa* constitute five complete cycla, very well developed, and a sixth cyclum incomplete, more or less rudimentary in some parts, but most apparent in the systems situated near the long axis of the calice. The septa of the first three cycla are nearly of the same size, and the septal apparatus is therefore divided into twenty-four groups or apparent systems, containing each seven septa, or only five, as is often the case when those of the sixth cyclum are missing in half of these groups. In general, these minor septa are most developed in the half of the lateral groups adjoining the extremities of the long axis of the calice, and at the same time the septa of the fourth cyclum enlarge in these groups so as to resemble the neighbouring ones of superior orders, and produce an appearance of there being twenty-six or twenty-eight systems; but in these lateral groups the number of septal elements never exceeds three.

The septa are straight, thin, closely set, and do not rise quite so high as the mural

[1] The *Fungia semilunata* of Lamarck, to which this fossil was referred by Mr. Searles Wood, belongs to the genus *Diploctenium* of Goldfuss; hence the necessity of giving a new name to the above-mentioned species. (See our Monograph of Astreidæ, Ann. des Sc. Nat., 3me série, vol. x, p. 248.)

epitheca; their upper edge is slightly sinuous, and their surface covered with projecting granulæ of various sizes, disposed rather irregularly in rows nearly parallel to the upper edge. These granulæ are much larger along the inner and inferior part of the edge of the septa of the superior orders, where they assume the appearance of alternate trabiculæ or spines. It is also to be noted that the principal septa are slightly emarginated near the border of the calice, and that their free edge is thin and arched above, thick, subflexuous, and obliquely truncate towards the columella. A horizontal section of the corallum, made a little below the edge of the calice, shows the thickness of the walls, and of the inner part of the large septa; it also renders evident the bifoliate structure of these septa. Height twelve lines; long axis of the calice from twelve to sixteen lines; the short axis from four to six lines.

The genus Flabellum contains a great number of species, and has been subdivided into three sections, according to the state of the basis of the corallum, which is sometimes pedicellate or truncate, and in others widely adherent. The *Flabellum Woodii* is easily distinguished from the fixed *Flabellum* and the truncated *Flabellum*, by the permanence of its narrow peduncle, and differs from most of the pedicellated *Flabella* by its simple non-cristate, non-spinous costæ. Seven species, *F. Gallapagense*, *F. Michelinii*, *F. Thouarsii*, *F. cuneatum*, *F. subturbinatum*, *F. majus*, and *F. Sinense*, have the same character; but *F. subturbinatum* and *F. Michelinii* are recognisable by their horizontal calice and their lateral costæ, almost vertical. *F. Gallapagense* also resembles *F. Woodii* by the rudimentary state of its columella, but is of a more elongated form, and is much less compressed laterally. *F. cuneatum* and *F. majus* are still nearer allied to *F. Woodii*, their characters, however, are not yet completely known; but the first of these fossil species has the septa much thicker than in the above-described Coral, and *Flabellum majus* is remarkable by its great size, its highly-compressed calice, and the peculiar structure of its principal septa.[1]

The *Flabellum Woodii* has been found in the Coralline Crag at Iken, and appears to be very rare; for in 1844, when Mr. Searles Wood published his 'Catalogue of the Zoophytes of the Crag,' only two specimens, one belonging to Mr. Bunbury, and the other to Mr. W. Colchester, were known, and we believe that since that time only two more specimens, now in the possession of Mr. Searles Wood, have been found. Those figured and described in this Monograph were communicated to us by Mr. Searles Wood.

[1] See our Monograph of Turbinolidæ, loc. cit., p. 260.

Family ASTREIDÆ (p. xxiii).

Tribe ASTREINÆ (p. xxxi).

Genus CRYPTANGIA (p. xliv).

1. CRYPTANGIA WOODII. Tab. I, figs. 4, 4 *a*, 4 *b*, 4 *c*, 4 *d*, 4 *e*.

CLADOCORA CARIOSA, *Lonsdale;* in Searles Wood's Catal. Ann. of Nat. Hist., vol. xiii, p. xii, 1844.[1]

CRYPTANGIA WOODII, *Milne Edwards* and *J. Haime*, Mém. sur les Astreides, Comptes rend. de l'Acad. des Sciences, vol. xxvii, p. 496, 1848.

This singular fossil Coral is always found immersed in a mass of Cellepora, a peculiarity which is also met with in another speeies of the samc genus, belonging to the Faluns of Touraine. At first sight, thc vesicular mass formed by thcse Bryzoa may easily be mistaken for a eellular epithecal cœnenehyma, resembling that of Sarcinula; but an attentive examination of the cells will lead to a recognition of their real nature, and similar masses of Cellepora, not containing any Cryptangia, are often found in the samc loealities. It is however remarkablc, that Corals of this genus should never be found adhering to other extraneous bodies, and should always take up their abodc on a eluster of Cellepora, whieh, inereasing as they thcmselves grow up, imbcds them so completely, that thc calices alone remain free on the surfacc of the eommon mass.

The mode of multiplication of Cryptangia is also worthy of notiee. These Corals always form elusters, and must be produced by gemmifcrous stolons, but the radieiform expansions from whieh they must procced do not beeome selerenehymatous, and leave littlc or no trace of their existenee; so that when the soft parts are destroyed, as is always the case in fossils, the different eorallites appear to be quite independent, and would be free, were it not for the extraneous cellular mass in which they are so deeply immersed. It is therefore easy to perceive that these Corals differ widely from *Cladocora*, to which they were referred by Mr. Lonsdale, and are equally distinct from the generic forms to which the name of *Lithodendron*, applied by M. Michelin to the Tourainc species, had been previously given. They are nearly allied to the *Astreinæ reptantes*, for whieh we have established the genera *Angia* and *Rhizangia*, but must constitute a separatc generic group, which we have proposed ealling *Cryptangia*.

[1] The *Madrepora cariosa* of Goldfuss, to which this fossil was referred by the above-mentioned author, is a true Madrepora, and neither the one nor the other can be placed in Ehrenberg's genus Cladocora, The typic specimen of *M. cariosa*, figured and described by Goldfuss, is preserved in the Museum of Bonn, where it was attentively examined by one of us; it is a fossil of the Parisian basin, having a spongy cœnenchyma, and the visceral cavity of the corallites divided into two parts in consequence of the great development of two opposite primary septa.

The corallites penetrate almost perpendicularly to the surface of the celleporous mass, and, when isolated from this extraneous body, present the appearance of small, subturbinate cylinders, the walls of which are covered with a thick epitheca; there is no trace of costæ visible, and the epitheca forms round the calice a small exsert rim. The *calice* is circular, and its fossula large, but not deep. The *columella* is well developed, papillose, and not projecting, nor is it placed exactly in the axis of the visceral chamber, the septa being more developed on one side of the corallite than on the other. The *septa* of different orders are nearly equal in size, and do not form well-characterised systems; they vary in number from sixteen to twenty, and consequently must belong to three cycla, the first two of which are probably complete, and the third developed only in two or four of the six systems normal in all Astreidæ. It is also to be noted, that all these septa are very thin excepting near the wall, closely set, slightly bent inwardly, and terminated by an oblique edge, armed all along with strong dentations, the size of which increases towards the columella. A few large granulæ are seen on the lateral surfaces of the septa, and the loculi are divided by very thin dissepiments, placed at a distance of about two thirds of a line from each other.

The length of these corallites, when adult, is about four lines; the diameter of the calice, one line and a half; and the depth of the fossula, two lines.

Cryptangia parasita[1] of the Faluns of Touraine, is very nearly allied to the above-described species, but differs from it by the small dimensions of its calices, and the constant existence of eight principal septa.

Cryptangia Woodii is found in a good state of preservation in the Coralline Crag at Ramsholt. Specimens which appear to belong to the same species, but are not well preserved, are met with in the Red Crag of Sutton.

These fossils are to be seen in the collections of the Geological Society of London, and of Messrs. Searles Wood, Bowerbank, D'Archiac, and Milne Edwards.

Family EUPSAMMIDÆ (p. li).

Genus BALANOPHYLLIA (p. lii).

BALANOPHYLLIA CALYCULUS. Tab. I, figs. 3, 3 *a*, 3 *b*, 3 *c*, 3 *d*.

. . . . *R. C. Taylor*, Mag. of Nat. Hist. vol. iii, p. 272, fig. D, 1830. (Very rough figure.)

BALANOPHYLLIA CALYCULUS, *Searles Wood*, Ann. of Nat. Hist., vol. xiii, p. 12, 1844.

— — *Milne Edwards* and *Jules Haime*, Annales des Scien. Nat., vol. x, p. 84, 1848.

Corallum simple, cylindrico-turbinate, adherent by a large basal surface, erect, and in general not very tall. The *walls*, of a spongy tissue and rather thin, are covered in most

[1] *Lithodendron parasitum* Michelin Icon. Zooph., pl. lxxix, fig. 3.

parts by a pellicular epitheca, which Mr. Searles Wood has designated by the name of *periostracum*, and presents some slight transverse folds. In the parts where the epitheca is worn off, the *costæ* become visible. These are narrow, equal, closely set, and composed of a single series of indistinct, obtuse granulæ. The intercostal spaces present a series of small mural perforations, disposed with some regularity. None of the numerous specimens of this fossil which we have examined had the calice well preserved, and consequently we have not been able to ascertain as yet whether its margin is crenulated or entire, the fossula deep or shallow, and the columella projecting or not; but it is evident that the calice must be sub-circular, or slightly elliptic, with its two axes in the proportion of 100 : 120, and that the *columella* is spongy, not greatly developed, and spread in the direction of the long axis of the calice.

The *septa* are well developed, and always form five cycla, but do not appear ever to constitute a sixth cyclum. The mode of arrangement of these laminæ, which is characteristic in the family of Eupsammidæ, is very evident in this species: the septa of the first four cycla are straight, but those of the fifth cyclum deviate a great deal from the direction of the radii of the circle represented by the calice, and are bent. In this last cyclum the septa of the sixth order are placed very close to the primary septa, and are united to them to a certain extent, near the wall, but diverge strongly from them as they advance towards the centre of the visceral chamber, and join the ternary septa near the columella; those of the seventh order are disposed in the same way near the secondary septa, and are also united to the ternary septa by their inner edge, but do not advance quite so near the centre of the visceral chamber; the septa of the eighth and ninth orders, which complete the fifth cyclum, are smaller than the preceding ones, and are strongly bent, so as to join the septa of the sixth and seventh orders; and the septa of the fourth and fifth orders, which constitute the fourth cyclum, remain free, and advance in the middle of the sort of irregularly circular depressed area, formed by the coalescence of the septa of the eighth and ninth orders with those of the sixth and seventh. All the septa are very closely set and thin, but the primary and secondary ones enlarge a little towards their inner edge, and are almost equally developed, so that the adult corallum assumes the appearance of having twelve septal systems instead of six, which is the real number. We must also add, that the laminæ constituting all these septa are cribriform, and not very granulate.

The length of this corallum is commonly about eight lines, but the individual represented by fig. 3 is more than twice as tall, without being broader than usual. The calice is in general about seven or eight lines broad in one direction, and six lines in the other.

The greater development of the epitheca might suffice to distinguish *Balanophyllia calyculus* from all the other species belonging to the same genus, but it differs also from *B. prælonga*[1] (a fossil species belonging to the Miocene deposits of Turin) by its broad basis,

[1] *Turbinolia prælonga*, Michelin, Icon., pl. ix, fig. 1.

whereas the *B. prælonga* and the *B. Gravesii*[1] of the Paris basin have a narrow peduncle; from *B. cylindrica*[2] (a Miocene species found at Turin and Verona), *B. geniculata*[3] (a fossil belonging to the Nummulitic formation of Port des Basques), and *B. Cumingii*[4] (a recent species from the Philippine Islands), by the existence of the fifth cyclum of septa; and from *B. tenuistriata* (fossil of the Paris basin), *B. desmophyllum*[5] (fossil of the London Clay), *B. italica*[6] (fossil of the Pliocene deposits of Asti), and *B. Bairdiana* (a recent species), by its general form, and the slight elongation of its calice. The species which it most resembles is *B. verrucaria*, which exists at the present period on the coast of Corsica; but in the latter the columella is less developed, and the arrangement of the septa of the last orders is less regular.[7]

Balanophyllia calyculus is common in the Red Crag of Sutton, but has not, to our knowledge, been met with in other localities. Mr. Searles Wood considered it as identical with some fossil Coral found in the Faluns of Touraine, but the latter are young specimens of the *Dendrophyllia amica;* they resemble *B. calyculus* by their epitheca, but are easily recognisable by the mode of arrangement of their septa, and their multiplication by gemmation when in the adult state.[8]

We have examined numerous specimens of this species in the collections of the Geological Society of London, of Messrs. Bowerbank and Searles Wood, of the Museum of Natural History, and of MM. D'Archiac, Michelin, and Milne Edwards, in Paris.

1 *Turbinolia Gravesii*, ibid., pl. xliii, fig. 7.

2 *Turbinolia cylindrica*, Michelin, ibid. pl. viii, fig. 19.

3 *Caryophyllia geniculata* d'Archiac, Mém. Soc. Géol. France, 2d series, vol. ii, pl. vii, fig. 7 *a*.

4 See our Monograph of Eupsammidæ, Ann. des Sc. Nat., 3me série, vol. x, pl. i, fig. 8.

5 See tab. vi, fig. 1.

6 *Caryophillia italica*, Michelin, Icon., pl. ix, fig. 19.

7 See our Monograph of Eupsammidæ, Ann. des Sc. Nat., 3me série, vol. x, p. 85, tab. i, fig. 6.

8 Loc. cit., tab. i, fig. 9.

CHAPTER II.

CORALS OF THE LONDON CLAY.

The Eocene deposits, known by the name of London Clay, contain various Corals, most of which belong to the two subordinate forms predominant among the Polypi of the present period, *Zoantharia aporosa* and *Zoantharia perforata;* but none of these organic remains can be considered as appertaining to species now in existence, or even to those found in the more recent tertiary formations. The general aspect of this portion of the fossil Fauna of England resembles very much that of the Corals imbedded in the "Calcaire grossier" of the Parisian basin. Some species, such as *Turbinolia sulcata, Stylocœnia emarciata*, *Stylocœnia monticularia*, and *Holaræa Parisiensis*, are common to both these localities; but most of those found in the Eocene strata of the environs of Paris have not been met with in the London Clay, and many of the Corals belonging to these last-mentioned deposits have not been discovered elsewhere. Thus the London Clay appears not to contain any Milleporidæ, Madreporidæ, or Lophoserinæ, families which have various representatives in the Fauna of the Calcaire grossier, and the only Parisian fossil Coral referable to the order of Alcyonaria is a Distichopora; whereas both Pennatulidæ and Gorgonidæ have been met with in the London Clay. At the present period similar differences exist at small distances in the same zoological region, and appear to depend principally on the depth of the sea and the nature of the bottom; by analogy we are therefore led to suppose that in the Eocene marine Fauna they are only indicative of some such local peculiarities. Indeed, most of the Corals of the London Clay belong to Polypi nearly allied to species which are now found in very deep water, and seem to be particularly organized for living on a loose, muddy, or sandy ground; whereas many of the fossil Corals of the Calcaire grossier resemble those which now inhabit rocky shores, and are seen very near the surface of the sea.

The principal localities from which our London Clay Corals have been obtained are, Haverstock Hill, Highgate and Holloway, near London; Barton, Sheppy, Bracklesham Bay, on the coast of Sussex, and Alum Bay (Isle of Wight); most of the species were found by Mr. Bowerbank, Mr. Frederick Edwards, and Mr. Frederick Dixon, to whom we are indebted for the specimens figured in this Monograph.

Order 1.—ZOANTHARIA.

Family TURBINOLIDÆ (p. xi).

Tribe TURBINOLINÆ (p. xvi).

1. *Genus* Turbinolia (p. xvi).

1. Turbinolia sulcata. Tab. III, figs. 3, 3 *a*, 3 *b*, 3 *c*.

Turbinolite de deuxième grandeur, *Cuvier* and *Alex. Brongniart*, Géogr. Minéral. des Environs de Paris, pl. ii, fig. 3, 1808.

Turbilonia sulcata, *Lamarck*, Hist. des An. sans Vert., t. ii, p. 231, 1816; 2d edit., p. 361.

— — *Lamouroux*, Expos. méth. des Genres de Polypiers, p. 51, tab. lxxiv, figs. 18-21, 1821. (Very bad figures.)

— — *Cuvier* and *Brongniart*, Descript. Géol. des Environs de Paris, p. 33, tab. viii, fig. 3, 1822.

— — *Deslongchamps*, Encyclop. méthod. Zooph., p. 761, 1824.

— — *Goldfuss*, Petref. Germ., vol. i, p. 51, tab. xv, fig. 3, 1826. (This figure is very good, excepting that the columella is not conical enough.)

— — *Fleming*, Hist. of British Animals, p. 510, 1828.

— — *Defrance*, Dict. des Scien. Nat., vol. lvi, p. 93, 1828. (The Coral figured under this name in the Atlas of the Dictionnaire des Sciences Naturelles, tab. xxxvi, fig. 2, and in the Manuel d'Actinologie, by M. de Blainville, is not a Turbinolia, and appears to belong to the genus Trochocyathus.)

— — *Holl*, Handb. der Petref., p. 415, 1829.

— — *Bronn*, Lethæa Geognostica, vol. ii, p. 899, tab. xxxvi, fig. 4, 1838. (This figure is good, but the columella is rather too thick.)

— — *Nyst*, Descript. des Coquilles et Polypiers fossiles de la Belgique, tab. xlviii, fig. 11, 1843. (This figure is copied from Goldfuss; the description is referable to the *Turbinolia Nystiana*.)

— — *Michelin*, Iconogr. Zooph., p. 151, pl. xliii, fig. 4, 1844.

— — *Graves*, Topogr. Géogn. de l'Oise, p. 701, 1847.

— — *Milne Edwards* and *Jules Haime*, Annales des Scien. Nat., 3me série, vol. ix, p. 236, 1848.

This corallum has the form of a cylindroid, elongated cone, and is not contracted just above its basis, nor inflated near the calice (figs. 3, 3 *b*); sometimes only the cone is somewhat shorter in proportion to its length (fig. 3 *a*). The *costæ* are very thin, sharp, straight, and very prominent from top to bottom, but particularly so near the basis of the corallum. The secondary costæ are nearly as long as the primary ones; they do not, however, originate quite at the same level. The tertiary costæ begin to appear about half way up the wall in young specimens, and occupy two thirds of the height of the Coral in the adult state. The intercostal grooves are deep and broad; near the calice a small longitudinal line is visible in each of them, and indicates the existence of a fourth cyclum of rudimentary costæ, which do not correspond to any of the septa on the inner side of the wall. These vertical furrows also present a double series of small dimples, which are prolonged laterally on the sides of the costæ, so as to constitute a sort of transverse fluting, and are arranged alternately; they are very closely set, and about fifteen occupy the space of a line. The *wall* is very thin. The *calice* is circular, and its fossula is not very deep. The *columella* is terminated by a conical, pointed apex, which rises higher than the septa, and is delicately granulated. The *septa* are thin and very exsert, but not quite so much so as in the *Turbinolia Dixonii*;[1] their upper edge is strongly arched, and their lateral surfaces present small granulations, which form short submarginal, radiate lines near the apex, and are arranged in nearly horizontal rows towards the lower part of the visceral chamber. The inner edge of the apical portion of the septa is slightly concave, and soon becomes horizontal, so as to meet the columella, to which it unites. A projecting line extends from each of the six primary septa up the apical portion of the columella; the secondary septa join the columella much lower down, but they are broader than the primary ones. The tertiary septa are narrower at the apex, and less exsert than the preceding ones; they converge towards the intermediate primary septa, and become united to them all along their inner edge, at about two thirds of the breadth of the latter. The height of the corallum is usually about three or four lines, and the diameter of the calice about one line and a half. In young specimens the calice is larger in proportion.

This fossil is the only species belonging to the genus Turbinolia as now circumscribed, which was known at the time when Lamarck first established the group bearing that name. Shortly afterwards, Mr. Defrance discovered a second species, and Mr. Isaac Lea has since then found a third. In our Monograph of Turbinolidæ, published about a year ago, six species were described, and we now know double that number of true Turbinoliæ, but they all belong to the same geological period, and are imbedded in Eocene deposits. They appear to be more abundant in England than elsewhere; the London Clay contains eight species, only one of which (the fossil just described) has been met with in the synchronous formation of the Parisian basin.

Turbinolia sulcata differs from *Turbinolia dispar*,[2] and from *Turbinolia costata*,[3] by the number of the septa which in these two last-mentioned species form four cycla. An additional cyclum of costæ distinguishes *Turbinolia Fredericiana*[4] from it; in *Turbinolia Prestwichii*,[5] *T. minor*,[6] and *T. firma*,[7] the costæ are not so thin, prominent, and wide apart as in this species, and the last of these characters separates it also from *Turbinolia pharetra*[8]

[1] See plate iii, fig. 1. [2] Michelin, Icon., pl. xliii, fig. 5.

[3] These species, as well as the others only quoted here, have been described at full length in our Monograph of Turbinolidæ, published in the Annales des Sciences Naturelles, 3me série, vol. ix.

[4] See pl. iii, fig. 2. [5] See tab. iii, fig. 5. [6] See tab. ii, fig. 5.

[7] See tab. ii, fig. 4. Contrib. to Geol., tab. vi, fig. 210.

and *T. Nystiana*,[1] to which it is, however, elosely allied. The species which it resembles most are, however, *Turbinolia Dixonii*, *T. humilis*,[2] and *T. Bowerbankii*.[3] The last of these differs from *T. sulcata* by its form, which is more elongate and conical, by the thiekness of the lower part of its primary costæ, and by its very slender eolumella. *Turbinolia Dixonii* is easily distinguished by its compressed eolumella, by the enlargement of its walls near the calice, and by the great prominence of its costæ. To eonelude this brief comparison, we must add, that *Turbinolia sulcata* differs from *T. humilis* by its size, by its form, which is not near so cylindrieal as in the latter, and by the normal number of its septa.

This species is extremely abundant in certain localities of the environs of Paris, such as Grignon, Parnes, and Auvert; it is also found in the tertiary strata of Hauteville, in Normandy, and in the London Clay at Bracklesham Bay, but it is not common in this last-mentioned deposit. We are indebted to Mr. Frederick Edwards and to Mr. F. Dixon for the specimens figured in this Monograph.

2. Turbinolia Dixonii. Tab. III, figs. 1, 1 *a*, 1 *b*, 1 *c*, 1 *d*.

Turbinolia Dixonii, *Milne Edwards* and *J. Haime*, Monogr. des Turbinolides, Ann. des Sc. Nat., 3^me^ série, vol. ix, p. 238, tab. iv, figs. 2, 2 *a*, 2 *b*. 1848.[4]
— sulcata, *Lonsdale*, in the MS. work of M. Dixon on the Chalk Formations and Tertiary Deposits of Sussex.

Corallum slightly eontracted just above its basis, and rather inflated near the calice. *Costæ* very thin, and projecting very much, especially towards the lower part of the wall; those of the third eyelum beginning very near the basis, and those of the first and seeond cycla beginning almost at the same height. Intereostal furrows nearly of the same size, very broad, and very deep; intercostal dimples very distinct, separated by small transverse laminæ, disposed as usual, in two vertical rows, and prolonged laterally, so as to produee the appearance of transverse fluting on the sides of the eostæ; about ten of these dimples

[1] We have given this specific name to the Turbinolia described by M. Nyst, and considered by that author as being referable to the *Turbinolia sulcata* (see Coquilles et Polyp. des Ter. tert. de la Belgique, p. 629; but not the corresponding figure, which is copied from the work of Goldfuss, and belongs to *T. sulcata*). In order to facilitate the comparison between the British Turbinolia and the species found in other countries, we think it may be useful to point out the characteristic features of the *T. Nystiana*, which were not known to us when we published our Monograph of Turbinolidæ.

Turbinolia Nystiana, nob. (*T. sulcata*, Nyst, loc. cit.) Corallum elongated, slightly contracted a little above its basis, and somewhat inflated near the calice. Costæ very slightly prominent, and rather thick; the primary and secondary ones very broad towards the basis; the dimples of the intercostal furrows very small, but distinct, and those of one series alternating with those of the other. No rudiments of a fourth cyclum of costæ. Columella small, and almost cylindrical. Septa rather thick, slightly granulated, and forming three complete cycla. Length $3\frac{1}{2}$ lines; diameter of the calice $1\frac{1}{3}$ line. Fossil from the environs of Brussels. (Cabinet of M. Nyst at Louvain.)

[2] See tab. ii, fig. 4. [3] See tab. ii, fig. 3.

[4] In fig. 2 *a* of this plate, the principal septa are not broad enough towards the calice, and the concavity of their inner edge is placed rather too high.

occupy a line in length. No rudiments of a fourth cyclum of costæ, and a well-marked depression in calicular edge of the wall, corresponding to each of the intercostal spaces. *Calice* with a very narrow, but rather deep fossula. *Columella* compressed, arched at the apex, granulated on the surface, reaching in general to the same height as the septa, or even higher, and presenting, in the part where it begins to become isolated, six vertical striæ, which are in continuity with the inner edge of the six primary septa; rather lower down, the columella is slightly contracted, and a vertical section of the corallum (fig. 1*b*) shows that its tissue is compact, and that towards the bottom of the visceral chamber it becomes united with the septa, so as to form a solid mass. *Septa* thin, unequal, very exsert, having their upper edge strongly arched near the outer margin, but concave near the centre of the calice, slightly granulated laterally, and forming three cycla; those of the first and the second cycla nearly of the same height, but the secondary ones much broader at the apex than the primary ones, and not extending so far up the columella. The tertiary septa much narrower and shorter than the older ones; very thin towards their inner edge, and cemented to the primary septa, as in the preceding species (fig. 1*b*). Interseptal loculi large. Height of the corallum about four lines. Diameter of the calice, two lines and one third. The form and the proportions not differing in the young and in the adult specimens.

Turbinolia Dixonii is the largest known species of the genus, but *T. dispar* and *T. Prestwichii* are almost of the same size. This species is very closely allied to *T. sulcata*, from which it differs principally by its form (rather more inflated near the calice), by its compressed columella, by its septa being more exsert, and its costæ more projecting and more distant. The breadth of the intercostal furrows distinguishes both *T. Dixonii* and *T. sulcata* from *T. Prestwichii*, *T. minor*, *T. firma*, *T. pharetra*, *T. Nystiana*, and *T. Bowerbankii*. The existence of only three cycla of costæ does not allow of its being confounded with *T. Fredericiana*, *T. dispar*, and *T. costata*, and, finally, *T. humilis* is easily distinguished from it by its cylindroid form, non-compressed columella, and glabrous septa.

