V. *An Attempt to Account for the Origin and the Formation of the Extraneous Foſſil commonly called the* Belemnite. [*Vide* TAB. III. IV. V.] *By Mr.* Joſhua Platt.

To the Right Honourable George Earl of Macclesfield Preſident, and to the Council and Fellows, of the Royal Society, the following Attempt to account for the Origin and true Formation of the Extraneous Foſſil commonly called the Belemnite, is humbly addreſſed, by

Their much obliged and obedient

humble Servant,

Joſhua Platt.

The

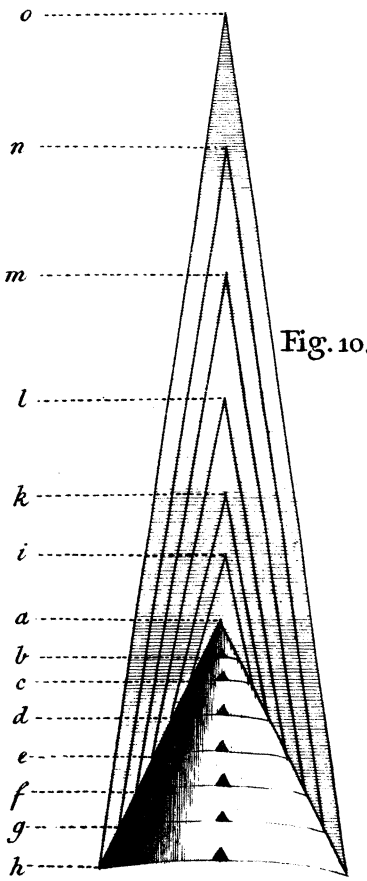


Fig. 10.

Fig. 6.

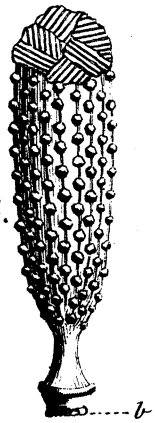
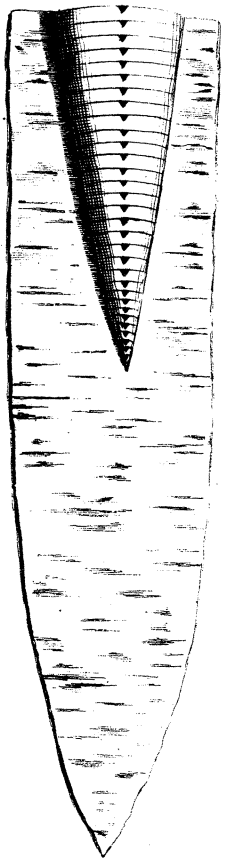


Fig. 11.



Fi

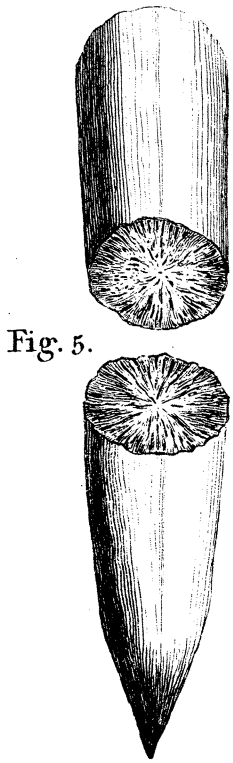
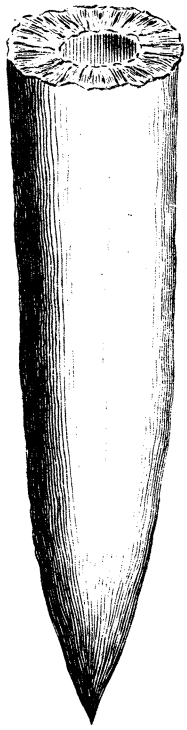


Fig. 5.

Fig. 1.



J. Miller fc.

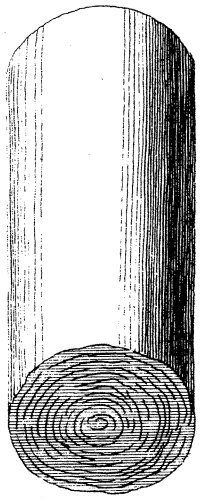
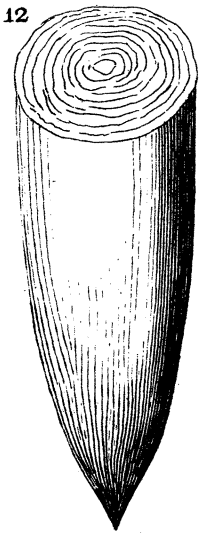


