



XXX. Observations on some of the strata in the neighbourhood of London, and on the fossil remains contained in them

James Parkinson Esq.

To cite this article: James Parkinson Esq. (1811) XXX. Observations on some of the strata in the neighbourhood of London, and on the fossil remains contained in them , Philosophical Magazine Series 1, 38:160, 130-153, DOI: [10.1080/14786441108638619](https://doi.org/10.1080/14786441108638619)

To link to this article: <http://dx.doi.org/10.1080/14786441108638619>



Published online: 27 Jul 2009.



Submit your article to this journal [↗](#)



Article views: 3



View related articles [↗](#)

130 *On some of the Strata in the Neighbourhood of London,*

of the tube drawn out. In this example $\frac{15}{100} - \frac{1}{10} = \frac{5}{100} = \frac{1}{20}$, which by the table is = 15.22 seconds.

Then $99''\cdot6 \times 18 - 15''\cdot22 = 1777''\cdot58 = 29'37''\cdot58 =$ the apparent diameter of the moon at that time.

Example 2.—Suppose the distance between two stars was observed to extend over more than 15 divisions of the micrometer, but not 16, the eye-tube being drawn out $\frac{1}{10}$ th of an inch; but on drawing out the eye-tube $\frac{37}{100}$ th parts of an inch, their distance extended over 16 divisions: What was the apparent angle subtended by those stars?

In this example $\frac{37}{100} - \frac{1}{10} = \frac{27}{100}$, which are = 81''·9.

Then $99''\cdot6 \times 16 - 81''\cdot9 = 1511''\cdot7 = 25' 11''\cdot7$, which is the apparent angular distance between the two objects.

This micrometer is represented in fig. 5, Pl. III. The middle part of the scale is divided into 20 equal parts by parallel lines drawn at the distance of $\frac{1}{100}$ th part of an inch from each other, and the large divisions on the sides are each = $\frac{1}{100}$ th parts of an inch. These lines are drawn as fine as possible to appear distinct.

Angles may be taken in any direction by this micrometer, as it is easily turned round upon its axis; and as it is fixed against the eye-stop only by a ring of wire, in the same manner that glasses are fixed in ordinary instruments, it may be taken out and put in again with as little trouble as any other glass in the telescope.

I am, sir,

Your obedient servant,

Lynn, August 14, 1811.

E. WALKER.

XXX. *Observations on some of the Strata in the Neighbourhood of London, and on the Fossil Remains contained in them.* By JAMES PARKINSON, Esq. Member of the Geological Society*.

THE study of fossil organized remains has hitherto been directed too exclusively to the consideration of the specimens themselves; and hence has been considered rather as an appendix to botany and zoology, than as (what it really is) a very important branch of geological inquiry.

From a comparison of fossil remains with those living or extant beings to which they bear the closest analogy, great

* From the Transactions of the Geological Society, vol. i.

resemblances and striking differences are at the same time perceivable. In some instances the generic characters materially differ, but in most they very closely correspond; whilst the specific characters are very rarely found to agree, except when the fossil appears to have existed at, comparatively, a late period. Of man, who constitutes a genus by himself, not a single decided remain has been found in a fossil state.

Chemical analysis has been called in to the aid of the naturalist, in order to account for the perfect state of preservation observable in remains organized with the most exquisite delicacy, and which there is every reason for supposing to have been readily decomposable in their recent state. From this investigation we learn the manner in which these memorials of the old world, so interesting and so frail, have been preserved. Some have been impregnated with calcareous matter, others with siliceous, and others with iron or copper pyrites.

But these facts, however important and interesting, cannot, when considered by themselves, add much to our knowledge respecting the formation and structure of the earth. To derive any information of consequence from them, on these subjects, it is necessary that their examination should be connected with that of the several strata in which they are found*.

Already have these examinations, thus carried on, taught us the following highly instructive facts. That exactly similar fossils are found in distant parts of the same stratum, not only where it traverses this island, but where it appears again on the opposite coast: that, in strata of considerable comparative depth, fossils are found, which are not dis-

* This mode of conducting our inquiries was long since recommended by Mr. W. Smith, who first noticed that *certain fossils are peculiar to, and are only found lodged in, particular strata*; and who first ascertained the constancy in the order of superposition, and the continuity, of the strata of this island. It will appear from the following quotation, that these observations have lately also occurred to Messrs. Cuvier and Brongniart, whilst examining into the nature of the strata of the neighbourhood of Paris. "Cette constance dans l'ordre de superposition des couches les plus minces, et sur une étendue de 12 myriamètres au moins, est, selon nous, un des faits les plus remarquables que nous ayons constatés dans la suite de nos recherches. Il doit en résulter pour les arts et pour la géologie des conséquences d'autant plus intéressantes qu'elles sont plus sûres.

"Le moyen que nous avons employé pour reconnoître au milieu d'un si grand nombre de lits calcaires, un lit déjà observé dans un canton très éloigné, est pris de la nature des fossiles renfermés dans chaque couche: ces fossiles sont toujours généralement les mêmes dans les couches correspondantes, et présentent des différences d'espèces assez notables d'un système des couches à un autre système. C'est un signe de reconnaissance qui jusqu'à présent ne nous a pas trompé."—*Annales du Muséum d'Hist. Nat.* tome xi p. 307.

132 *On some of the Strata in the Neighbourhood of London*

covered in any of the superincumbent beds: that some fossils, which abound in the lower, are found in diminishing numbers through several of the superincumbent, and are entirely wanting in the uppermost strata: that some fossils, occurring in considerable numbers in one stratum, become very rare in the adjacent portion of the next superincumbent stratum, and afterwards are lost: that fossils of one particular genus, which exist abundantly in the lower strata, and occur in several of the superincumbent ones, are not found in the three highest strata; whilst one species of that genus, but which has not been found in a fossil state, exists in our present seas: and lastly, that most of the remains which are abundant in the superior strata, are not at all found in the lower. These general facts lead us to hope, that geology may derive considerable assistance from an examination of fossils, made in connexion with that of the strata to which they belong.

The following is an attempt to investigate on this plan some of the upper strata in the vicinity of the metropolis with their contained fossils; and, although by no means complete, it will, it is hoped, induce others, who possess superior abilities and opportunities, not only to re-examine more correctly these strata, but to extend their researches to the subjacent strata.

