Observations on some new organic remains in the flint of chalk / [Joseph Bancroft Reade].

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THE FLINT OF CHALK.

BY

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WITH TWO PLATES.

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ON

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IN

THE FLINT OF CHALK.

It is now very generally admitted that a geologist is as much in need of a microscope as of a hammer. Instruments of the latter class may indeed be sufficient for the exhumation of the gigantic remains of Tilgate Forest; but accurately to follow out the workings of an Omnipotent agent, and to explore what may be justly termed the secret things in the kingdom of nature, puts into requisition the talent of our ablest opticians. Were any proof of this assertion necessary, it would more than suffice to refer, on the one hand, to the thousands of microscopic bodies which Mr. Lonsdale has discovered in chalk, or to the infinitely greater number of far more minute forms which Prof. Ehrenberg has discovered in the siliceous earths; and, on the other hand, to bear in mind that the results of the latter distinguished philosopher have set at rest the many unsatisfactory theories respecting the formation of the siliceous nodules of the chalk, and have naturally led to the conjecture, that, "as the formless cement in the semiopal of Bilin has been derived from the decomposition of animal remains, so also even those parts of chalk flints in which no organic structure can be recognised may nevertheless have constituted a part of microscopic animalcules."

A series of microscopic observations upon the ashes of plants which were commenced in the spring of 1837, led me, by steps heretofore stated in a communication to the British Association*, to examine into the condition of silica generally; and

* Seventh Report. Transactions of the Sections, p. 103.

I not only can bear testimony to the accuracy of Prof. Ehrenberg's conclusion, that to a very great extent the organic remains of Infusoria swell the amount of solid matter of the crust of the earth, but I am able also to prove by careful experiments, that in plants certainly, and therefore probably in animals, the living principle is endowed with the power of elaborating out of their proper nutriment the solid materials or frame-work of their support. And hence the origin, and in the present day the increase both of silica and lime.

With respect to the agency of animalcules secreting carbonate of lime, it may be observed, that a thin transparent section of the Sussex marble shows in the most satisfactory manner, that the mouths of the *Paludinæ*, instead of being filled up with indurated marl, as was once supposed, abound with the remains of *Cyprides*, and that, in point of fact, the entire mass of the marble is nothing more than an aggregation of these infusoria interspersed with the larger univalve. That the apparently inorganised particles are derived from the decomposition of the *Cypris* will scarcely be doubted, and to what extent each individual is capable of yielding a supply of calcareous matter is easily ascertained by incinerating recent examples. For it thus appears, that not only is there an indestructible though slender shell covering the body properly so called, but the delicate branches of the rami or arms inserted on each side of the head, as well as the arms themselves, are equally supplied with a frame-work of solid matter.

But my present object is to allude more particularly to some of the fossil contents of flint pebbles and of the flint nodules of chalk. It is now well known that flint of every kind is rich in organic remains, and few persons who use the microscope at all, have neglected the examination of these minute forms which had their little moment of life and enjoyment in ages of the most remote antiquity. Perhaps, however, it is not so generally understood, that in the hands of a skilful geologist a promiscuous series of flint pebbles would be assigned, with the utmost precision, and by means of their fossil

* One of these pebbles abounds with remarkably fine examples of *Pyxidicula*, and its crystalline state, by no means common to flint nodules, is decidedly proved by its action on polarized light.

contents alone, to their proper periods and strata. Yet such is the fact, and I have had the pleasure of seeing it verified by my friend Mr. Bowerbank, who lately took advantage of a geological tour to establish this curious result. I had, indeed, myself suspected that the flint of different strata had not a common origin, in consequence of the absence of the *Xanthidium* from many of the pebbles of the Brighton beach*. This highly interesting animalcule, of which several species occur in the flint of Kent and Surrey, I discovered first of all about a year ago in the flint of the Sydenham gravel; and this specimen was compared and identified with a French one, then but just imported at an expense exceeding 20 francs. I learnt on that occasion that Prof. Ehrenberg had already named and described this new fossil genus, and to him I am indebted for the names of the species which accompany this paper. Of the beauty of the drawings it is unnecessary to speak, and their accuracy is secured by the image of the objects having been thrown on paper by means of a Camera eye-piece, and then carefully traced. At the same time I cannot but observe that a magnifying power of 1000 linear, together with Ross's fine adjustment, gives a reality which no drawing can impart. We can trace our way down the arms, and penetrate what, comparatively speaking, appears to be a vast sphere, since it is no exaggeration to say that it would require nearly a thousand million individuals to fill up the image thus presented to the mind.