Turbinolia Dixonii is a fossil very abundant in the London Clay at Bracklesham Bay, and has probably been confounded with *T. sulcata* by Mr. Fleming, and some other geologists, who mention the latter as being found in that locality, where it appears to be very rare. In Mr. Dixon's work, now passing through the press, Mr. Lonsdale has also described it as a variety of the *T. sulcata* of Lamarck.

The specimens, the examination of which has enabled us to recognise this new species, were given to us by Mr. Dixon and by Mr. Frederick Edwards.

3. Turbinolia Bowerbankii. Tab. II, figs. 3, 3 *a*, 3 *b*.

Corallum almost conical, rather short. *Costæ* not very prominent; those of the first two cycla inflated near the basis; the tertiary ones beginning at less than a quarter of the distance from the basis to the calicular edge of the wall; slight rudiments of a fourth cyclum of costæ appearing near the calice, and consisting in very short, prominent, thin lines, most developed between the primary and the tertiary septa. Intercostal furrows rather narrow, but presenting very clearly a double row of small dimples. *Calicular fossula* not deep. *Columella* cylindrical, prominent, and very slender in proportion to the size of the calice. *Septa* very thin, exsert, rather unequal, and forming six regularly-developed tertiary systems (fig. 3 *b*). No traces of a fourth cyclum of septa corresponding to the rudimentary costæ of the fourth cyclum. The tertiary septa joining the primary ones very near the columella. The lateral surfaces of all the septa presenting delicate granulations. Height two lines; diameter of the calice one line and a third.

This species bears great resemblance to *Turbinolia Fredericiana;* it differs from it by the rudimentary state of the fourth cyclum of costæ, and by its slender, round columella. The existence of well-formed intercostal dimples distinguishes it from *T. minor*, *T. costata*, *T. Prestwichii*, and *T. firma;* the costæ are much less prominent than in *T. sulcata*, and *T. Dixonii*, from which this Coral may also be distinguished by its form; the costæ are thinner than in *T. pharetra* and *T. Dixonii*, and the complete development of its six systems of septa does not admit of its being confounded with *T. humilis*.

We have seen but one specimen of this species; it was found at Barton, and belongs to the collection of the fossils of the London Clay formed by Mr. Frederick Edwards. We have dedicated it to our friend Mr. J. S. Bowerbank, whose active researches have much contributed to the extension of our knowledge relative to this portion of British palæontology.

4. Turbinolia Fredericiana. Tab. III, figs. 2, 2 *a*, 2 *b*.

Corallum of a regular conical form, not much elongated, and rather broad towards the calice. *Costæ* numerous, forming four cycla, closely set, unequal, and projecting very little; the secondary ones beginning a little above those of the first cyclum, but very near the basis of the corallum, and being, as well as the former, much thicker near their lower end than higher up, where they become very delicate (fig. 2 *a*). The tertiary costæ begin also at a short distance from the basis, but those of the fourth cyclum appear only in the upper half of the corallum; they are also rather thinner than the others. The intercostal furrows very narrow, and not very deep; the mural dimples not very apparent, small, closely set, and forming towards the calice, if not from top to bottom, only a single series in each intercostal furrow. *Calicular fossula* very narrow and shallow. *Columella* thick, compressed, granulated, rising higher than the septa, and presenting well-marked prolongations of the principal septa. Three cycla of septa, and no vestiges of a fourth cyclum corresponding to the quaternary costæ (fig. 2 *b*). The septa are much like those of the two preceding species, but they are a little thicker, and not so exsert; the primary ones are, as usual, narrower than the secondary ones, and these reach higher up along the columella; the tertiary septa are small, and join the primary ones, but appear to be cemented to them. The sides of all the septa present granulations arranged in radiate lines, but not very prominent. Height of the corallum two lines and a half; diameter of the calice one line and a third.

Mr. Frederick Edwards, to whom we dedicate this species, has submitted to our investigation a series of young individuals, showing the changes of form produced by age. The young Corals are rather shorter in proportion, to their breadth, than the adult ones, and consequently never resemble *Turbinolia humilis*, whatever their size may be, for the latter species is always much more cylindrical. The tertiary costæ make their appearance in *T. Fredericiana* when very young, but those of the fourth cyclum exist only in individuals that are nearly adult,

These quaternary costæ, occupying at least one third of the height of the corallum, and not corresponding to any rudiments of septa, distinguish *Turbinolia Fredericiana* from all the other species of the same genus; in some others, such as *T. sulcata* and *T. Bowerbankii*, the rudiments of similar costæ can be seen with the help of a strong lens, but these intercostal lines never become cristiform, as is the case here. The great development of quaternary costæ and the general form of the corallum make this species have some resemblance to *Turbinolia dispar;* but in the latter, as well as in *T. costata*, there is always a fourth cyclum of septa corresponding to the last cyclum of costæ. It is to *T. Bowerbankii* that *T. Fredericiana* approximates most; but in the former the columella is perfectly cylindrical and extremely slender, whereas in the latter it is large and compressed.

Turbinolia Fredericiana has as yet been found only in the London Clay, at Barton, and the specimen figured in this Monograph belongs to the collection of Mr. Frederick Edwards.

5. Turbinolia humilis. Tab. II, figs. 4, 4 *a*, 4 *b*.

This little Turbinolia is of a much more cylindroid form than preceding species, and is not so slender at its basis. The *costæ* are thin, prominent, and not closely set; the secondary ones begin very near the basis, and those of the third cyclum at about a quarter of the way up the wall. The intercostal furrows are broad, and present each a double row of small dimples, separated by transverse or oblique bars (fig. 4 *a*). The *columella* is prominent, round, and conical. The *septa* belong to three cycla, the last of which is always incomplete, and is wanting in two of the systems;[1] but it is nevertheless evident that the number of systems is as usual six, and not five, as would at first appear, for the secondary costæ corresponding to the two incomplete systems begin near the basis of the corallum, at the same level as those of the other systems, and are as much developed as these, whereas they would have been much shorter, and would have began much higher

[1] By an inadvertency of our artist, the third cyclum is represented in fig. 4 as if it were perfect; but the specimen did not in reality present tertiary septa in more than four of the systems.

up, if they had corresponded to septa belonging to the third cyclum. All the septa are very thin, almost glabrous, exsert, and terminated by a regularly arched apex, rising more or less, according to the cyclum to which they belong. Height not quite a line and a half; diameter of the calice two thirds of a line.

This Coral is one of the smallest of the genus Turbinolia, and is indeed usually even smaller than the species designated by the name of *Turbinolia minor*, for which it may very easily be mistaken; its characteristic features can only be seen with the help of a lens, but when sufficiently magnified, the appearance of its walls will make it immediately recognisable; for in *T. minor* the costæ are very thick, crenulated laterally, and the intercostal furrows do not present any dimples, whereas in *T. humilis* these dimples are well marked, and the costæ are thin. These two species are the only ones of the genus that have apparently but five tertiary systems, and their diminutive size contributes also to make them not easily recognisable.

Turbinolia humilis is found in the London Clay at Barton, where it appears to be abundant. We are indebted to Mr. F. Dixon and Mr. Frederick Edwards for the specimens in our possession.

6. Turbinolia minor. Tab. II, figs. 5, 5 *a*, 5 *b*.

Turbinolia minor, *Milne Edwards* and *J. Haime*, Annales des Sc. Nat., 3me série, vol. ix, p. 239, 1848.

Corallum of a cylindrico-conical form, rather short, and very obtuse at its basis. *Costæ* very thick, closely set, and not very prominent; those of the first and second order particularly thick near the basis; the outer edge of all very obtuse, and their sides delicately crenulated. Intercostal furrows very narrow, linear, and presenting no trace of the dimples, which are so apparent in the preceding species. The form of the costæ is particularly well marked near the calice (fig. 5 *b*), the lateral crenations of which are sometimes so developed near the basis, that they assume a crispate appearance; in other specimens they are scarcely visible, but the variations met with in the form of these parts are never such as to make them resemble the costæ of *T. humilis*. *Calice* very deep. *Columella* cylindrical, slender, and exsert. *Septa* belonging to three cycla, and appearing to form only five systems, although there are in reality six systems as usual; only in two of these there are no tertiary septa, and the secondary septa are of the size of the other tertiary ones, but correspond to secondary costæ, the development of which are normal (fig. 5 *b*). All the septa are thin, exsert, and slightly granulated on their lateral surfaces; the secondary ones are nearly as large as those of the first order, but those of the third cyclum are much smaller. This species is always remarkably small; it is not more than a line and a half high, and two thirds of a line in diameter.

Turbinolia minor differs from *T. sulcata, T. pharetra, T. Nystiana, T. Dixonii, T. Fredericiana,* and *T. humilis,* by not having the intercostal furrows ornamented with a double row of dimples, a character which in these can always be ascertained with the aid of a good lens. The imperfect development of two of the systems of septa, and the apparent existence of only five systems which is thus produced, is also sufficient to distinguish *T. minor* from *T. costata, T. dispar, T. Prestwichii,* and *T. firma.*

This fossil has been found only in the London Clay, at Alum Bay, in the Isle of Wight. The specimen figured in this Monograph belongs to the cabinet of Mr. J. S. Bowerbank.

7. Turbinolia firma. Tab. II, figs. 4, 4 *a*, 4 *b*.

Corallum subturbinate, and elongated; narrow at the basis. *Costæ* thick, obtuse, closely set, and prominent; those of the first two cycla very broad below the under end of the tertiary ones. Intercostal furrows narrow, and presenting neither mural dimples nor well-marked lateral transverse flutings or costal crenations. *Columella* compressed, and not very large. *Septa* rather thin, delicately granulated, and forming three complete cycla; the tertiary ones less developed than the secondary ones, and cemented to the primary ones at a small distance from the columella. Height three lines and a half; diameter of the calice, one line and a half.

Turbinolia firma differs from *T. costata, T. dispar, T. Bowerbankii,* and *T. Fredericiana,* by the non-existence of a fourth cyclum of more or less developed costæ; from *T. minor* and *T. humilis,* by the complete development of the tertiary septa in the six systems, and from *T. sulcata, T. pharetra, T. Nystiana, T. Dixonii,* and *T. humilis,* by the non-existence of dimples in the intercostal furrows. It resembles very much *T. Prestwichii,* but differs from it by its general form and by its thick obtuse costæ.

We have as yet seen but one specimen of this species; it was found at Barton, and given to us by Mr. Dixon: unluckily the artist in whose hands it was placed in order to have it figured, has broken it so much that it is no longer recognisable.

8. Turbinolia Prestwichii. Tab. III, figs. 5, 5 *a*, 5 *b*.

Corallum of a cylindroid form, much elongated, and very obtuse at the basis. *Costæ* strong, rather thick, and very prominent, especially towards the basis; those of the third cyclum beginning much lower down than in most species (figs. 5 *a*), and contributing to form the convex star seen at the basis of the corallum (fig. 5 *b*). Some slight vestiges of a fourth cyclum of costæ at the bottom of the intercostal furrows near the calice. These furrows very deep, becoming very narrow near the wall, and not presenting any mural dimples but irregularly crenulated laterally, especially towards the basis. Height four lines; diameter one line and two thirds.

The only specimen of this species which we have seen belongs to the collection of Mr. Frederick Edwards, and is so much filled up with clay at its upper end, that we have not been able to ascertain well the form of the columella and the septa; we are, however, inclined to think that the columella is slightly compressed, and the septa rather thick.

Turbinolia Prestwichii differs from all the preceding species by its cylindrical form and broad convex basis; it differs also from *T. sulcata*, *T. Dixonii*, *T. pharetra*, *T. Nystiana*, *T. humilis*, and *T. Bowerbankii*, by not presenting any vertical rows of intercostal dimples; from *T. dispar*, *T. costata*, and *T. Fredericiana*, by having only three cycla of costæ, instead of four, and from *T. minor* and *T. firma*, in which the intercostal dimples are equally wanting, by its sharp-edged costæ.

This remarkable species was found at Haverstock Hill, and appears to be very scarce, for Mr. Frederick Edwards, whose collection of London Clay Fossils is extremely rich, has only one specimen of it, and we are not aware of its existing in the cabinet of any other palæontologist.

Sub-family of the CYATHININÆ (p. xii).

1. *Genus* Leptocyathus (p. xiv).

Leptocyathus elegans. Tab. III, figs. 6, 6 *a*, 6 *b*, 6 *c*.

Corallum extremely short, nearly discoidal, and presenting, in the adult state, no trace of adherence. *Costæ* distinct from the centre of the under part of the corallum to the calice, strong, projecting externally, cristiform, closely set, rather unequal, separated by rather deep radiate furrows, and rendered echinulate by the presence of a multitude of granulations crowded together (figs. 6 *a*, 6 *b*). *Calice* circular, and regularly excavated in the centre. *Columella* not much developed, and delicately papillose. *Septa* constituting four complete cycla, closely set, broad, projecting much above and externally; very thin near the columella, but remarkably thick towards the circumference, and rather unequal (fig. 6 *c*); those of the first two cycla nearly equal, and larger than the others; the tertiary ones broader than those of the fourth cyclum, but not so high; all are straight, and none adhere together by their inner edge; their sides are covered with granulations, which are obtuse towards the circumference of the calice, but become spiniform in the inner part, where the septa themselves are slender. *Pali* corresponding to all the septa (even to those of the last cyclum, a mode of structure which is very rare), very thin, slightly echinulated, becoming broader as they correspond to younger septa, and appearing to be lobated, as in the genus Paracyathus. Height of the corallum, one line; diameter, three lines and a half.

The genus Leptocyathus, which we have established for this fossil, is nearly allied to Trochocyathus, but differs from it by its subdiscoidal form, the absence of all sign of adhesion at the basis, and the existence of pali corresponding to all the septa. The genus Ecmesus of Philippi[1] appears to present most of the same characters, but, as far as we can judge by the very short description, and by the rough figure given by that author, the calice appears to be eccentric, a mode of structure which is quite exceptional, and very remarkable.

The fossil Coral from the environs of Biaritz, mentioned by Viscount d'Archiac[2] under the name of *Turbinolia atalayensis*, belongs probably to the same generical division as our *Leptocyathus elegans*, but differs from it by its large size, by the existence of a fifth cyclum of septa, and by the smooth surface of the central portion of its wall.

Leptocyathus elegans was found in the London Clay, at Haverstock Hill, by Mr. Frederick Edwards, who obligingly communicated to us the only specimen that has as yet been seen.

2. *Genus* Trochocyathus (p. xiv).

Trochocyathus sinuosus.

Turbinolia turbinata (*pars*), *Lamarck*, Hist. des An. sans Vert., t. ii, p. 231, 1816.
— . . . . *Parkinson*, Organic Remains, vol. ii, tab. iv, fig. 11, 1820.
— sinuosa, *Alex. Brongniart*, Mém. sur les Terr. du Vicentin, p. 83, pl. vi, fig. 17, 1823.
— — *Bronn*, Syst. des Urweltlichen Pflanz., tab. v, fig. 12, 1825. (Bad figure.)
— dubia, *Defrance*, Dict. des Sc. Nat., vol. lvi, p. 92, 1828.
— sinuosa, *Bronn*, Lethea Geognostica, vol. ii, p. 897, 1838.
— — *Leymerie*, Mém. de la Soc. Géol. de France, 2me série, pl. xiii, figs. 7, 8, 1845.
— — *Michelin*, Icon. Zooph., p. 270, pl. lxiii, fig. 1, 1846.
Trochocyathus sinuosus, *Milne Edwards* and *J. Haime*, Ann. des Sc. Nat., 3me série, vol. ix, p. 314, 1848.

We have not met with this fossil in any collection of the British Corals, but Parkinson has figured it in a very recognisable way, and mentions it as having been found in the Isle of Sheppy; we must therefore recall its specific characters in this monograph, although we deem it advisable not to have it figured from a foreign specimen.

Corallum subturbinate, rather compressed, and having its inferior extremity slightly curved in the direction of the small axis of the calice. *Costæ* distinct from the basis, very narrow, numerous, closely set, simple, unequal, delicately granulated, and projecting very little. *Calice* oval, and contracted in the middle, so as to assume the form of an 8.

[1] Neues Jahrb. für Mineral. Geol., vol. ix, p. 665, tab. xi, fig. B 1, 1841.

[2] Bulletin de la Soc. Géol. de France, 2me série, vol. ii, p. 1010, 1847.

Columella fasciculate, with very slender elements. *Septa* forming six complete cycla, closely set, very thin and broad; those of the first three cycla nearly equal. *Pali* rather large, and thin, scarcely thicker than the septa, and presenting laterally spiniform granulations; those corresponding to the penultimate cyclum of septa being the most developed, the others nearly equal.

This Coral soon acquires all its septa and its final diameter, but continues growing up, so that it becomes sometimes very tall, without expanding proportionally; we have seen specimens three or four inches high, or even still longer. It has been found in the lower tertiary deposits of several localities in the south of France and the north of Italy.

3. *Genus* PARACYATHUS (p. xiv).

1. PARACYATHUS CRASSUS. Tab. IV, figs. 1, 1 *a*, 1 *b*, 1 *c*.

Corallum subturbinate, short, fixed by a very broad basis, slightly contracted just above the lower end, and rather inflated at the upper part. *Costæ* well marked from top to bottom, closely set, nearly equal in breadth, but alternately more or less prominent, especially near the calice, and covered with very delicate granulations. *Calice* nearly circular when young, but becoming soon more or less oval; fossula deep. *Columella* concave, papillose, thick, and not distinctly separated from the inner lobes of the pali. *Septa* forming four complete cycla, and an incomplete rudimentary fifth cyclum, in one half of the systems corresponding to the long axis of the calice; closely set, straight, slightly exsert, thin towards the centre of the visceral chamber, rather thick externally, granulated laterally, and unequally developed according to relative age. *Pali* corresponding to the septa of the first three cycla, thick, tall, strongly granulated, and denticulated along the inner edge, which is rather oblique; those corresponding to the tertiary septa larger than the others, and those that correspond to the primary septa being the smallest of all. Height, five or six lines; long axis of the calice, four lines; short axis, three lines; depth of the fossula, three lines.

This Paracyathus is easily distinguished from the other species of the same genus by the number of the septa, which in *P. procumbens*,[1] *P. Stokesii*,[2] and *P. Desnoyersii*, form an additional cyclum; by the size of the pali, which are much thicker than in *P. caryophyllus*, and *P. brevis*,[4] and by the lobulate edge of these same organs, and the oval form of the calice, from *P. æquilamellosus*, *P. Pedemontanus*,[5] and *P. Turonensis*.

Paracyathus crassus has as yet been found only in the London Clay of Bracklesham Bay, and has been communicated to us by Mr. Dixon and Mr. Frederick Edwards.

[1] Milne Edwards and J. Haime, Monogr. of Turbinolidæ, in Ann. Sc. Nat., 3d ser., vol. ix, pl. x, fig. 6.
[2] Idem, loc. cit., pl. x, fig. 7. [3] See tab. iv, fig. 2. [4] See tab. iv, fig. 3.
[5] *Caryophyllia pedemontana*, Michelin, Icon., pl. ix, fig. 16.

2. Paracyathus Caryophyllus. Tab. IV, figs. 2, 2 *a*, 2 *b*, 2 *c*, 2 *d*, 2 *e*.

Turbinolia caryophyllus, *Lamarck*. Hist. des Anim. sans Vertèb., t. ii, p. 232, 1816; 2d edit., p. 362.
— — *Deslongchamps*. Encyclop. méthod., Zooph., p. 761, 1824.
— — *Lamarck*. Tableau encyclop. et méthod. des trois Règnes, t. iii, p. 483, fig. 3, 1827.
— — *Defrance*. Dict. des Sc. Nat., t. lvi, p. 92, 1828.
Paracyathus caryophyllus, *Milne Edwards* and *J. Haime*. Monogr. des Turbinolides, Ann. des Sc. Nat., 3me série, vol. ix, p. 322, 1848.

Corallum turbinate, elongated, almost cylindrical in the tallest specimens, usually straight, or very slightly curved, and adhering by a moderately developed basis. *Costæ* well marked, distinct from top to bottom, nearly equal, rather narrow, not much more prominent towards the calice than near the basis, separated by broad, deep furrows, and covered with small granulations, which exist also in the intercostal furrows (fig. 2 *b*). *Calice* circular; fossula not very deep. *Columella* concave, delicately papillose, and not distinctly separated from the pali (fig. 2 *g*). *Septa* forming four cycla, the last of which is wanting in half of one or two systems; closely set, not very exsert, thin, strongly granulated laterally, and rather unequal in accordance with their relative age; the primary and secondary ones rather thick externally. *Pali* very thin, rather tall, lobated, with the inner edge oblique, and gradually larger as the septa to which they correspond are younger. Height, varying from five to eight lines; diameter of the calice, three or four lines; depth of the fossula, one line and a half.

This fossil is in general found in a bad state of preservation, being much worn away, with its basis obtuse, its wall almost entirely destroyed, and the visceral chamber filled with a carboniferous substance, the black tint of which contrasts with the white colour of the septa. Lamarck, who had only seen specimens in this state, was thus led to suppose that the corallum was free, and to consider it as appertaining to the genus *Turbinolia*. But, through the kindness of Mr. Bowerbank and Mr. Dixon, we have been enabled to examine a great number of specimens, some of which presented a complete calice, well-preserved costæ, and a basis that had evidently been adherent, so that no uncertainty could remain as to their belonging to our genus *Paracyathus*. This species differs from most other nearly allied species by the thinness of the pali, a character which is to be seen only in one other species; the *Paracyathus brevis*, from which *T. caryophyllus* is easily distinguished, by its septa being also much thinner. The number of the septa can equally serve as a character, for in *Paracyathus Stokesii*, *P. Desnoyersii*, and *P. procumbens*, there is a cyclum more than in the species here described.

Paracyathus caryophyllus is a very common fossil in the London Clay at the Isle of Sheppy; specimens of it are preserved in the collections belonging to the Geological Society of London, Mr. Bowerbank, Mr. Dixon, Mr. Frederick Edwards, the Museum of Paris, and M. Milne Edwards.

3. Paracyathus brevis, Tab. IV, figs. 3, 3 *a*, 3 *b*, 3 *c*.

Paracyathus brevis, *Milne Edwards* and *J. Haime.* Ann. des Scien. Nat., 3me série, vol. ix, p. 323, 1848.

The fossil remains of this species which we have had an opportunity of examining, are all more or less imperfect, and could not give us a complete knowledge of its character, but are sufficient to show that it belongs to the genus Paracyathus, and differs from all the other species of the same group. The general form of the corallum appears to be usually subturbinate and short (as in fig. 3); but if, as we have some reason to think, the natural interior cast represented in fig. 3 *c* belongs to this species, the proportions of height and breadth must be very variable. The *costæ* are closely set, nearly equal, thick, and covered with dense granulations. The *calice* is circular, and the fossula deep. The *columella* is concave, large, and delicately papillose. The *septa* are but very slightly exsert, closely set, thin towards the centre, and very thick towards the outer edge, strongly granulated laterally, and almost equally developed. The *pali* correspond to the septa of the first three cycla, and are very thin, lobulated, and, as usual, developed in an inverse ratio with the septa, in the prolongation of which they are placed. Height, from four to seven lines; diameter of the calice, six lines; depth of the fossula, one line and a half.

The existence of only four cycla of septa distinguishes this species from *Paracyathus Stokesii*, *P. Desnoyersii*, and *P. procumbens*, in which there are five of these cycla; the tenuity of the pali distinguishes it from *P. æquilamellosus*, *P. Pedemontanus*, *P. Turonensis*, and *P. crassus;* it is nearest allied to *P. caryophyllus*, in which the pali are also very thin, and lobulated, but in the latter the septa are much thinner, and the general form is very different.

Paracyathus brevis is found at the Isle of Sheppy, and the specimens figured in this Monograph belong to the cabinet of Mr. Bowerbank.

Aberrant Group of the PSEUDOTURBINOLIDÆ (p. xix).

Genus Dasmia (p. xix).

Dasmia Sowerbyi. Tab. IV, figs. 4, 4 *a*, 4 *b*.

Desmophyllum, *J. Decarle Sowerby.* Trans of the Geol. Soc. of London, vol. v, p. 136, tab. viii, fig. 1, 1834.

Dasmia Sowerbyi, *Milne Edwards* and *J. Haime.* Ann. des Sc. Nat., 3me série, vol. ix, p. 329, tab. vii, figs. 8, 8 *a*, 1848.

Corallum subturbinate, straight, or slightly curved, and subpedicellate or adherent by a very narrow basis. *Costæ* extremely broad, separated by deep, narrow furrows, obtuse

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towards the basis, rather prominent; and subcristate near the calice, covered with granulations, which become much larger towards the calice, and varying in number (17 in one specimen, 18 in another, and 22 in a third); about two thirds of them begin at the basis of the corallum, and the others about half way up towards the calice, but all are of the same breadth; the position of these younger costæ does not appear to be constant, for some are separated by three longer ones, and others by two, or only one; in general, however, two long ones are placed between two short ones, so that the latter are only about half as numerous as the former. The *calice* is nearly circular, or slightly elliptical, and the fossula appears to be deep; we are also inclined to think that there is no columella, and that the septa are free all along their inner edge, but the calice being clogged up with carboniferous matter in all the specimens that we have seen, we have not been able to determine these points with any degree of certainty. The mode of arrangement of the septa is quite abnormal; three vertical plates advance from each of the costæ towards the centre of the visceral chamber; they are all extremely thin, broad, somewhat flexuous, free from all adherence among themselves, and rendered echinulate laterally by a few prominent granulations; the plate placed in the middle of each of these groups is rather thicker than the others, and the space existing between it and the latter is rather larger than that comprised between the lateral laminæ of two neighbouring groups. Height of the corallum, about four lines; long axis of the calice, three lines and a half; short axis, two lines and a half; breadth of the costæ, more than half a line.

The three specimens of this species, from which we have drawn up the preceding description, belong to Mr. Bowerbank's palæontological collection, and were found at Highgate; Mr. Prestwich has met with it also at Clarendon Hill.[1]

Dasmia Sowerbyi is the only known species of this genus which by its general characters appears to be closely allied to the family of Turbinolidæ, but differs from it, and even from all the other Zoantharia, by the abnormal structure of the septal apparatus: when our attention was first called to this point, we endeavoured to explain the mode of radiation of the calice by supposing that each of the laminæ corresponding to the middle of the costæ belonged to one cyclum, and that the two lateral laminæ of two neighbouring groups, corresponding to the two sides of each intercostal furrow, represented the two halves of septa belonging to another cyclum;[2] the slight difference in the thickness of the middle and the lateral laminæ, as well as the facility with which the two constituent plates of the septa separate from each other in some Corals, had induced us to admit that this structure was only an exaggerated form of that which is frequently met with in certain Turbinolidæ, in many species of Flabellum, for example, where the line of junction of the two laminæ that constitute each septum is indicated externally by a single costal ridge. But a more attentive study of this singular fossil has made us change our opinion, and

[1] Journ. of the Geol. Soc. of London, vol. iii, p. 368.

