extensively used on the continent in administering this not very pleasant balsam. *Decoctum Cinchonæ Acidulum ;* by the addition of the dilute sulphuric acid, the whole active principles are more completely dissolved and removed, and the deposit which takes place on the cooling of the ordinary decoction is prevented. *Extractum Filicis Maris Ethereum*, the oil of Filix-Mas, an anthelmintic deserving a more extended use than it has met with in this country. *Linteum Adhesivum* (a bad name by the way), meaning the isinglass plaster so extensively used by Mr Liston for dressing wounds.

Among the formulæ which will appear somewhat novel to English readers are the various combinations of herbs chiefly for making infusions and decoctions, bearing, as they always do, in the Foreign Pharmacopœias, the title of *Species*, with an accompanying adjective indicative of the qualities ascribed to them. Thus we have *Species Pectorales*, containing marsh-mallow, coltsfoot, sage, elecampane, liquorice, poppy-heads, and fennel ; *Species Antiscorbuticae*, containing fir-tops, milfoil, wormwood, marsh trefoil, juniper berries, and *Calamus aromaticus*. It appears to us rather curious to see these *herb teas* in a scientific work. In this country, the compounding and administration of such formulæ has in a great measure fallen into the hands of old women.

Want of space compels us to refrain from quoting any of the formulæ for prescriptions, many of them no doubt excellent. We retain our opinion as to the general inexpediency of such formulæ being published at all.

We conclude our notice of Sir James Wylie's book, by again expressing our admiration of it as a whole. We have in its perusal had much pleasure as well as instruction, and shall be happy to avail ourselves of many of the hints which it contains. We have derived additional gratification from this book, on account of its being the work of a countryman abroad, who has contributed to elevate the character and maintain the dignity of British medicine in a foreign land, and who, though by the exertions and good fortune of his earlier years he has attained an unusual degree of exaltation in his adopted country, has chosen the honourable part of continuing to labour in an extensive and important field of professional study, instead of folding his arms, and sitting down to enjoy his *otium cum dignitate*.

Art. II.—*Odontography, or a Treatise on the Comparative Anatomy of the Teeth ; their physiological relations, mode of developement, and microscopic structure, in the Vertebrate Animals, illustrated by upwards of* 150 *Plates.* By Richard Owen, F. R. S. Hunterian Professor to the Royal

College of Surgeons, London, &c. &c. Part 1. London, 1840. Pp. 112, and 50 Plates.

Mr Owen has been long favourably known to the scientific world for his varied researches in comparative anatomy; and the present work, on the Teeth of the Vertebrated Animals, so far as a judgment may be formed from the small portion before us, bids fair to sustain the reputation which he has already acquired both in this country and on the continent. It appears to be an extension of his paper "on the Structure of the Teeth," read before the British Association at Newcastle in August 1838, an abstract of which was published in the seventh volume of their Reports. In that paper he endeavoured to show that the general tendency of the modifications observable in descending from man to the lower classes of the vertebrated animals, was a nearer approximation of the substance of the teeth to the vascular and organized texture of bone; and his chief and strongest reason for arriving at this conclusion appeared to be, because the microscope showed that the teeth of all these animals were composed of tubular structures,—structures which also constituted no inconsiderable portion of the solid bones. The fallacy of this conclusion will be adverted to afterwards.

The present portion of his work is devoted to the dental system of fishes, and commences with a few general observations on the varieties in their number, form, situation, attachment, substance, chemical composition, structure, and developement.

Mr Owen remarks, that "the greater number of fishes have their teeth composed of an osseous substance, somewhat denser than the jaws to which they are affixed. In some instances, as in the teeth of the flying-fish (*Exocœtus*), and sucking-fish (*Remora*), the substance of the tooth is uniform, and not covered with a layer of denser texture. In others, as the shark, sphyræna, &c. the tooth is coated with a dense shining enamel-like substance; but this is not true enamel, nor the product of a distinct organ; it differs from the body of the tooth only in the greater proportion of the earthy particles, their more minute diffusion through the gelatinous basis, and the more parallel arrangement of the calcigerous tubes; but it is developed in and by the same matrix, and, resulting from the calcification of its external layer, is the first part of the tooth which is formed. In the *Sargus* and *Balistes*, the dentine, or proper osseous substance of the tooth, is harder than that of the fishes last cited, and is covered with a thick layer of a denser substance, developed by a distinct organ, and differing from the enamel of the higher animals only in the more complicated and organized mode of deposition of the earthy particles. The ossification of the capsule of the matrix gives the enamel of the teeth of the file-fish, and some others, a

thin coating of a third substauce analogous to the "cæmentum, or crusta-petrosa" of the mammalian teeth. And in the pharyngeal teeth of the parrot-fish a fourth substance is added to the structure of the tooth by the coarser ossification of the pulp, after its peripheral part has been converted into the dense ivory. The teeth, consisting of dentine, enamel, cement, and coarse bone, are the most complicated as regards their substance that have yet been discovered."—P. 8, 9.