Fig 12



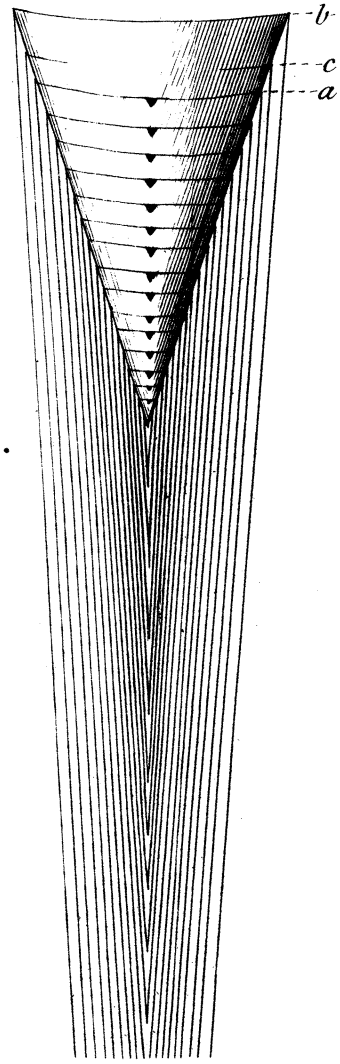


Fig. 13.

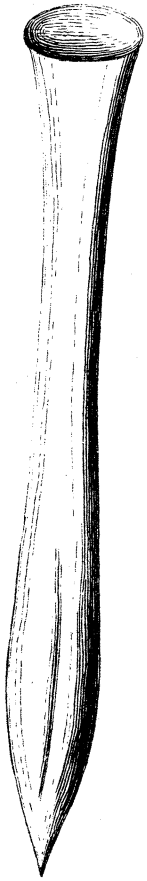


Fig. 14.

Fig.

Fig. 4.

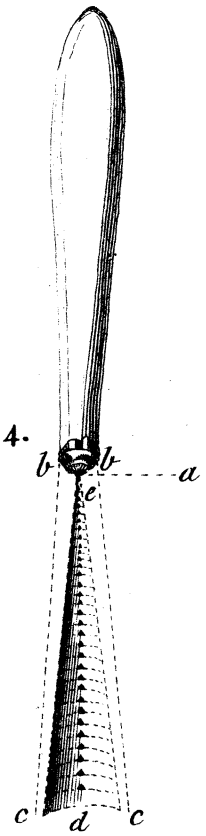


Fig. 2.

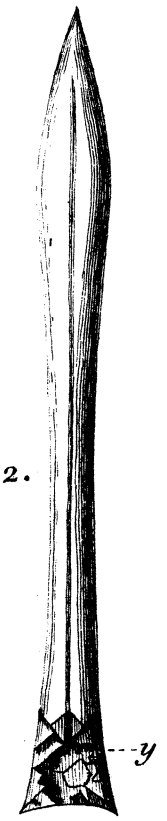
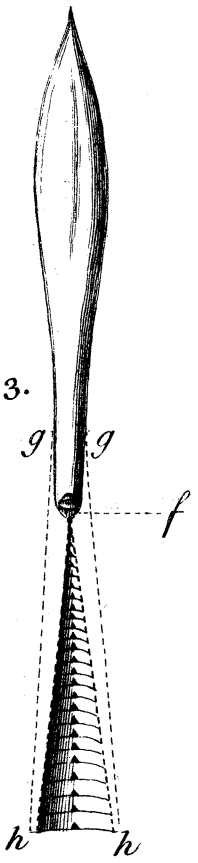


Fig. 3.

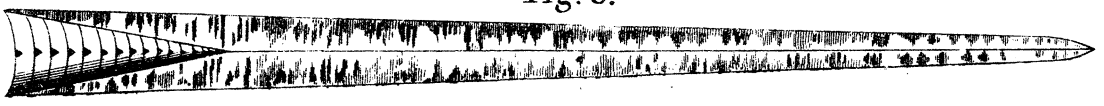


J. Mynde sc.

Fig. 17.

Fig. 15.

Fig. 8.



Found at Headington Stone pit near Oxon

Fig. 7.

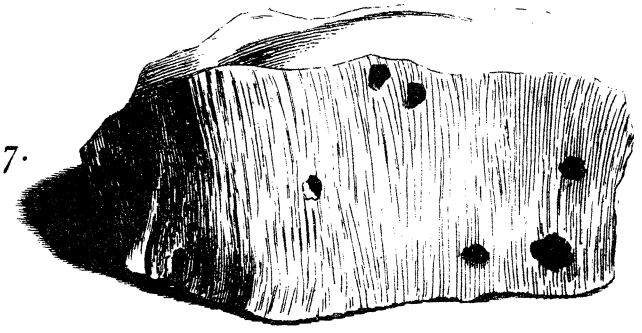


Fig. 16.