[2] Monogr. des Turbinolides, loc. cit.

has induced us to think that each group composed of three laminæ, and corresponding to one costa must be the homologue of a single normal septum. It also appears evident that the first-mentioned hypothesis is incompatible with the mode of development of the younger septa corresponding to the short costæ; for wherever one of these younger costæ interposes itself between two older ones, a new group of three septal laminæ makes its appearance in the visceral chamber, between two of the old lateral plates, which, according to this view, would belong to one septum, and a young septum, accompanied by two half septa, would thus be included in the interior of an elder septum. Nothing of the sort is ever met with in any known corallum, and would be contrary to the general laws which appear to regulate the formation of the septal apparatus; but if we admit that each group of these vertical laminæ corresponds to a single septum in the ordinary Polypidoms, all serious difficulties disappear, and a circumstance that tends to corroborate this view of the subject, is, that in some Turbinolidæ an intermediate tissue is seen between the two lateral plates constituting each of the larger septa, so that if these three vertical strata of sclerenchyma, instead of being in contact, and intimately united, were separated by a membranous fold or duct, each septum would no longer have the appearance of a simple partition, but would resemble the trilaminate septal groups of the Dasmia. In the present state of our knowledge concerning the structure and the mode of development of this curious fossil, we must be cautious in our speculations concerning the signification of the parts just described; but it is to be hoped that a complete solution of the question will be obtained by the study of a greater number of these Corals. At all events, the development of the septal apparatus must be very abnormal in Dasmia, and appears to warrant the establishment of a separate zoological division for the reception of this extinct genus.

Family OCULINIDÆ (p. xix).

1. *Genus* Oculina (p. xix).

Oculina conferta. Tab. II, figs. 2, 2 *a*, 2 *b*.

Corallum composite, incrusting, forming an irregular, subglobose, or lobated mass, and appearing to have always grown on some extraneous stem, which has disappeared during the process of fossilization. The corallites are not arranged in a regular way, but are usually very closely set, and the calices are unequally prominent on the surface of the cœnenchyma, which is compact, and moderately thick; its surface is covered with round, unequal, crowded granulations, and presents no distinct costæ. The *calices* are in general quite circular, excepting when preparing to multiply by fissiparity, which is very seldom the case; the edge is rather thin, and the fossula large, but not very deep. The *columella* is sub-papillose. The *septa* (fig. 2 *b*) constitute three complete cycla, besides which some vestiges of an incomplete fourth cyclum often exists. The six systems, independently of these rudimentary septa, are equally developed; the septa are thin, narrow towards the apex, strongly granulated laterally, of unequal size according to their relative age, scarcely exsert, and terminated by a slightly arched, almost undivided edge. The *pali* are thick, narrow, and crispate; they form two coronets, and those corresponding to the secondary septa are rather larger and more distant from the columella than those corresponding to the primary septa. Diameter of the calice, two thirds of a line; depth of the fossula, half a line.

A vertical section of one of these corallites (fig. 2*a*) shows that the walls, as well as the cœnenchyma, are of a very compact structure, and are covered with minute granulations; that the small tubercles arising on the lateral surface of the septa are much less crowded; that the columella is constituted by small, irregular, filiform, ascending trabiculæ, and that the loculi are devoid of dissepiments, or only contain very few of them.

The genus Oculina, reduced to the limits here assigned to that zoological division, appears to have very few fossil representatives, for this is as yet the only known species belonging to it that is not exclusively recent; and it might be almost considered as constituting a distinct generic type, for it differs from all the recent species of Oculina by the mode of arrangement of the corallites. In the latter the corallites affect a spiral order in the ascending branches constituted by their union, and the cœnenchyma presents near the calices some slight indication of radiate costæ, whereas in this fossil the corallites, as we have already remarked, are quite irregularly grouped, and the surface of the cœnenchyma is not at all striated.

Oculina conferta appears to be abundant in the London Clay at Bracklesham Bay. We have received specimens of this fossil from Mr. Dixon and Mr. Frederic Edwards.

2. *Genus* Diplhelia (p. xxi).

Diplhelia papillosa. Tab. II, figs. 1, 1*a*, 1 *b*.

Corallum composite, subdendroid, and rather tall. *Corallites* usually disposed alternately in contrary directions, but appearing sometimes irregularly grouped, in consequence of two series becoming united so as to form a single branch, or of a few individuals multiplying by fissiparity. The *calices* placed far apart, quite circular, scarcely prominent, if at all so, and united by a highly-developed mural cœnenchyma, the surface of which is covered with closely-set, unequal, minute granulations, rather oblong, especially in the vicinity of the calices (fig. 1 *a*). Calicular margin very thin; fossula large, and very deep. *Columella* very large, of a spongiose texture, and sub-papillose at the apex. *Septa* forming three complete cycla, and six equally-developed systems; very narrow at the upper end, not exsert, thin, granulated on their lateral surface, and presenting along their inner edge delicate denticulations, which become larger towards the columella, but do not assume the appearance of rudimentary pali. The secondary septa are almost as large as the primary ones, and thus give the appearance of twelve systems (fig. 1 *b*). Sometimes septa of the fourth order exist in one of the real systems, and in that case the neighbouring tertiary septa become at the same time as large as the elder ones, so that the septal apparatus becomes divided into fourteen almost equal parts. Diameter of the calice, one line; depth of the fossula, one line, or more.

The great development and the compact structure of the cœnenchyma are rendered manifest by a vertical section of one of these corallites (fig. 1*a*); this preparation is also necessary to show the denticulations of the inner edge of the septa, and if continued to a certain distance from the calice, brings to view a few irregular, incomplete, locular dissepiments.

The new generic division, to which we have given the name of *Diplhelia*, comprises the Oculinidæ that multiply by alternate gemmation, and have denticulated, non-exsert, unequal septa, no pali, and a large columella. It differs from Astrhelia by the mode of arrangement of the corallites dependent on the alternate position of the reproductive buds, by the existence of a well-developed columella, and the absence of costal striæ near the calices. The mode of gemmation is the same in Amphelia and Enallhelia, but in these Oculinidæ the septa are entire and exsert, the columella is rudimentary, and the costal striæ are well marked near the calices.

Four species compose at present this small group; they are all fossil, and belong to the Eocene Fauna. Two of these Corals have been described by M. Defrance, under the names of *Oculina raristella* and *O. Solanderi;* the third is the *Caryophyllia multostellata* of M. Nyst; the fourth is our *Diplhelia papillosa*. *Diplhelia Solanderi*, of which a pretty good figure has been given by M. Michelin,[1] differs from the latter by the existence of numerous delicate, vermiculated, longitudinal sulci on its surface. *Diplhelia raristella*[2] differs from *D. papillosa*, by the calices being smaller and not so deep, by the septa being thicker, and the columella less developed. *Diplhelia multostellata*[3] is principally characterised by the approximation of the calices, and their dilated form.

Diplhelia papillosa has as yet been found only at Bracklesham Bay, where it appears to be abundant. The specimens here described have been communicated to us by Mr. Bowerbank, Mr. Dixon, and Mr. Frederic Edwards.

[1] Icon. Zooph., tab. xliii, fig. 19.
[2] Michelin, loc. cit., tab. xliii, fig. 16.
[3] Nyst, Coq. et Pol. foss. des Terr. tert. de la Belgique, tab. xlviii, fig. 10.

Family ASTREIDÆ (p. xxiii).

Tribe EUSMILINÆ (p. xxiii).

(*Eusmilinæ aggregatæ*).

1. *Genus* Stylocœnia (p. xxix).

Stylocœnia emarciata. Tab. V, figs. 1, 1 *a*.

Astroite demi-cylindrique, *Guettard,* Mém. sur les Arts et les Sciences, t. iii, p. 480, tab. xxxi, figs. 40, 41, 42, 1770.

Astrea emarciata, *Lamarck,* Hist. des Anim. sans Vertèb. t. ii, p. 266, 1816; 2me edit. p. 417.

— — *Lamouroux,* Encyclop. Zooph., p. 127. 1824.

— — *Defrance,* Dict. des Scien. Nat., t. xlii, p. 389, 1826.

— cylindrica, Ejusd., loc. cit., p. 379. (From a worn specimen.)

— stylopora, *Goldfuss,* Petref. Germ., vol. i, p. 71, tab. xxiv, fig. 4, 1826. (From a frustrate specimen.)

Cellastrea emarciata, *Blainville,* Dict. des Sc. Nat., vol. lx, p. 342, 1830; and Manuel d'Actinologie, p. 377. (The fossil figured in the atlas of this work, pl. liv, fig. 5, under the name of *Cellastrea hystrix,* belongs to this species.)

Astrea emarciata, *Michelin,* Icon. Zooph., p. 154, tab. xliv, fig. 6, 1844.

— cylindrica, Ejusd., op. cit., tab. xliv, fig. 4.

— decorata, Ejusd., op. cit., p. 161, tab. xliv, fig. 8.

Stylocœnia emarciata, *Milne Edwards* and *J. Haime,* Monogr. des Astreides, Ann. des Sciences Naturelles, 3me série, vol. x, p. 293, tab. vii, figs. 2, 2 *a*, 1848.

It is only in the Eocene deposits of the Parisian basin at Grignon and at Parnes that this species has as yet been met with in a good state of preservation, but its existence in the London clay is sufficiently established by two small fossils found at Bracklesham Bay, by Mr. Frederick Edwards, which do not appear to differ from the worn specimens found, together with the well-characterised ones in the first-mentioned localities. The following description is consequently derived principally from the Parisian specimens; but in order to avoid introducing into this Monograph any uncertain elements, we have figured the British specimens in preference to more perfect foreign fossils with which we consider them as being specifically identical.

Astrea emarciata is a composite Coral, of an oval, gibbous, or subramose form, which at first sight appears to be completely free, but was in all probability primitively fixed on some soft, globular, extraneous body, which after having been completely covered by the incrusting Coral, disappeared by the progress of putrefaction, and has only left a central cavity in the middle of the irregular globose mass thus produced: it consists of a thick lamellar expansion, bent so as to shut up completely an irregular cavity, and to have all the calices of its constituent corallites turned outwards. The basal or inner surface of this lamellar corallum is coated with a thin, membranous epitheca, in which circular striæ, indicative of its mode of growth, are perceptible. The *calices* are polygonal, and rather unequal in size; they are separated by a simple edge, which is common to the two adjoining corallites, and is thin where these corallites are crowded together, but rather thick where the reproductive process has been less active; in the latter case these mural edges are covered with numerous well-marked granulations, but in the former, no appearance of granulations is to be seen. Sometimes these two states are met with in different parts of the same specimen, but in others the whole mass presents one or the other of these forms, and may then be easily mistaken for distinct species. It is thus that M. Michelin has been led to consider the thick-walled variety as constituting a new species to which he has applied the name of *Astrea decorata*. The calicular margins present also at each corner a well-formed cylindro-conical columnar tubercle or process, which is not very thick at the basis, and is usually fluted by six or eight vertical furrows. In specimens that have been much rolled by the sea, these mural processes are often worn away, and these dilapidated Corals have also been described by palæontologists as a distinct species; they constitute the *Astrea cylindrica* of M. Defrance. The *columella* is slender, cylindrical, and free down to a great distance from its apex, but presents at the bottom of the fossula vertical striæ, which are produced by the prolongation of the principal septa along its sides, and are particularly manifest in some worn-down specimens, such as those found at Bracklesham, and figured in this Monograph (fig. 1 *a*). The *septa* form two complete well-developed cycla; a third cyclum is rudimentary in four of the systems, but well developed in two systems, the secondary septa of which become nearly as large as the primary ones, so as to give to the calice the appearance of having eight systems instead of six, which is the fundamental number. The eight large septa thus formed are broad, very thin, almost glabrous, not exsert, and terminated by regularly-arched, undivided edges; the other intermediate septa are very small. The interseptal dissepiments are simple, somewhat concave, slightly raised towards the columella, and placed at the distance of about one third of a line apart. The breadth of the calice is about one line and a third; the height of the mural processes two thirds of a line.

The British fossils which we refer to this species, and which we have figured in the annexed plates, have evidently been modified by the long-continued action of the sea; the septa are much broken, and the granulations of the calicular margins are not visible; it appears not improbable that the polypi to which they belonged did not live in the locality where these remains have been found, and that the Corals were brought there by some marine current. They are very rare at Bracklesham Bay, but extremely common in the Calcaire grossier of the environs of Paris. M. Michelin states that the same species is met with at La Palarea, and the Stylocœnia found in this locality is certainly very similar to *S. emarciata*, but all the specimens that we have been able to examine, were in such a bad condition that we cannot give any decided opinion as to their specific identity with the Corals described above.

Stylocœnia emarciata differs from *S. monticularia,*[1] and from *S. Taurinensis*[2] by the number of the large septa which in the latter species is only six; it differs much by its general form from *S. Lapeyrousiana,*[3] and resembles most *S. lobato-rotundata,*[4] from which it may be distinguished by a greater development of the mural tubercles, the tenuity of the septa, and the general form of the mass.

2. Stylocœnia monticularia. Tab. V, figs. 2, 2 *a*, 2 *b*.

> Stylopora monticularia, *Schweigger*, Beob. auf Naturg. reisen, tab. vi, fig. 62, 1819. (Correct figure.)
> Astrea hystrix, *Defrance*, Dict. des Sc. Nat., vol. xlii, p. 385, 1826.
> Cellastrea hystrix, *Blainville*, Dict. des Sc. Nat., vol. lx, p. 342, 1830; Manuel d'Actin., p. 377.
> Astrea hystrix, *Michelin*, Icon., p. 160, tab. xlv, fig. 1, 1845.
> Stylocœnia monticularia, *Milne Edwards* and *J. Haime*, Ann. des Sc. Nat., 3me série, vol. x, p. 294, 1848.

Corallum composite, elongated, and nearly cylindrical when young, but becoming, by the progress of growth, oval, sub-globose, and free, (fig. 2); with an empty central cavity, the parietes of which are coated with a thin epitheca, wrinkled circularly (fig. 2 *b*). The exterior surface of this hollow mass is covered with the *calices*, the borders of which vary in form according to the age of the compound Coral; when the colony of polypi is young, the margins of the calices are circular, prominent, and separated from each other by a striated surface; but in older groups, they become polygonal and united, so as to form a single thin ridge common to the two neighbouring corallites. The mamilliform processes that rise at the angles of the calices are stout, conical, broad at the basis, and covered with numerous prominent, sub-lamellar, finely-denticulated, vertical striæ. The *columella* is very slender, prominent, free a great way down, cylindrical towards the apex, and slightly compressed at the basis. The *septa* form only two complete cycla; the primary ones are much larger than those of the second cyclum, broad, not exsert, granulated laterally, and terminated by an undivided convex edge. Sometimes the striæ of the mural processes are continued down along the parietes of the visceral chamber, and assume the appearance of rudimentary septa. Diameter of the calice, two thirds of a line; height of the mural processes, half a line.

This species differs from *Stylocœnia emarciata*, and *S. lobato-rotundata*, by the regular and equal development of the six systems of septa, whereas, in the latter, two of these

[1] See tab. iv, fig. 2.
[2] Michelin, Icon., tab. xiii, fig. 2.
[3] Michelin, op. cit., tab. lxx, fig. 3.
[4] Michelin, op. cit., tab. xiii, fig. 2.

systems are apparently double, so that the septal apparatus is divided into eight nearly equal groups. *Stylocœnia Lapeyrousiana* differs from it by its conical form, and by the existence of three complete cycla of septa. *Stylocœnia Taurinensis* has equally but two septal cycla, but the mural processes are much smaller than in *S. monticularia;* the calices are larger, and the primary septa are united to columella very high up.

Stylocœnia monticularia has been found at Bracklesham Bay, by Mr. Frederick Edwards, but appears to be rare in that locality; it is, on the contrary, very common at Grignon, and in many other places near Paris.

2. *Genus* Astrocœnia (p. xxx).

Astrocœnia pulchella. Tab. V, figs. 3, 3 *a*, 3 *b*, 3 *c*.

Corallum composite, astreiform, massive, or subcolumnar, and presenting at its under surface a common plate, covered with a complete epitheca, delicately wrinkled by concentric striæ. Corallites approximating more or less, according to the age of the Coral and the degree of activity with which gemmation has been carried on. When the corallites are not crowded together, the calices are circular, and have a distinct though not prominent edge; they are also separated by a pseudo-cœnenchyma, the surface of which is covered with small costal ridges, that are usually denticulated, so as to assume the appearance of rows of round, obtuse granulæ (fig. 3*c*). When the calices approximate, they become somewhat polygonal, and their margins are separated only by a narrow furrow, or united so as to appear simple. The calicular fossula is very shallow. *Columella* cylindrical, obtuse, and free to a considerable extent, but not rising quite so high as the septa. Three complete cycla of *septa,* and six equally-developed systems; the septa of unequal size, according to their relative age, straight, slightly exsert, closely set, feebly granulated, rather thick externally, and having their upper edge entire and convex. Breadth of the calices, two thirds or three quarters of a line.

This species belongs to the division of the irregular Astrocœnia,[1] for independently of the slight inequality perceptible in the size of the calices, it is evident that gemmation takes place in this Coral simultaneously at various parts; but it differs from the other species of the same section, by the number of the septa; here, as we have already said, the six systems are equally developed, whereas in *Astrocœnia Koninckii, A. Orbignyana, A. reticulata, A. ornata, A. ramosa,* and *A. decaphylla,* there is always apparently eight or even ten systems.

We know of only three small specimens of this species, which were found at Bracklesham Bay, and belong to the cabinet of Mr. Frederick Edwards.

[1] See our Monograph of the Astreidæ, Ann. des Sc. Nat., 3me série, vol. x.

Family EUPSAMMIDÆ (p. li).

1. *Genus* STEPHANOPHYLLIA (p. liii).

STEPHANOPHYLLIA DISCOIDES. Tab. VI, figs. 3, 3 *a*, 3 *b*.

STEPHANOPHYLLIA DISCOIDES, *Milne Edwards* and *J. Haime*, Ann. des Sc. Nat., 3me série, vol. x, p. 93, 1848.

Corallum simple, extremely short, and discoidal; its under surface almost horizontal, somewhat prominent in the middle, and showing no trace of adhesion. *Costæ* very narrow, radiate, alternating with the septa, corresponding to these in number, and nearly equal in breadth, but differing much in length, according to the cycla to which they belong; the smaller ones often united to the larger ones at their basis, and thus giving to the latter a dichotomous appearance (fig. 3*b*). All these costal striæ are composed of a single row of rather indistinct granulæ, and are united by small intercostal trabiculæ, thus constituting the tissue of the discoidal wall, and the radiate rows of pores that exist in this part of the corallum, and give to it the appearance of a microscopical sieve. The upper or *calicular surface* somewhat convex, and presenting in the centre a small, narrow fossula, at the bottom of which there appears to be a rudimentary papillose columella. *Septa* forming five cycla, of very unequal size, thin, very slightly granulated, not projecting laterally beyond the edge of the wall, and having the upper edge rather angular. Those of the first and second order large, straight, and free at their inner end; all the others bent towards one another, and cemented along their inner edge, so as to constitute a series of slightly undulated arches, superposed and increasing in size from the circumference of the calice towards the centre; the largest are formed by the septa of the fourth cyclum, which unite two by two, along the inner edge of the tertiary ones (which are very short), and thus constitute on each side of the secondary septa a single lamina, that advances still further towards the centre of the calice, and joins the neighbouring secondary septum opposite the point of junction of its homologue, so as to give to the central portion of the calice the appearance of a six-branched cross of Malta; the septa of the fifth cyclum very small and marginal. Diameter, two lines or two lines and a half; height, about half a line.

This fossil Coral differs from *Stephanophyllia Suecica*[1] and *S. Bowerbankii* (Tab. IX, fig. 4), by the form of the septa, which in the latter two species are terminated by an arched edge, and are spinulose laterally; it is distinguished from *Stephanophyllia astreata*[2] by the distance that separates the large septa near the columella, and from *S. elegans*,[3] *S. imperialis*,[4] and

[1] See our Monograph of Eupsammidæ, Ann. des Sc. Nat., 3me série, vol. x, p. 94.

[2] *Fungia astreata*, Goldfuss, Petref. Germ., vol. i, tab. xiv, fig. 1.

[3] Ann. des Sc. Nat., 3me série, vol. x, tab. i, figs. 10, 10 *a*.

[4] Michelin, Icon. Zooph., tab. viii, fig. 1.

S. Nystii,[1] by its diminutive size, and by its low, very feebly-granulated septa. It is worthy of notice that *S. discoides* is the only species of this genus that has as yet been found in the Eocene formations. We have seen four specimens of this Coral; they were all met with at Haverstock Hill, and belong to the cabinet of Mr. Frederick Edwards.

2. *Genus* Balanophyllia (p. lii).

Balanophyllia desmophyllum. Tab. VI, figs. 1, 1 *a*, 1 *b*, 1 *c*.

Balanophyllia desmophyllum, *Milne Edwards* and *J. Haime*, Monog. des Eupsammides, Ann. des Sc. Nat., 3^{me} série, vol. x, p. 86, 1848.

Corallum simple, adherent by a broad, incrustating basis, subturbinate, straight, rather elongated, and slightly compressed. *Costæ* almost straight, closely set, and formed of one or more rows of irregular granulæ; the primary and secondary ones much taller and much larger than the others, especially near the calice, and usually separated by five small ones, two of which begin to appear at about two thirds down the wall, whereas the others extend to the basis. *Calice* slightly arched, and almost elliptical; its long axis being to the short one in the proportion of 100 : 160. Calicular fossula deep and narrow. *Columella* spongy, not highly developed, flat, and not prominent at the bottom of the calice. *Septa* forming five cycla, usually complete; those of the fifth cyclum more developed than those of the third order, and becoming cemented together two by two beyond the inner edge of those of the fourth cyclum, and constituting thus in each half system two septal laminæ, that in their turn unite between the inner edge of the tertiary septa and the columella. In the neighbourhood of the wall, the septa of the fifth cyclum that are situated next the primary and the secondary ones are cemented to them, and do not usually correspond to any distinct costæ; so that in each half system there are only five costæ corresponding to seven septa. The large septa are terminated by an undivided edge, and are much more exsert than the others; all are thin, granulated laterally, very porous, and closely set; those of the younger orders are delicately denticulated. Height of the corallum about

[1] We have given this name to a Stephanophyllia of the Antwerp Crag that we have seen in M. Nyst's cabinet at Louvain, and had been referred by that author to the *S. imperialis* (Coquilles et Polyp. foss. de Belgique, p. 633, tab. xlviii, fig. 17). This figure is pretty good, but does not show the small septa. Not having described it in our Monograph of Eupsammidæ, we point out here its characteristic features. The under surface of *Stephanophyllia Nystii*, nob., is somewhat concave. The *costæ* are of almost equal thickness, and do not appear distinctly composed of rows of granulæ; they alternate with the well-developed septa, but correspond to rudimentary septa of the sixth cyclum; the younger ones are, as usual, united by their base to the elder ones, but this apparent bifurcation takes place only very near the centre of the corallum; the intercostal furrows become gradually wider from the centre towards the circumference of the wall, and are bored with pores, that increase in size in the same manner. The *calicular fossula* is very deep. The *septa* are disposed in the same way as in *S. discoides* and *S. elegans*, but are much taller, thinner, and more angular; they are denticulated externally, and present on their lateral surfaces radiate striæ, which resemble incomplete synapticulæ; those of the last cyclum are very small. Diameter nearly an inch; height, 5½ lines.

seven lines; long axis of the calice, three lines and a quarter; short axis, two lines; depth of the fossula, two lines.

This species belongs to the section of the fixed Balanophylliæ, and is consequently easily distinguished from *B. prælonga*[1] and *B. Gravesii*,[2] which are only sub-pedicellate. The nakedness of the wall, and quite rudimentary state of the epitheca, distinguishes it also from *B. calyculus*,[3] *B. verrucaria*,[4] and *B. cylindrica*.[5] In *B. geniculata*[6] and *B. Cumingii*[7] there are but four cycla of septa, whereas in the above-described fossil there are five cycla. It differs from *B. italica*[8] by its elongated and compressed form, from *B. Bairdiana* by its exsert septa, and from *B. tenuistriata* by the compressed form of its lower part, and the thickness of its principal costa. It resembles most this last-mentioned species, which belongs to the Calcaire grossier of the Parisian basin.

Balanophyllia desmophyllum is found at Bracklesham Bay, and has been communicated to us by Mr. Dixon and Mr. Frederick Edwards.

3. *Genus* Dendrophyllia (p. liii).

Dendrophyllia dendrophylloides. Tab. VI, figs. 2, 2 *a*, 2 *b*, 2 *c*.

Oculina dendrophylloides, *Lonsdale*, in Mr. Dixon's manuscript work on the Chalk Formations and Tertiary Deposits of Sussex.

Dendrophyllia dendrophylloides, *Milne Edwards* and *J. Haime*, Ann. des Sc. Nat., 3me série, vol. x, p. 102, 1848.

Corallum composite, appearing usually to have incrusted the stem of some marine plant which has been destroyed during the process of fossilization. Gemmation irregular. Corallites short, very unequal in size, rather closely set, united by their basis, and free down to a variable distance from the calice, so as to project more or less on the surface of the common mass, or even to form a certain number of somewhat ramified branches (fig. 2). *Costæ* delicate, numerous, closely set, almost equal in breadth, composed of a row of irregular, conical granulæ, having a sub-vermiculate appearance, and becoming more irregular and more flexuous in the parts where they unite with those of neighbouring corallites (fig. 2 *b*). Mural pores large, and very distinct near the calice, but ceasing to be so lower down, where the tissue of the wall becomes very compact. *Calices* regularly circular, with the edge rather thin, and the fossula infundibuliform, but not deep. *Columella* spongiose, not much developed, and appearing to be but slightly prominent at the bottom of the fossula. *Septa* forming four complete cycla, and sometimes a rudimentary incomplete fifth cyclum; very thin, unequal, not exsert, or only very slightly so, and granulated

1 Michelin, Icon., tab. ix, fig. 2.
2 Michelin, Icon., tab. xliii, fig. 7.
3 See tab. i, fig. 3.
4 Milne Edwards and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. i, figs. 6, 6 *a*.
5 Michelin, op. cit., tab. viii, fig. 15.
6 D'Archiac, Mém. de la Soc. Géol., 2me série, vol. ii, tab. vii, fig. 7.
7 Milne Edwards and J. Haime, loc. cit., fig. 8.
8 Michelin, loc. cit., tab. ix, fig. 15.

laterally. The six systems very distinct; the primary septa much broader and taller than the others; the secondary ones smaller than those of the fourth order, which unite to those of the fifth order opposite the almost rudimentary tertiary septa, and continuing to bend towards the secondary ones, unite two by two along the inner edge of these, and so constitute six laminæ, that advance almost to the columella, and appear at first sight to be prolongations of the secondary septa (fig. 3 *a*). The largest of these corallites are about two lines in diameter at the calice, and project little more than a line above the common mass; the depth of the fossula is about one line and a quarter. The young individuals very soon acquire all their septa.