As to the manipulation of the flint, in order to prepare it for the stage of the microscope, the readiest method by far is to break a large nodule in half, and from the flat faces to chip off thin fragments, which may be attached by means of Canada balsam to slips of glass of the usual form, and then coated on their outer surface with hard spirit varnish. A hundred specimens may be thus cut, mounted, and polished, without trouble or expense, and in less time than an expert lapidary could prepare a single slice with the diamond-mill and polishing tool.

It is the received opinion among geologists, that the nature of the strata of the chalk, and the organic remains which they inclose, prove that the chalk was deposited in the tranquil depths of an extensive and profound ocean. This conclusion

is rendered probable by the chambered *Nautili* and microscopic Foraminifera of flint, and it will derive additional force from a recent very interesting discovery of scales of fossil fishes, of great variety of form and in a state of most delicate preservation, throughout the entire series of the flint nodules both of the chalk and gravel, from Gravesend to Rochester and Gillingham*. A few weeks ago a single scale was discovered by Mr. Darker upon a fragment of flint which he had selected for a supply of the *Xanthidium*, but as he was ignorant of its locality he made no further search for similar remains: shortly afterwards a pebble was brought to me for my usual mode of examination, and upon its surface, I accidentally discovered the second scale, and had the advantage of knowing that I could apply to an inexhaustible store.

These two specimens were exhibited to Prof. Ehrenberg during his visit in London, to whom, as to other observers, they were previously unknown. That they should so long have escaped our notice is to me a marvel, and I can only account for it, by making what I feel to be the very extravagant supposition, that the flints hitherto examined did not contain them. They are not like the infusoria, requiring great amplification to be rendered visible at all, but possess, in many cases, all the brightness, and more than half the magnitude, of a silver penny; and I am even tempted to ask how our geological sportsmen can have overlooked them; for of the only half dozen gun-flints which have ever been in my possession, I find a brilliant scale sparkling upon the surface of one of them. However, it is now a matter of certainty that we shall all find them, and in great numbers.

The value of this discovery in a geological point of view cannot be better stated than in the following extract from Prof. Phillips's 'Treatise on Geology'†: "M. Agassiz has proved the importance of the indications afforded by the nature of the dermal covering, and applied it to the classification of fishes with peculiar success. Instead of the divisions usually adopted from the nature of the skeleton,—cartilaginous

* The rolled flints of the Norfolk gravel-beds also abound with fossil scales.

† Cabinet Cyclopædia. Phillips on Geology, p. 88.

and osseous fishes,—he distinguishes four great orders of fishes *from the nature of their scales*, and finds that with these differences of scales other great and important distinctions harmonize; but that the possession of a bony or cartilaginous skeleton is a question of comparative unimportance. The abundance and perfection of scales of fishes in a fossil state render this view, valuable as it is in recent zoology, absolutely essential to a study of the fossil kingdom; for thus *a few scales remaining, may lead to a knowledge of the species or genera belonging to each epoch*, and as portions of fishes are found in every one system of strata, from the ancient silurian to the most recent of lacustrine deposits, we are presented with a *second scale of organization* nearly as complete and as distinctly related to *time*, higher in the ranks of creation, and therefore *more sensibly dependent on physical conditions* than the well-known and justly valued series of remains of mollusca.

"The orders of fishes, according to their scaly coverings, are four; viz.

"1st. *Scales enamelled.*

"Placoid fishes, whose skin is *irregularly* covered with large or small plates, or points of enamel, as the rays and sharks* (Etym. πλαξ, a broad plate) occur recent, and numerous in the fossil state, being found in nearly all the systems of strata, though the genera are mostly peculiar in each system.

"Ganoid fishes are *regularly* covered with annular thick scales, composed internally of bone, and externally of enamel, generally smooth and bright (Etym. γανος, splendour). Occur recent, but more abundantly in the fossil kingdom, in which fifty extinct genera have been recognized.