In speaking of the structure of the teeth, it is remarked that the tubular structure is common to the teeth of fishes as well as to those of all the other classes of vertebrated animals; and that four principal modifications of this structure occur.

Premising that the essential character of this structure is the presence of a *cavitas pulpæ*, or medullary canal, from which the calcigerous tubes radiate, the *first* modification, he remarks, is observed in the rostral teeth of the saw-fish, where the tooth is traversed by a number of equidistant and parallel medullary canals, each canal, and its system of medullary tubes, representing a cylindrical or prismatic denticle, which is separated from the contiguous denticles by a thin coat of bone or cement. Occasionally, as in the teeth of the parrot-fishes and chimæra, the contiguous medullary canals anastomose together.

In the *second* modification the substance of the tooth is traversed by medullary canals, somewhat less regularly equidistant and less parallel than in the first, having the boundaries of their respective systems of radiated calcigerous tubes indicated by the minute calcigerous cells with which the terminal branches of those tubes communicate. These boundaries are more or less obscured by the terminal branches of the calcigerous tubes crossing into the interspaces of the corresponding branches of an adjoining system of tubes, and anastomosing with them immediately or through intervening dilatations or cells. The medullary canals often dichotomize, and anastomose more frequently than in the first modification. The teeth are generally of a large size; and a good example occurs in the Port-Jackson shark, *(Cestracion Philippi.)*

The *third* modification is the most common and characteristic of the dental structures of fishes. The tooth is permeated by a network of medullary canals, of which the interspaces are occupied by the calcigerous tubes or cells. The medullary tubes are directly continuous with those of the common bone with which the tooth is anchylosed. As these proceed through the tooth they maintain a course more or less parallel, and more or less straight or wavy; but they ramify abundantly, and gradually diminish in calibre as they approach the surface of the tooth. This form of structure is seen in the perch, salmon, herring, and other families of fishes.

The *fourth* modification is that which approaches nearest to what is met with in the higher classes of vertebrated animals, and is characteristic of the teeth of most of the reptiles and of the Mammalia. The tooth consists of a single medullary or pulp canal, and a single system of calcigerous tubes, radiating from the central canal at right angles to the periphery of the tooth. This structure is met with in the teeth of the extinct sauroid fishes, in the file-fish *(Balistes)*, angler *(Lophius)*, &c.

Mr Owen takes occasion to state his opinion as to the vitality of the teeth in the following words:

"The uniform result of my researches on the structure of the teeth in all grades of vertebrate animals, and in their natural and diseased states, has been a conviction of the untruthfulness of the terms inert, dead, and unorganized, as applied to the substance of any tooth whatever. Extra-vascular undoubtedly is all that portion which consists of the calcigerous tubes; the capillary circulation is confined to the pulp or medullary canals; but since every secretive process and the developement of the primordial cells of every tissue are due to changes produced in the *liquor sanguinis* transuded from and beyond the sphere of the ultimate capillaries, the absence of these vessels in the dense dental substance is as little conclusive against its vital and organized nature, as it would be to prove the inert condition of the germinal membrane of the ovum before the thirtieth hour of incubation."—P. 13.

In the fifty-third volume of this Journal the question as to the vitality of the teeth was fully discussed, and the conclusion arrived at was, that the teeth, being destitute of blood-vessels, nerves, and absorbents, and no changes occurring in them which could fairly be attributed to a vital agency, they ought to be regarded as destitute of vitality.