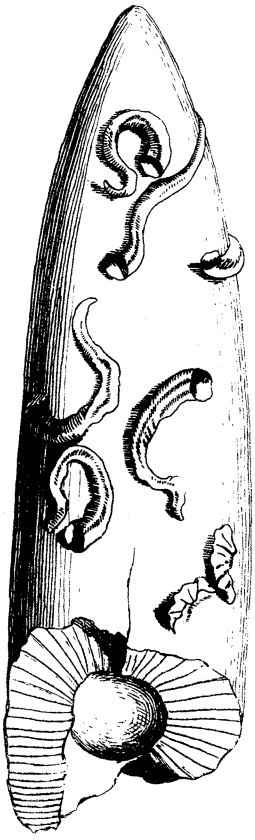
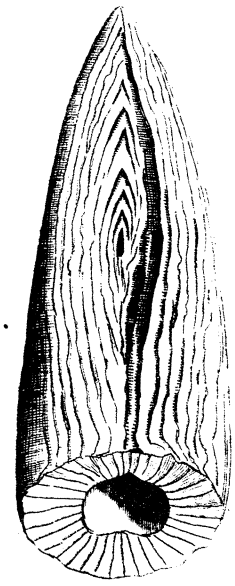


Fig. 9.



J. Mynde sc.

Read Jan. 26, 1764. THE public hath of late been agreeably entertained with deſcriptions of many curious Foſſils diſcovered in different parts of this kingdom: but very little hath been offered with a view to aſcertain their origin and formation; a point of much greater importance to a curious mind, than the moſt accurate deſcriptions, or the neateſt delineations. It may indeed be thought unneceſſary at this time, to ſay any thing of the origin of extraneous Foſſils in general; all our modern naturaliſts being fully convinced, that they are the exuviæ or remains of animals and vegetables, and the greater part of them of marine production.

But as to their particular origin and formation; in what manner they were produced in the recent, and how and with what matter they afterwards became impregnated in their foſſil ſtate; all this is a field of natural inquiry, that has been very much neglected, notwithſtanding it is the moſt fertile and productive of uſeful and entertaining knowledge. Beſides, were we to conſider it in this view, the recent and foſſil remains would be found to throw a mutual light upon each other, and the naturaliſt would not be ſo often at a loſs to claſs every new foſſil acquiſition, of which the recent ſpecimen is not to be found, eſpecially whenever the foſſil has any thing ſeemingly æquivocal in its formation, ſo as on a ſuperficial inſpection to render the matter doubtful, whether the body belongs to the animal or vegetable kingdoms, or indeed to either of them. One of the firſt note is the Belemnite, which has not until very lately been even ranked amongſt the marine productions; but

but whoſe origin and formation have never yet been fully explained. I ſhall not enter into a minute detail of the ſeveral ſpecies of the Belemnite. The hiſtory of this extraneous foſſil, or an attempt to account for the origin and formation of the Belemnite, ſo far as they can be diſcovered and confirmed by reaſonings drawn from facts and experience, is the object of the preſent enquiry. I ſhall therefore confine my ſelf to two ſpecies of the Belemnite; the one common in moſt counties of this kingdom, and vulgarly known by the name of Thunder-bolt [*a*]: the other that of the fuſiform or Spindlekind [*b*], found in ſlate-ſtone at Stons-field, but in far greater plenty in the clay near Piddington [*c*] Oxfordſhire; and in the chalk-pits of Kent and Surrey [*d*]. Thoſe in chalk have been often miſtaken for ſpines of the ſea-hedgehog, or Echinus Ovarius; but the characteriſtics of theſe two bodies are widely different. The Belemnite breaks in a direction perpendicular to its axis [*e*]· the ſpine obliquely [*f*]. The Belemnite, when broken, exhibits central rays; the Spine a ſmooth reſplendent ſurface. This diſtinction is invariable, if the trial be repeated a thouſand times. Theſe different appearances are probably the effects of different formations: and therefore the Belemnite ſeems to be formed by appoſition, and the Aculeus or Spine by protruſion, or, as Mr. Reaumur calls it, by intus-ſuſception. The radii in the Belemnite are owing to the fine laminæ, of which it is compoſed; they are ſo very thin, and break ſo nearly alike, that they have ever an horizontal ſurface when broken,

[*a*] Tab. III. Fig. 1. [*b*] Fig. 2. [*c*] Fig. 3. [*d*] Fig. 4. [*e*] Fig. 5. [*f*] Fig. 6.

which

which is common to all the ſhells of the trichite kind [*g*]. The ſpine being formed by protruſion, its component parts are adjuſted on a different manner, and the pores like the cancelli in bones (though not ſo diſtinct) are irregular, which is the reaſon of its breaking obliquely in any direction, but it is generally ſmooth by being ſaturated with a plated kind of ſpar [*h*].

My ingenious and very worthy friend Mr. Brander, in a diſſertation on the Belemnite, preſented to the Royal Society [*i*], juſtly obſerves; "that the Be-"lemnite belongs to the teſtaceous part of the ani-"mal kingdom, and to the family of the nautili." And I would beg leave farther to add, that this gentleman's ſentiments are greatly ſtrengthened by the ſurpriſing analogy, which the Belemnite bears to the little pearly concamerated ſhell, or cornu Ammonis; and the orthoceratites, to the large nautilus; the former having its ſiphunculus upon the verge, as the latter has it in the center of the diaphragm, or partition, of each cell or chamber. "It has indeed been truly matter of ſpeculation (continues Mr. Brander) how this huge ſolid ſubſtance called the Belemnite, excluſive of the nucleus, could be formed; and how it happens, that ſome Belemnites ſhould have the nucleus within them, others not; the cavity to

[*g*] Fig. 7. A piece of the Penna Marina, perforated by the Pholades.