The whole of this island displays evident marks of its stratification having, since its completion, suffered considerable disturbance from some prodigious and mysterious power. By this power all the known strata, to the greatest depths that have been explored, have been more or less broken and displaced; and in some parts have been so lifted, that some of the lowest of these have been raised to the surface; whilst portions of others, to a very considerable depth and extent, have been entirely carried away*. From these circumstances great difficulties and confusion frequently arise in examining the superior strata: the counties however immediately surrounding the metropolis, as well as that on which it stands, having suffered least disturbance, are those in which an investigation of these strata may be carried on with the smallest chance of mistake.

Real alluvial fossils, washed out of lifted or original superior strata by strong currents, and which in other parts

* See several essays on this subject in the Philosophical Magazine, by Mr. Farey, and the Report on Derbyshire, vol. i. p. 105.

Also A Letter on the Alterations which have taken place in the Structure of Rocks, on the Surface of the Basaltic Country in the Counties of Derry and Antrim, by William Richardson, D.D. Phil. Trans. 1808.

are very abundant, are rarely seen in the counties adjacent to the metropolis. This remark is rendered necessary, since those widely extended beds of sand and gravel, with sandy clay, sometimes intermixed and sometimes interposed, and which have been generally hitherto considered as alluvial beds, are here assumed to be the last or newest strata of this island, slowly deposited by a pre-existent ocean: with the strata, therefore, of this formation, these remarks commence.

BEDS OF SAND AND GRAVEL.—The sands of this formation vary in colour from white, which is most rare, through different shades of yellow up to orange-red: the colour proceeding partly from a ferruginous stain on the surface of the particles of sand, and partly from the intermixture of yellow oxide of iron. Particles of those sands, which are disposed in distinct seams or beds, when examined by the microscope, are found to be transparent, most of them angular, but some a little rounded, with all their surfaces smooth, having no appearance of fracture, and resembling, in every respect, an uniform crystalline deposition. Those sands on the contrary, which blended with broken and unbroken pebbles form gravel, appear, when thus examined, to be mostly opaque, to be variously coloured, and to be marked with conchoidal depressions and eminences, the result of fracture.

The pebbles of this formation appear to be of four kinds; 1st. Various pieces of jasper, gritstone, white semi-transparent quartz, and other rocks. These have acquired, in general, smooth surfaces and roundish forms, evidently from attrition, and exhibit no traces of organization, except when, as is very rarely the case, the substance of the pebble is jasperized wood. The white quartz pebbles, like quartz crystals, on being rubbed together, emit a strong white lambent light, with a red fiery streak on the line of collision, and an odour which much resembles that of the electric aura.

2d. Oval or roundish, and rather flat siliceous pebbles, generally surrounded by a crust or coat differing in colour and degree of transparency from the internal substance, which also varies in different specimens, in these respects, as well as in the disposition of the parts of which the substance is composed. In some this is spotted, or clouded, in very beautiful forms; in others it is marked by concentric striæ, as if the result of the successive application of distinct laminæ: the prevailing colours in most of these pebbles being different shades of yellow. In several the traces of marine remains are observable: these are, in some

134 *On some of the Strata in the Neighbourhood of London,*

the casts of *anomia*, and the impressions of the spines and plates of *echini*; and in others, which generally possess a degree of transparency, the remains of *alcyonia*. The impressions, though frequently on the surface of the pebble, seldom, if ever, appear to be in the least rubbed down; thus seeming to prove decidedly, that these pebbles have not been rounded by rolling, but that they owe their figures to the circumstances under which they were originally formed: it is apprehended therefore, that these pebbles have each been produced by a distinct chemical formation, which, it may be safely concluded from the remains of marine animals so frequently found in them, took place at the bottom of the sea, while these animals were yet living.

The formation of these fossils at the bottom of a former sea, and perhaps on the identical spots in which they are now frequently found, is more plainly evinced by pebbles agreeing in some peculiar characters being found together in particular spots. Thus those in the county of Essex, ten miles northward of London, contain a much greater proportion of argil and iron than those met with in many other places; hence their colours are darker, and the delineations which their sections display are very strong and decided, sometimes closely agreeing with those seen in the Egyptian pebbles*. Passing on into Hertfordshire, pebbles of a very different character are found: their crust is nearly black, and their section displays delicate tints of blue, red, and yellow, disposed on a dead-white ground in very beautiful forms. In another part of the same county occurs the pebble of the pudding-stone, which also presents peculiar characters of colour, &c.

3d. Large tuberous, or rather ramose, irregularly formed flints, somewhat resembling in figure the flints which are found in chalk, materially differing however from them, not only in the colour of their external coat, which is of various shades of brown, but also in that of their substance, which is seldom black, but exhibits shades of yellow or brown, in which red likewise is sometimes perceptible. The traces of organic structure, particularly of the *alcyonium*, occasionally seen in these stones, determine them also to have been formed at the bottom of the sea.

4th. Pebbles, owing their form to an investment and

* The gravel pebbles of Epping Forest are of this description; and on most of the grounds leading down from the forest to the hamlet of Sewardstone and to the town of Waltham, white, opaque, and partly decomposed pebbles are frequently seen, in which the argil and iron have been removed, and the silex only has remained.

impregnation with siliceous matter of various marine animals of unknown genera, but bearing a close affinity to the *alcyonia*. These stones display, in general, not only the external form but the internal structure also of these animals. The congregation of many pebbles of this genus, and indeed of the same species, in particular tracts, warrants the conclusion, that these animal substances were thus changed, whilst inhabiting that bottom of a former ocean, which now forms the stratum the contents of which are here sketched. Pebbles of this description are most frequently found in the gravel pits of Hackney, Islington, &c.

Among the traces of organization discoverable in this stratum are casts of *echini*, which are frequently found among the gravel, and which have generally been supposed to have been washed out of the chalk. But these casts have their origin plainly stamped on them. Their substance is covered with iron; they are almost always of a rude and distorted form, and I apprehend that they are never found with any part of the crust of the animal converted into spar, adherent to them, as is commonly the case with the casts of *echini* found in chalk.