After an impartial examination of their structure, growth, &c. it was also stated, that teeth ought to be classed along with the other cuticular appendages, as hair, feathers, claws, spines, &c.; organs which, though organized, as being the result of an organic secretion, were at that time usually regarded as destitute of vitality. That the opinion then expressed, regarding the class of organs to which teeth ought to belong, was correct, the researches of Professor Owen fully establish. With regard to what conclusion he himself may draw from the facts which he states in the present work, we have no means of ascertaining, the work not yet being completed; but as from the same facts, in his paper read before the British Association, he concluded that teeth ought to be arranged in the same category as bones, and this from both these organs possessing a somewhat similar tubular structure, it may be necessary to advert very shortly to the arguments in favour of the opinion expressed in the former volume of this Journal.

All organs secreted by the cuticular or dermoid tissue are composed of a tubular structure, either in single tubes, as seen in hair, or in various forms of aggregation and modification, as observed in nails, feathers, claws, bills of birds, spines of fishes, &c.; nay, the very epidermis itself is composed of tubular scales; in fact, the essential structure of the cuticular surface, and of all its appendages, is the tubular structure. The microscope shows that many of the spines of fishes possess in all respects the identical minute structures observed in the teeth of the same animals; and the very formation of these two classes of organs is now proved, beyond the possibility of a doubt, to be precisely similar. Hair, spines, feathers, &c. all grow from vascular papillæ or bulbs on the surface of the dermoid tissue. The researches of Muller, Arnold, and Goodsir, have proved that the human teeth are formed from papillæ of the mucous surface of the mouth; and every fact regarding the dentition of the lower animals, and especially the varied and extensive researches of Professor Owen, clearly demonstrate that these organs are always produced from papillæ formed on the surface of the mucous or dermal tissues. The teeth of the saw-fish, in fact, are spines, formed on the dermal surface; and yet in no respect, either in their mode of growth, or internal structure, do they differ from true teeth. So long as the facts were limited to the examination of the human teeth, doubts may have remained as to whether they ought to be regarded as bones, or appendages of the skin; but the examination of these organs in the lower classes has now brought so many new facts to light, that not a doubt can remain as to which class they ought to belong. So that whether these organs be examined in their intimate internal structure, in their mode of developement and growth, or in their relations to the other organs of the body, they must be regarded as simple cutaneous appendages.

As the subject of the developement of the teeth is one of the most important parts of the general subjects treated of in the present work, it is imposssible to pass it over without quoting the details.

"In all fishes, as in other vertebrate animals, the first step is the production of a simple papilla from the free surface of either the soft internal integument, as in the young *Pristis*, or on the mucous membrane of the mouth, as in the rest of the class. In these primitive papillæ there can be early distinguished a cavity containing fluid, and a dense membrane, *membrana propria pulpi*, surrounding the cavity, and itself covered by the thin external buccal mucous membrane, which gradually becomes more and more attenuated as the papilla increases in size. In some fishes, as the sharks and rays, the dental papillæ do not sink into the substance of the vascular membrane from which they grow, but become buried in depressions

of an opposite fold of the same membrane: these depressions enlarging with the growth of the papillæ, and forming the cavities or capsules in which the developement of the tooth is completed. They differ from the capsules of the matrix of the mammiferous tooth in having no organic connection with the pulp, and no attachment to its base; the teeth when fully formed are gradually withdrawing from the above described extraneous capsules, to take their place and assume the erect position on the alveolar border of the jaws.

"Here, therefore, is represented on a large and, as it were, persistent scale, the first and transitory papillary stage of the developement of the mammalian teeth; and the simple crescentic cartilaginous maxillary plate with the mucous groove behind it containing the germinal papillæ of the teeth, offers in the shark a magnified representation of the earliest condition of the jaws and teeth in the human embyro.

"In many fishes, as the lophius and pike, the dental papillæ become buried in the membrane from which they arise, and the surface to which their basis is attached becomes the bottom of a closed sac. But this sac is never lodged in the substance of the jaw, the developement of the tooth being completed in the tissue of the thick and soft gum or mucous membrane from which the papillæ were originally developed: hence teeth in various stages of growth are frequently brought away with that membrane when it is reflected from the jaw-bone. The ultimate fixation of the teeth, so formed, is effected by the developement of ligamentous fibres in the submucous tissue between the jaw and the base of the tooth; which fibres become the medium of connection between those parts, either as elastic ligaments, or by continuous ossification.

"Here we have the second step in the developement of the mammalian tooth represented, viz. the imbedding of the pulp in a follicle of the mucous membrane; but the eruptive stage of the tooth takes place without any previous inclosure of the follicle and pulp in the substance of the jaw.