[*h*] Spar ſeems to be nothing but cryſtal debaſed by a calcareous earth: the more debaſed ſort breaks in a hairy trichite manner, the more pellucid kind with a ſmooth ſurface; and always in an oblique rhomboidal direction; which perhaps may in ſome meaſure enable us to account for its double refraction.

[*i*] Philoſophical Tranſactions, Vol. xlviii. for 1754, page 803.

contain the ſame in ſome very ſmall, in others ſcarce or not at all viſible".— But I flatter myſelf, that it will be found upon enquiry, that theſe are only circumſtances, which are common to other teſtaceous bodies, that have been accidentally broken or decayed by time, when forſaken by their inhabitants. For no teſtaceous body can be formed without an inhabitant; nor does it appear to me, that any Belemnite was ever formed without an alveolus, or concamerated ſhell.

The conical cavity and its nucleus are always proportioned to the bulk of the Belemnite, but not to its length: ſome are four times longer in proportion to the alveolus than others. The apex of the conical cavity, where the alveolus is firſt formed, in ſome runs up about half the length of the whole Belemnite; in others not a ſixth part of the whole [*k*]: but the aperture, or upper chamber [*l*] is equally proportionable to the bulk, or circumference of the Belemnite, of whatſover ſize or ſhape; and is the ſeat [*m*] or dwelling-place of the animal, that forms the Belemnite. In what manner this work is executed, I ſhall now endeavour to explain.

A conſiderable part of marine bodies, eſpecially thoſe of the teſtaceous tribe, are generally buried in mud or ſand, except ſome few, which ſtick to rocks, &c. as the limpets and periwincles; by which means we are prevented from making thoſe remarks upon the ſeveral ſtages of their growth, which an accurate enquirer would deſire. We muſt therefore have re-

[*k*] Fig. 8. [*l*] Fig. xiii. *b. c.*

[*m*] We never find a Belemnite with part of the alveolus, but the veſtigia or marks of the remainder appear in the cavity, and are continued to the verge of it.

courſe

courſe to the different ſteps or periods of their life and growth, as they are marked out by the indented lips or foldings of the ſhell; untill they arrive at their full ſize; when they begin to fortify themſelves, by bulwarks and ſtrong holds, againſt the injuries and incidents, which attend old age. This is moſt conſpicuous in the cowree, or concha Veneris of Liſter, book iv. ſect. 9.

Mr. Reaumur [*n*] found, by repeated experiments, that land ſnails form their ſhells by juxtapoſition: as the animal grows in bulk, the ſhell is increaſed by a mucous matter emitted from the body of the animal, whic hhardens by degrees into a teſtaceous ſubſtance: and from the experiments upon land ſhells that great naturaliſt concludes by analogy, that all teſtaceous bodies are formed in the like manner, particularly thoſe of the turbinated kind.

To this general rule an objection is made by Mr. Poupart, from the formation of the cowree, or concha Veneris before mentioned: but this learned gentleman was not aware, that this ſhell is firſt a buccinum, forming many convolutions before it draws in the verge to form the indented lip.

It was this very objection of Mr. Poupart, which led me to examine into the growth of the cowree; and by ſawing one of them through the middle, I found a turbinated ſhell within the outer wall, conſiſting of ſix or ſeven convolutions, but no ſtages, or periods, of the indented lip appeared in any of the convolutions, as we find in the helmet ſhell, and ſeveral of the buccinæ. I then began to conſider how this animal enlarged its dwelling; and was fully convinced, that

[*n*] See his book of inſects.

no more convolutions could be carried on; the indented lips being a full ſtop to its inward dimenſions; and that here was the period of its growth. My ſentiments were juſt as to its inward dimenſion; but obſerving that the lips of ſome were much larger than others, and that the curved part of the outer lip appeared thicker, when ſawed open, than the other parts of the ſhell; I began to think, that the animal, inſtead of enlarging the inner dimenſions, was employed in thickening the outer wall, to guard againſt injuries and accidents, ſo common to the inhabitants of that turbulent element the ſea. I was the more confirmed in theſe ſentiments by ſeeing the beautiful ſpots, with which this animal decorates its houſe, covered by other ſpots of different colour and ſize, as new laminæ were added to ſtrengthen the laſt-formed convolution. It is really matter of admiration to ſee how theſe ſhells are adorned and variegated; the exquiſite poliſh, which covers the whole infinitely ſurpaſſing the ſkill even of the moſt accompliſhed human artiſt. Theſe new coverings or laminæ, which are carried from the lips, terminate in the middle of the back part of the ſhell; and there form a liſt, or ſeam, of a quite different colour from that of the other part of the ſhell, and of an unequal ſurface.