"M. Agassiz appears to have ascertained that the strata be-

* A small shark, taken a few years ago near the island of Trinidad and now in my possession, has the scales arranged over every part of the body and fins with the utmost regularity. They are somewhat oval in form, the larger diameter being $1\frac{1}{10}$th and the smaller $\frac{1}{100}$th of an inch. Three equidistant ribs strengthen this delicate tissue, and project beyond the posterior margin similarly to the ribs of the scale represented in plate viii. No. 25. —J. B. R.

low the cretaceous rocks contain very few, *if any*, other fishes than such as are included in these orders.

"2nd. *Scales not enamelled.*

"Ctenoid fishes have their scales of a horny or bony substance, without enamel; serrated or pectinated on the free posterior margin (whence their name, from κτεις, a comb).

"Cycloid fishes have smooth horny or bony unenamelled scales, entire at the posterior margin, with concentric or other lines on the outer surface (Etym. κυκλος, a circle).

"To the last two orders with unenamelled scales belongs by far the greater proportion of existing species of fish, which, according to Cuvier, exceeded 5000, but are stated by M. Agassiz to amount to 8000. On the contrary, the greater number of fossil fishes belong to the two orders with enamelled scales."

It will be evident from an inspection of the plates, that the scales now described, with the exception of those represented at Nos. 2, 6, and 25, belonged to fishes of the last two orders, or those with unenamelled scales, indicating therefore an approximation to existing species; and the extraordinary similarity in general characters between the fossil and recent scales will at once be apparent from a comparison of the respective drawings. The latter were very obligingly supplied to me by Mr. Yarrell out of his private and unpublished collection, and are from the pencil of Mr. Charles Curtis. The former I traced under the microscope with a power of about 25 linear, and they were reduced and lithographed by Mr. Aldous, who is making larger drawings to preserve their relative proportions.

These scales vary in size from $\frac{3}{10}$ths to $\frac{1}{20}$th of an inch in diameter,* and are arranged in the order of their magnitude. The concentric lines, which vary with the age of the fish, are the most numerous on No. 10, being nearly 100, whereas there are about 14 only on No. 27. In Nos. 3, 12, 19, there are be-

* The largest scale I have as yet found is similar to No. 2, and measures $\frac{6}{10}$ths by $\frac{4}{10}$ths of an inch. Very fine examples of coniferous wood occur also in these flints.

tween 40 and 60. A recent scale in Mr. Yarrell's collection, which measures $8\frac{1}{2}$ inches in circumference, has upwards of 300 concentric circles. The fish from which this scale was taken is of the genus *Chatœssus*, Cuv.†, and is now in the British Museum. The row of scales along the sides of fishes, forming the well-known lateral line, in addition to the structure common to the scales of the other parts of the body, are pierced through near the centre by a tube which allows the escape of the mucous secretion, produced by the glands beneath. Each of the scales represented in Nos. 4, 12, 14, 18, exhibits this tube with the numerous lines peculiar to the species. It is here no doubt that we are to look for scales possessing the most decided specific characters, for, as I learn from Mr. Yarrell, who has gone into much detail upon this subject which he has not yet made public, though scales of the same fish differ in size, and even to a certain extent in form, yet a given series of scales from the lateral line, exhibiting a marked difference in structure, would undoubtedly indicate a corresponding series of species or genera.

That scale, for such I am now disposed to class it, which is represented at No. 13, has given me the most trouble to decipher. It has, at first sight, the appearance of a tooth, but it differs from that of a shark, to which, were it a tooth, it would be the most nearly allied, by the great length of the fangs. And indeed there are no instances of teeth being thus let into the jaw; for they are either immoveable and to be considered as parts of the bone, or if moveable they are fixed to the skin. The subject in question, I believe to be the triple subcutaneous insertion of a ventral spine or quasi-scale of a fish nearly allied to the *Diodon orbicularis*, or porcupine fish of the present period. This similarity no sooner occurred to me than I immediately boiled a small portion of a *Diodon* in order to separate the triple-fanged insertion of a spine from its investing cartilage, and the only reason of my not figuring the latter example is the very satisfactory one of there being no difference except that of size to describe.