"In the *Balistes, Sparoids, Sphyræna, Scarus,* and many other fishes, the formation of the teeth presents all the usual stages which have been observed to succeed each other in the dentition of the highest organized animals; the papilla sinks into a follicle, becomes surrounded with a capsule, and is then included in a closed alveolus of the growing jaw, where the developement of the growing tooth takes place, and is followed by the usual eruptive stages.

"The developement of the dental pulp in fishes, prior to the deposition of the calcareous particles in it, corresponds in the main with the processes described by Purkinje and Raschkow in the mammalia. The pulp-substance, or contents of the *membrana propria* remain, in fishes, for a longer period in a fluid or semifluid state, and the granules or nucleated cells which are first developed, float loosely or in small aggregated groups in the sanguineo-serous fluid: they first attach themselves to the inner surface of the *membrana propria,* if these be not originally developed from that sur-

face, and the whole of the contents of the growing pulp becomes soon after condensed by the numerous additional granules which are rapidly developed in it after it has become permeated by the capillary vessels and nerves. The arrangement of these particles into linear series, or fibres, is first observable at the superficies of the pulp to which the fibres are vertical; and, at this period, ossification has commenced in the dense and smooth *membrana propria* of the pulp; it is thence continued centripetally in the course of the above-mentioned lines, towards the base of the pulp, either regularly progressive, as in the incisors of the *Sargus* and *Balistes*, or radiating, as in *Sphyræna*, and (if we may judge by *à posteriori* observation of the structure of the fully developed teeth) in most other fishes, from the various centres formed by the persistent capillaries of the pulp, around which the cells or granules become condensed into concentric layers, which then become, as they are successively impregnated with the calcareous salts, the walls of the medullary canals.

"In the shark, and all those fishes in which the teeth are completely formed without going beyond the papillary stage of developement, there is no distinct enamel pulp; the dense exterior layer of the tooth is formed by the calcification of the *membrana propria* of the pulp, which, therefore, precedes the formation of the ordinary dentine. But in the file-fish *(Balistes)*, the sargus, the gilt-head *(Chrysophrys)*, and some other fishes, a conspicuous enamel-pulp is developed from the inner surface of the capsule which surrounds the bone-pulp; this enamel organ terminates, as in the human subject, before the capsule is reflected upon the base of the pulp. It has a firmer tissue, more closely resembling that of the ordinary pulp, than in the mammalia: and, when examined under the microscope, presents numerous and close-set fine fibres near that surface which is next the bone-pulp, and to which these fibres are generally placed at right angles. The base of the enamel organ, which is attached to the capsule, presents a granular and fibrous tissue blended together. I have not been able to trace any capillaries from the capsule into the substance of the enamel-pulp. In the incisors of the sargus, the developement of the enamel and dentine begins simultaneously upon the contiguous surfaces, and when we observe how close and compact is the package of the matrix of the tooth in the alveolar cavity of the jaw, it is hardly possible to conceive how either of these substances could be the product of transudation from their respective pulps. It is, however, easier to separate the primary layers of the enamel and dentine from their respective pulps than from each other; yet if the denuded surfaces of the uncalcified portions of the pulps be examined by reflected light under a compound lens of a half-inch focus, they are seen to be ragged and punctate, and evidently different from the original surfaces prior to the commencement of the deposition of the calcareous salts in them. The formation of the enamel resembles more closely that of the dentine in the fishes cited than it does in the mammalia, and the enamel contains a greater proportion of persistent animal matter.

"The course of calcification of the two pulps takes opposite directions, and in the *Balistes*, the process finishes by the ossification of the outer layer of the capsule itself, by which both the enamelled crown and the base of the tooth are coated with a thin layer of bone. I have not been able to discern any radiated cells in this analogue of the *crusta petrosa*, or cement of the mammalian teeth. It soon wears off from the crown of the extruded tooth.

"In all fishes, the teeth are shed and renewed, and this not once only, as in most mammalia, but frequently, and during the whole lifetime of the animal. Fishes, indeed, can hardly be said to have permanent teeth. The rostral teeth of the pristis constitute, perhaps, the sole exception; and these may be regarded rather as modified dorsal spines.

"In all cases where the first teeth are developed in alveolar cavities, the succeeding ones follow them in the vertical direction, and owe the origin of their matrix to the continuation, from the mucous capsule of their predecessors, of a cœcal process, in which the papillary rudiment of the dental pulp is developed. But in the great majority of fishes, the germs of the new teeth are developed, like those of the old, from the free mucous membrane of the mouth through the whole period of succession, a condition which is peculiar to the present class."—Pp. 14–19.