This very circumſtance gave birth to my ſentiments concerning the formation of the Belemnite: for whoever conſiders the ſeam or ſulcus in the Belemnite, will, I think, conclude with me, that the outward lamina is formed lateſt, as in the cowree, and that the ſeam or ſulcus is cauſed by the ſeveral additional coverings or laminæ terminating there. But as the anatomiſt makes freſh diſcoveries by diſſecting the ſubject,

ſubject, ſo (if I may be allowed the compariſon) I received farther information by luckily meeting with a Belemnite, whoſe laminæ were in a manner diſſected and laid open by the vague acid, or ſome other corroding menſtruum, which every where pervades the earth, deſtroying ſome bodies [*o*], and forming others [*p*]. The laminæ of this truly wonderful body are here expoſed to view [*q*], and plainly ſhew us, that nature, in this, as in all her works, purſues the moſt ſimple, eaſy, and ſhorteſt methods, though they appear ever ſo intricate and interwoven. This ſpecimen will, I hope, ſerve to explain a matter, which hath ſo long puzzled the curious in natural hiſtory; and convince us, that there is nothing more wonderful in the formation of the Belemnite, than in that of a cockle, oyſter, or any other teſtaceous ſubſtance; with this difference only, the oyſter ſtrengthens its ſhell, and excludes its firſt habitation, by additional laminæ formed *within*; the Belemnite incloſes its dwelling by adding new laminæ *without*. Figure X. repreſents the Belemnite ſplit up the middle, with the ſiphunculus in the front: *a*, *b* exhibit the firſt formed cell, or ſeat of the animal ab ovo. As the animal grows larger, it forms a ſecond cell or chamber *b* to *c*, at the ſame time covers the firſt cell, by forming the appendage or guard *c*, *i*, which is the firſt ſtage of the Belemnite. In forming the third cell *c*, *d*, freſh laminæ or coverings are carried on from *d*, to *k*; and ſo of the reſt, *e*, *f*, *g*, *h*; or *l*, *m*, *n*, *o*. When we have duly conſidered the manner, in which the ſhell is

[*o*] All calcareous ſubſtances.

[*p*] Such as ſelenites, pyrites, marcaſites, talk, gypſum, &c.

[*q*] Fig. 9.

thus

thus formed; it will be no difficult taſk to account for the different ſections and broken parts of the Belemnite; and in what manner they were reduced to the ſeveral forms or appearances, in which we commonly find them.

The better to illuſtrate my conjecture, I ſhall firſt exhibit ſome drawings, which ſhew the ſeveral ſpecimens broken and imperfect; and then propoſe my ſentiments concerning them before they were deſerted by their inhabitants. Figure 6. ſhews the ſpine of the echinus ovarius broken obliquely, as is common to all of them. Figure 5. exhibits the inward ſtructure of the Belemnite, when broken horizontally, with the central rays. Figure xi. is the ſame Belemnite ſplit through its axis. Figure xii, and xiii, are broken in the ſame direction as Fig. 5. and xi, and ſhew how the ſeveral laminæ [*r*] are placed one over another in the manner, in which it is formed. Fig. xiv. ſhews the Belemnite in the moſt perfect ſtate we ever find it. Fig. 4. is the fuſiform Belemnite found in chalk, which has been often taken for a ſpine. *a*, which is the termination of the conical cavity, has been thought to be the *ſocket* of the ſpine, which receives the papilla, when growing to the echinus; but, when compared with the ſocket of the true ſpine [*s*], we find it widely different. The pricked lines *b*, *c*. *b*, *c*. ſhew what the fuſiform Belemnite was, when perfect, with the alveolus *d*, *e*. Many of

[*r*] Theſe diſtinctions of the laminæ I preſume to be owing to the mineral ſteams inſinuating themſelves into the Belemnite, when the ſpar pervaded the pores, and deſtroyed the texture, but retained the true form by ſubſtituting its ſelf, and filling the Plaſm or mould of the Belemnite.

[*s*] Fig. 6. *b*.

thoſe

thoſe found in chalk ſeem to be ſomewhat injured at the end *a*, where they are deficient, and are rounded, but have an uneven ſurface, as if they had been gnawed or eaten by the pholas. Thoſe found in clay near Piddington [*t*], Oxfordſhire, approach nearer to the fuſiform kind, and have a different appearance at the ſmaller end *f*, where the laminæ are reduced to a white impalpable powder, by corroſive juices in the earth, ſo as to ſtain the fingers when firſt taken out; and they afterwards retain a white chalky appearance: but, amongſt a great number, I never found one that was three inches long. Theſe have ſuffered in the ſame manner as Fig. iv. Fig. 3. *f*, ſhews where the alveolus terminates: *g*, *h*. *g*, *h*. how much has been deſtroyed by vitriolic acids [*u*]. At Stons-field they are found much longer than at Piddington, and are incloſed in ſtone, which is ſplit by the workmen to make ſlates. Here we often find

[*t*] Fig. 3.