I find also with the scales, traces of ribs and fins, small sharp-pointed teeth, and parts of the vertebræ, and in a few in-

† Règne Animal. Edition 1829, vol. ii. p. 320.

stances I have found portions of the body with the scales *in situ*. But here I close this short account of an investigation which no right-minded man will prosecute without directing his thoughts to Him who of old "turned the hard rock into a standing water, and the flint-stone into a springing well."

Peckham, October 5, 1838.

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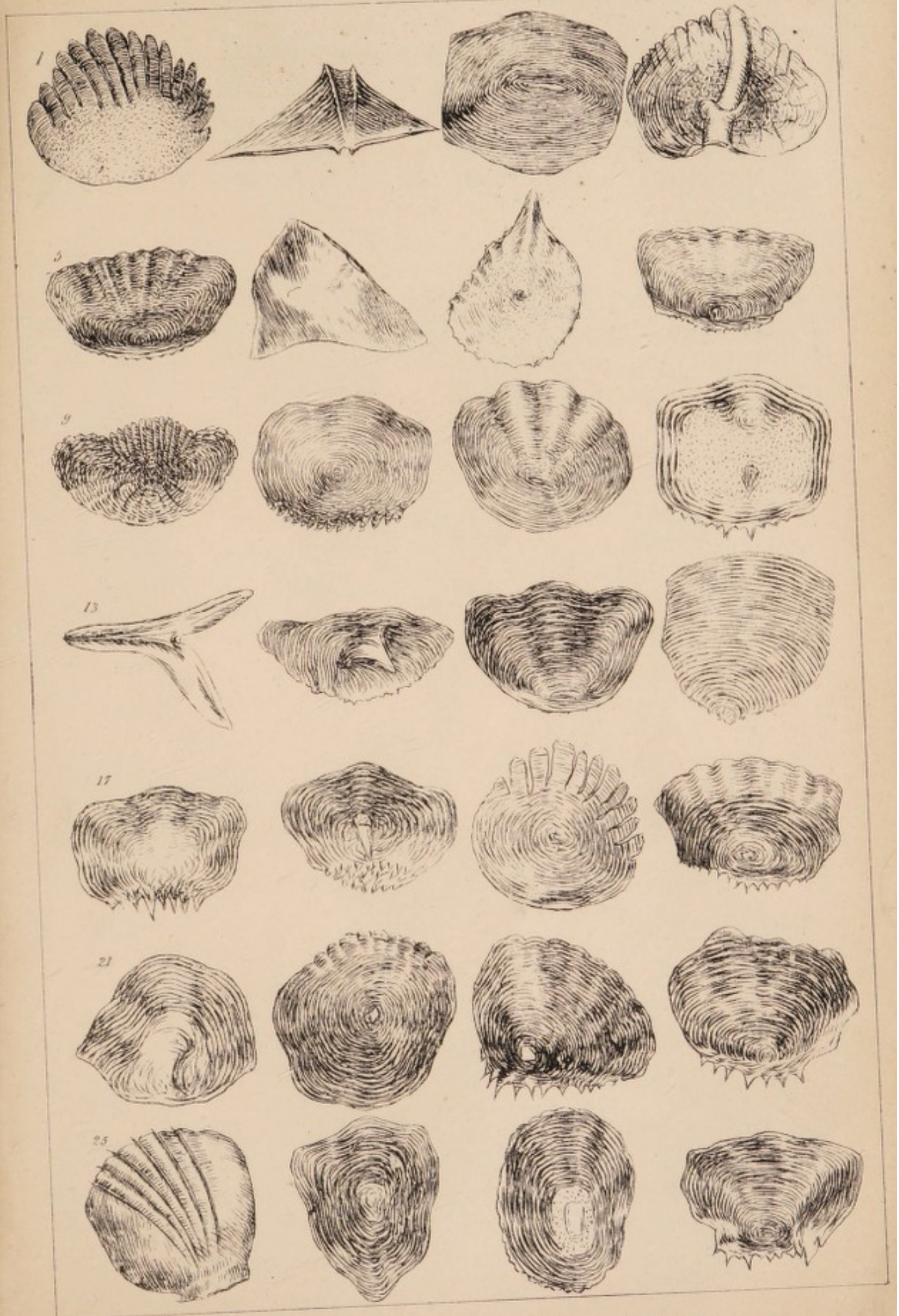
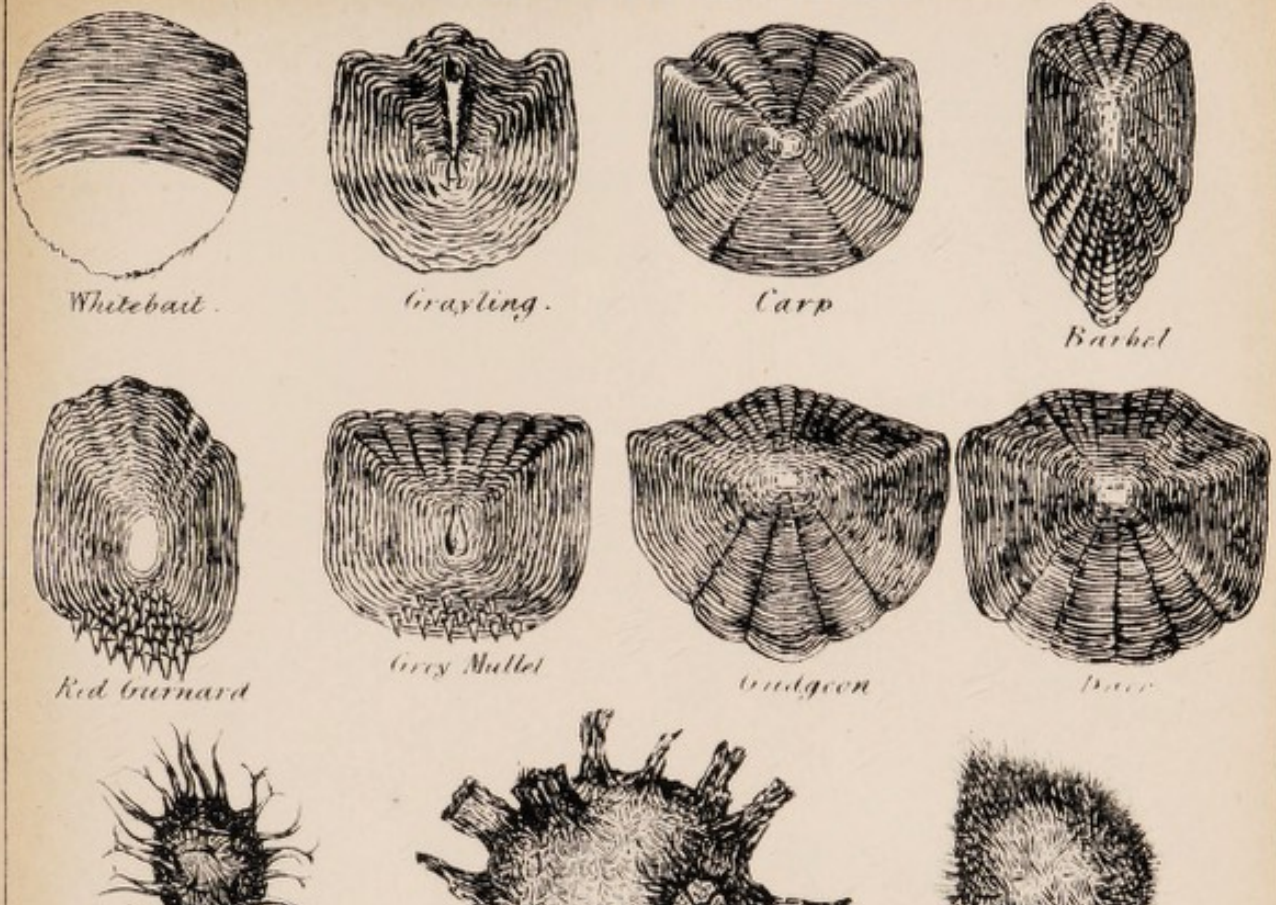