A sufficient proof, that these several strata of gravel, sand, &c. have been deposited by a former ocean, is to be found in a circumstance which does not appear to have been hitherto sufficiently adverted to. This circumstance is the existence of fossil shells belonging to, and accompanying, the superior part of these strata in particular spots; their absence in other parts being, perhaps, attributable to the removal of the upper beds.

These fossil shells are still found disposed over a very considerable extent. Their nearest situation to the metropolis is at Walton Nose, a point of land about sixteen miles S. E. of Colchester. Here a cliff rises more than fifty feet above high-water mark and the adjacent marshes. It is formed of about two feet of vegetable mould, twenty or thirty feet of shells, mixed with sand and gravel, and from ten to fifteen feet of blue clay. The bed of shells is here exposed for about three hundred paces in length, and about a hundred feet in breadth.

Immediately beyond the Nose the shore suddenly recedes and forms a kind of estuary, terminated towards the east by the projecting cliff of Harwich, which is capped in a similar manner with beds of these shells. The height of this cliff is from forty to fifty feet, about twenty-two feet of the lower part of which is the upper part of the blue clay stratum: "above which," as Mr. Dale observes, "to with-

136 *On some of the Strata in the Neighbourhood of London,*

in two feet of the surface, are divers strata of sand and gravel mixed with fragments of shells, and small pebbles; and it is in some of these last-mentioned strata that the fossil shells are imbedded. These fossils lie promiscuously together, bivalve and turbate, neither do the strata in which they lie observe any order, being sometimes higher and sometimes lower in the cliff; with strata of sand, gravel, and fragments of shells between. Nor do the shells always lie separate or distinct in the strata, but are sometimes found in lumps or masses, something friable, cemented together with sand and fragments, of a ferruginous or rusty colour, of which all these strata are *."

The coast of Essex is here separated from that of Suffolk by the river Stour, by which the continuity of this stratum is necessarily interrupted. It however occurs again on the opposite side of the river, and through Suffolk and great part of Norfolk the same bed of shells is found on digging; thus appearing to extend over a tract of at least forty miles in length.

These shells are in general found in the same confused mixture as is described by Mr. Dale; but they are also sometimes so disposed, that patches of particular genera and species appear to be now occupying the very spots where they had lived. This seems particularly the case with the small *pectens*, the *mactræ*, and the *left-turned whelk*.

From the excellent state of preservation in which many of these shells have been found, it has been thought that they could hardly be regarded as fossil. Many acknowledged fossil shells, however, have undergone much less changes than those of this stratum; the original coloured markings are entirely discharged, and the external surfaces are deeply penetrated with a strong ferruginous stain; the inner surfaces also are considerably changed, their resplendence being superseded, to a considerable depth, by a dead whiteness, the consequence of the decomposition of this part of the shell.

Like the fossils of most other strata, this assemblage of shells manifests a peculiar distinctive character. A few shells only, which may be placed among those which are supposed to be lost, or among those which are the inhabitants of distant seas, are here discoverable: the greater number appearing not to differ specifically, as far as their altered state will allow of determining, from the recent shells of the neighbouring sea.

* Appendix by Samuel Dale to the *History and Antiquities of Harwich and Dovercourt* by Silas Taylor, 1732.

Among those of which no recent analogue is known, appears to be the *terebratula*, figured in Dale's History and Antiquities of Harwich, &c. tab. xi. fig. 9, p. 294, and described, Phil. Trans. No. 291, p. 1578. Mr. Dale describes this shell as *Concha longa fossilis fasciata*, and remarks that he has not observed "either in Aldrovandus, Rondeletius, Belonius, Gesner, Johnson, Lister, or Bonanus, any shell that resembles this our fossil, unless it is one of those figured by Lachmund, p. 43, No. 6 and 7, the inward part resembling our fossil." The shells figured by Lachmund are undoubtedly *terebratulæ*, but they manifest no particular agreement with this fossil.

This shell appears to be figured by Lister, *Histor. Conchyl. tab. 211, fig. 45*, and is assumed by Gmelin as *Anomia spondylodes*. The other shells, fig. 46, of the same plate, referred to by Gmelin as *Anomia psittacea*, appear to be mutilated specimens of the same shell. This opinion is corroborated by the tint given by the accurate artists to the whole of the shells contained in this plate, agreeing with the dark colour of the Essex fossil; and by the circumstance of their being generally found in the mutilated state in which they are here figured by Lister. Besides, neither of Lister's specimens at all agrees with the pellucid shell, with a triangular foramen, of *Anomia psittacea*, but they all agree with the oval antiquated shell, with an obtuse canaliculated beak, of *Anomia spondylodes*.

In consequence of this agreement, it seems proper to consider this fossil shell as forming the species *Anomia spondylodes*. But as the channelled beak is not natural to it, but is the consequence of injury; and as this part, in its natural state, is pierced with a large round foramen, a correspondent change should be made in the description, and it may be placed under the more appropriate genus of *terebratula*, as *Terebratula spondylodes*, with an oval antiquated shell, the beak pierced by a large round foramen.

This shell is, in general, about an inch and a half long, thick, nearly oval, roughly striated transversely, and has its large foramen defined by a distinct border. It appears to differ from every known recent or fossil *terebratula*.

Another of the probably lost shells of this stratum is the fossil *oyster*, figured Organic Remains, &c. vol. iii. pl. xiv. fig. 3, and which is there conjectured to be the same oyster as that which is described by Lamarck as *Ostrea deformis*.

The *volute*, Organic Remains, vol. iii. pl. v. fig. 13, is another shell belonging to this stratum, of which it is believed that no recent analogue has been yet found. This
ovate

ovate and rather fusiform shell appears to have been smooth; and at its full size about four inches in length: the columella has four folds, and the shell is formed by about six spiral turns, the last of which makes two thirds of the shell, dilating at about its centre, and contracting nearly equally upwards and downwards. The specimens yet seen give no opportunity of judging of the lip, or of the termination of the spire.

The *Essex reversed whelk*, as it has been termed, *Murex contrarius*, Linn. *Hist. Conch.* of Lister, tab. 950, fig. 44. b. c. which is here very abundant, does not appear to be known in any other stratum of the island. The fossil shell, with the whirls in the ordinary direction, is sometimes found in this stratum*.