[*u*] It may be aſked, why one part ſuffers more than another, as all parts are homogeneous, and free from extraneous mixtures? My anſwer is; becauſe thoſe parts, where the concamerated ſhell is lodged, are much thinner than the other parts of the Belemnite; and conſequently the walls are more eaſily broken down, and the alveolus, being ſtill leſs ſolid, is ſooner deſtroyed, and reduced to an impalpable powder, by vitrolic and other acids, which the water takes up as it paſſes through different ſtrata, abounding more or leſs with pyritical matter. Where no ſpar follows the acid, the parts are carried away and loſt in the interſtices of the earth, and a mould or plaſm is left, which Steno calls an aërial ſhell. See his Prodomus, pag. 84. But where the ſpar abounds, it pervades the whole ſubſtance, fills up the cavity, and aſſumes the true form of the ſhell; and ſometimes, by burſting the pores, is ſo far ſubſtituted in the place of the original particles, that the ſeveral diaphragms, with the ſiphunculus of the alveolus, are acurately and nicely preſerved.

them

them in a much more perfect ſtate [*w*] than the former, with the alveolus in many of them; but that part is commonly cruſhed [*x*] by the incumbent matter.

The ſiphunculus of the Belemnite is always upon the verge of the chamber, or cell; and in the ſiphunculus is a little gutt or ductus, proceeding from the body of the animal, by dilating or contracting of which the animal, it ſhould ſeem, may go out or into its cell at pleaſure. This is the only ſtay, which the animal has to ſecure its retreat: but I cannot agree with the learned doctor Hooke [*z*], *that the gut or ductus paſſes through all the cells to the end of the ſpiral cone*, either in this ſhell or the nautilus. His diſcovering of a ſpiramentum in the center of the latter was merely conjectural; for the ends of the ſpiral cone of concamerated ſhells [*a*] are ſhut up in the ſame manner with thoſe of the turbinated kind: and it is common for all turbinated ſhell-fiſh, as they increaſe in bulk, and enlarge their ſhells, to leave their bottom or firſt-formed convolutions. Therefore I make no doubt but the ſame is done by the concamerated tribe; for if the gut go through only one or two valves, it will be a ſufficient ſtay to the animal, and, being contracted or dilated, will ſerve all the purpoſes above mentioned. How far this is practicable by our little inhabitant, cannot abſolutely be determined; but if it be conſtantly fixed by the gut to the ſiphunculus, it has a ſurpriſing power of contracting and dilating its body, to extend ſo far as the bottom or point of the Belemnite,

[*w*] Fig. 2. [*x*] Ibid. at *y*.

[*z*] Hooke's poſthumous works publiſhed by Derham 8°. p. 306.

[*a*] See the little pearly cornu-ammonis ſhell.

which

which in ſome is more than thirty times the length of the cell, into which it returns [*b*]. I am apt to think, that this gut or ductus, as well as the body of the creature, is capable of being extended very conſiderably, to ſerve all the uſes of forming the Belemnite, without leaving the ſiphunculus; and that the gut ſerves for the ſame purpoſes with the tendons of the oyſter; the latter to open and ſhut the ſhell; the former to allow the animal to go out and in at pleaſure. And as the oiſter feeds altogether in the ſhell, by opening the verge, the Belemnite (whoſe reſidence is in the great deep, which is ſeldom diſturbed) very likely goes out in queſt of food, but travels only upon the guard or rampart, leaving a trail behind, as all land ſnails do; which hardening into a teſtaceous ſubſtance, increaſes the dimenſions of the outer walls, both in length and thickneſs, from the cell or chamber, to the bottom or point of the whole Belemnite. The animal in its progreſs and return claſps the whole guard, as a ſnail does a ſmall branch of a tree in the gardens; and where the two ſides meet, there the ſulcus is formed, as is evident from the laminæ in Fig. 9.

The Belemnites, like all other teſtaceous bodies, have the vermicular tribe attached to them, and are perforated by the pholades. Other marine bodies alſo affix themſelves to the Belemnites, oiſters in particular: but this never happens whilſt the animal inhabits the ſhell, becauſe the new additional laminæ would ſo cover the affixed body, and alſo the cells of the pholades and vermiculi, that they could have no communication with the water, and muſt conſequently

[*b*] Fig. 8.

periſh. Theſe bodies, thus attached, are the ſtrongeſt proof we can deſire, that the Belemnite is of marine production. Indeed it may be objected, that the bones of quadrupeds, wood, and ſtone have theſe bodies adhering to them, and therefore may be ſaid to be marine, as well as the Belemnite. But when we bring them to chemical tryal, the objection vaniſhes; for the bones either come out of the furnace with a black core, or they are reduced to aſhes; whereas the Belemnite is changed into a fine calx, after the manner of all teſtaceous bodies, and is converted into a ſpecies of phoſphorus [*c*]. The oiſters, having no loco-motion, frequently affix themſelves to other bodies, that they may be better able to ſtem the tides, and currents, which might otherwiſe carry them from their proper beds, and places of feeding. This attachment to other bodies no way incommodes them, becauſe they increaſe the dimenſions of their ſhells by adding freſh laminæ inwardly: the firſt formed laminæ, being, as it were, excluded, lie in the manner of tiles upon the roof of a houſe, and exhibit the ſeveral ſteps or ſtages of their growth.