The genus Dendrophyllia has many representatives in the seas of the present period, and in the upper tertiary formations, but the species here described is the only one that has as yet been found in Eocene deposits, and is the oldest known, for the various fossil Corals appertaining to remoter geological periods that have been referred to this generic division by M. Michelin, and by some other authors, do not in reality belong to it. *Dendrophyllia dendrophylloides* differs from *D. ramea*,[1] *D. Taurinensis*,[2] and *D. digitalis*,[3] by its irregular gemmation; from *D. Cornigera*,[4] *D. irregularis*,[5] *D. amica*,[6] and *D. axifuga*, by having fewer septa (a cyclum less); and from *D. gracilis*[7] by not being arborescent. It resembles most our *Dendrophyllia Cecilliana*, but this last-mentioned species, which lives in the Chinese seas, is sufficiently characterised by its broad costæ, formed by double or triple rows of small granulations, and by its large prominent columella.

This fossil Coral is found at Bracklesham Bay, and has been communicated to us by Mr. Bowerbank, Mr. Dixon, and Mr. Frederick Edwards.

4. *Genus* Stereopsammia (p. liii).

Stereopsammia humilis. Tab. V, figs. 4, 4 *a*, 4 *b*.

Corallum composite, incrusting, glomerulate, remaining low, and increasing by means of an irregular basal gemmation. Corallites crowded together, cylindrical, short, united by the basis, and free down at least two thirds of their length from the calice. The costal tissue which unites them at their basis, is in general but little developed, and does not deserve the name of cœnenchyma. Gemmation seldom takes place laterally; sometimes, however, reproductive buds are formed on the side of a parent corallite at a certain distance from its basis, and will thus produce a slight appearance of ramification. *Costæ* very

[1] *Madrepora ramea*, Solander and Ellis, Zooph., tab. xxxviii.

[2] Michelin, op. cit., tab. x, fig. 8.

[3] Michelin, loc. cit., tab. x, fig. 10; and tab. lxxiv, fig. 4.

[4] Esper, Pflanz. Madrep., tab. x.

[5] Michelin, op. cit., tab. lxxiv, fig. 3.

[6] Milne Edwards and J. Haime, Ann. des Sc. Nat., 3me série, vol. x, tab. i, fig. 9.

[7] Milne Edwards and J. Haime, loc. cit., fig. 13.

slender, closely set, projecting very little, equal, sub-vermiculate, and assuming the appearance of vertical striæ irregularly broken at short distances, but not distinctly composed of granulations, as is the case in most Eupsammidæ (fig. 4 *a*). *Walls* perforated, as usual in this family, near the calice, but becoming compact lower down. *Calices* circular, infundibuliform, rather deep, and having an obtuse edge. *Columella* quite rudimentary, or not existing at all. Four *septal cycla*, the last of which is quite rudimentary, whereas the others are well developed proportionably to their age. The septa are very thin, closely set, not remarkably exsert, terminated by an oblique, nearly entire edge, and proceed in a straight direction towards the axis of the corallum, but present an undulate appearance, due principally to the existence of a few large lateral granulæ. The six systems are equally developed, and very distinct; the primary and secondary septa meet along their inner edge in the middle of the visceral chamber. Height of the corallites, about two or three lines; diameter of the calices, about two thirds of a line.

This fossil, of which we have seen but one specimen, that was found at Bracklesham Bay, and belongs to the cabinet of Mr. Frederick Edwards, is the only known species of the genus Stereopsammia. The regular radiate structure of its calice distinguishes it from most of the Eupsammidæ, and in the genus Cœnopsammia, where the same character is met with, the columella is essential and well developed,[1] whereas in Stereopsammia it does not exist, or is quite rudimentary.

Family PORITIDÆ (p. lv).

Tribe PORITINÆ (p. lv).

1. *Genus* LITHARÆA (p. lv).

LITHARÆA WEBSTERI. Tab. VII, figs. 1, 1 *a*, 1 *b*, 1 *c*.

ASTREA WEBSTERI, *J. S. Bowerbank*, on the London Clay Formation, in Charlesworth's Mag. of Nat. Hist., new series, vol. iv, p. 23, figs. A, B, 1840.
SIDERASTREA WEBSTERI, *Lonsdale*, in Mr. Dixon's unpublished work on the Chalk Formations and Tertiary Deposits of Sussex.

Corallum composite, incrusting, adhering in general to large pebbles, and forming a thick convex mass, on the edge of which some traces of a rudimentary epitheca are sometimes perceptible. Multiplication by gemmation in the spaces comprised between the calices. Corallites sometimes united by a spongy cœnenchyma; in other parts crowded together so as to render the calices almost polygonal, and separated only by a thin, simple, common margin. *Calices* infundibuliform, but not deep. *Columella* well developed,

[1] Annales des Sc. Nat., 3[me] série, vol. x, tab. i, figs. 11, 12.

of a spongy texture, not projecting at the bottom of the fossula, and terminated by a somewhat papillose surface. *Septa* thin towards the columella, thick externally, strongly echinulated laterally, broad, closely set, not exsert, terminated by an oblique crenulated edge, and forming three complete cycla, besides which there is sometimes a very incomplete fourth cyclum. The secondary septa differ but little from those of the first order; the tertiary ones also well developed, bent towards those of the second cyclum, and cemented to them along the inner edge near the columella. A horizontal section shows that the visceral chamber is cylindroid at some distance from the calice, and that the spongy tissue of the walls and the columella becomes much developed (fig. 1 *c*). The fenestrate structure of the septa is seen in a vertical section of the corallum, represented at fig. 1 *b*.

Breadth of the calices, nearly two lines; depth, half a line.

This fossil is very abundant at Bracklesham Bay. The specimens from which we have drawn up the preceding description belong to the collections of the Geological Society, of Mr. Bowerbank, Mr. F. Dixon, and Mr. Frederick Edwards.

Some other Corals that have been described under the names of *Astrea* or of *Porites*, and that belong to the Calcaire grossier of the Parisian basin, are also referable to our genus Litharæa, but all differ specifically from *L. Websteri*. In *L. Deshayesiana*,[1] *L. Heberti*,[2] and *L. bellula*,[3] the calices are smaller, and the septa less numerous; the third cyclum, which is always complete in *L. Websteri*, is incomplete in the last of these three species, and does not exist in the first two. In *Litharæa ameliana*[4] and *L. crispa*,[5] which resemble most the London Clay fossil, the walls are thinner and more prominent, and the septa more echinulate.

[1] *Porites Deshayesiana*, Michelin, Icon. Zooph., tab. xlv, fig. 4.

[2] *Litharæa Heberti*, nob. This undescribed species presents the following characters: Corallum composite, convex, massive, and often formed of superposed layers. Common epitheca moderately developed. Walls scarcely distinct. Calices polygonal and shallow. Columella not well developed, and appearing to be formed only by the inner marginal *denta* of the septa. Septa not exsert, very thick, especially outwardly, strongly echinulated laterally, terminated by an almost horizontal, spinular edge, and forming only two cycla. The twelve septa are nearly equal in size, and of a very porous structure; the spiniform granulations which cover their lateral surfaces are so highly developed, that they often become united to those of the neighbouring septum. This fossil has been found in an excellent state of preservation at Auvert, by M. Hebert, and appears to be specifically identical with same dilapidated corals met with at Valmondois.

[3] *Astrea bellula*, Michelin, op. cit., tab. xliv, fig. 2.

[4] *Astrea ameliana*, Defrance; *Astrea muricata*, Goldfuss, Petref. Germ., vol. i, tab. xxiv, fig. 3.

[5] *Astrea crispa*, Michelin, loc. cit., tab. xliv, fig. 7; (but not the *Astrea crispa* of Lamarck).

2. *Genus* Holaræa (p. lvi).

Holaræa Parisiensis. Tab. VI, figs. 2, 2 *a*.

Alveolites Parisiensis, *Michelin*, Icon. Zooph., p. 166, tab. xlv, fig. 10, 1845.

Corallum composite, and appearing to have lived fixed to the stem of some Fucus, which it incrusted all round, so as to constitute, after the destruction of this extraneous body, a hollow cylinder, open at both ends. The lamellar expansion thus rolled round is very thin, and its inner or basal surface is covered by an extremely delicate epitheca. The *calices* which occupy the opposite surface, and are consequently placed all round the exterior of the above-described cylinder, are infundibuliform, deep, irregularly polygonal, surrounded by a prominent margin, and sometimes slightly turned towards one of the extremities of the corallum, which was probably its upper end. The fossula is small and circular; its centre is occupied by a fasciculated *columella*, composed of delicate vertical processes, which are quite separated from each other, excepting towards the apex (fig. 2 *a*). The vertical section of the corallum, by means of which the composition of the columella is seen, shows also that the tissue of the whole mass is uniformly and delicately spongy; no appearance of costæ, of septa, or of any radiate structure is perceptible. The diameter of the specimen that we have figured is about a line and a half, and the thickness of the lamellar expansion that constitutes this cylinder, about half a line; the calices are also about half a line in breadth.

This species has been found both in the London Clay at Barton and the Calcaire grossier of the environs of Paris. The British specimen represented in our plates belongs to the cabinet of Mr. Frederick Edwards. We have examined many of these fossils, but owing to the very small size of the corallites, and the extremely delicate structure of their constituent parts, we fear that some of their characteristic features may have escaped from observation, and we feel much uncertainty respecting the natural affinities of the generic division of which it is as yet the only representative. We have not been able to ascertain the existence of any tabulæ in the interior of the visceral cavity, and therefore it would appear to be allied to Poritidæ rather than to Milleporidæ; but it bears great resemblance to the latter, and we are inclined to think that, when better-preserved and older specimens become known, it will prove to be a tabulated Zoantharia, and if that be the case, there will no longer be any reason for distinguishing Holaræa from our genus Axopora (p. lix). It is therefore only provisionally that we place it in the family of the Poritidæ.

Order 2.—ALCYONARIA.

Family PENNATULIDÆ.

Genus Graphularia.

Graphularia Wetherelli. Tab. VII, figs. 4, 4 *a*, 4 *b*, 4 *c*, 4 *d*, 4 *e*.

Pennatula, *J. Decarle Sowerby* and *Wetherell,* in Geol. Trans., 2d series, vol. v, part 1, p. 136, tab. viii, fig. 2 *a*, *b*, 1834.

Corallum styliform, straight, very long, cylindroid towards the lower extremity, sub-tetrahedral at the upper part, and presenting on one side a broad shallow furrow. Surface appearing smooth, when examined by the naked eye, but showing, when placed under the microscope, a multitude of small, longitudinal, closely-set, striæ, that seem to indicate a fibrous structure. Transverse section showing the existence of a thin coating and a radiate structure in the body of the Coral. Diameter of the thickest part, two thirds of a line; probable length, more than a foot.

We have only seen small fragments of this styliform Coral, that evidently constituted the central stem of some aggregate polypi of the family of the Pennatulidæ. Some of these broken remains are almost cylindrical, and usually thicker than others that are imbedded in the same mass of clay, and have a sub-tetrahedral form; others, again, are intermediate between the former, both by their size and their form, and have the same radiate structure and striated surface. It is therefore probable that they all belonged to the same species, and constituted a long, slender, sclerenchymatous axis, somewhat similar in form to that of Pennatula, but resembling that of Virgularia by its structure. The characters of the corallum thus reconstructed are also nearly allied to those of Pavonaria and Umbellularia, but differ from those of all the known recent genera of Pennatulidæ. It is brittle, and presents a radiate section, as in Virgularia, but is not cylindrical from one end to the other, as is the case in the latter, nor is it from top to bottom of a tetrahedral form, as in Pavonaria; it never appears to be twisted like the stem of Umbellularia; it united in its different parts the two forms that are found separately in the two first-mentioned genera, and so far resembles Pennatula; but in the latter the square portion is situated towards the lower end, and the apex is cylindrical, whereas in the above-described fossil, it is the upper slender part that presents a square section, and the thick basal part is cylindrical; it must also be remembered that the axis of Pennatula is not very brittle, and does not present a radiate structure when cut transversely, but appears rather of a fibrous structure. In the recent genus Lithuaria, the styliform axis is tapering towards the lower end, and inflated, pitted, and even somewhat echinulate at its upper extremity. It is also impossible to refer the elongate stem of our London Clay Pennatulida to the genus

Veretellum, for in the latter the axis is quite rudimentary. We therefore considered it advisable to designate this fossil Coral by a peculiar generic name, but we are not as yet sufficiently well acquainted with its characters to be able to form a complete idea of the polypi to which it belonged.

Graphularia Wetherelli is the only known species of this genus of Pennatulidæ; it was discovered about twenty years ago by Mr. Wetherell in the London Clay at Hampstead Heath and at Highgate. Mr. Frederic Edwards has also found fragments of it at Barton and at Haverstock Hill; and it is to his kindness that we are indebted for the specimens described in this Monograph.

Family GORGONIDÆ.

Tribe ISINÆ.

1. *Genus* Mopsea.

1. Mopsea costata. Tab. VII, figs. 3, 3*a*.

Corallum arborescent, dichotomous, and composed of epidermic basal sclerenchyma, the ossification of which is intermittent, so as to constitute a series of calcified cylinders, separated by non-ossified discs. The branches appear to spread out in one plane; they are thin, elongated, cylindrical, and deeply fluted longitudinally; each of them, immediately above its separation from the parent branch or stem, is bent outwards and upwards, so as to represent an inverted ogival angle. The corneous articulations, which have been destroyed during the process of fossilization, are very thin, and do not appear to have existed in any of the non-bifurcated branches. The longitudinal costæ are straight, thick, prominent, denticulated on their sides, and separated by deep furrows. All those belonging to the same joint are in general of the same size; but in some of the thickest branches, where they are the most numerous (about twelve), some very small ones are sometimes visible between the larger ones. The diameter of the thickest branches in the specimens here described is about half a line; that of the smallest not more than a tenth of a line.

The genus Mopsea was established by Lamouroux, but more correctly characterised by Ehrenberg, who refers to it four recent species—the *Mopsea dichotoma* of Lamouroux, the *M. gracilis*, *M. erythræa*, and *M. encrinula*, Ehrenberg; but it is doubtful whether the last does in reality appertain to this division of the Isinæ. Mr. Dana is of opinion that the *Isis coralloides* of Lamarck is also a Mopsea; but in all of these species the corallum is but slightly striated, and never presents anything like the strong costæ which exist in the above-described fossil.

We have seen two specimens of this Gorgonida, found in the London Clay at Holloway, by Mr. Frederic Edwards.

2. *Genus* Websteria.

Websteria crisioides. Tab. VII, figs. 5, 5 *a*.

Corallum composite, slender, and dichotomous, with its branches straight, flat, of the same dimensions as the stem, spreading out on one plane, and forming very acute angles with each other. Corallites subverruciform, disposed in opposite order, and forming two vertical series, the outer edge of which is occupied by a row of small, oblique, circular calices. These two lateral parts are separated by a median line, which usually has the appearance of a small furrow; sometimes they disunite, and so bring to view a small, styliform, central axis. Breadth of the branches about a fifth of a line; height of the corallites, a quarter of a line.

It is not without much uncertainty that we refer this delicate fossil to the family of the Gorgonidæ. By its general aspect, and by the mode of arrangement of the verruciform individuals of which it is composed, it resembles the genus Pterogorgia of Ehrenberg, and the existence of a central axis furnishes a strong argument in favour of the opinion which we have adopted provisionally; but, on the other hand, the structure of the individuals is very similar to that of some Sertularidæ, and still more so to divers Bryozoa, such as *Crisia denticulata.* The specimens that we have examined have not enabled us to decide the question concerning the natural affinities of the animals to which these organic remains belonged; but whether they be Polypi or Bryozoa, they appear to differ from all the known generic forms, and to constitute the type of a new genus, that we dedicate to Mr. Webster, whose observations on the formation in which they are found have been so serviceable to geology.

Websteria crisioides is the only species belonging to this zoological division. It was discovered in the London Clay at Haverstock Hill, by Mr. Frederic Edwards, to whose kindness we are indebted for the communication of the specimens here described.

CHAPTER III.

CORALS OF THE UPPER CHALK.

The fossil Corals found in the Upper Chalk of England are not numerous; they belong principally to the section of simple Eusmilinæ, and appear to be peculiar to the British Fauna. One species, it is true (the *Parasmilia centralis*), has been mentioned by different geologists as existing also in the Chalk of Beauvais and in the north-west of Germany, but we have great reason to think that these fossils are not specifically identical. It is also worthy of notice, that even no species corresponding to those met with among the Corals of the Upper Chalk of England have as yet been seen in the Chalk of Meudon, and that a great difference exists between the predominant generical forms in the first of these formations, and in the Chalk of Maestricht. In the latter some Cyathininæ nearly allied to that of England are met with; but the Diploctenium, the Cyclolites, and the aggregate Astreidæ of Maestricht are represented by no corresponding forms in this part of the British fossil Fauna, and the organic remains found in these two cretaceous deposits have consequently a very different aspect. We must add, that the fossil Corals of the Chalk of Faxoe are equally distinct from the British species, and that none of the latter have been met with in the Lower Chalk Formations of England.

Order ZOANTHARIA (p. ix).

Family TURBINOLIDÆ (p. xi).

Tribe CYATHININÆ (p. xii).

Genus Cyathina (p. xii).

Cyathina lævigata. Tab. IX, figs. 1, 1*a*, 1*b*, 1*c*, 1*d*.

Cyathina lævigata, *Milne Edwards* and *J. Haime*, Monogr. des Turbinolides; Ann. des Sc. Nat., 3^{me} série, vol. ix, p. 290, 1848.

Monocarya centralis (*pars*), *Lonsdale*, in Dixon's unpublished work on the Chalk Formations and Tertiary Deposits of Sussex, tab. xviii, figs. 12, 12*a*, (perhaps also fig. 5, but not the other figures bearing the same name, which are *Parasmilia* and probably *Cœlosmilia*).

Corallum simple, elongated, adherent, cylindro-turbinate, straight, and in general much contracted just above the basis, which is broad. *Walls* quite smooth, and polished towards the basis, but presenting towards the calice slightly-marked *costæ,* which are closely set, glabrous, or very delicately granulated, and almost equal in size.. *Calice* circular, or sometimes rather oval, shallow. *Columella* moderately developed, not projecting in the centre of the calicular fossula, composed of six or eight twisted, vertical processes, and terminated by an equal number of papillæ. *Septa* forming four cycla, the last of which is in general incomplete; the septa of the fourth and fifth orders not existing in one half of three of the systems or even of all six of these, so that the number of these radiate laminæ is reduced to 42, or even to 36; sometimes, however, four of the systems are complete, and the number of the septa then amounts to 48. These septa are well developed, closely set, thin, but slightly granulated, rather exsert, and almost equal; the principal ones are, however, a little thicker than the others. The *pali* are narrow, but very thick, prominent, and terminated by a curved edge; they all correspond to the tertiary septa, and in the specimens where the fourth cyclum is complete, they exist in front of all the septa of the penultimate cyclum, and are therefore twelve in number; but they are never so numerous when the fourth cyclum remains incomplete, and never correspond to tertiary septa that are not separated by septa of the fourth cyclum. As mentioned above, these latter septa are often wanting in one half of three of the systems, and in that case there are consequently no pali corresponding to the tertiary septa of these incomplete half systems, so that the number of pali is reduced to nine; two belonging to each of the three complete systems, and one to each of the incomplete ones. The same rule also holds good when all the six systems are deficient of the septa of the fourth cyclum in one of their halves; the tertiary septa of the complete halves are the only ones having corresponding pali, so that the number of these organs is only six. The height of the corallum varies between one inch and one inch and a half; in the tall specimens the diameter of the calice is about four lines; in the short and broad ones it is sometimes five lines.

This species is easily distinguished from the *Cyathina Cyathus,*[1] *C. Smithii,*[2] and *C. pseudoturbinolia,*[3] by its never having a fifth cyclum of septa. *C. Guadulpensis*[4] and *C. arcuata*[5] differ from the above-described fossil by the existence of distinct costæ down to the basis of the walls, and by the large size of the pali. *C. lævigata* most resembles *C. Koninckii,*[6] *C. Bowerbankii,*[7] *C. Debeyana, C. Bredæ,* and *C. cylindrica,*[8] and it may

[1] See our Monograph of Turbinolidæ, Ann. des Sc. Nat., 3[me] série, vol. ix, p. 287, tab. iv, fig. 1.

[2] Loc. cit., p. 288. [3] Loc. cit., p. 289, tab. ix, fig. 1. [4] Loc. cit., p. 290.

[5] Loc. cit., p. 290. [6] Loc. cit., p. 290. [7] Loc. cit., p. 292.

[8] The three last-mentioned species were not known to us when we published our Monograph of Turbinolidæ, and in order to render the comparison between the *T. lævigata* and the rest of the genus more complete, it appears to us advisable to give a description of them here.

Cyathina cylindrica, nob. Corallum fixed by a broad basis, regularly cylindrical, straight, and not very tall. Costæ equal, flat, straight, closely set, not very broad, and very indistinct, especially towards the basis. Calice circular, having a thick edge, and the fossula rather shallow. Columella very small, and reduced to two or three small, almost indistinct, tubercles. Septa forming four complete cycla, very closely not be unworthy of notice that these five species are as yet the only representations of the genus Cyathina that have been met with in the Chalk Formation. At first sight they appear very similar, but by an attentive examination, constant and well-defined characteristic differences are found between all. In *C. Koninckii*, the corallum is always shorter, and more regularly turbinate; the pali are thicker, and the columella is reduced to two or three thick, twisted processes. In *C. Bowerbankii*, on the contrary, the pali are much thinner, and the surface of the walls appears granulous. *C. cylindrica* and *C. Bredæ* differ from it by a very peculiar character, which exists also in *C. Koninckii*, but which is not met with in any other species of the same genus, and is indeed quite an exception to the family of Turbinolidæ, the pali being only six in number, although the four cycla of septa be complete, and corresponding to the septa of the antepenultimate cyclum, whereas they usually correspond to those of the penultimate cyclum. The thin, elongate form of *C. Bredæ* and the quite cylindrical form of *C. cylindrica*, will also help to distinguish them from *C. lævigata*, which differs also from *C. Debeyana*, by the latter having a well-marked epithecal fold near the calice, a small columella, and thinner pali.

Cyathina lævigata is found in the Upper Chalk at Dinton, in Wiltshire; specimens may be seen in the collections of the Geological Society, of Mr. Bowerbank, and of the Museum at Paris.

set, and having stronger lateral granulations near the inner edge. The primary ones larger and rather thicker than the others, but differing very little from the secondary ones; the tertiary ones are thinner and smaller; those of the fourth cyclum are distinct, but very small. Pali prominent, extremely thick, narrow, strongly granulated laterally, and corresponding to the secondary septa. Height of the corallum about six lines; diameter of the calice three lines. Fossil from the Chalk of St. Peter's Mountain, at Maestricht; specimens exist in the Museum of Natural History of Paris, and in the Tylerian Museum at Haarlem.

Cyathina Bredæ, nobis. This fossil corallum, which we dedicate to Professor Van Breda, is adherent by a rather broad basis, contracted immediately above, elongate, slender, much bent, and cylindrical towards its upper part. The costæ are not well marked, and the walls are almost smooth, but present sometimes slight horizontal folds. Calice circular; fossula shallow. Columella but little developed, and sometimes reduced to a single twisted process. Septa forming four complete cycla; but those of the last cyclum rudimentary though distinct; the primary ones rather thick, especially towards the inner edge; the secondary ones resembling those of the first cyclum, but rather narrower; the others very thin. The granulations on the sides of the septa are conical, and very prominent. The pali corresponding to the secondary septa, well developed, prominent, narrow, and appearing very thick, because they are flexuous. Height, seven or eight lines; diameter of the calice, two lines and a half. This species is also found in the fossil state in the Chalk of St. Peter's Mountain, at Maestricht; specimens exist in the collections of MM. Van Riemsdyck and Bosquet, at Maestricht; of M. Van Breda, at Haarlem; and of the Museum at Paris.

Cyathina Debeyana nob. Corallum cylindrical, elongate, slightly curved, and presenting near the calicular margin a small but well-marked circular band, representing an incomplete epitheca. Calice circular; fossula not deep. Septa unequal, closely set, somewhat exsert, rather thick externally, but thin towards the inner edge, and forming four complete cycla; the secondary ones almost as large as those of the first cyclum. Pali rather narrow, and not very thick. Height, one inch; diameter of the calice, three lines; depth of the fossula, one line. Fossil from the Chalk of Aix-la-Chapelle, discovered by M. Debay.

Family ASTREIDÆ (p. xxiii).

Tribe EUSMILINÆ (p. xxiii).

1. *Genus* PARASMILIA (p. xxiv).

1. PARASMILIA CENTRALIS. Tab. VIII, figs. 1, 1*a*, 1*b*, 1*c*.

MADREPORITE, *Parkinson,* Organ. Remains of a Former World, vol. ii, tab. iv, figs. 15, 16, 1820.
MADREPORA CENTRALIS, *Mantell,* Geol. of Sussex, p. 159, tab. xvi, figs. 2, 19, 1822. (Correct figures.)
CARYOPHYLLIA CENTRALIS, *Fleming,* British Animals, p. 509, 1828.
— — *Mantell,* Trans. of the Geol. Soc., 2d series, vol. iii, p. 204, 1829.
— — *Phillips,* Illust. of the Geol. of Yorkshire, part i, p. 119, tab. i, fig. 13, 1829; 2d edit., p. 91.
— — *S. Woodward,* Synoptic Table of Brit. Org. Remains, p. 6, 1830.
CARYOPHYLLIA, *R. C. Taylor,* in Mag. of Nat. Hist., vol. iii, p. 271, fig. *f,* 1830.
LITHODENDRON CENTRALE, *Ch. Keferstein,* Die Naturgeschichte des Erdkorpers, vol. ii, p. 789, 1824.
TURBINOLIA EXCAVATA (?), *Hagenow,* in Leonard's und Bronn's Jahrbuch für Mineral., p. 229, 1839.
— CENTRALIS, *Fred. Adolph Rœmer,* Verstein. des Norddeutschen Kreidegebirges, p. 26, 1840.
— — *Bronn,* Index Paleontologicus, p. 314, 1848.
PARASMILIA CENTRALIS, *Milne Edwards* and *J. Haime,* Monogr. des Astreides, Ann. des Sc. Nat., 3^{me} série, Zool. vol. x, p. 244. 1848.
MONOCARYA CENTRALIS (*in parte*), *Lonsdale,* in Dixon's unpublished work on the Chalk Formations of Sussex, tab. xviii, figs. 1, 3, 7, 7 *a*, 9 (cæteris exclusis).