It has been said that the recent analogues of both these shells are found in the adjoining sea. A recent shell is indeed found, which very nearly agrees with the ordinarily turned shell in its general characters: but there appears no authority for supposing that the analogue of the left-turned variety has been discovered there.

Among those recent shells, the resemblance of which to the fossil ones of this stratum is such as appears to render a comparison by an experienced conchologist necessary, may be enumerated:

Patella ungarica, *Patella militaris*, *Patella sinensis*, (*Calyptinæ*, Lam.) *Patella fissura*, (*Emarginula*, Lam.) one or two species of *Patellæ*, with a perforation in the apex, (*Fissurella*, Lam.) *Nerita glaucina*, *Nerita canrena*, (*Natica*, Lam.) *Turbo terebra*, (*Turritella*, Lam.) *Murex cornutus*, *Murex erinaceus*, *Strombus pes pelicani*, *Cypræa pediculus*, with no sulcus along the back, *Pholas crispatus*, in fragments, *Solen ensis*, and *Solen siliqua*, in fragments, *Cardium edule*, *Cardium aculeatum*? bearing the size and form of this shell, but having from thirty-four to thirty-six ribs, with no depressed line down their middle, nor vestiges of spines; *Mactra solida*, *Venus exoleta*, *Venus scotica*? *Venericardium senilis*, Lam. *Arca glyceris*, *Arca nucleus*.

Besides these remains of marine animals, the fossil hollow tubercles, having lost the spines, of the *thornback* are here found; also fragments of the *fossil palate*, (*Scopula littoralis* of Lhwydd) and fossil remains of *sponge* and *alcyonia*, particularly a very fair specimen of the *reticulated alcyonium*. Org. Rem. vol. ii. pl. ix. fig. 9.

* It is erroneously stated, *Organic Remains*, vol. iii. p. 66, that this shell has not been yet mentioned, as found in this stratum; since it is so particularised by Dale.

In this bed, among the gravel and the shells, are frequently found fragments of *fossil bone*, which possess some striking peculiarities. They are seldom more than half an inch in thickness, two inches in width, and twelve in length; always having this flat form, and generally marked with small dents or depressions. Their colour, which is brown, light or dark, and sometimes inclining to a greenish tint, is evidently derived from an impregnation with iron. From this impregnation they have also received a great increase of weight and solidity; from having been rolled they have acquired a considerable polish; and on being struck by any hard body they give a shrill ringing sound. These fragments, washed out of the stratum in which they had been imbedded, are found on the beach at Walton, but occur in much greater quantity at Harwich.

Of the flat rounded pieces described above, no conjecture can be formed as to the particular bone or particular animal to which they belonged. But within these few years an Essex gentleman found, on the beach at Harwich, a tooth which was supposed to have belonged to the *mammoth*. This fossil was kindly obtained, at my request, for the purpose of being exhibited to the members of the Geological Society, by my late friend Dr. Menish; and certainly it appeared to be part of a tooth of that animal. It had been broken and rounded by rolling, but its characters were still capable of being ascertained. It possessed, in the softer parts, the colour and appearance of the Essex mineralised bones so distinctly, as to leave not a doubt of its having been imbedded in this stratum; whilst in the enamel it manifested decided characters of the tooth of some species of the *mammoth*, or *mastodon* of Cuvier.

The actual limit of this stratum has not been ascertained; it is however known to extend through Essex, Middlesex, part of Kent, and Surry, and through Hertfordshire, Buckinghamshire, and indeed much further both to the northward and westward. In many parts its continuity has been interrupted, apparently by partial abruptions of it, together even with a portion of the stratum on which it rests. The shells of this stratum have hitherto been discovered only in the parts already noticed.

BLUE CLAY STRATUM.—This, the next subjacent bed, is formed of a ferruginous clay exceeding two hundred feet in thickness. Its colour for a few feet in the upper part is a yellowish-brown, but through the whole of its remaining depth is of a dark-blueish gray, verging on black. It is not only characterized by these circumstances, but by the numerous

numerous *septaria* which are dispersed through it, and by the peculiar fossils which it contains.

The difference of colour observed between its superior and inferior part, and which has generally been supposed to be owing to a difference in the degree of oxidation of the iron present in it, appears to be the result of a difference in the quantity of it, occasioned by the washing away of this metal in the upper part by the water which percolates through it, and which runs off laterally by the numerous drains made near the surface. The dark-red colour of tiles made from the blue clay, the reddish-yellow colour of the *place* bricks made of the yellowish-brown clay, and the bright-yellow hue of the *washed malms*, those bricks which are formed of the yellow clay which has been exposed to repeated washings, are thus accounted for.

The *septaria* lie horizontally, and are disposed at unequal distances from each other in seemingly regular layers; and, as has been just observed of the stratum itself, they become of a paler colour, and it may be added suffer decomposition, when placed so high in the stratum as to be exposed to the action of percolating water. They frequently include portions of wood pierced by the *Teredines*, *Nautili*, and other shells; and it is a fact that may be worthy of being attended to, whilst inquiring into their formation, that the septa of calcareous spar frequently intersect the substances enclosed in the *septaria*.

This stratum is to be found not only wherever the preceding deposition extends, but in other parts also where that has been removed. The cliffs of this clay, at Shepey, extend about six miles in length; the more elevated parts, which are about ninety feet in height, being about four miles in length, and declining gradually as they terminate towards the east and west.

The fossils of this stratum have been already carefully particularised. A catalogue of those found at Shepey was added by Mr. Jacobs to his *Plantæ Favershamienses*; and an account of several of the fossil fruits found at Shepey was published by Dr. Parsons in the fiftieth volume of the Philosophical Transactions. The fossils of Hampshire have been scientifically described by Dr. Solander, in the *Fossilia Hantoniensia* of Mr. Brander, where the fossils themselves are very exactly figured.

It was not supposed, even after the publication of these accounts, that the fossils of Shepey and those of Hampshire were of the same stratum. Among the Hampshire fossils no mention is made of *crabs*, *lobsters*, *tortoises*, *nautili*,

nor

tion of the heads or bodies of *fishes* so abundant at Shepey; whilst the *Murex pyrus*, *Murex longævus*, *Strombus amplus*, &c. of the Hampshire cliff had never, perhaps, been enumerated among the Shepey fossils.