I believe a Belemnite is very rarely found perfect in the foſſil ſtate: thoſe in gravel-beds [*d*] have ſuffered very much by being rubbed againſt ſtones, &c. by the fluctuating waters: thoſe, which we find in rubble at Garſington-pitts [*e*], have many adventitious bodies adhering to them, and conſequently were deſerted by

[*c*] The Belemnite after calcination, has all the properties of the Bolognian ſtone. If it be expoſed a few minutes to the Sun, and immed ately taken into a dark room, it will ſhine like Phoſphorus for ſome time; and when the light diminiſhes, if again expoſed to the Sun, its ſplendor will be renewed.

[*d*] Fig xv. [*e*] Fig. xvi.

their inhabitants before they reſted there. In the clay at Shotover [*f*] near Oxford, they have a curious ſmooth ſurface, but are otherwiſe imperfect: at Stonsfield, in the ſlate-ſtone, they are generally cruſhed [*g*]: thoſe approaching neareſt to perfection, which I have ſeen, came out of the ſand [*h*], under the bed of ſtone at Garſington-pitts near Oxford: the outer part is quite perfect, and the verge of the conical cavity is as thin as paper, but the alveolus is deſtroyed, except the apex or point. At Thame, in digging for ſtone, ſeveral ſmall ones were found in a ſtratum of blue clay of a more cylindrical form [*i*]; ſome of which have the pearly ſubſtance ſtill remaining; an inconteſtable proof of their being marine productions.

How much of the cavity is occupied by the alveolus, cannot be truly aſcertained, until a perfect one can be found, which it will be hard to do in the foſſil-ſtate; but if we may judge from the nautilus, the walls are carried to a diſtance from the laſt formed valve, much greater than that, at which the valves are placed from each other; as in fig. xiii. from *a*, to *b*, which gives the animal all the convenience of forming a new valve or diaphragm, *c*. This circumſtance has been very ingeniouſly cleared up by a learned phyſician in one of our monthly papers [*k*].

The recent nautili are very common in the eaſtern ſeas; and in the foſſil ſtate are frequently found with the Belemnites at Garſington near Oxford. Why may we not therefore expect to find a recent Belemnite,

[*f*] Fig. i. [*g*] Fig. 2. y.
[*h*] Fig. xiii. [*i*] Fig. xvii.
[*k*] Gent. Magazine for Jan. 1752. pag. 8.

as well as a recent nautilus, if a diligent perſon were ſtrictly to examine the coaſts, where the nautili are found? Perſons commiſſioned to collect ſhells, and other curioſities, generally graſp at ſuch things as feaſt the eye; not regarding thoſe of leſs beauty and luſtre, which would help us in our reſearches, and greatly illuſtrate the more uſeful parts of this ſtudy. A premium, offered by a Society of Vertuoſi, might encourage our ſea-faring gentlemen to ſearch the ſeveral coaſts, upon which they touch in their long voyages, and to uſe drag-nets as they do in drudging for oiſters: from ſuch aſſiſtance, variety of new ſubjects would be produced; and great improvements might be expected, if their inquiries ſhould be ſucceſsful.

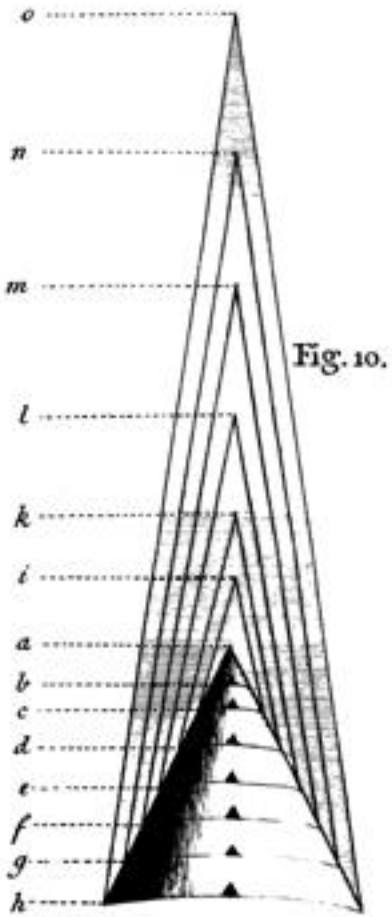


Fig. 10.

Fig. 6.

Fig. 11.

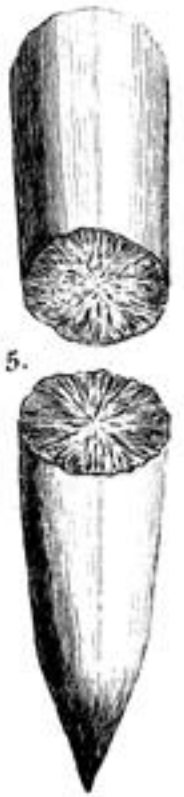


Fig. 5.