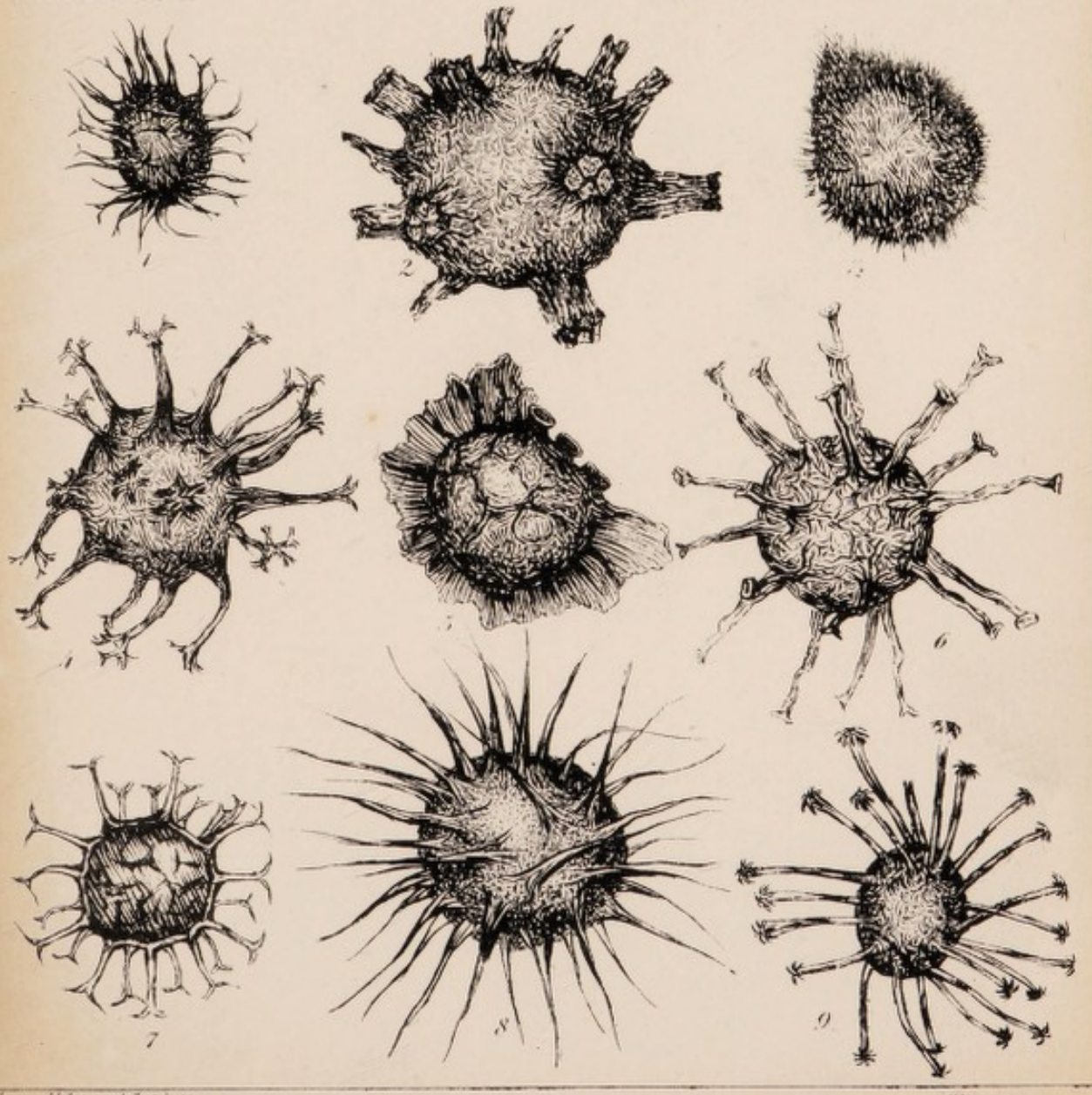


Lens Adams, del. et lith.

SCALES OF FISHES IN THE FLINT OF CHALK.

SCALES of EXISTING FISHES.





Lens Aldeus del et lith

INFUSORIA IN FLINT.

1 Xanthidium furcatum. – 2. X. crassipes. – 5. D° var. – 3. X. hirsutum. – 8 D°. – 4. X. – ramosum. – 7 D°. – 6 X. tubiferum. – 9 D°