The identity of the stratum at Shepey and in Hampshire has, within a few years, been decided by digging into this same stratum at Kew, where several of the fossils, which had hitherto been supposed peculiar to Shepey, were found in the same pit with those which had been considered as peculiar to Hampshire.

In the present year, on cutting through a mound of this stratum which forms Highgate-hill, this identity has been still further manifested by the discovery of great numbers of those fossils mingled together which had been generally distinguished into Hampshire and Shepey fossils; as *crabs*, *nautili*, &c. like those of Shepey, together with several shells which had been generally regarded as peculiar to Hampshire, and in particular that uncommon alated shell, *Strombus amplus*, Solander. (*Rostellaria macroptera*, Lamarck.)

In examining this stratum, the curious fact that certain organic remains are peculiar to particular depositions, is first observed. Very few indeed of the fossil shells of the gravel strata are to be found in the bed of blue clay. In the gravel strata, by far the greater number of the shells bear a close agreement with those which now exist in not very distant seas; but in this clay stratum, "very few of the shells are known to be natives of our own, or indeed any of the European shores, but the far greater part of them, upon a comparison with the recent, are wholly unknown to us*."

But although this clay stratum contains fossils of a much older date than those of the gravel stratum, it possesses other marks which agree with its position in showing that it is of comparatively modern formation. It includes none of the remains of any of the lost fossils, such as the *Cornu ammonis*, *Encrinites*, &c. Mr. Jacobs indeed speaks of one imperfect specimen of *Belemnites* and of *Astroites* having been found, but at the same time as being very uncommon. Mr. Brander however does not appear to have met with any of these older fossils; nor have any of them been discovered either at Kew or at Highgate. Hence it seems reasonable to conclude, that the single imperfect belemnite and the few *astroites* were not inhabitants of the sea at the period when this stratum was deposited, but were washed

* *Fossilia Hantoniensia*, p. 5.

out of some of the more ancient strata, and lodged by accident in the bed where they were found*.

The quantity of fruit or ligneous seed-vessels and berries, which has been found in this stratum at Shepey, is prodigious. Mr. Francis Crow, of Feversham, has procured from this fertile spot a very large collection; and by carefully comparing each individual specimen by their internal as well as their external appearance, he has been enabled to select seven hundred specimens, none of which are duplicates, and very few agree with any known seed-vessels. These vegetable remains have also been found on the opposite Essex shore, but in very small numbers. They have also been met with in that part of the stratum which has been examined at Kew. At Highgate and at Shepey a resinous matter, highly inflammable, of a darkish-brown colour, and yielding, on friction, a peculiar odour, has also been found. This substance has been conjectured to exist in an unaltered state, and this indeed seems to be the fact from its resinous fracture; but it must be observed, on the other hand, that pieces of it occur which are penetrated by iron pyrites.

This stratum is also rendered exceedingly interesting by its surface appearing to have been the residence of land animals, not a single vestige of which seems to have been found in any of the numerous subjacent strata of the British series. Mr. Jacobs relates that the remains of an *elephant* were found at Shepey. The remains of the *elephant*, *stag*, and *hippopotamus* have also been dug up at Kew. At Walton in Essex, not only the remains of the *elephant*, *stag*, and *hippopotamus* have been discovered, but also remains of the *rhinoceros*, and of the *Irish fossil elk*. Org. Rem. vol. iii. p. 366.

It has been generally supposed that these remains were contained within the stratum of blue clay; but the circumstances under which they are found seem rather to warrant the conclusion, that they were deposited on the surface of those low spots where abruptions of the superior part of this stratum had taken place. Thus the remains of the elephant mentioned by Mr. Jacobs were not in the cliff, but in a low situation at a distance from it: so

* It appears to be necessary to guard against two sources of error whilst appropriating fossils to their respective strata: one is the circumstance here alluded to, where the fossils of a preexistent stratum have been washed out by the waters while depositing a more recent stratum: the other is where, at the line of junction of two strata, the animals of the one are found within the borders of the other stratum; a circumstance by no means difficult to be conceived or explained.

also the remains of land animals in Essex occur a little below the surface, in a line with the marshes, which are a very few feet above high-water mark. By a communication of the late Mr. William Trimmer of Kew, it appeared that he found, under the sandy gravel, a bed of earth, highly calcareous, from one foot to nine feet in thickness; beneath this a bed of gravel a few feet thick, containing water, and then the main stratum of blue clay. At the bottom of the sandy gravel, he observed that the bones of the *hippopotamus*, *deer*, and *elephant* were met with; but not in those parts of the field to which the calcareous bed did not extend. Here also a considerable number of small and apparently fresh-water shells, and at the bottom snail-shells, were found. Does it not seem that the first appearance, or creation, of land-animals was on the dry land of this stratum, and that they were overwhelmed in these spots by that sea which deposited the present superincumbent strata of gravel?

STRATA INTERPOSED BETWEEN THE CLAY AND THE CHALK.

It is almost impossible to speak with precision of the subjacent strata, which are situated between the clay and the chalk, since very considerable variations occur as to their thickness, and indeed as to the form in which their constituent parts are disposed; and since there exist but few sections, at least in the neighbourhood of the metropolis, which present a view of the strata composing this formation. They are included in the following account by Mr. Farey: "A sand stratum, of very variable thickness, next succeeds, and lays immediately upon the chalk, in most instances, as between Greenwich and Woolwich, on the banks of the Thames; which has often been called the *Blackheath sand*: it frequently has a bed of cherty sandstone in it, called the gray-weatherers*."

On the upper part of a mound at New Charlton some traces of the lowest part of the blue clay appear, covered by not more than a foot of vegetable earth. This layer of clay does not seem to exceed two feet in thickness, which, indeed, it possesses only on the top of some of those mounds, which occur so frequently as to render the surface in this district very irregular. In this clay, oysters of different forms are found; some approaching to the recent species, and others longer and somewhat vaulted: but they are in general so tender as to render it very difficult to obtain a

* Report on Derbyshire, &c. vol. i. p. 111.

tolerable specimen. With these also occur numerous *Cerithia*, *Turritellæ* and *Cythereæ*, Lam. all of which are in a similar state with the oysters, and appear to be shells strictly belonging to the subjacent stratum, but which, having lain uppermost, became involved in the first or lowest deposition of the blue clay.