Fig. 1.

J. Mynde fc.

Fig 12

Fig. 13.

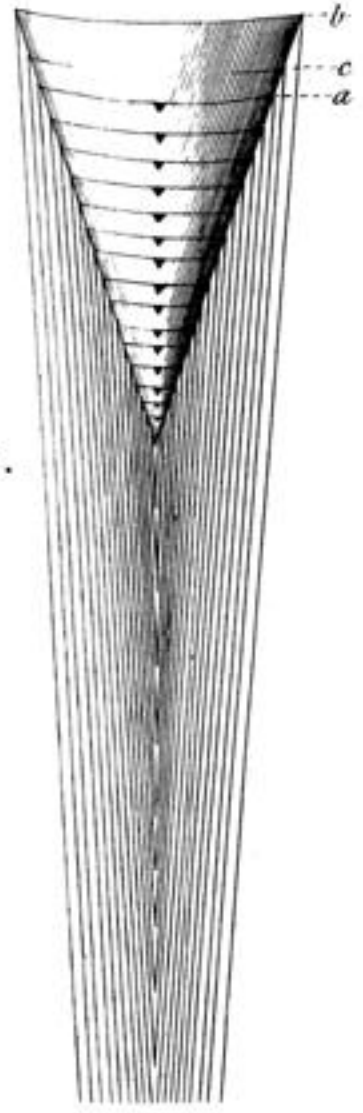


Fig. 14.

Fig. 4.

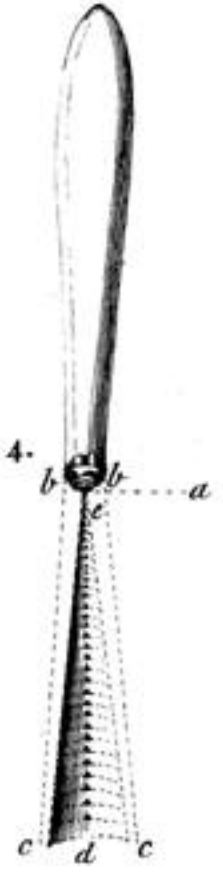


Fig. 2.

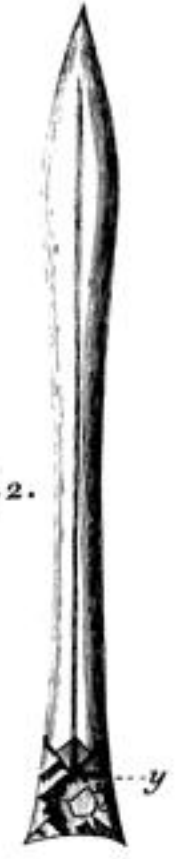
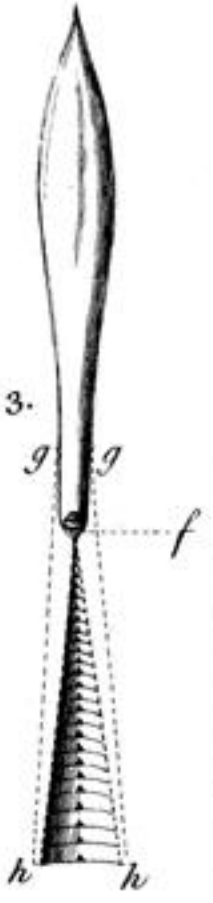


Fig. 3.



J. Mynde sc.

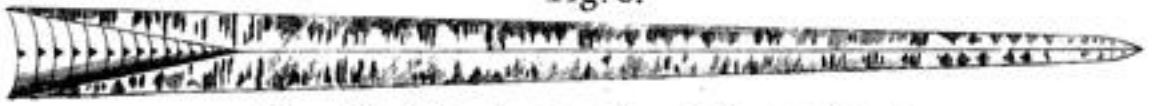
Fig. 17.

Fig. 15.

Fig. 16.

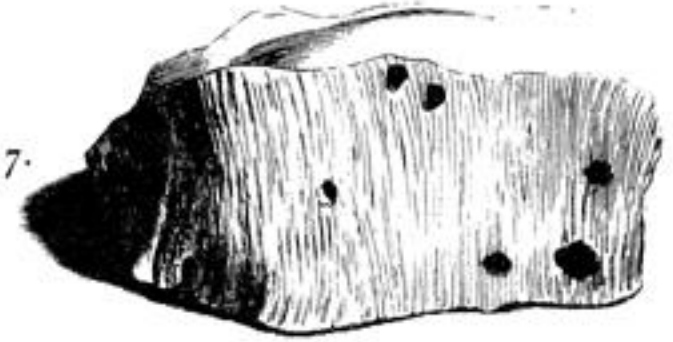
Fig. 9.

Fig. 8.



Found at Headington Stone pit near Oxon

Fig. 7.



J. Mynde sc.