After these preliminary observations Mr Owen passes to the consideration of the structure of the teeth in the different orders, genera, and species of fishes; his varied remarks on each being illustrated by beautiful lithographic plates, exhibiting both their external form and magnified views of their internal minute structures.

The teeth of the *Plagiostomata*, or cartilaginous fishes, appear particularly to have attracted the author's attention. After some general remarks on the present state of our knowledge as to the bones which enter into the formation of the jaws of this class of fishes, and showing how other comparative anatomists have mistaken the different modifications in the structure of these parts, Mr Owen arrives at the conclusion, that the "dentigerous cartilaginous arches of the sharks and rays represent, the one, the combined maxillaries and intermaxillaries, the other, the confluent articular and dentary elements of the lower jaw."

The teeth of the cartilaginous fishes are not immediately connected with the cartilaginous arches, are never implanted in maxillary alveolar cavities, nor are they confluent with the substance of the jaw, even when the external crust of the jaw is ossified, but are always attached to the fibrous and mucous membranes which cover the maxillary cartilages. Retaining their common and characteristic type of structure, the teeth of these fishes exhibit every grade of modification of form, from the laniary to the molar type,

suited to the varied habits of the animals, and the kinds of food on which they subsist.

In all the sharks the body of the tooth is principally occupied with two kinds of canals, which Mr Owen terms medullary and calcigerous, the latter being, essentially, minute branches of the former. In the newly-formed tooth, these are distinguishable by the nature of their contents; but the characteristic marks of each are gradually obliterated by the progressive developement of calcareous matter by concentric layers in the medullary canal.

The formation of the teeth of the sharks exemplifies on a large scale the earliest or papillary stage of dental developement seen in the higher classes of animals. It is not, however, succeeded either by the follicular or eruptive stage; the formative papillæ are never enclosed, and consequently never break forth. The pulp, when consolidated by the deposition of calcareous salts in the pre-existing cells and tubes, is gradually withdrawn from the protective sheath which the thecal fold of mucous membrane afforded it during the early stage of its developement. Mr Owen thus describes the particular appearance of these structures in the uterine fœtus of the common white shark:

"A fissure presents itself on the inner side of the margin of each jaw, running parallel with it, between the thin smooth membrane covering the convex edge of the cartilage, and the free margin of a fold of mucous membrane which lies parallel to, and upon the inner edge of the jaw. When this fold is drawn away from the jaw, the minute teeth are exposed, arranged in the usual vertical rows; their points are all directed backwards and towards the base of the jaw, and are seen to slip out of fossæ, or sheaths in the membranous fold, as this is gradually reflected backward to its line of attachment near the base of the jaw. Here the anterior lamina of the fold, which, from its office, may be termed thecal, is continuous with the mucous membrane at the base of the rows of teeth; the posterior layer is reflected backwards to the frœnal line of attachment of the tongue. Close to the anterior line of reflection there is a row of simple conical papillæ; in the succeeding row, the papillæ are larger, the cone broader and flatter, and its apex is covered with a small cap of dense and glistening dental substance, which is readily removed; though not without displacement of part of the pulp, the granules of which, adherent to the cavity of the displaced dental cap, are always readily recognizable under the microscope. The third series of papillæ, counting from below in the lower jaw, have acquired the size and shape of the future tooth, with the crenate edges well marked; half the tooth is completed, and its removal from the fleshy base of the pulp cannot be effected without evident laceration of the pulp; when this is done under the microscope, the torn processes of the pulp continued into the medullary canals of the new formed tooth are plainly visible. The fourth tooth is completely formed, as also the fifth and sixth, in the as-

cending series; these progressively diminish in size. The last or highest, which is first exposed on reflecting the thecal fold, and the first which is completed in the order of developement, consists of a simple cone, similar in form and size to the apical third of the ordinary sized teeth below it; yet its growth is quite completed, and its base firmly attached to the maxillary membrane."