Corallum simple, cylindrico-turbinate, fixed by a rather broad basis, above which it is much contracted, elongate, irregularly bent in various directions, and presenting a series of unequal contractions and circular dilatations. *Costæ* closely set, and distinct from the calicular margin down to the basis, where they are the most prominent; those corresponding to the primary and secondary septa are rather larger than the others towards the basis; but the tertiary ones soon become almost similar to the former, and at the upper part of the wall all these large costæ alternate with smaller ones belonging to the fourth cyclum. All are covered with delicate granulations, which are most prominent towards the lower part of the costæ of the fourth cyclum, where they form simple series. *Calice* circular, with the fossula less shallow than usual in this genus. *Columella* well developed, somewhat prominent and crispate. *Septa* forming six equally developed systems and four complete cycla; closely set, very unequal, broad, thin, slightly exsert, straight, or very slightly flexuous, and presenting laterally a few large granulations. *Dissepiments* simple, almost horizontal, and few in number; about three from the top to the bottom of each principal septum, as may be seen by means of a vertical section. Height varying from one to two inches; diameter of the calice, four lines; depth of the fossula, two lines.

The genus Parasmilia, circumscribed within the limits assigned to it in the Introduction to this Monograph, only contains seven species, all of which belong exclusively to the upper beds of the Chalk Formations. Three of them (*P. centralis*, *P. Gravesiana*, and *P. elongata*) have already been described in our Monograph of the Astreidæ,[1] and the four others (*P. Mantellii*, *P. Fittonii*, *P. cylindrica*, and *P. serpentina*) will be made known in the present work. They all differ but little from each other, and in order to recognise them, it is necessary that they should be compared together with attention. *P. centralis*, which may be considered as the type of this small generic group, differs from *P. Gravesiana*, *P. elongata*, *P. cylindrica*, and *P. Mantellii*, by its costæ being always straight, rather thick and never sub-lamellous, and rather flexuous, as in the four last-mentioned species; it is also to be remarked, that its costæ are rather more prominent near the basis than higher up, whereas the contrary is seen in the *P. Gravesiana*, and that the loculi are never subdivided by small dissepiments, as is the case in *P. elongata*, *P. cylindrica*, and *P. Mantellii*. *P. serpentina*, which bears more resemblance to it, is characterised by the septa forming only three cycla, and the costæ being very delicate, and rather indistinct towards the basis. But it is with *P. Fittonii* that *P. centralis* is most closely allied; the former, however, is of a thicker form, its tertiary costæ are more developed and more delicately granulated, and its columella is much larger, and terminated by a sub-papillose surface.

The specimens of *P. centralis* which we had the opportunity of examining were found in the Upper Chalk at Northfleet, near Gravesend, and at Norwich. Mr. Phillips mentions the existence of the same fossil at Dane's Dike;[2] and Dr. Mantell has met with it at Brighton, Lewes,[3] Steyning, and Heytesbury.[4] Mr. Graves also alludes to it as being found in the Chalk Formation of the Parisian basin at Beauvais;[5] but we have much reason to think that the species observed by that geologist is not the one here described, and must be referred to our *P. Gravesiana*. M. Rœmer and other authors equally apply the name of *C. centralis*[6] to a fossil found in the north-west of Germany, but we have not been able as yet to verify the propriety of this determination, not having seen any of the specimens discovered in that part of the Continent.

[1] The species described in that work under the names of *Parasmilia poculum*, *P. Faujasii*, and *P. punctata*, must now be referred to our genus *Cœlosmilia*, which is characterised by the entire absence of the columella.

[2] Op. cit., part i, p. 119.

[3] Illust. of the Geol. of Sussex, p. 160.

[4] Geol. Trans., 2d series, vol. iii, p. 204.

[5] Geogn. de l'Oise, p. 701.

[6] Versteinerungen des Norddeutschen Kreidebirges, p. 26.

We must also remark that, in a note just published, our able friend M. Aleide d'Orbigny[1] refers to the *Caryophyllia* or *Parasmilia centralis* as the type of a new genus, designated under the name of *Cyclosmilia,* and eharaeterised in the following terms: "Cyelosmilia are Parasmilia, in whieh the loeuli are but very little divided by dissepiments, the growth of the eorallum is intermittent, the ealiee eireular instead of being oval, and the external eostæ distant from each other." Now, with the exeeption of this last peculiarity, whieh is not even met with in *P. centralis,* all these eharaeters may be seen in every speeies belonging to our genus Parasmilia, and we therefore ean find no reason for separating from it this new generie division.

2. Parasmilia Mantelli. Tab. VIII, fig. 2, 2 *a*.

We have as yet seen but one speeimen of this speeies, whieh appears to be very distinet from all others. It is a small eorallum, nearly straight, adherent by a broad basis, regularly turbinate, and not very tall; but being in all probability suseeptible of inereasing mueh in height by progress of age, as is the ease with the other speeies belonging to the same genus. The *costæ* are narrow, sublamellar, elosely set, distinet down to the basis of the eorallum, very eehinulate, and somewhat erispate. Those of the primary and seeondary eyela are equally developed, and rather more prominent than the others, espeeially towards the basis and the calieular margin; the tertiary ones also extend on the basal expansion of the eorallum, but are smaller; and those of the fourth eyelum begin at a short distanee above the basis, and are very narrow at their lower part. The intereostal furrows are broad, deep, and divided by small transverse dissepiments, formed by rudiments of an exotheea. *Caliec* eireular; fossula not deep. *Columella,* as far as we ean judge by the speeimen here deseribed, very similar to that of *P. centralis.* *Septa* forming four eomplete eyela; well developed, thin, straight, elosely set, rather unequal, and presenting well-marked striæ on their lateral surfaees. Height, seven or eight lines; diameter of the ealiee, nearly five lines.

This fossil differs from the other speeies belonging to the same genus, and more espeeially from *P. centralis* and *P. Fittoni,* by its eostæ, whieh are equally prominent and suberispate, whereas in the latter they are smooth and never sublamellar. It resembles more closely *P. Gravesiana, P. cylindrica,* and *P. elongata;* but it differs from them by the strong granulations of the eostæ. In *P. serpentina* the basis is almost smooth, and the septa do not form so many eyela.

Parasmilia Mantelli was met with in the upper ehalk at Bromley in Kent, by our friend Mr. J. S. Bowerbank.

[1] This paper, bearing the title of 'Note sur des Polypiers Fossiles,' and published on the 10th of October, 1849, contains the exposition of the characters of a series of new genera proposed by M. d'Orbigny. The author assigns to most of these divisions the date of 1847, a period at which he appears to have adopted them in the arrangement of his private collection; but in referring to them here or elsewhere, we have considered it proper to quote the year of their publication, which is the only authentic date that could be made use of if any question of priority should arise concerning them.

3. Parasmilia Cylindrica. Tab. VIII, fig. 5.

It is not without some hesitation that we inscribe this species in the list of our Parasmilia, for the specimen about to be described is extremely incomplete; but it does not present the specific characters of any other species, and although very nearly allied to *P. elongata* and *P. Mantelli*, it appears to differ from both in some essential points. The fragment here alluded to is deficient both in the basis and in the calice, but it appertained to a tall, nearly cylindrical corallum, that was somewhat bent. The *costæ* are almost equal, extremely thin, sublamellar, but not very prominent, subflexuous, very slightly granulated, and divided at short intervals by circles of small dissepiments, formed by rudiments of an exotheca. The intercostal furrows are broad, rather shallow, almost destitute of granulations, and presenting sometimes in the middle a small rudimentary costa. *Columella* well developed. *Septa* forming four complete cycla, not very closely set, somewhat flexuous, and slightly granulate; those of the first and second cycla equally developed, and rather thick; the tertiary ones smaller and thinner; those of the fourth cyclum very small, although the costæ corresponding to them are as large as those of the other cycla. Length, above two inches; diameter, about six lines.

This fossil much resembles the *Parasmilia elongata* found at Ciply, but differs from it by the unequal development of the septa belonging to the first two and to the last two cycla, a mode of structure which does not exist in *P. elongata*. It differs from *P. centralis*, *P. Fittoni*, and *P. serpentina*, by the delicacy and almost lamellar form of the costæ, and bears greater resemblance to *P. Mantelli* and *P. Gravesiana*, from which it may, however, be easily distinguished by the breadth of its intercostal furrows.

The specimen here described belongs to the Palæontological collection of Mr. J. S. Bowerbank, and was found in the upper chalk at Norwich. Another fossil, which we consider as belonging to the same species, exists in the Poppelsdorf Museum at Bonn, and was found in the upper chalk at Darup, in Westphalia.

4. Parasmilia Fittoni. Tab. IX, fig. 2, 2 *a*, 2 *b*.

Corallum stout, adherent by a somewhat broad basis, immediately above which it in general becomes very narrow; elongate, much bent, and presenting at intervals circular constrictions. *Costæ* broad, closely set, not very prominent, excepting near the basis, down to which they are quite distinct, rather unequal alternately, and covered with very numerous and small granulations. *Calice* circular; fossula large and rather shallow. *Columella* well developed, but very slightly prominent, of a spongy structure, and terminated by a broad subpapillose surface. *Septa* forming four complete cycla, rather thin, straight, not very closely set, slightly exsert, and having but few granulations on their lateral surfaces.

Those of the second order are nearly as large as those of the first set, and thus produce the appearance of twelve tertiary systems. Height, from one to two inches; diameter of the calice five lines; its depth, two lines.

This species is easily distinguished from all the other Parasmilia by the great development of its columella, which occupies nearly half the diameter of the calice, and by the spongy structure of this organ. It most resembles *P. centralis*, from which, however, it differs also by its thick form and the greater development of the tertiary costæ towards its basis. The breadth and delicate granulations of the costæ may equally serve to distinguish it from *P. Gravesiana*, *P. elongata*, *P. cylindrica*, and *P. Mantelli*. It differs from *P. serpentina* by having an additional cyclum of septa, and by its basis not being smooth, as is the case in the latter.

This fossil is found in the upper chalk of Norwich, and exists in the collections of the Geological Society, of the Geological Survey, and of the Museum at Paris. It appears probable that it has often been confounded with *P. centralis*, and that some of the figures referred to that species may in reality belong to it; but the engravings here alluded to are not correct enough to enable us to decide this question.

5. Parasmilia (?) serpentina. Tab. VIII, fig. 3, 3 *a*, 3 *b*.

It is not without some doubts that we place this fossil in the genus Parasmilia, for in the unique specimen that has come under our observation, the calice was in so bad a state of preservation that it was impossible to decide whether the papillæ seen near the centre of that part were fractured septa or remains of pali, or even trabiculæ belonging to the columella. However, the first hypothesis appears most probable, and the general appearance of the corallum is also very similar to that of all the other Parasmilia.

This fossil is almost cylindrical, slender, much elongated, and bent; it presents some strongly marked circular constrictions, indicative as usual of a certain intermittence in the progress of its growth. The *costæ* are narrow, straight, rather unequal alternately, scarcely distinct near the basis, but more prominent towards the upper part of each inflated ring and near the calice; the *calice* is circular. The *septæ* form three complete cycla and are rather closely set, exsert, and somewhat dilated exteriorly. The *columella* is well developed. Length, one inch, seven lines. Diameter of the calice, two lines and a half.

This coral, belonging to Mr. Bowerbank's collection, was found in the upper chalk at Bromley, in Kent.

It is the only species of Parasmilia in which the fourth cyclum of septa does not exist; it is also characterised by its basis not being costulated.

2. *Genus* CŒLOSMILIA (p. xxv.)

CŒLOSMILIA LAXA. Tab. VIII, fig. 4, 4 *a*, 4 *b*, 4 *c*.

Corallum simple, turbinate, slightly bent, rather intermittent in its growth, and appearing to have been adherent. *Costæ* distinct from the basis to the calice, very distant from each other; those belonging to the first three cycla subcrestiform; those of the last cyclum flat and scarcely visible, delicately granulated and crossed by small horizontal striæ. *Calice* circular; fossula narrow and rather deep. No *columella*. *Septa* forming four complete cycla; but those of the last cyclum almost rudimentary. The six systems equally developed. The septa very unequally developed, broad, very exsert; thin, but rather less so near the inner margin, presenting a few round granulations on their lateral surfaces. Those of the first and second cycla united along the lower part of their inner edge. Height, from one inch to one inch and a half; diameter of the calice, seven lines.

We have given the generic name of *Cœlosmilia* to a certain number of Eusmilinæ which we formerly placed in our genus *Parasmilia*, but which are characterised by the absence of the columella and the rudimentary state of the endotheca. *Parasmilia poculum*, *P. Faujasi*, and *P. punctata*[1] belong to this group, and differ from *C. laxa* by their costæ being flat and granulated near the calice, whereas in the above-described fossil these parts are subcrestiform. It is also to be remembered that in *Cœlosmilia poculum* and *C. Faujasi* the septa form five complete cycla, and that in the last-mentioned species, as well as in *C. punctata*, the principal septa are much thicker than in *C. laxa*. M. Alcide d'Orbigny has lately discovered in the white chalk of Césanne a new species which he designates by the name of *Cœlosmilia Edwardsiana*, and which differs from *C. laxa* by its costæ being rudimentary and its septa thinner.

[1] See our Monograph of the Astreidæ (Ann. des Scien. Nat. 3me série, vol. x). It is possible that our *Cœlosmilia punctata* may be only a young form of *C. Faujasi*, but we have not as yet seen a sufficient number of specimens to be able to decide the question.

CHAPTER IV.

CORALS FROM THE LOWER CHALK.

The number of British Corals known to belong to this formation is as yet so very small, that it would be premature to speculate on their mode of distribution. We have seen but two species, one appertaining to the family of Oculinidæ, the other to that of Eupsammidæ; both appear to be peculiar to the lower chalk of England.

Family OCULINIDÆ (p. xix).

Genus SYNHELIA (p. xx).

SYNHELIA SHARPEANA. Tab. IX, fig. 3, 3 *a*.

Corallum composite, dendroid, with thick, erect branches, forming acute angles with each other, and presenting on their surface large, non-exsert, circular calices, which are not closely set, and are united by rather indistinct, small costal striæ. *Calices* quite superficial, and presenting scarcely any central depression. *Columella* assuming the appearance of a small, obtuse tubercle. Three complete cycla of *septa,* and in one half of each system two quaternary septa, of which no homologues exist in the other half. The septa are thick, very closely set, almost straight, and unequally developed, but those of the second order differ but little from the primary ones. The upper edge of all is horizontal, and closely denticulated; towards the columella the denticulations are rather larger than towards the calicular margin, and we have not been able to decide whether some of them do not constitute pali. The lateral surfaces of the septa present oblong transverse granulations, which much resemble incomplete synapticulæ, but they are not prominent enough to meet those of the adjoining septa, and to subdivide the interseptal loculi. The height of the specimen here described is about two inches and a half, and the diameter of the calices two lines.

We are as yet acquainted with but two other species that can be referred to our genus *Synhelia;* one is the *S. gibbosa,* which was first described by Goldfuss under the name of

Lithodendron gibbosum,[1] and which belongs also to the lower Chalk formation, but is found at Bochum, in Westphalia, and at Blaton, near Mons, in Belgium. It differs from *S. Sharpeana*, by its calices being more closely set; rather oblong, with a more prominent margin, and twenty-four nearly equal, very thick septa, separated by an equal number of rudimentary ones. The other is the *Madrepora Meyeri*, found by MM. Koch and Dunker in the Jurassic formation at Elligser-Brinke; it has deep calices.[2]

The unique specimen here described appears to have been found in the lower chalk near Dover, and was kindly communicated to us by Mr. Daniel Sharpe.

Family EUPSAMMIDÆ (p. li).

Genus STEPHANOPHYLLIA (p. liii).

STEPHANOPHYLLIA BOWERBANKII. Tab. IX, fig. 4, 4 *a*, 4 *b*, 4 *c*.

STEPHANOPHYLLIA BOWERBANKII, *Milne Edwards* and *J. Haime*, Monogr. des Eupsammides, in Annales des Sciences Naturelles, 3me série, Zool. vol. x, p. 94, 1848.

Corallum simple, resembling, in its general form, a plano-convex lens. *Wall* discoidal and horizontal. *Costæ* numerous, delicate, nearly equal, closely set by pairs, and formed by a simple series of granulations, which become the most distinct near the outer edge of the mural disc. Twenty-four of these costæ begin near the centre of the corallum, and soon after bifurcate; the forty-eight costæ thus produced soon divide again, in the same manner, and near the edge of the disc the number of these radiate ridges amounts to ninety-six. The mural pores are small, not very distinct, and arranged in series in the intercostal furrows. *Calice* quite circular, and appearing to be regularly convex, excepting towards the centre, where there is a slightly-marked, shallow fossula. *Columella* almost rudimentary, and formed only by two or three trabiculæ, which are often scarcely distinct from the edges of the *septa*. These last-mentioned organs arise from the upper surface of the mural disc, and are thin, especially outwards, closely set, and covered laterally with large, prominent granulations. They form five complete cycla, and represent six well-characterised and equally-developed systems. The primary and secondary septæ are straight, and extend to the columella; their upper edge is arched, or slightly angular. The tertiary septa are also much developed, and bend towards the secondary ones, to which they become united by their inner edge, near the columella. The septa of the fourth and fifth orders, constituting the fourth cyclum, are united in a similar way to the tertiary septa, at about half way from the margin of the mural disc to the columella, but not exactly at the same point, those of

[1] Petref. Germ., vol. i, tab. xxxvii, fig. 9.

[2] Beiträge zur Kenntniss des Norddeutschen oolithgebildes, p. 55, tab. vi fig. 11, 1837.

the fifth order being rather longer than those of the fourth order. The septa of the fifth cyclum are small, thin, low, and unite to the neighbouring principal septa; those of the sixth order join the primary ones; those of the seventh order adhere by their inner and upper edge to the secondary ones, and those of the eighth and ninth orders to the tertiary septa; or, in other words, each element of this fifth cyclum joins the eldest of the two septa between which it is placed. Independently of these junctions, which are normal, and always take place along the inner edge of the septa, the interseptal loculi are irregularly divided in some places by the projecting lateral granulæ of two neighbouring septa meeting, and becoming cemented together. By this character, as well as by its general form, this species tends to unite the family of Eupsammidæ with the Fungidæ.

Height of the corallum, one and a half or two lines; diameter, three or four lines. Some specimens, which were probably not adult, were only two lines and a half in diameter.

This delicate little Coral differs from *Stephanophyllia elegans*, *S. imperialis*, and *S. discoides*[1] by the form of the septa, which do not appear to be angular and lacerated, as in the three latter species. *Stephanophyllia astreata*[2] differs from it by having a large fossula and a well-developed columella. It most resembles *S. suecica*;[3] but in this species the two tertiary septa of each system unite below the columella and the secondary septa, which consequently do not extend to the centre of the calice; whereas in *S. Bowerbankii* these tertiary septa, as we have already stated, adhere to the secondary septa, and these last-mentioned septa extend to the columella. The Fossil Coral figured by M. von Hagenow, under the name of *Fungia clathrata*,[4] and found by that geologist in the chalk formation of Rugen, is evidently very nearly allied to the British species here described; but as far as we can judge of it by M. von Hagenow's engraving, it appears to differ from it by its more elevated form, by the strongly-marked concentric striæ visible on the mural disc, and by its basis being more prominent.

We must also remark, that the section of the genus Stephanophyllia, to which this species belongs, and to which we applied the name of *Lenticular Stephanophyllia*,[5] has of

[1] See our Monograph of the Eupsammidæ, Ann. des Sc. Nat., 3[me] série, vol. x.

[2] *Fungia astreata*, Goldfuss, Petref. Germ., vol. i, p. 47, tab. xiv, fig. 1 (where it is by mistake designated under the name of *Fungia radiata*). This species not having been, as yet, well characterised, we think it may be useful to give a short description of it here. Corallum simple, very short, and having the form of a plano-convex lens. Calicular fossula circular, and well developed. Costæ very delicate and not closely set. Septa forming five complete cycla, and appearing to be thin and strongly granulated. Size very variable; in the adult, diameter three lines, height about one line. Fossil found at Aix-la-Chapelle, in Westphalia, and existing in the Museums of Bonn and Paris. All the specimens yet found are in a very bad state of preservation.

[3] Monogr. of the Eupsammidæ, loc. cit., p. 94.

[4] In Leonhard and Bronn's Jahrbuch für Mineralogie, 1840, p. 684, tab. ix, fig. 3.

[5] Monogr. of the Eupsammidæ, loc. cit., p. 94, 1848.

late been considered by M. Alcide d'Orbigny as deserving to be elevated to the rank of a genus, and has been named by that author *Discopsammia*;[1] but M. d'Orbigny has not pointed out any new characters in addition to those on which this separation was primitively established in our Monograph, and consequently we see no reason for altering the classification previously adopted.

Stephanophyllia Bowerbankii is found in the lower chalk near Dover, and does not appear to differ from some corals which one of us[2] has lately met with in a bed of chlorited chalk at Orcher, near le Havre. The specimens here described belong to the collections of Mr. Bowerbank, Mr. D. Sharpe, and the Geological Society.

[1] Note sur les Polypiers Fossiles, p. 10, 1849.

[2] M. Jules Haime.

CHAPTER V.

CORALS FROM THE UPPER GREENSAND.

The class of Polypi had not, in all probability, numerous representatives in the seas where the Upper Green Sand was deposited, for we have as yet seen only four British species belonging to that formation, and the English geologists do not appear to have met with many more. Most of these fossils belong to the family of Astreidæ, and have been found at Haldon, at Blackdown, or at Warminster. One of these British species appears to be identical with a coral described by Goldfuss, and found in the chalk formation of Essen; and Mr. Morris has pointed out two others as being referable to species found in the chalk of Maestricht, but we have not had an opportunity of recognising the specific identity of these last-mentioned fossils.

Family ASTREIDÆ (p. xxiii).

Tribe EUSMILINÆ (p. xxiii).

1. *Genus* Peplosmilia (p. xxv).

Peplosmilia Austeni. Tab. X, fig. 1, 1 *a*, 1 *b*.

Corallum simple, fixed by a broad basis, cylindrical, and surrounded from top to bottom by a membraniform epitheca, presenting some slight transverse folds. *Calice* circular, or somewhat oval; fossula shallow, narrow, and elongated. *Columella* well developed and lamellar. *Septa* appearing to form four well-developed cycla, and a fourth rudimentary one. The primary and secondary ones equal, and differing but little from the tertiary ones; they are all thick, broad, closely set, slightly exsert, not quite straight, those on one side inclining to the right near the columella, and those of the other side bending in an opposite direction. A vertical section of this Coral (fig. 1 *b*) shows that the septa are granulated on their lateral surfaces, especially near their inner edge, which joins the columella, and that these granulations form closely-set radiate rows. *Dissepiments* vesicular, and rather abundant. Height of the coral, one inch and a half; diameter of the calice, above an inch.

This speeics is as yet the only known representative of our genus Peplosmilia,[1] and is easily distinguished from the other true Eusmilinæ, either by its lamellar eolumella or its complete epitheea; it may be eonsidered as a Montlivaltia, having a lamellar columella. We have seen but one specimen of this fossil; it was found in the Greensand at Haldon, and presented to the Geological Soeiety by Mr. R. H. C. Austen.

2. *Genus* Trochosmilia (p. xxiv).

Trochosmilia (?) tuberosa. Tab. X, fig. 2, 2 *a*.

Turbinolia compressa, (?) *Morris*, Cat. of Brit. Foss., p. 46, 1843.

Corallum simple, compressed, even at its basis, cuneiform, subpeduneulated, and presenting on each of its lateral edges, at a short distance above the basis, a broad but not very prominent tuberosity. *Costæ* delicate, straight, not prominent, but very distinet from the basis upwards, elosely set and somewhat unequal. *Calice* elliptic and horizontal; its small axis only half the length of the long axis. Fossula narrow, rather shallow, and elongated. No *columella*. *Septa* forming five complete cycla; very thin, straight, closely set, and delieately granulated laterally; those of the first and second cycla nearly equal in size and larger than the others, so as to produce the appearance of twelve systems; those of the fifth cyclum very small. Height, seven lines; diameter of the calice, eight lines by four.

The above-described specimen was found in the Greensand of Blackdown by our able friend Mr. J. S. Bowerbank. We have not, as yet, been able to aseertain the existence of dissepiments in the interseptal loeuli, and consequently are not quite sure that it belongs to the genus Trochosmilia; if these parts do not exist it must be referred to the family of the Turbinolidæ, but we have not had the materials necessary for deciding that question. We shall therefore only add here, that this coral differs from the other species of Troehosmilia deseribed in our 'Monograph of the Astreidæ' by the existenee of the lateral tuberosities, and the basis presenting scarcely any traces of adherence.

It is probably this fossil which Mr. Morris referred to the *Turbinolia compressa* of Lamarck, and mentioned as existing in the Greensand of Blackdown. *T. compressa* belongs also to our genus Troehosmilia, and is found in the Greensand at Uehaux in the South of France, but differs from *T. tuberosa* by its general form.

[1] The fossil described by M. Michelin under the name of *Anthophyllum detritum* (Icon. Zooph., tab. x, fig. 1) might at first sight be supposed to belong to this genus, for it presents some appearance of a lamellar columella; but that is owing to the presence of some extraneous matter adhering to the specimen figured by M. Michelin, and although the epitheca does no longer exist in this fossil, we have no doubt that it is in reality a Montlivaltia.

Tribe ASTREINÆ (p. xxxi).

Genus Parastrea (p. xliii).

Parastrea stricta. Tab. X, fig. 3, 3 *a*.

Corallum composite, forming a mass not very tall, and slightly convex on its upper surface. *Calices* seldom circular, in general oblong or irregularly polygonal, projecting very little, and having always distinct margins. *Costæ* delicate, closely set, nearly equal, almost horizontal, nearly straight or slightly bent, and united by their extremity to those of the neighbouring corallites, which, however, remain circumscribed by a small furrow. *Calicular fossula* shallow. *Columella* of a dense tissue, subpapillose, and not much developed. *Septa* thin, broad, closely set, terminated by a series of calicular dentations, the last of which (towards the columella) appears to be more developed than the others; the number of these septa seldom exceeds forty, and they are rather unequal. *Walls* thin, but well developed. Diameter of the calices, usually between two lines and two lines and a half; distance between the calices, at least half a line.

This species, found in the Greensand at Blackdown, is characterised from a specimen belonging to the Geological Society; it differs from all the previously described Parastrea by the approximation and delicate structure of the septa.