Immediately beneath the clay there is found a line of about three or four inches of the preceding shells imbedded in a mass of calcareous matter, the result of their disintegration. Beneath this are numerous alternating layers of shells, marl, and pebbles, for about twelve or fifteen feet. The shells are those which have been already mentioned; but are very rarely to be met with whole, and when entire are so brittle as to be extricated with much difficulty. In some of these layers scarcely any thing but the mere fragments of shells is to be found, and in others a calcareous powder only is left.

The pebbles are almost all of a roundish oval form, many of them being striped, but differing from those of the superior gravel stratum, in being seldom broken, in there being few large ramose masses, and in their not bearing any marks or traces of organization. Many of these pebbles are passing into a state of decomposition, whence they have in some degree the appearance of having been subjected to the action of fire: small fragments of shells are every where dispersed amongst them.

Beneath the pebbles is a stratum of light fawn-coloured sand of about ten feet in depth, and immediately under this is the stratum of white sand, which is about five-and-thirty feet deep, and is here seen resting immediately on the chalk.

At Plumstead, about a mile distant in a south-eastern direction, there is a pit, in which the shells, about two years ago, were to be obtained in a much better state of preservation than at New Charlton; but this seam of shells, as the pit has been dug further in, has by degrees become so narrow as to be now nearly lost. In this pit, not only the shells already mentioned were found, but many tolerably perfect specimens of *Calyptræa trochiformis*, Lam. *Trochus apertus*, Brander. *Arca glycemeres*, *Arca Naticæ*, and many minutes shells in good preservation. All these shells appear to have entirely lost their animal matter, and not having become imbued with any connecting impregnation, they are extremely brittle. On examination with a lens, it also appears that in most of the specimens nothing of their original surface remains, it having been every where indented with impressions of the surrounding minute sand,
made

made whilst the shells were in a softened state. This circumstance is particularly evinced in the *Cyclades*, in which a particular character in the hinge was thus concealed: in a mass of these shells from the Isle of Wight, it appears that the lateral teeth are crenulated, somewhat similar to those of the *Mastra solida* in the gravel stratum; but in the *Cyclades* of Plumstead this was not discoverable, from the injuries which their surface had sustained from the sand.

The fossils of this stratum evidently agree with those found by Lamarck and M. De France above the chalk at Grignon, Courtagnon, &c. and they have been just shown, incidentally, to exist in the Isle of Wight. In an eastern and southern direction from London this stratum with its fossils is frequently discovered.

On the heath near Crayford, about four miles eastward of Charlton, long vaulted oysters are found similar to those already mentioned. About two miles further, in the parish of Stone, is *Cockle-shell-bank*, so called, as Mr. Thorpe, the author of *Custumale Roffense*, says, p. 254 of that work, "from the great number of small shells there observable." These are the *Cyclades* already spoken of, and which Mr. John Latham, author of *The general Synopsis of Birds*, thought bore some resemblance to *Tellina cornea* Linn. *Histor. Conchyl.* of Lister, tab. 159, fig. 14. Mr. Latham here also met with a species of *Cerithium*, and another of *Turritella*. Fragments of these shells are also frequently turned up with the plough in that neighbourhood. They have likewise been found at Dartford, at Bexley, and at Bromley, to the southward.

Mr. Thorpe also relates that in the parish of Stone there was a large mass of stone, of some hundreds weight, full of shells, which was brought from a field, and used as a bridge or stepway over a drain in the farm-yard. (*Custumale Roffense*, p. 255.)

In several spots in the neighbourhood of Bromley, stone is found near the surface, formed of oyster-shells still adhering to the pebbles to which they were attached, and which are similar to those which have been just described as occurring at Plumstead and at Charlton; the whole being formed by a calcareous cement into a coarse shelly limestone containing numerous pebbles. The only quarry of this stone which has been yet worked is in the grounds of Claude Scott, Esq. The opening hitherto made is but small; it is however sufficient to show that the stratum here worked has suffered some degree of displacement, as it dips with an angle of about forty-five degrees.

At Feversham, over the chalk, Mr. Francis Crow has discovered a bed of dark-brown sand, slightly agglutinated by a siliceous cement, and intermixed with a small portion of clay. In this stratum, which has been hitherto but little explored, he has found in a siliceous state specimens of *Strombus pes pelicani* and a species of *Cucullæa*, nearly resembling those which are met with in the Black-down whetstone pits.

Patches of plastic clay are frequently found over the chalk: some of these are yellow, and employed for the common sorts of pottery; but others are white, or grayish-white, and are used for finer purposes. The coarser clay is very frequently met with, nor are the finer kinds of very rare occurrence. In the Isle of Wight two species of plastic white clay are worked for the purpose of making tobacco-pipes. A similar clay, which is used for making gallipots, is dug from the banks of the Medway. A fine, light ash-coloured nearly white clay, which is employed in pottery-works, is also dug at Cheam near Epsom in Surry.

The UPPER OF FLINTY CHALK, which is the next older stratum, is extremely thick, forming stupendous cliffs upwards of six hundred and fifty feet high, on the south-eastern coast of the island. It extends nearly through almost all that part of the island which lies south of a line supposed to be drawn from Dorchester in the county of Dorset to Flamborough-head in Yorkshire.

In this stratum there is a great quantity of flint, chiefly in irregularly formed nodules, disposed in layers, which preserve a parallelism with each other and with continuous seams of flint, sometimes not exceeding half an inch in thickness. The chalk contains a fine sand, which may be separated by washing*.

The fossils of this stratum are for the most part peculiar to it; very few of them being found in any other. They also appear to agree very closely with those species found in the chalk of France, by Messrs. De France, Cuvier and Brongniart. The number of fossils noticed by these gentlemen amounts to fifty; but they have as yet only particularised a part of them. These are here compared with what appeared to be the correspondent fossils in the English part of this stratum; and some others are also pointed out, which these gentlemen have not yet mentioned as being found in the neighbourhood of Paris.

* The chalk in the neighbourhood of Paris contains, according to M. Boisson La Grange, *magnesia* 0.11, and *silex* 0.19.

In the French stratum there occur,

Two *Lituolites*. No species of this genus is noticed as having been seen in our English chalk. But research has not been made with the necessary precision.