"The unossified pulps, examined with a higher power, consist of semi-opaque polyhedral granules or cells suspended in a clear *matrix*, and the whole enclosed in a tough transparent membrane, which forms the outer surface of the pulp. Beneath this membrane, at the crenate margins, the granules or cells are arranged in lines precisely corresponding with those of the subsequent calcigerous tubes. The formation of the tooth commences by the deposition of earthy particles in the tough external membrane of the pulp. I have been unable to recognize the distinct arrangement of the hardening salts in this layer. It is transparent, extremely dense, and forms the enamel-like polished coating of the tooth; in sections of fully formed teeth, the finest terminal branches of the parallel peripheral calcigerous tubes are lost in the above clear enamel-like substance. When the enamel-like outer layer of the apex of the tooth is completed, it is so easily detached from the subjacent pulp that it might be readily supposed that there was no organic connection between them. If, however, the so exposed pulp be now examined with the microscope, and compared with an uncalcified pulp, it is seen to be no longer covered with the smooth dense membrane observable in the latter; but the apical edges, from which the enamel-like cap has been detached, appear villous or floccular. It is obvious, that the first shell of the tooth has been neither transuded from the superficies of the external membrane of the pulp, nor has been deposited between that membrane and the granular part of the pulp, but is due to a conversion of the external membrane into a dense enamel-like bone. The formation of the body of the tooth by deposition of earthy particles in pre-existing and pre-arranged cavities is still more satisfactorily demonstrable. In proportion as the formation of the tooth has advanced, the difficulty of separating the calcified from the uncalcified portion of the pulp is increased, and at the same time it becomes easier to detect the continuation of the processes of the pulp into those medullary canals which form so many centres of radiation of the plexiform calcigerous tubes."—Pp. 35–37.

"As a consequence of a formation of a tooth by *conversion of*, instead of *transudation from*, a pre-existing pulp, the successive formation of these pulps necessarily follows, where a succession of teeth is required; these reproductive pulps are developed in the shark in the vascular mucous membrane at the angle of reflection of the thecal fold upon the groove at the basal line of the jaws. They gradually advance from this situation towards the margin of the jaw, the centripetal ossification extends as they advance, and consolidation is completed by the time they are ready to

change their recumbent for the erect position, and take the place of the tooth previously shed."—P. 39.

Mr Owen has rendered it extremely probable that the change of place, and direction of the teeth of the sharks, depends on some process of partial absorption and deposition operating on the membrane to which the teeth are attached, but not on the jaw; consisting in a slow and gradual sliding motion of the dentigerous membrane upon the jaw. The fact upon which this opinion is mainly founded is, that in the jaw of a *Galeus*, which had been penetrated with the barbed spine of a sting-ray, which had broken off and remained fixed in the jaw, a double row of imperfectly formed teeth was found continued from the internal surface of the perforated part of the jaw to the margin supporting the erect teeth; a circumstance which Mr Owen considers to prove that the dentigerous membrane advanced, whilst the particles of the jaw remained stationary.

The teeth of the *Myliobates* or rays, are, like those of the shark, formed at the posterior part of the tesselated series, in proportion as they are worn away in front. A series of minute and closely aggregated papilliform matrices rise from the mucous membrane behind the teeth, and are covered by a fold of the same membrane, which is reflected forwards, so as to conceal the pulps and last formed teeth. The papilliform pulps are ossified by the deposition of the calcareous salts in the peripheral cells and radiating tubes, but the medullary or central canal of such pulp continues to retain its vascular contents, till the whole of the compound tooth is completed. The calcified wall of the medullary canal is then thickened, and the area diminished by the successive formation of concentric laminæ of osseous matter.

The peculiar formation of the jaws of the *Cestracion*, or Port-Jackson shark, is next noticed, approaching, as they do, in their greater elongation and more horizontal position, to those of the osseous fishes. The author shows that the upper dentigerous arch represents the ordinary maxillary and intermaxillary bones, whilst the labial cartilages or their rudiments, thought by Cuvier to represent in the cartilaginous fishes the maxillary, intermaxillary, and premandibular bones, are entirely awanting.

In the teeth of this fish, when the dense outer layer is removed from the crown of the newly formed teeth, the orifices of the medullary canals perforating the whole body of the tooth, are brought into view. These tubes or canals are more or less occupied in the recent fish by a vascular pulp, and are continued directly from the irregular cells and canals of the semi-ossified crust of the jaw. In the large crushing teeth, the greater number of the medullary canals proceed in pretty regular and slightly wavy courses towards

the grinding surface, whilst the outer ones incline towards the lateral surfaces; but they soon begin to divide, and the divisions continue to ramify dichotomously. The branches anastomose, particularly near the surface, and each maintains nearly the same size as the trunk. The process of dentition is most clearly one of conversion not of excretion; the earthy particles being deposited in the microscopic cells and tubes of the formative matrix.