Mr. Morris mentions, in his 'Catalogue of British Fossils,'[1] two other species which have been found by M. Austen in the Greensand at Haldon, and which belong to the family of Astreidæ. M. Austen considers the one as being identical with the Maestricht fossil coral described by Goldfuss under the name of *Astrea elegans*,[2] and he refers the other to the *Astrea escharoides*[3] of the same author[4]. We regret not having had an opportunity of examining these fossils.

[1] Loc. cit., p. 31.

[2] Petref. Germ., vol. i, tab. xxiii, fig. 6.

[3] Goldfuss, op. cit., tab. xxiii, fig. 2; fossil from Maestricht.

[4] Austen, on the Geol. of the South-east of Devonshire, Trans. of the Geol. Soc., Second Series, vol. vi, p. 452.

Family FUNGIDÆ (p. xlv).

Genus MICRABACIA (p. xlvii).

MICRABACIA CORONULA. Tab. X, fig. 4, 4 *a*, 4 *b*, 4 *c*.

CYCLOLITES, *W. Smith,* Strata identified by Organic Fossils, p. 12; Greensand, p. 15, 1816.
FUNGIA CORONULA, *Goldfuss,* Petref. Germ., vol. i, p. 50, tab. xiv, fig. 10, 1826.
— — *F. A. Rœmer,* Die Verstein. des Norddeutschen Kreidegebirges, p. 25, 1840.
— — *Morris,* Cat. of Brit. Fossils, p. 38, 1843.
FUNGIA CLATHRATA (?) *Geinitz,* Grundriss der Versteinerungskunde, tab. xxiii, fig. 2, 1849.

Corallum simple, lenticular, short; its under surface horizontal or slightly concave; its upper surface somewhat convex. Mural disc completely naked and regularly perforated by small intercostal pores. *Costæ* closely set, almost straight, equally narrow, not prominent, and but slightly echinulated; only twelve of them arise in the centre of the disc, but these soon bifurcate, and the twenty-four costæ so formed soon divide again; at about half the distance from the centre to the circumference of the disc each costa bifurcates once more, and the two terminal costæ so formed are grouped two by two towards the periphery of the disc. The granulations which form all these costæ are not very distinct, and are arranged in single lines. *Calicular fossula* small and not very deep, but well marked and rather elongated laterally. *Columella* very small, oblong, and subpapillose. *Septa* forming five complete cycla, and corresponding to the intercostal spaces; those of the last cyclum quite rudimentary; the others tall, thin, straight, and united by sub-spiniform trabiculæ. Those of the first cyclum larger than the others, and augmenting slightly in thickness towards the middle; the secondary ones almost as large; all delicately denticulated along their upper edge, and much thinner towards their outer and inferior angle than in any other part. Diameter, three or sometimes four lines; height, one line and a half.

The above-described fossils were found in the Greensand at Warminster, in Wiltshire, and according to William Smith, who was the first author that mentions this fossil, are also met with at Chute Farm and Puddle Hill, near Dunstable.

By an attentive comparison with the specimens described by Goldfuss, and belonging to the Poppelsdorff Museum at Bonn, we have ascertained the specific identity of this British Coral with the *Fungia coronula* found in the chalk of Essen. Specimens exist in Mr. Bowerbank's cabinet, and in the collections belonging to the Geological Society, the Museum of Paris, the Museum of Bonn, and M. Defrance at Sceaux, who has designated it by the unpublished name of *Fungia dubia.*

CHAPTER VI.

CORALS FROM THE GAULT.

The Fossil Corals contained in the Gault are more numerous than those imbedded in the upper greensand and the lower chalk. Most of them belong to the family of Turbinolidæ, and the principal localities where they have been met with in England are Folkstone and Cambridge.

Family TURBINOLIDÆ (p. xi).

Tribe CYATHININÆ (p. xii).

1. *Genus* Cyathina (p. xii).

Cyathina Bowerbankii. Tab. XI, fig. 1, 1 *a*, 1 *b*.

> Cyathina Bowerbankii, *Milne Edwards* and *J. Haime*, Monogr. Turbin., in Ann. des Sc. Nat., 3ᵐᵉ série, vol. ix, p. 292, 1848.

Corallum simple, elongated, turbinate, very narrow, and slightly bent near the basis, which does not appear to have expanded much. *Wall* quite naked. *Costæ* almost flat, distinct from the basis, or nearly so, covered with small granulations, nearly equal, and showing a slight tendency to form binary groups. *Calice* circular. *Columella* not much developed, and composed of twisted blades. *Septa* forming four complete cycla; very thin, but slightly granulated, and rather unequal. Those of the last cyclum very little developed, and the tertiary ones rather thickened towards the inner edge. *Pali* corresponding to the penultimate cyclum of septa, and rather broad. Height of the coral, eight or nine lines; diameter of the calice, three lines and a half.

This fossil was found in the Gault at Folkstone, by our friend Mr. Bowerbank. All the specimens that we have seen were very incomplete, but some showed all the principal characters represented in the figures which we have given.

C. Bowerbankii is easily distinguished from *C. Smithii* and *C. pseudoturbinolia*, by not having a fifth cyclum of septa. It differs also from *C. arcuata* by the delicacy of its septa, and from *C. Guadulpensis* by the circular form of its calice, and its round columella.

C. cylindrica, C. Bredæ, and *C. Koninckii*, have only six large *pali*, whereas in *C. Bowerbankii* the number of these organs amounts to twelve. *C. lævigata*[1] differs from the above-described species, by the pali being narrow, and very thick, and *C. Debeyana* by the existence of a well-marked epitheeal band near the calice.

M. Alcide d'Orbigny has, in a recent publication,[2] referred to this species as the type of his new genus *Amblocyathus*, which he defines as being *Cyathina*, with a circular calice and a round columella. He adds that Amblocyathus is a lost genus, and contains three fossil species belonging to the Neocomian and Albian[3] strata. We must, however, beg leave to remark, that the two above-mentioned characters are met with in almost every species of our Cyathina, and most especially in *C. cyathus*, which is the type of the genus *Cyathina*, and is actually living in the Mediterranean sea. Only two of the species referred to the genus Cyathina in our 'Monograph of the Turbinolidæ' present a slightly oval calice and a transversal columella—*C. pseudoturbinolia* and *C. Guadulpensis*. In *C. Smithii* the columella is oblong, but the calice is circular, or nearly so. If it be considered necessary to separate the Cyathina with a circular calice from those that have an oval calice, it would therefore be more proper to give a new generic name to the latter, and not to change the denomination of the group containing the very species for which Ehrenberg first established the genus Cyathina. But this innovation, proposed by M. d'Orbigny, appears to us as being in every respect unnecessary, for the slight deformation of the calice and the columella which forms the sole basis of the new generic division, can hardly be considered as characters of sufficient value; species that differ in no other respect are often found to vary in this way, and even specimens belonging to the same species sometimes differ much in the form of the calicular margin. Thus, although the calice is circular, or nearly so, in most specimens of *C. cyathus* and *C. Smithii* that are met with, we have seen some that were compressed, and had the calice as oval as in *C. pseudoturbinolia* and *C. Guadulpensis*; similar deviations from the normal form are also to be met with in the columella; in *C. Smithii*, for example, this organ is sometimes quite circular, although it is in general oblong. Differences of this kind, when not more marked than is the case among the various species of Cyathina, can therefore scarcely be deemed important enough to characterise generic divisions; and, as in the present case, they do not appear to coexist with any other structural peculiarity, we see no reason for admitting the new genus *Amblocyathus*.

[1] Tab. ix, fig. 1.

[2] Note sur des Polypiers Fossiles, Paris, 1849.

[3] M. d'Orbigny employs the name of *Albian* formation to designate the *Gault*.

2. *Genus* Cyclocyathus (p. xiv).

Cyclocyathus Fittoni. Tab. XI, fig. 3, 3 *a*, 3 *b*.

Corallum simple, discoidal, short; mural disc horizontal, or slightly concave, and presenting in its centre a small, irregular cicatrix, indicative of its primitive adherence. *Epitheca* very thin, presenting some slight concentric striæ, and not preventing the radiate costæ from being visible. These are straight, and not very prominent; but those of the first and second order are well marked. The edge of the mural disc is thin, and slightly prominent. The upper or *calicular surface* of the corallum is rather convex externally, and concave towards the centre. The fossula is shallow, but large, and well marked. *Columella* fasciculate, well developed, and terminated by a broad, papillose surface. *Septa* forming four complete cycla. The six fundamental septal systems distinct, but the septa of the second order not differing much from those of the first order. All the septa well developed, straight, rather thick exteriorly, arched above, and granulated laterally; their outer edge somewhat crenulated, granulose, slightly concave near the mural disc, and projecting a little towards the upper part. *Pali* well developed, very distinct from the septa, and corresponding to those of the third cyclum. Height of the corallum, two or three lines; diameter, in general not more than five or six lines.

This fossil is the only known species of the genus *Cyclocyathus;* its form renders it very remarkable. It has been found in the Gault at Cambridge, Drayton, West Malling, and Folkstone, but appears to be most abundant in the last-mentioned locality. The specimens here described belong to the collections of the Geological Society, of Mr. Bowerbank, and of Mr. D. Sharpe.

3. *Genus* Trochocyathus (p. xiv).

1. Trochocyathus conulus. Tab. XI, fig. 5, 5 *a*.

Caryophyllia conulus, (?) *Phillips*, Illust. of the Geol. of Yorkshire, tab. ii, fig. 1, 1829. (A rough figure without any description.)

— — *Michelin*, Mém. de la Soc. Géol. de France, vol. iii, p. 98, 1838.

Turbinolia conulus, *Michelin*, Icon. Zooph., p. i, pl. i, fig. 12, 1840.

Trochocyathus conulus, *Milne Edwards* and *J. Haime*, Monogr. des Turbin., Ann. des Sc. Nat., 3me série, vol. ix, p. 306, 1848.

Corallum simple, turbinate, rather elongate, straight or slightly bent, and pedicellated. *Wall* presenting in general some slight traces of an incomplete epitheca. *Costæ* simple, distinct from the basis, closely set, delicately granulated, not very prominent, and alternately of unequal size towards the calicular edge. *Calice* almost circular, or somewhat oval and shallow. *Columella* fascicular, well developed, not prominent at its apex, and terminated by ten or fifteen papillæ of equal size. *Septa* forming four complete cycla and six well-marked, equally developed systems, in which, however, the secondary ones differ but little from those of the first cyclum. The septa are slightly exsert, closely set, unequal, and rather thicker outwards than towards the columella. *Pali* narrow and unequal; those corresponding to the tertiary septa broad and rather stout; the others, and most especially those corresponding to the primary septa, narrow and thinner. Height of the corallum, seven or eight lines; diameter of the calice, almost seven lines.

This species belongs to the first section of the genus Trochocyathus (*T. simplices*), and differs from *T. impari-partitus*[1] and *T. Bellingherianus* by not having a fifth cyclum of septa; its general form distinguishes it from *T. mitratus*,[2] *T. crassus*, *T. simplex*, and *T. costulatus*, which are all short, broad, and curved; and from *T. elongatus*, *T. Koninckii*, and *T. gracilis*, which are much elongated, curved, and very narrow towards the basis. It appears to resemble most, especially by its general form, *T. cupula*,[3] which is also conical and straight, but this last-mentioned species differs from it by the thickness and strong granulations of the septa, and by the breadth of the basis.

Trochocyathus conulus appears to have been very widely spread in the seas where the Gault formations were deposited. The specimens which we most particularly studied were

[1] See our Monograph of Turbinolidæ, loc. cit., p. 307.

[2] Since the publication of our Monograph of the Turbinolidæ (in 1848) we have recognised that the fossils from Tortona, which M. Michelotti designates under the name of *Turbinolia plicata*, do not differ specifically from the specimens existing in the Poppelsdorf Museum under the name of *Turbinolia mitrata*, Goldfuss. As we already expected, the latter specific name must therefore be substituted for the one employed by M. Michelotti, and M. Michelin.

[3] This new species, designated under the name of *Turbinolia cupula*, by M. Alex. Rouault, (Bulletin de la Soc. Géol. de France, 2^{me} série, vol. ix, p. 206, 1848), was found by that geologist at Bos d'Arros, in the department of the Lower Pyrennees, and does not appear to differ from a fossil which exists in the collection of M. Nyst, and was found in the Eocene formation at Lacken, near Brussels. *Trochocyathus cupula* belongs to the first section of our genus Trachocyathus, and presents the following characters:

Corallum straight, or almost so, subturbinate, but short, and having a broad peduncle, but not remaining adherent in the adult state. *Costæ* distinct from the basis, straight, unequally developed alternately, rather prominent, especially near the calice, granulated and striated transversely; rudimentary costæ, that do not correspond to any septa, are seen in the intercostal furrows. *Calice* circular; fossula not deep. *Columella* crispate, well developed. *Septa* forming three complete cycla, and in general a fourth incomplete cyclum in one half of three of the systems; exsert, rather unequal, strong, and presenting on their lateral surfaces large prominent granulations, which are arranged in lines nearly parallel to the upper edge. *Pali* thick, strongly granulated, and unequal; those corresponding to the tertiary septa the largest in the half systems where the septa of the fourth cyclum exist, and those corresponding to the secondary septa most developed in the other part of the calice. Height of the corallum, three lines; diameter of the calice almost as much. By the strong granulations of the septa, and the breadth of its basis, this species tends to establish a transition between the genus *Trochocyathus* and the genus *Paracyathus*.

found near Cambridge, in England; at Gatis de Gerodot, Dienville, near Brienne (department of the Aude), and Etrepy (department of the Marne), in France. Other specimens, which in all probability belong also to this species, are designated in M. Michelin's collection as having been found at Novion-en-Porcien; at Macheromenil, in the Ardennes, and at the Perte du Rhone, in the department of the Ain; but we suspect that some mistake may have been made in the labelling of the specimen which is designated in the same collection as belonging to the chalk of Tournay, in Belgium. We must also add, that the fossil designated by Professor J. Phillips under the name of *Turbinolia conulus* was found by that eminent geologist at Speeton, in Yorkshire; but its characters are not sufficiently well known for us to be able to identify it with the above-described species, specimens of which exist in the collections of the Geological Society, of the Museum at Paris, and of MM. d'Orbigny, Michelin, and Milne Edwards.

M. Al. d'Orbigny has lately given the name of *Aplocyathus*[1] to those species of our genus Trochocyathus in which the calice is circular. If this new generic division was adopted, the species here described would be referred to it; but that is not, in our opinion, advisable. The calice, which is quite circular in a great many species of our genus Trochocyathus, becomes slightly elongated in some, quite elliptical in others, and not only would the line of separation be difficult to establish between these different forms, but certain species which are evidently most closely allied by all their other organic characters, would be separated generically in the classification proposed by M. d'Orbigny. We cannot, therefore, adopt his views in this respect; but, in justice to that distinguished palæontologist, we must remark that the species[2] chosen by him as the type of his genus *Aplocyathus* differs much in its general aspect from most species of our genus Trochocyathus, and, when more completely known, may be found to present characters of sufficient value to authorise the establishment of a separate generic group, which must then be so defined as not to comprehend *T. conulus*, nor most of the other species that have a circular calice.

2. Trochocyathus Harveyanus. Tab. XI, fig. 4, 4 *a*, 4 *b*.

Trochocyathus Harveyanus, *Milne Edwards* and *J. Haime*, Monogr. des Turbinolides, in Ann. des Sc. Nat., 3me série, vol. ix, p. 314, 1848.

Corallum simple, straight, short, almost hemispherical, and terminated by a very short peduncle, the basal surface of which is concave. *Costæ* distinct from the basis, and delicately striated transversely; the primary and secondary ones very prominent and sharp; those of the third cyclum well developed along the upper half of the wall, but those of the fourth cyclum very small and obscure. *Calice* circular and flat; fossula shallow. *Columella* well developed and papillose. *Septa* forming four complete cycla; exsert, thin,

[1] Note sur des Polypiers Fossiles, p. 5, 1849.

[2] The *Trochocyathus armatus*.

broad, straight, granulated laterally, unequally developed, but not differing much in the first and second cycla. *Pali* corresponding to the septa of the first three cycla, rather narrow, and unequally developed in an inverse ratio to the corresponding septa; no pali in the radii of the septa belonging to the fourth cyclum. Height of the corallum, three lines; diameter of the calice, four lines.

This species belongs to the fourth section of our genus Trochocyathus (*T. breves*), and consequently its characters need not be compared with those of the various species belonging to the sections of the *T. simplices, T. cristati,* and *T. multistriati*, the description of which may be found in our 'Monograph of the Turbinolidæ.' It differs from *T. obesus, T. armatus,* and *T. perarmatus*,[1] by not having any costal spines, and from *T. Michelini* by the costæ being distinct down to the basis, and by its general form being less depressed. It appears to be most closely allied to the fossil which we shall next describe under the name of *Trochocyathus* (?) *Konigi*, but is of a more slender form.

T. Harveyanus was found in the Gault at Folkstone, the birthplace of the illustrious physiologist to whom we have dedicated this species. The specimens here described belong to the collections of Mr. Bowerbank and Mr. D. Sharpe.

3. Trochocyathus (?) Konigi.

Turbinolia Konigi, *Mantell*, Illust. of the Geol. of Sussex, p. 85, tab. xix, figs. 22, 24, 1822.

— — *Fleming*, British Animals, p. 510, 1828.

— (trochocyathus?) Konigi, *Milne Edwards* and *J. Haime*, Monogr. des Turb., in Ann. des Sc. Nat., 3me série, vol. ix, p. 335, 1848.

The specimens of this fossil figured by Mr. Mantell, and those which we have seen in the collections of MM. d'Orbigny and Michelin, are in a very bad state of preservation,

[1] This species, which has been lately designated under the name of *Turbinolia perarmata* by M. Talavignes, but has not yet been described, and has been given to us by that geologist, was discovered at Fabresan, in the department of the Aude. M. Alex. Rouault has since then met with the same species at Bos d'Arros in the Lower Pyrennees. (See Bull. Soc. Géol., 2me série, vol. v, p. 206.) It may be recognised by the following characters:

Corallum very short, subdiscoidal; its under surface flat and almost smooth; sometimes adhering to a small shell. *Costæ* distinct near the calice, projecting very little, closely set, almost equal, and delicately granulated; those of the first cyclum not differing much from the others, but bearing, at a short distance from the calicular edge, a strong spiniform appendix, which is rather compressed, extends outwards, and presents, on its under edge, a small pointed tubercle. *Calice* circular. *Septa* forming four complete cycla and six equally developed systems; closely set, rather exsert, thin, and unequally developed; but those of the second cyclum differing very little from the primary ones. *Pali* narrow and rather thick. Height of the corallum, one line and a half; diameter of the calice, two lines and a half. Fossil from the Nummulitic formation at Fabresan and Bos d'Arros.

and have lost their walls; we are, therefore, unable to characterise the species with any degree of precision, and it is with much doubt that we refer it to the genus Trochocyathus, for we are not as yet sufficiently satisfied as to the existence of pali. M. Michelin is of opinion that these fossils are merely specimens of *Trochocyathus conulus* with their basis worn away. They are of a conico-convex form, and are broader in proportion than *T. Harveyanus*, to which they bear, however, great resemblance. Their height is about four lines, and their diameter a little more. We have not considered it necessary to give a new figure of these corals, for the specimens in our possession do not show anything more than those represented in Dr. Mantell's plates.

The specimens that we have had an opportunity of examining were found in the Gault at Folkstone, in the environs of Boulogne-sur-Mer, at Wissant, at Les Fiz, near Chamounix, and at the Perte du Rhone, in the department of the Ain. According to Dr. Mantell the same species is met with at Lewes in Sussex, and Godstone in Surrey, at Malling in Kent, in Cambridgeshire,[1] at Ringmer, and at Bletchingley.[2]

Trochocyathus (?) Warburtoni.

We are inclined to think that a cast found in the Gault of Cambridgeshire by Mr. H. Warburton, and presented by that gentleman to the Museum of the Geological Society, must belong to a distinct species of Trochocyathus. It is about six lines in height, and seven in diameter; the number of septa is forty-eight. For the sake of convenience we have given a specific name to it, but we are not able to characterise it.

4. *Genus* Bathycyathus (p. xiii.)

Bathycyathus Sowerbyi. Tab. XI, fig. 2, 2 *a*.

Bathycyathus Sowerbyi, *Milne Edwards* and *J. Haime*, Monogr. des Turbinolides, Ann. des Sc. Nat., 3me série, vol. ix, p. 295, 1848.

Corallum simple, adherent by a broad basis, straight, tall, compressed, and having its lateral edges somewhat prominent. *Wall* delicately granulated. *Costæ* not very distinct in the lower half of the corallum, but becoming rather prominent higher up, especially those of the first and second orders. *Calice* elliptical and horizontal, the relative length of its long and short axis varying much (in one specimen = 100 : 170, and in another = 100 : 250). *Fossula* narrow, and appearing to be deep, but completely filled up with extraneous matter in all the specimens that we have seen, so as not to enable us to obtain any knowledge respecting the columella and the pali. It is therefore with some uncertainty that we refer this species to the genus Bathycyathus, and in doing so we have been guided

[1] Geol. of Sussex. [2] Trans. of the Geol. Soc., s. 2, vol. iii, p. 210.

only by characters of secondary value, which agree, however, very well with those of the other Corals belonging to the same generical division. *Septa* forming four complete cycla; exsert, thick exteriorly, but thin inwardly, and presenting but few granulations on their lateral surfaces. Those of the second cyclum almost as large as the primary ones; the tertiary ones but little developed, although they correspond to large costæ, and not as tall as those of the last cyclum, which are grouped very closely on each side of the primary and secondary ones. Height of the corallum, one inch two or three lines; great diameter of the calice, six or seven lines.

The genus *Bathycyathus* contains two other species, which are both recent: *B. Chilensis*[1] and *B. Indicus*,[2] which differ from *B. Sowerbyi* in having an additional cyclum of septa, the calice arched, and the costæ more developed near the basis. We have seen but two specimens of this fossil; one, belonging to the collection of Mr. D. Sharpe, is catalogued as having been found in the Gault near Folkstone; the second, belonging to the museum of the Geological Society, is referred with doubt to the upper greensand of Kidge, in Wiltshire.

Family ASTREIDÆ (p. xxiii).

Tribe EUSMILINÆ (p. xxiii).

1. *Genus* TROCHOSMILIA (p. xxiv).

TROCHOSMILIA SULCATA. Tab. XI, fig. 6, 6 *a*, 6 *b*.

Corallum simple, turbinate, straight, tall, much compressed, subpedicellate, and appearing to be free. *Wall* presenting on each side two deep longitudinal furrows. *Costæ* distinct from the basis, slightly prominent, closely set, and unequal, especially towards their upper end. *Calice* elliptical, sublobulated, and slightly arched; its long and short axis in the proportion of 100 : 200. *Fossula* very narrow, elongated, and not very deep. No *columella*. *Septa* forming four cycla or more, rather unequal, closely set, thin, and slightly exsert. *Dissepiments* not numerous. Height of the corallum, nearly one inch; diameter of the calice, six or seven lines by three; depth of the fossula, two lines and a half.

We have seen but one specimen of this fossil, which, although somewhat weather-worn, appeared sufficiently distinct from all other species to authorise us in giving it a peculiar specific name. It differs from *Trochosmilia didyma*[3] by its calice being straight, and not

[1] See our Monograph of Turbinolidæ, tab. ix, fig. 5.

[2] Loc. cit., tab. ix, fig. 4.

[3] *Turbinolia didyma*, Goldfuss, Petref. Germ., vol. i, tab. xv, fig. 11.

bent in two; from *T. Boissyana, T. Patula,*[1] *T. cernua,* and *T. crassa,*[2] by being subpedicellated, and not adherent in the adult state; from *T. irregularis, T. corniculum, T. Faujasii, T. Gervillii,* and *T. uricornis,*[3] by being strongly compressed quite down to the basis; and from *T. Saltzburgiensis, T. cuneolus, T. compressa, T. complanata, T. Basochesii,* and *T. tuberosa,* by the existence of the above-mentioned four deep mural furrows. By their general form, all these corals much resemble many species belonging to the division of Cyathininæ, but differ from them, and from all other Turbinolidæ, by having interseptal dissepiments.

This fossil was found in the Gault at Folkstone, by Mr. Bowerbank.

The LITHODENDRON GRACILE, Goldfuss,[4] is mentioned by Mr. Morris[5] as having been found in the Gault of Kent, but as yet we have not met with any specimens of that species in any of the British palæontological collections.

[1] See our Monogr. des Astreides, Ann. des Sc. Nat., 3[me] série, vol. x, p. 236.

[2] We here designate, under the name of *Trochosmilia crassa,* the fossil described by M. Michelin under the name of *Turbinolia cernua,* Goldfuss, and by ourselves as *Trochosmilia cernua;* for, on comparing it with the specimens previously described by Goldfuss under the name of *Turbinolia cernua,* we have ascertained that they are not specifically identical.

The species which must retain the name first applied by Goldfuss presents the following characters:

Corallum pedicellated and strongly compressed quite from the basis. *Costæ* thin, alternately unequal; the larger ones rather prominent and somewhat lamellar. *Calice* arched and elongated in the proportion of 100 : 230. *Septa* thin, very closely set, and presenting on their lateral surfaces a great number of granulations arranged somewhat regularly in convex lines parallel to the upper edge. Forty-eight principal septa, separated by an equal number of small ones; some indications of an additional rudimentary cyclum. Height of the corallum, one inch and a half; long diameter of the calice, twelve lines; short axis, five lines. (The figure given by Goldfuss, tab. xv, fig. 8, is not quite accurate.)

[3] Monogr. des Astreides, loc. cit.

[4] Petref. Germ., vol. i, tab. xiii, fig. 2.

[5] Catalogue of British Fossils, p. 40.

CHAPTER VII.

CORALS FROM THE LOWER GREENSAND.

The remains of true Polypi are very rare in this part of the British geological strata; the fossil which Mr. Lonsdale has lately described under the name of *Choristopetalum impar*,[1] and which was found in the lower greensand at Atherfield, does not appear to us to belong to this class, and is, in our opinion, a Bryozoon. We have as yet met with but one species of Zoantharia, which can be referred with any degree of certainty to this formation.

Family STAURIDÆ (p. lxiv).

Genus Holocystis (p. lxiv).

Holocystis elegans. Tab. X, fig. 5, 5 *a*, 5 *b*.

> Astrea, *Fitton*, On the Strata below the Chalk, in Geol. Trans., s. 2, vol. iv, p. 352, 1843.
> Astrea elegans, *Fitton*, in Quarterly Journ. Geol. Soc., vol. iii, p. 296, 1847.
> Cyathophora (?) elegans, *Lonsdale*, Proceed. of the Geol. Soc., vol. v, part i, p. 83, tab. iv, fig. 12, 15, 1849.