Three *Vermiculites*. The fossil figured Org. Rem. vol. iii. pl. vii. fig. 11, was considered as a vermiculite, until by removal of the chalk and opening different specimens it was found to be a chambered and an adherent shell. Should these gentlemen not have perceived these circumstances in the specimens they met with, they would certainly regard this fossil as a vermiculite. It must also be observed, that from the different forms in which the spiral part is disposed, its division into two or three species might be authorised.

Belemnites. These, according to M. De France, are different from those which accompany the *ammonites* of the compact limestone. The *belemnites* of our chalk are smaller than those of the limestone, besides which they are different in form, being narrower and more elongated. But M. De France may also have confounded with them the spines of the *echinus*, which so closely resemble the *belemnite*: if that gentleman should not have met with perfect specimens, he might not be able to remark the difference between these two fossils. The characters which he has noticed are however sufficient to lead to the belief of a correspondence between the French and English fossils.

Fragments of a thick shell of a fibrous structure.—The doubts expressed respecting the nature of this shell, and the observations made with regard to it, offer another strong point of agreement between the shells of the two strata. The shell here alluded to is most probably that represented Org. Rem. vol. iii. pl. v. fig. 3; the structure of which agrees exactly with that mentioned as found in the French stratum of chalk. That shell is however described as being of a tubular form; it is therefore right to observe, that fossil *pinnæ* do sometimes possess this peculiar structure.

A *Muscle*. No instance appears in which any shell of this genus has been found in our chalk.

Two *Oysters*. The Kentish chalk-pits yield at least three species of this genus. One of them bearing very much the form and appearance of *Ostrea edulis*, but being only about a fourth of its size; one smaller, the serrated edge of which places it in the family of *Cristæ galli*; and the third still smaller, not half an inch in length, crenulated on each side of the hinge.

A species of *Pecten*. There are two or three small species

of *pecten* in the English chalk ; besides a shell, with long slender spines, which may be safely classed with the *pecten*.

A *Crania* (*Anomia craniolaris* Linn. *Crania personatu* Lam.) This fossil is not known in the English chalk ; nor indeed could it be easily ascertained, unless the inferior valve happened to be well displayed.

Three *Terebratulæ*. *T. sulcata* and a *terebratula* agreeing with *Anomia terebratula* Linn. are frequently found in our chalk ; and sometimes another species, hardly half an inch in length, with remarkably acute and well defined ribs.

A *Spirorbis*. Traces of these shells are frequently found on the surface of the *echinitæ*.

Ananchitæ (*Echinus ovatus*). The crustaceous covering of which, it is remarked by MM. Cuvier and Brongniart, remains calcareous, and has assumed a sparry texture, whilst the middle alone is changed into silex. No actual change has however taken place, as far as respects the flinty part of the fossil, the flint having merely filled up the hollow of the sparry crustaceous covering. This fossil is frequently found in the English chalk.

Porpitæ. These also occur in the English chalk.

Five or six different fossil bodies called by the French oryctologists *Polypiers*, one appearing to belong to the genus *Caryophyllæa*. Several of these bodies, from the English chalk, have been figured in the *Org. Rem.* vol. ii. pl. xiii. fig. 70 to 79.

Another is supposed to belong to the genus *Millepora*. This is generally brown, and is in the state of oxidized iron, as resulting from the decomposition of pyrites. These fossils exist in the Wiltshire soft chalk.

Lastly, *Shark's teeth*. These also occur frequently in the English stratum.

Messrs. Cuvier and Brongniart state, that there are many more fossils in the chalk stratum of France than those which have been just referred to. This is also the case with the fossils of the English chalk ; since the following may be enumerated as occurring in this stratum. *Rugous palates*, and, though rarely, the *scales* and *vertebræ* of fishes. Three or four species of *stellæ marinæ*. A long *saccular bivalve*, with an uncommonly thin shell, of which so little has been hitherto saved, as not to give a chance of gaining a knowledge of its general form, or the structure of its hinge. A *bivalve*, which approaches to a circular form, but is so thin as to afford but little hope of discovering its
genus.

genus. *A bivalve, nearly circular, the margin turning upwards so as to give it a patella or disk form, with numerous long processes passing from the margin and external surface, and fixing it to other bodies. A small pecten with sharp unguated ribs, not exceeding a quarter of an inch in length. A bivalve, not an eighth of an inch in length, finely striated longitudinally, bearing a bright polish, and seemingly possessing its original light brown colour. Plates of the tortoise echinite, and several remains apparently of other species of this genus.*

When to these are added the remains of various *echini*, such as *conulites*, *cassidites*, and *spatangites*, and the different *spines* of *echini* which are found in this stratum; and when it is also considered that the present account is drawn up almost entirely from the productions of chalk cliffs, of not more than two miles in length, it will not be difficult to conceive, that the number of these fossils is not less in the English than in the French chalk.

The state in which these fossils are found, plainly evinces that the matrix in which they are imbedded was formed by a gradual deposition, which entombed these animals whilst living in their native beds. The fine and delicate spinous projections of the shells are unbroken, and the spines are still found adhering to the crustaceous coverings of the *echini*; neither of which circumstances could have occurred had these bodies been suddenly and rudely overwhelmed by these investing depositions, or had they been brought hither from distant spots.

It may be said that the specimens possessing the characters here alluded to are rare. With respect to the spinous shells, however, they certainly occur often, although it is almost impossible to extricate them unbroken from their surrounding chalk; and the rarity of the specimens of *echinites* with their attached spines, depends in a great measure on the mode in which these specimens are obtained. The specimens seen in cabinets are seldom found by the naturalist himself, but are preserved by the work people, who break the chalk when any uncommon appearances catch their eye. But it frequently happens that these marks are not seen until the piece is broken by their tool, and with it, perhaps, the entire animal.

The perfect state of the surfaces of the chalk fossils proves also that this deposition proceeded from the surrounding fluid, and that it was not derived from the immediate action of any chemical agent on the shells and other calcareous coverings of the animals living at the bottom of the sea.

In the fossil animal bodies found in chalk, not the least diminution of the sharpness of their ridges or points is observable, nor is the least dulness of the delicate lines and embossments of the crusts, or of the spines of the *echini*, to be detected.