The teeth of the various families included under the title of *Ganoid* fishes next engages Mr Owen's attention. In most of these there is but little to interest the general reader; though the minuteness and precision of his descriptions, together with the beautifully drawn lithographic plates, cannot fail to prove of the highest utility to the student of natural history, and especially to the geologist, in the elucidation of the extinct species.

In speaking of the compound teeth of the *Diodon*, Mr Owen takes occasion to correct the mistake into which Cuvier and Von Born had fallen regarding their structure and mode of formation. The teeth of the diodon were supposed by these naturalists not to be formed by the deposition of calcareous tubes in the pulp's substance, but by the apposition or transudation of layers of calcareous matter from the pulp's surface. The exposed surface of the tooth of the diodon presents, in fact, a series of transverse and parallel striæ, which, in a vertical section, are seen to be the margins of thin, superimposed, horizontal, and slightly flexuous plates, which have been partially abraded by trituration in an oblique plane. The superior layers are the most worn, and are evidently the oldest; in proportion as they descend, in the lower jaw, they increase in breadth, and, finally, instead of being soldered together, they become detached, thinner, and of a more friable texture; the lowest and incompletely developed plates lie loosely in the cavity of the jaw beneath the superincumbent dental mass. It was this peculiar appearance which deceived Cuvier and Von Born. The mode of formation of the tooth, however, is thus described by Mr Owen:

"The mucous membrane of the mouth and periosteum of the jaws are reflected into the cavities at the base of the compound tooth; the periosteum lines the parietes of the cavity, and the mucous membrane forms a thick cushion extending across its floor. From this surface a lamelliform pulp is developed, in which the calcifying process takes place in a direction from above downwards. At first the earthy salts are deposited in the state of such minute subdivision, and in such a direction and abundance, as to produce the dense and minutely tubular structure of the dental plate. When this has acquired its due thickness, the rest of the pulp becomes ossified, *i. e.* the calcareous salts are deposited in less abundance, and in the parietes and interspaces of coarse cells, instead of those of minute tubes. The margins of the ossified pulps, by this process, become

confluent with the parietes of the general dental cavity, and the mutual adhesion of the flattened surfaces of the impacted lamelliform teeth is promoted by the pressure to which their exposed surfaces is subject. By the time that ossification has begun in one pulp, a second has been developed beneath it, and it is the portion of the pulp solidified by the fine tubular calcification which gives rise in the macerated and dried jaws to the bone and thin lamellæ in the dental cavity. These lamellæ become fixed by means of the coarser calcification or ossification which subsequently takes place in the remains of the pulp, and their margins are thus anchylosed to the surrouuding bone, in a manner analogous to the fixation of the base of the ordinary shaped teeth in other fishes."—P. 79.

In the compound tooth of the diodon, then, parallel and aggregated series of short calcigerous tubes are separated by thin layers of a cellular bone. But the lamellæ in it, as well as in the tusk of the elephant, and the conical molar tooth of the cachalot, present an organized structure of aggregated calcigerous tubes, directed more or less at right angles to the plane of the lamellæ, and indicate that higher mode of developement by calcification of the pulp, which it is the chief object of Mr Owen's researches to exemplify.

In the published portion of this work the dental characters of another group of fishes is given, viz. the *Ctenoid* fishes, consisting chiefly of the Percoides, Gobioides, Squamipennes, and Pleuronectes of Cuvier; as also a portion of the first family of the Cycloid fishes, the Labroides of Cuvier.

Many and interesting are the details given on each of these groups, for which we must refer to the work itself. What we have said may serve to give some general idea of the interesting and original information here communicated, and what may be further expected from this accomplished anatomist.

Art. III.—1. *First Annual Report of the Registrar-General of Births, Deaths, and Marriages in England. Presented to both Houses of Parliament by Command of Her Majesty.* London, 1839.

2. *Second Annual Report of the Registrar-General of Births, Deaths, and Marriages in England, with Appendices. Presented to both Houses of Parliament by Command of Her Majesty.* London, 1840.

These reports, with the materials from which they are compiled, and the appendices with which they are accompanied, form valuable contributions to the statistics of the population of