Corallum complex, astreiform, constituting a convex mass, and augmenting by extra calicular gemmation; the young individuals being produced at the point of junction of the surrounding calices. *Corallites* somewhat prismatic, and cemented together laterally, either by the direct union of their walls, or by means of the costæ, which are thick, and in general pretty well developed. *Calices* subpolygonal, separated in general by a simple but thick mural ridge; sometimes by walls that remain distinct, and are in their turn separated by a small intermural furrow. *Fossula* deep. *Columella* very small, and appearing to be styliform. *Septa* forming three complete cycla, and four well-characterised systems. The four primary ones much more developed than the others, reaching almost to the centre of the fossula, and giving to the calice a crucial character, which is never met with in Astreidæ, Oculinidæ, Turbinolidæ, &c. The septa are slightly exsert, closely set, thick exteriorly, and very slightly granulated laterally; they appear to have undivided edges, and they differ much in size, according to the cycla to which they belong. The interseptal *dissepiments* are simple, horizontal, or slightly convex, and placed at the same level in the different loculi,

[1] Proceedings of the Geol. Soc., vol. v, part i, p. 69, tab. iv, figs. 5 to 11, 1849.

so as to constitute by their union a series of complete tabulæ, subdivided by the primary septa, and distant from each other about one fifth of a line. Exothecal dissepiments much resembling the preceding ones. Diameter of the calices, and depth of the fossula, about one line and a fourth.

Fossil from the lower greensand at Redhill cutting, Atherfield, in the Isle of Wight, and at Peasemarsh.

The specimens here described belong to the Museum of the Geological Society, and had been named by Mr. Lonsdale. The propriety of establishing a new generical division for this remarkable coral, was very judiciously pointed out by that indefatigable palæontologist; but, guided by reasons which we do not quite understand, he refers, with a sign of doubt, this same species to the *Cyathophora* of M. Michelin, a genus which, in our opinion, does not differ from true *Stylina*. The genus *Holocystis* differs from our genus *Stauria* by its extra calicular gemmation, and its costulated walls. It is the most modern representative of the great division of Zoantharia rugosa, which becomes predominant in the Palæozoic formations, and is principally characterised by the tendency to a quadrate arrangement of the constitutive parts of the Corallites, whereas in the other sections of Zoantharia, six is the fundamental number of the radiate organs.

TAB. I.

CORALS FROM THE CRAG.

SPHENOTROCHUS INTERMEDIUS (p. 2).

Fig. 1. An adult specimen; natural size.

1 *a.* An adult specimen; variety having a dilated basis; natural size.

1 *b.* A magnified view of the specimen represented at fig. 1.

1 *c.* A vertical section of the same, corresponding to the short diameter of the calice; magnified.

1 *d.* Calice of the same; magnified.

1 *e.* A very young individual, magnified; the natural size is indicated by the length of the line placed near this figure.

1 *f*, 1 *g*, 1 *h*, 1 *i*. A series of young individuals, at different periods of their growth; magnified.

FLABELLUM WOODII (p. 6).

Fig. 2. A side view of the corallum; natural size.

2 *a.* A specimen magnified, and showing the mode of arrangement of the septa; one half of the calice has been cut away down to the bottom of the fossula.

2 *b.* Calice entire; natural size.

BALANOPHYLLIA CALYCULUS (p. 9).

Fig. 3. Two individuals cemented together by their basis; natural size.

3 *a.* A variety with a narrow basis; natural size.

3 *b.* An individual remarkably tall, with its calicular extremity worn away; natural size.

3 *c.* Horizontal section of the same, near the calice, magnified so as to show the mode of arrangement of the septa.

3 *d.* A fragment of the wall deprived of its epitheca, and much magnified.

CRYPTANGIA WOODII (p. 7).

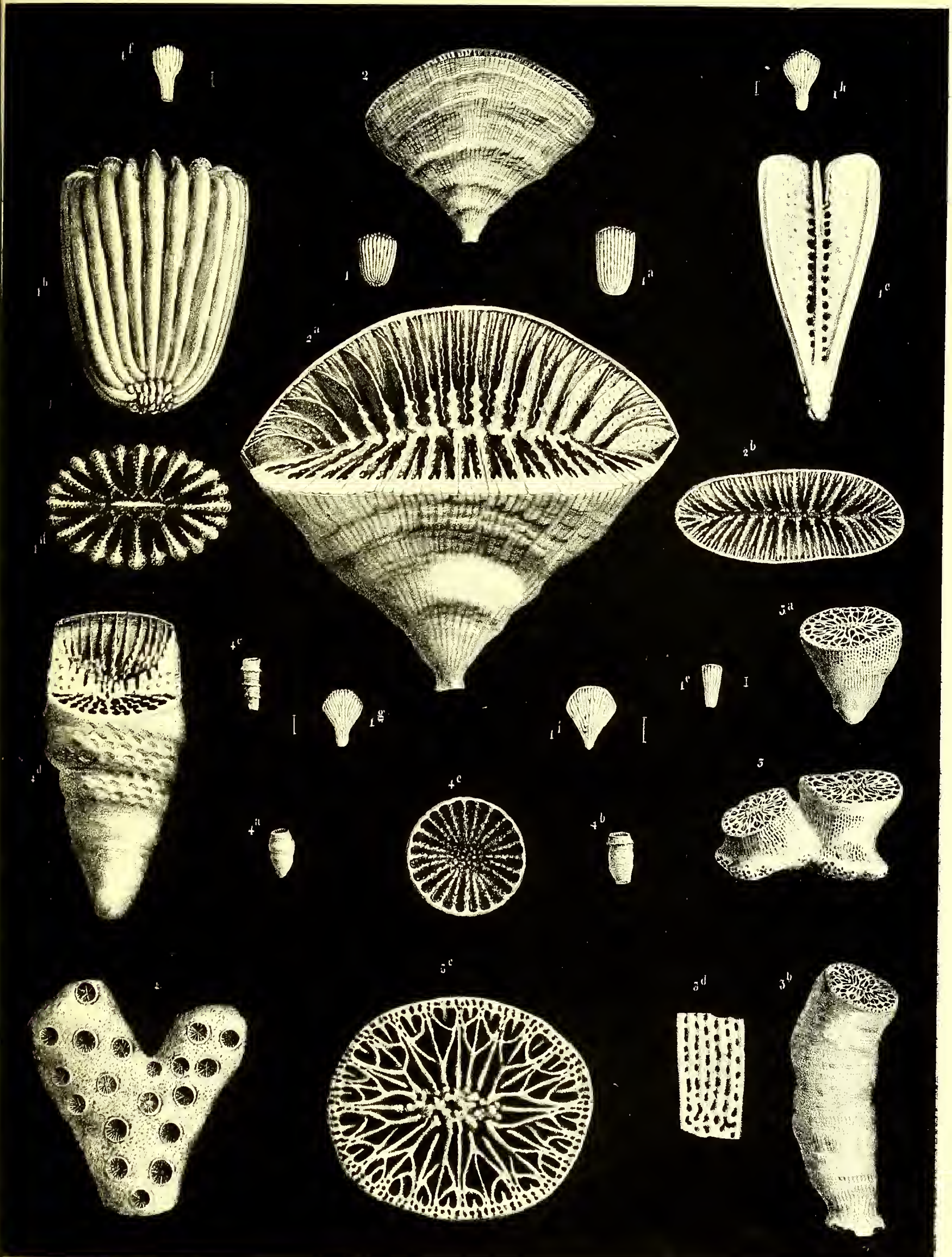
Fig. 4. A small aggregation of corallites imbedded in a mass of Cellepora; natural size.

4 *a.* One of these corallites extracted from the mass of Cellepora, and showing its epitheca; natural size.

4 *b.* One of the same separated from the extraneous mass, and having its epitheca dimpled by pressure of the surrounding Cellepora.

4 *c.* Calice, magnified.

4 *d.* One of the same corallites magnified, and having part of its calice cut away so as to show the denticulate edge of the septa; the dimples of the epitheca are accidental and produced by the investing Cellepora.



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TAB. II.

CORALS FROM THE LONDON CLAY.

DIPLHELIA PAPILLOSA (p. 28).

Fig. 1. A branch of this compound corallum; natural size.

1 *a*. Terminal portion of one of the corallites, much magnified, and having half of its calice cut away so as to show the structure of the septa and the thickness of the walls.

1 *b*. Calice, magnified.

OCULINA CONFERTA (p. 27).

Fig. 2. A small mass of this compound corallum; natural size.

2 *a*. Terminal portion of one of the corallites magnified, and cut down so as to show the structure of the columella, the pali, the septa, and the thickness of the walls.

2 *b*. Calice, magnified.

TURBINOLIA BOWERBANKII (p. 16).

Fig. 3. Adult specimen; natural size.

3 *a*. The same magnified, so as to show the characters of the intercostal furrows.

3 *b*. Calice, magnified.

TURBINOLIA FIRMA (p. 20).

Fig. 4. Adult specimen; natural size.

4 *a*. The same, magnified.

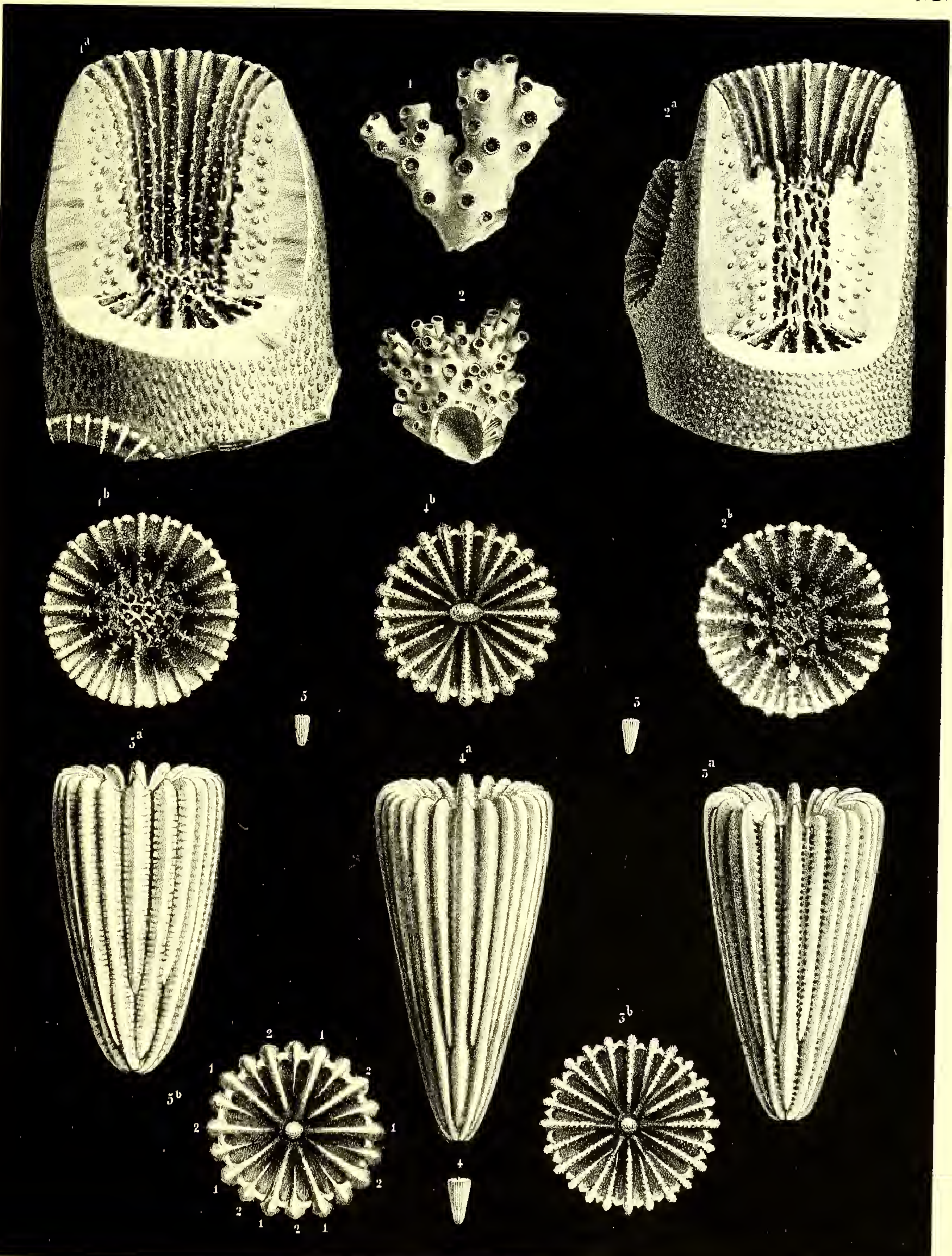
4 *b*. Calice, magnified.

TURBINOLIA MINOR (p. 19).

Fig. 5. Adult specimen; natural size.

5 *a*. Magnified view of the same.

5 *b*. Calice, magnified.



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TAB. III.

CORALS FROM THE LONDON CLAY.

Turbinolia Dixonii (p. 15).

Fig. 1. Adult specimen; natural size.

1 *a.* The same magnified, to show the characters furnished by the costæ, and the mural furrows.

1 *b.* Vertical section, showing the columella, the lateral surface of the septa, the wall, and the intercostal striæ.

1 *c.* Calice, magnified; the numbers surrounding the septa indicate the cycla to which each of these belong.

1 *d.* Fragment of the wall in which the lamellar costæ have been worn down, so as to show that the intercostal dimples are produced by transverse dissepiments, and are not pores, perforating the wall.

Turbinolia Fredericiana (p. 17).

Fig. 2. Adult corallum; natural size.

2 *a.* The same, magnified.

2 *b.* Calice, magnified.

In one of the systems the septa are numbered with reference to the cycla to which they belong.

Turbinolia sulcata (p. 13).

Fig. 3. An adult corallum; natural size.

3 *a.* An individual showing a variety of forms.

3 *b.* The first of the preceding corals, magnified.

3 *c.* Calice, magnified.

Turbinolia humilis (p. 18).

Fig. 4. An adult specimen; natural size.

4 *a.* The same magnified.

4 *b.* Calice, magnified.

By a mistake of the artist, the third cyclum of septa is here represented as being complete, whereas in reality these septa do not exist in two of the systems.

Turbinolia Prestwichii (p. 20).

Fig. 5. An adult specimen; natural size.

5 *a.* The same magnified.

5 *b.* Calice, magnified.

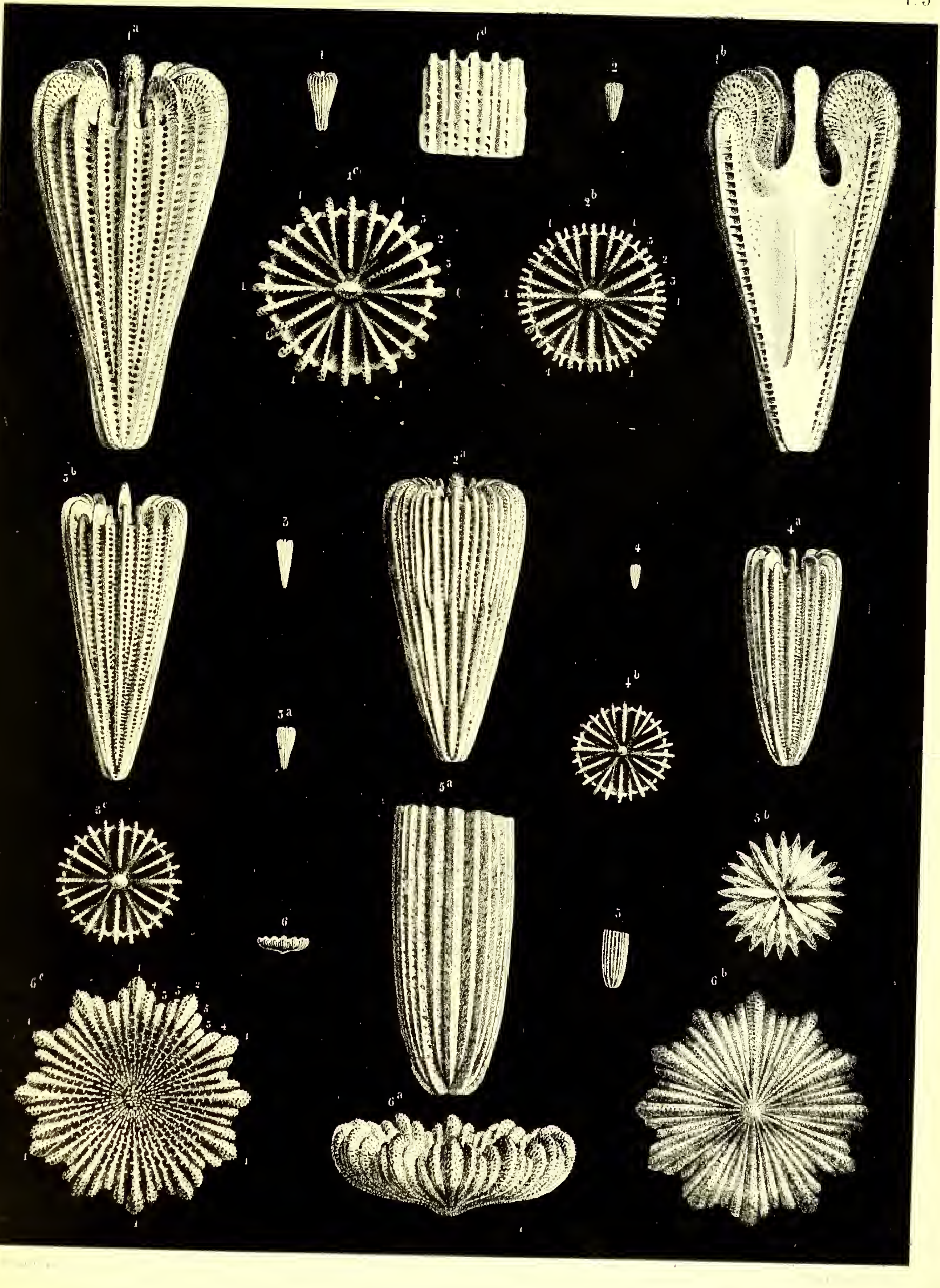
Leptocyathus elegans (p. 21).

Fig. 6. Side view of the corallum; natural size.

6 *a.* The same magnified.

6 *b.* Under surface of the same, magnified.

6 *c.* Calice, magnified;—1, 1, 1, 1, 1, 1, Septa of the first order; 2, Septa of the second cyclum; 3, Septa of the third cyclum; 4, 5, Septa of the fourth and fifth orders constituting the fourth cyclum.



TAB. V.

CORALS FROM THE LONDON CLAY.

STYLOCŒNIA EMARCIATA (p. 30).

Fig. 1. A small mass of this compound corallum ; natural size.

1 *a*. A portion of the calicular surface of the same, magnified.

This specimen is somewhat weather-worn.

STYLOCŒNIA MONTICULARIA (p. 32).

Fig. 2. A small, somewhat gibbose mass of this compound corallum ; natural size.

2 *a*. A portion of the calicular surface, magnified so as to show the structure of the calices and of the marginal processes.

2 *b*. Transverse section of the compound corallum, slightly magnified, to show the cavity circumscribed by its under surface.

ASTROCŒNIA PULCHELLA (p. 33).

Fig. 3. A small mass of this compound corallum, in which most of the corallites have been pressed together so that their calicular edges have become polygonal and completely united ; natural size.

3 *a*. Another group, in which most of the corallites have preserved their original circular form and free calicular margin.

3 *b*. A portion of the specimen fig. 3, magnified.

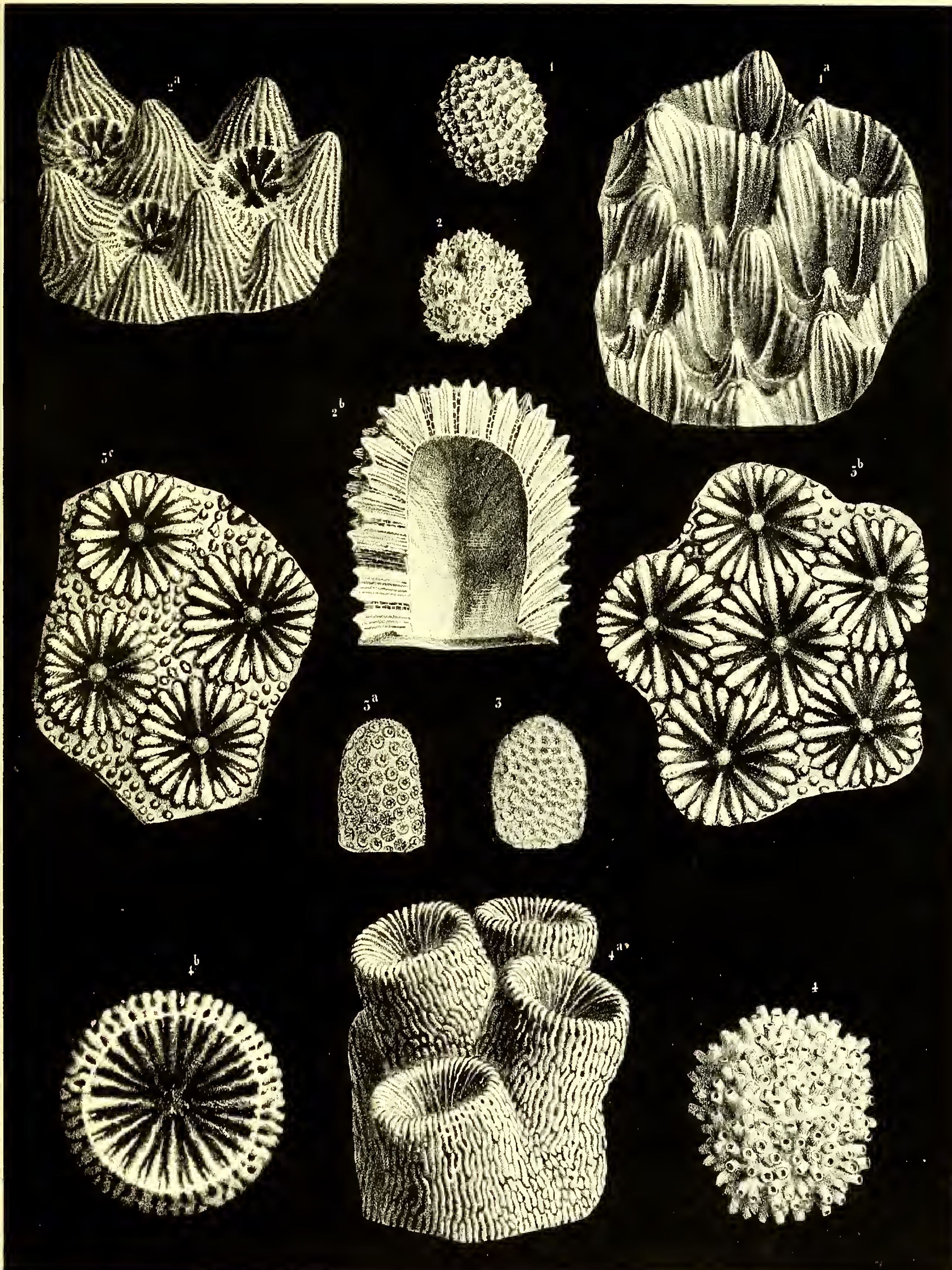
3 *c*. A portion of the specimen fig. 3 *a*, magnified.

STEREOPSAMMIA HUMILIS (p. 37).

Fig. 4. A group of corallites ; natural size.

4 *a*. Terminal portion of some of these, magnified.

4 *b*. Calice, magnified.



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TAB. VI.

CORALS FROM THE LONDON CLAY.

Balanophyllia desmophyllum (p. 35).

Fig. 1. Side view of a complete specimen; natural size.

1 *a*. The same, magnified.

1 *b*. Calice, magnified.

1 *c*. Side view of the upper part of the same, with half of the calice cut away in order to show the structure of the septa and the depth of the fossula.

Dendrophyllia dendrophylloïdes (p. 36).

Fig. 2. A large group; natural size.

2 *a*. Calice, magnified.

2 *b*. One of the branches, magnified to show the structure of the walls.

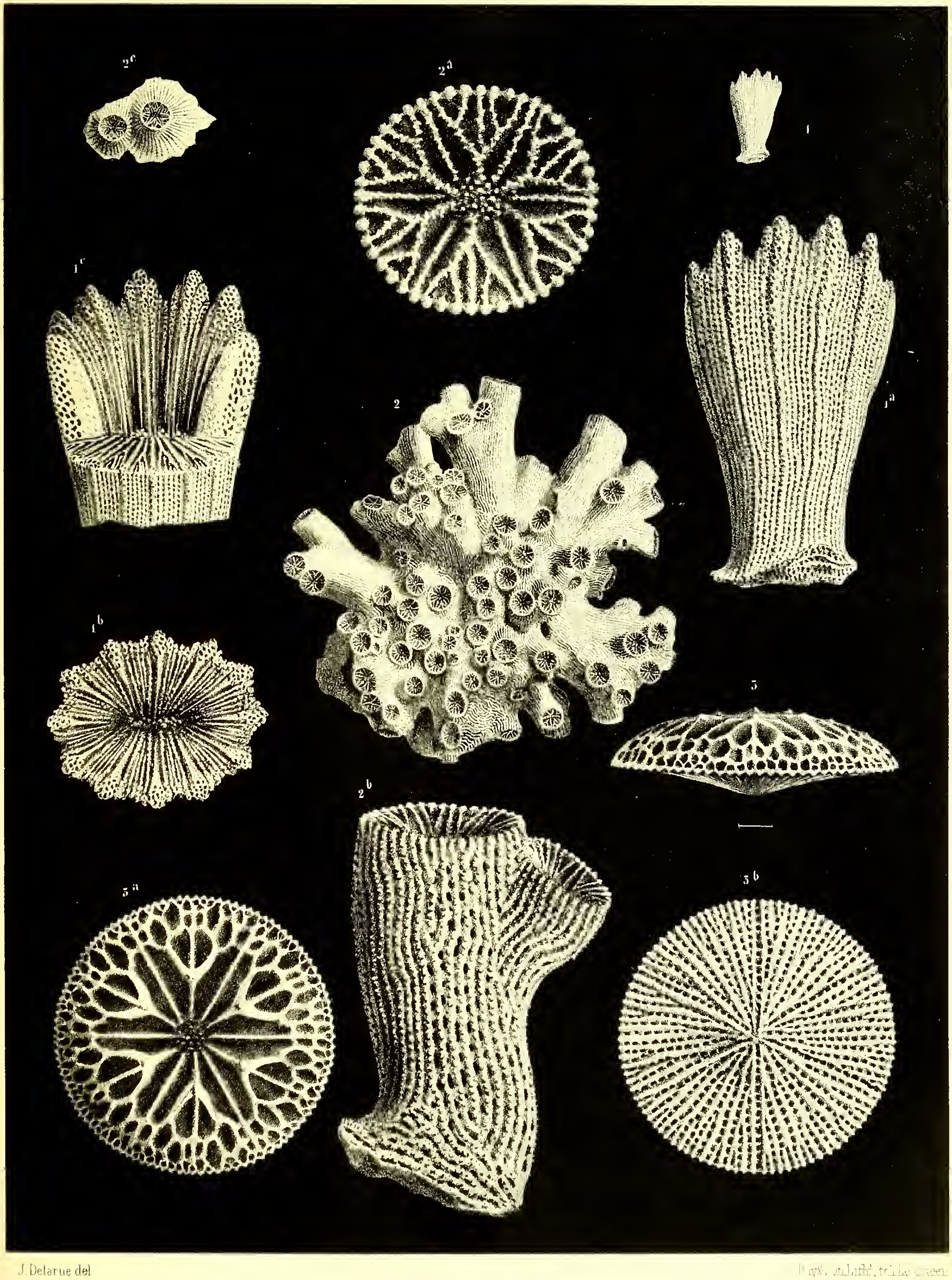
2 *c*. Two young individuals that have not yet produced young by gemmation, and are cemented together by their basis.

Stephanophyllia discoides (p. 34).

Fig. 3. Side view of a specimen, magnified; the natural size is indicated by the length of the line placed below.

3 *a*. Calicular surface, magnified.

3 *b*. Inferior surface, or mural disc, magnified.



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TAB. VII.

CORALS FROM THE LONDON CLAY.

LITHARÆA WEBSTERI (p. 38).

Fig. 1. A mass of this compound corallum adhering to the surface of a pebble; natural size.

1 *a*. Calicular surface, magnified.

1 *b*. Vertical section of two corallites, magnified to show their internal structure.

1 *c*. A transverse section made at a considerable distance below the calice, and magnified so as to show the structure of the columella, the septa, and the walls.

HOLARÆA PARISIENSIS (p. 40).

Fig. 2. A fragment of this cylindroid compound corallum magnified; the length of the line placed below indicates its real diameter.

2 *a*. Transverse section of the compound corallum, showing the vertical section of the corallites, magnified.

MOPSEA COSTATA (p. 42).

Fig. 3. A large specimen; natural size.

3 *a*. A fragment, magnified.

GRAPHULARIA WETHERELLI (p. 41).

Fig. 4. Fragments of the quadrangular portion of the sclerobasis; natural size.

4 *a*. A fragment of the cylindrical portion of the same.

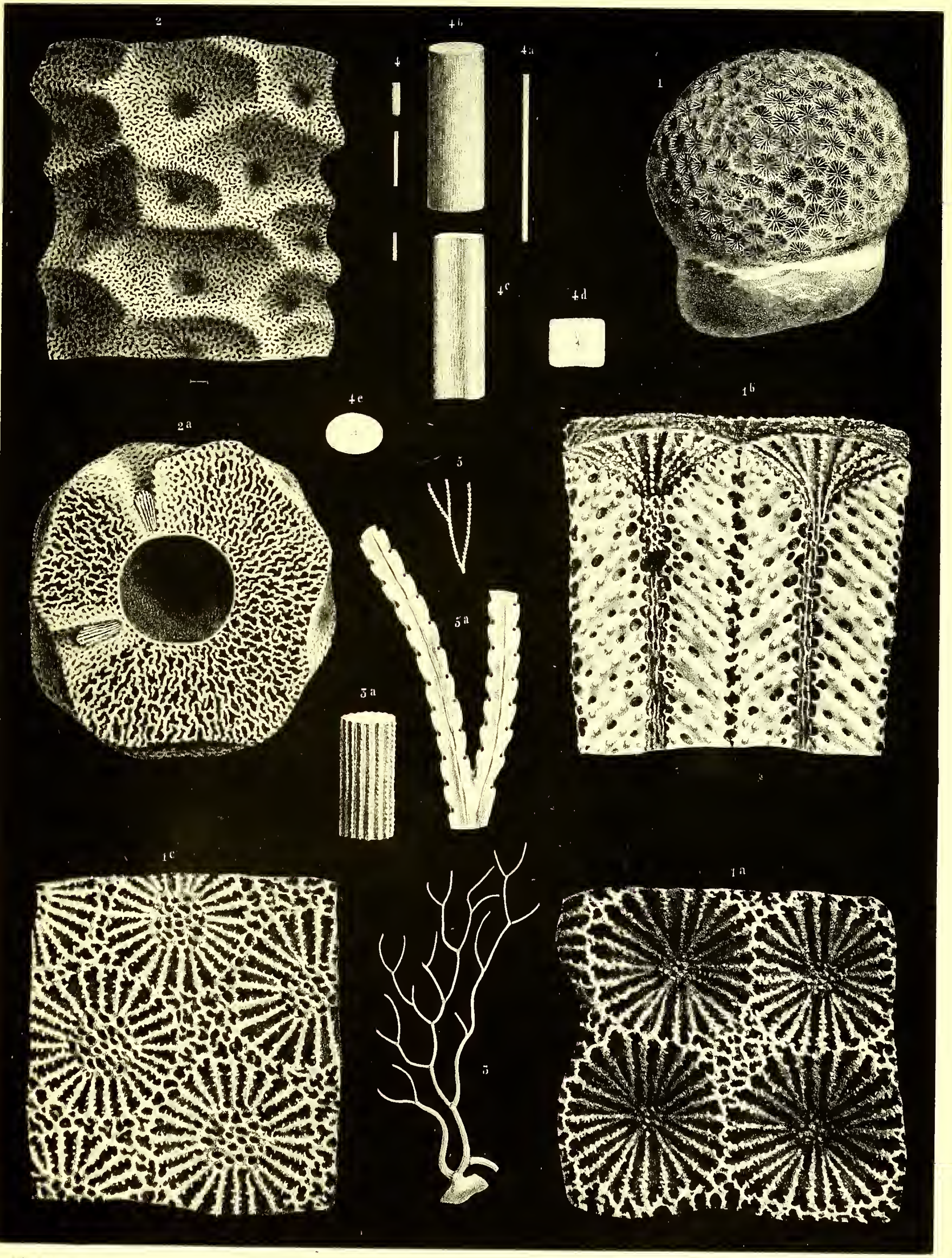
4 *b*, 4 *c*. Fragments of both forms, magnified.

4 *d*, 4 *e*. Transverse sections of the same magnified, so as to show their radiate structure.

WEBSTERIA CRISIOÏDES (p. 43).

Fig. 5. Fragment of a branch; natural size.

5 *a*. Portion of the same, magnified.



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TAB. VIII.

CORALS FROM THE UPPER CHALK.

PARASMILIA CENTRALIS (p. 47).

Fig. 1. A young specimen; natural size.

1 *a*. The same, magnified to show the structure of the wall.

1 *b*. Vertical section, magnified, so as to show the structure of the columella, the dissepiments, &c.

1 *c*. Calice, magnified; 1, septa of the first cyclum; 2 secondary septa; 3, septa of the third cyclum; 4, 5, septa of the fourth and fifth orders, constituting the fourth cyclum.

1 *d*, 1 *e*. Specimens remarkable by their great length.

PARASMILIA MANTELLI (p. 49).

Fig. 2. Side view of the corallum; natural size.

2 *a*. The same, magnified.

PARASMILIA SERPENTINA (p. 51).

Fig. 3. Side view of the corallum; natural size.

3 *a*. Calice, magnified.

3 *b*. Portion of the wall, magnified.

CŒLOSMILIA LAXA (p. 52).

Fig. 4. Side view of the corallum; natural size.

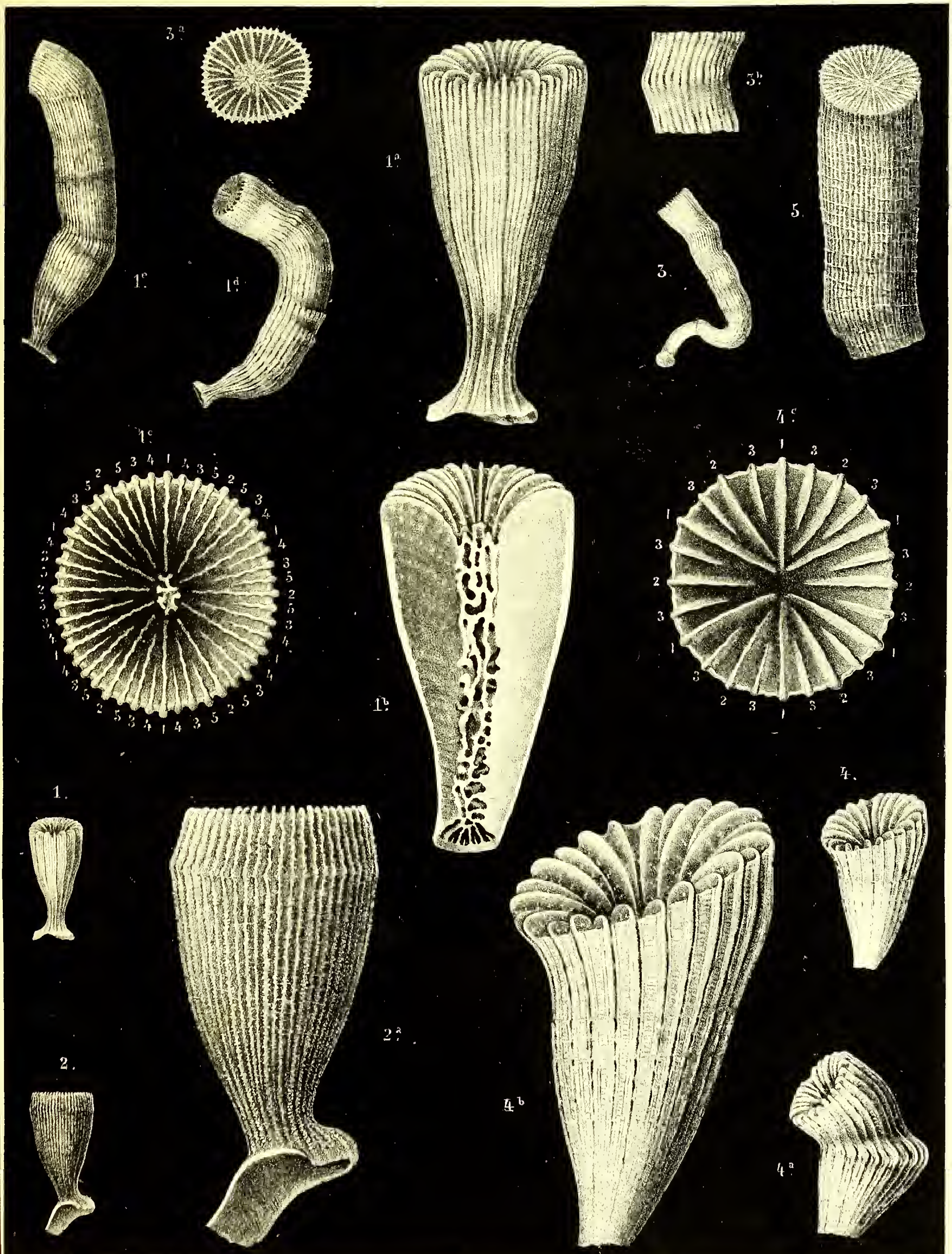
4 *a*. A specimen, the growth of which has been intermittent; natural size.

4 *b*. The specimen No. 4, magnified, to show the structure of the wall.

4 *c*. Calice, magnified.

PARASMILIA CYLINDRICA (p. 50).

Fig. 5. Side view of the corallum; natural size.



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TAB. IX.

CORALS FROM THE UPPER CHALK.

CYATHINA LÆVIGATA (p. 44).

Fig. 1, 1 *a*, 1 *b*. Specimens of different forms; natural size.

1 *c*. Calice of the specimen fig. 1, magnified. It is to be remarked that in this specimen there are only nine pali; these organs not existing in the half systems, where the septa of the fourth cyclum are not developed.

1 *d*. Calice of the specimen fig. 1 *b*, magnified, and showing the twelve pali and the complete fourth cyclum of septa.

PARASMILIA FITTONI (p. 50).

Fig. 2. Side view of the corallum; natural size.

2 *a*. Specimen of a different form, magnified to show the structure of the wall.

2 *b*. Calice, magnified.

CORALS FROM THE LOWER CHALK.

SYNHELIA SHARPEANA (p. 53).

Fig. 3. A branch of this compound corallum; natural size.

3 *a*. Portion of the same magnified.

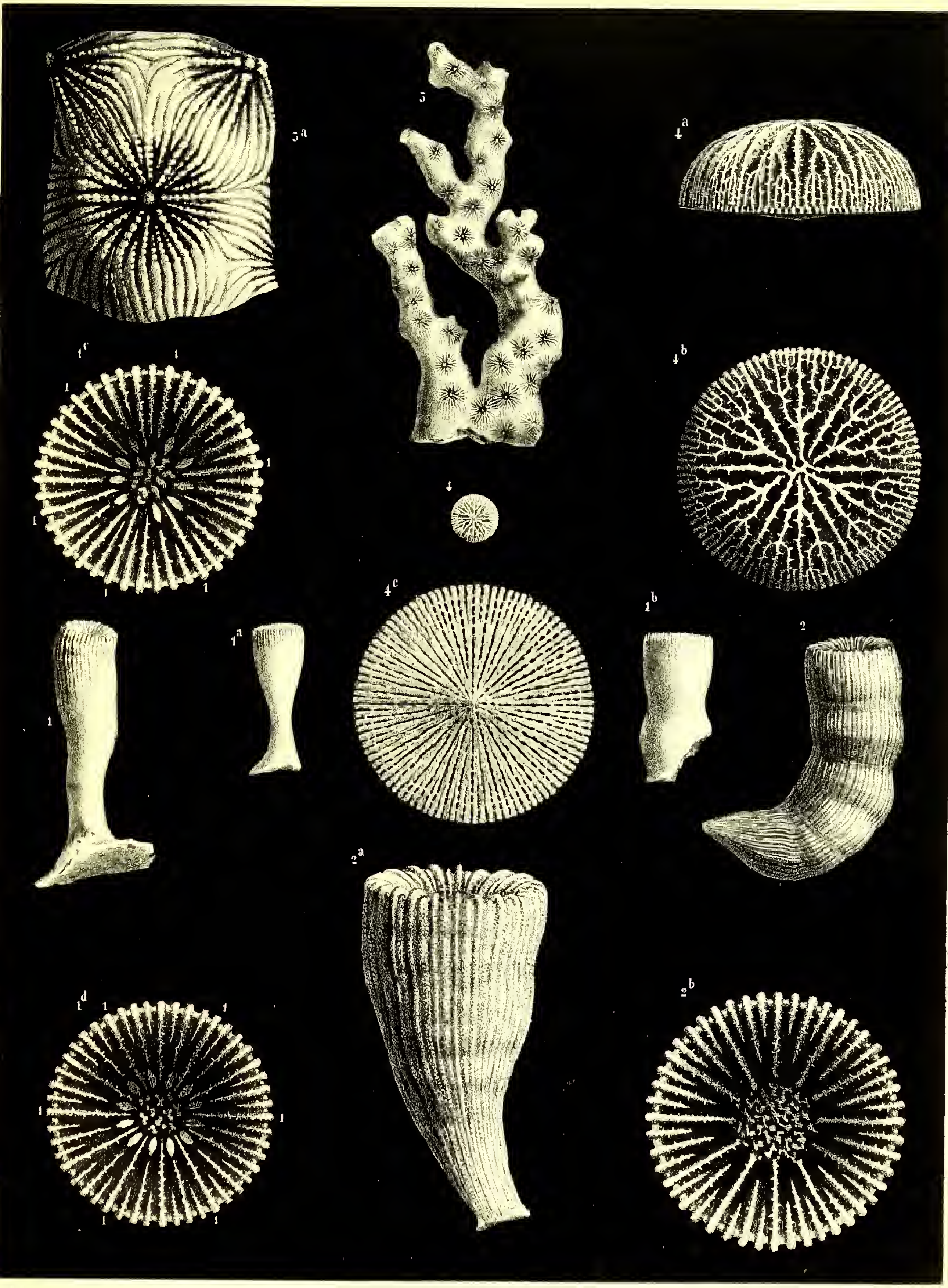
STEPHANOPHYLLIA BOWERBANKII (p. 54).

Fig. 4. Calicular surface; natural size.

4 *a*. Side view of the same, magnified.

4 *b*. Calice, magnified.

4 *c*. Mural disc, magnified.



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TAB. X.

CORALS FROM THE UPPER GREENSAND.

PEPLOSMILIA AUSTENI (p. 57).

Fig. 1. Restored figure of the corallum; natural size.
1 *a*. Calice; natural size.
1 *b*. A broken specimen, showing part of the epitheca, the columella, and the structure of the septa.

TROCHOSMILIA TUBEROSA (p. 58).

Fig. 2. Side view of the corallum; natural size.
2 *a*. Calice, magnified.

PARASTREA STRICTA (p. 59).

Fig. 3. A mass of this compound corallum; natural size.
3 *a*. Portion of the calicular surface, magnified.

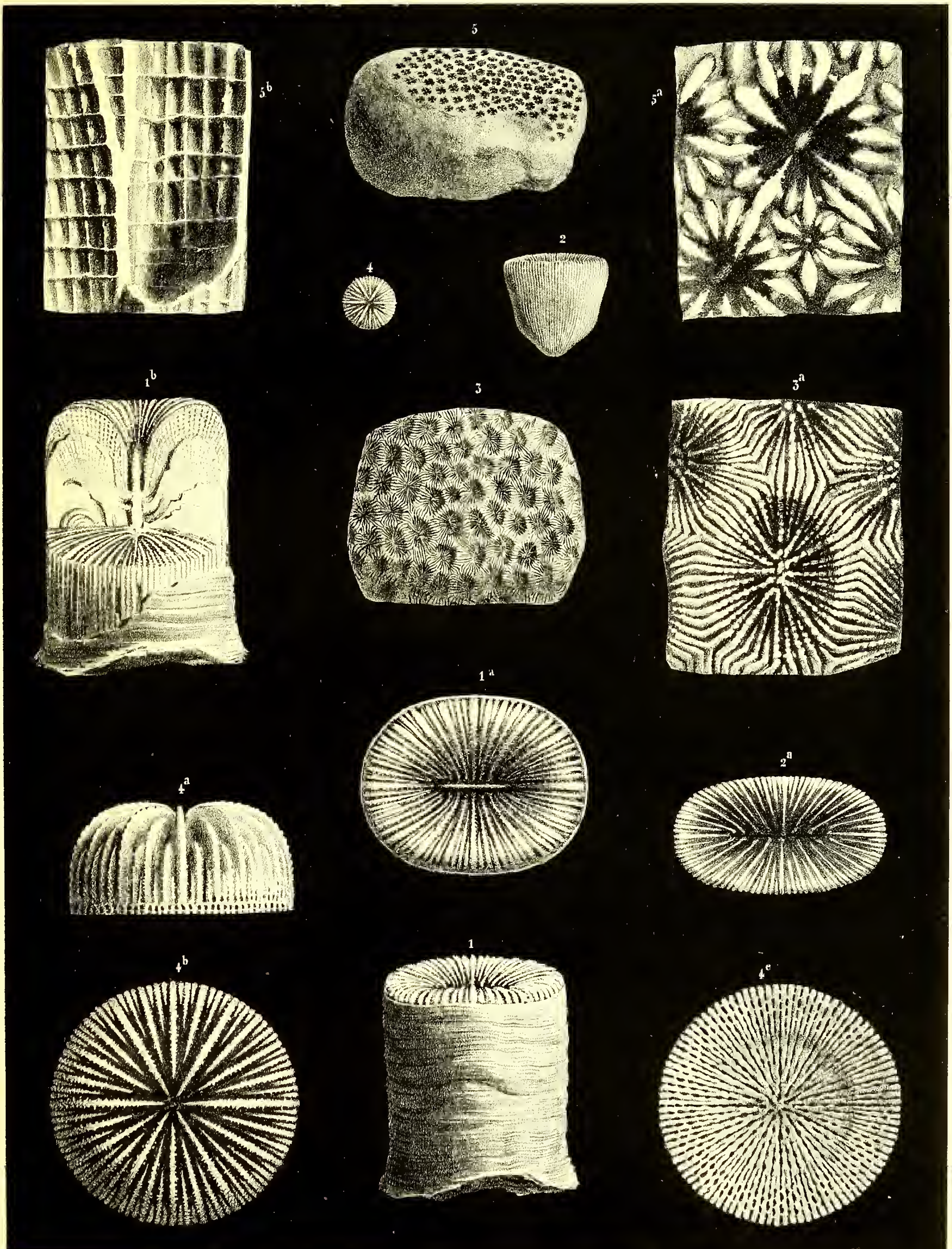
MICRABACIA CORONULA (p. 60).

Fig. 4. Calicular surface; natural size.
4 *a*. Side view, magnified
4 *b*. Calice, magnified.
4 *c*. Mural disc, magnified.

CORALS FROM THE LOWER GREENSAND.

HOLOCYSTIS ELEGANS (p. 70).

Fig. 5. A globose mass of this compound corallum; natural size.
5 *a*. Portion of the calicular surface, magnified.
5 *b*. Vertical section, magnified, of the visceral chambers in which the septa have been partly cut away, in order to show the tabular arrangement of the dissepiments.



J. Delarue del.

TAB. XI.

CORALS FROM THE GAULT.

CYATHINA BOWERBANKII (p. 61).

Fig. 1. A weather-worn specimen; natural size.

1 *a*. A specimen showing the wall, but not the calicular margin.

1 *b*. Horizontal section made near the calice, and magnified, to show the position of the pali, &c.

BATHYCYATHUS SOWERBYI (p. 67).

Fig. 2. Side view of a specimen, magnified, so as to show the structure of the wall. The line placed on the side shows the natural size of the corallum.

2 *a*. Calice magnified; the upper half is represented in its natural state, but in the under half the septa have been cut down; the centre is clogged up with extraneous matter.

CYCLOCYATHUS FITTONI (p. 63).

Fig. 3. Side view of the corallum, magnified. The line placed below shows the natural size of the specimen.

3 *a*. Calicular surface, magnified.

3 *b*. Under surface, or mural disc, magnified.

TROCHOCYATHUS HARVEYANUS (p. 65).

Fig. 4. Side view of the corallum; natural size.

4 *a*. Calicular surface, magnified.

4 *b*. Under surface, magnified.

TROCHOCYATHUS CONULUS (p. 63).

Fig. 5. Side view of the corallum; natural size.

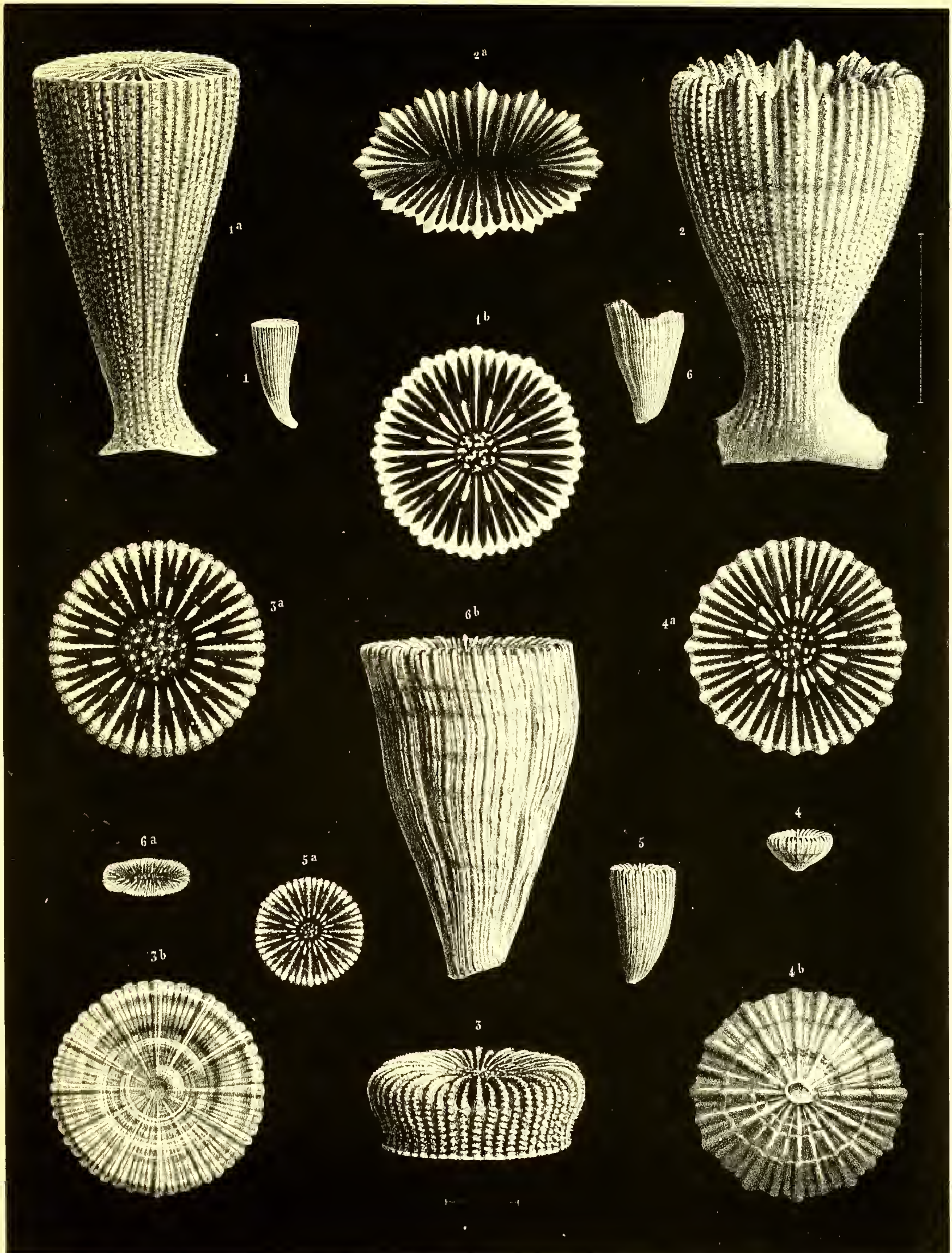
5 *a*. Calice, magnified.

TROCHOSMILIA SULCATA (p. 68).

Fig. 6. Side view of a specimen, the upper part of which is broken on one side; natural size.

6 *a*. Calice, magnified.

6 *b*. A restored specimen, magnified.


2a
1a
2
1b
1
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3a
6b
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4b

PALÆONTOGRAPHICAL SOCIETY.

MONOGRAPH:

BRITISH FOSSIL CORALS.

BY

PROFESSOR H. MILNE EDWARDS,

AND

JULES HAIME.

Part I.

CORALS FROM THE TERTIARY AND CRETACEOUS FORMATIONS.

1850.