That the deposition of chalk and of flint was sometimes alternate, and even, as it is expressed by Messrs. Cuvier and Brongniart, *periodical*, appears from the seams or strata of flinty nodules, and particularly from the widely extended flat or tabular flinty depositions interposed between the chalk.

But that the chalk was permeated by the silex at some distance of time after the deposition of the former, seems also to be proved by the state of the fossils of this stratum. There does not appear to be a single instance in which the animal remains are impregnated with silex. On the contrary, the substance of all these fossils has become calcareous spar, and their cavities have been filled with flint; thus plainly evincing that sufficient time must have elapsed for the crystallization of the calcareous spar, previously to the infiltration of the flint.

It may not be improper to remark, that in no instance does the flint, although in contact with the calcareous spar, appear to have become mixed with it. The reverse of this is the case with the chalk, since this latter may be seen in almost every degree of union with the flint; from being blended with its substance, to being merely united with its surface, and forming the white coat of the flint. It has been, without doubt, from certain appearances resulting from this union, that M. Carrosi and others have been led to believe in the change of lime to flint.

There can be hardly any hesitation in agreeing with Mr. Jameson, that the most probable explanation of the formation of imbedded flint is that which was first proposed by Werner, "that during the deposition of chalk, air was evolved, which, in endeavouring to escape, formed irregular cavities, that were afterwards filled up, by infiltration, with flint*." The decomposition of the softer parts of the animals, which were thus entombed, may be considered as a very probable source of a part of those gaseous matters which formed these cavities: and the connexion of the animal remains with these nodules of flint is easily explained by supposing the shells, crusts of the *echini*, &c. to have projected into these cavities, or to have been adherent to

* System of Mineralogy by Prof. Jameson, vol. i. p. 172.

their sides, at the period at which this infiltration took place.

That the separation and deposition of the matter forming these siliceous nodules have been the work of crystallization, is rendered evident by the cavities left either in these nodules, or in the fossils, being generally lined with quartz crystals.

Whilst endeavouring thus to explain the formation of these flinty nodules, and the filling up of the cavities of the fossils with flint, a difficulty arises from observing these bodies, insulated as it were in their bed of chalk; it not being easy to conceive, how so copious an infiltration should have taken place into these cavities, whilst the surrounding chalk should only have received a slight intermixture of siliceous grains.

Something analogous is however observable in the formation of the calcareous stalactite; since in those caverns in which these concretions have been forming for a very long period, the infiltration by which they are formed is found to continue to the present day; proving that the interstices of the superincumbent stone have not yet been filled by the concreting of the earthy particles held in solution in the percolating fluid, by the crystallization of which these bodies have been formed, and are now augmenting.

The Oberstein nodules of agate appear to have been formed under somewhat similar circumstances; since it is in general evident from their external surfaces, that they also have had very little adherence to their matrices; which would hardly have been the case had these been highly impregnated with silix.

The **HARD CHALK** lies immediately beneath the soft chalk. In this stratum there are no flint nodules. "Its beds," according to Mr. Farey, "increase in hardness, until near the bottom where a whitish freestone is dug, at Totternhoe in Bedfordshire, and at numerous other places: that brought from Ryegate and other quarries, of this stratum, south of London, is used as a fire stone*."

It has been generally supposed that these two strata of chalk are of one formation: but not only the absence of the flints but the characters of their fossils prove them to be of distinct formations. No fossils indeed are marked by more decidedly peculiar characters than those of this stratum; since hardly a single fossil has been found in it, which has been met with in the soft chalk, or any other stratum.

* Report on Derbyshire, &c. p. 112.

152 *On some of the Strata in the Neighbourhood of London,*

It is in this chalk that the genus *Ammonites* is first met with; or, in other words, it appears that the water which formed this stratum was that in which this genus last existed, no traces of it having been seen in the soft chalk or in the other superior strata. The chief, and perhaps the only circular species of this genus which has been found in this stratum, is of a large size, with nodular projections on its sides, towards the back, which is generally flat. This fossil appears to be of a different species from any of those that are found in the subjacent strata.

It is very remarkable that in this stratum, the last in which the genus *ammonites* is met with, so remarkable a deviation from the original form of the genus should occur, as almost to claim its being considered as the characteristic of another genus. In the fossil here referred to, which possesses all the other characters of *ammonites*, the spiral coil is disposed in a form rather approaching to that of the oval than the circle*.

In another fossil of this stratum, a still more extraordinary deviation exists. This fossil possesses the concamerations and the foliaceous sutures of the cornu ammonis; but, instead of being spirally coiled, it has its ends turned towards each other, somewhat in the form of a canoe. This peculiar form has led to the placing of this fossil under a separate genus, which has been named *Scaphites*†.

Of the extent of this stratum no correct account has been given; but there is sufficient reason for believing that it accompanies the other chalk in its range through this island. It also appears that its peculiar fossils exist in it at very considerable distances. Thus the *oval ammonite*, which is found in the Sussex hills, likewise occurs in the hard chalk of Wiltshire; and the *scaphites*, another inhabitant of the Sussex hills, has also been discovered in Dorsetshire.

On comparing the preceding sketch with the Essay on the Mineralogical Geography of the Neighbourhood of Paris, by Messrs. Cuvier and Brongniart, some important variations will be perceived between the strata found above the chalk in this island and in France. In France, the strata above the chalk differ both in number and quality from those which have been hitherto observed in a similar situation in England. In France, too, several strata of sand and sandstone exist above the strata of the gravel formation, which in this island appear to be highest.

* Organic Remains, vol. iii. pl. ix. fig. 6. - † Ibid. vol. iii. pl. x. fig. 10 & 11.

The first of these differences appears to result chiefly from the existence of numerous beds or patches, the formation of which must have depended on certain local circumstances, such as the existence of fresh or salt water lakes, at the period of the drying up of a former ocean; the different chemical combinations which might thence have taken place, &c. But the occurrence of such variations can hardly be considered as interrupting the continuity of the stratification.

Indeed, when it is considered that in France much more frequent opportunities are afforded of examining the stratification immediately above the chalk than in England, it will not be regarded as improbable, that several of these beds or patches may exist here, the discovery of which would render the accordance of the two series of strata much more close.

Even from the examinations which have been already made, the identity of the French and English chalk is established. The British strata above the chalk are also found to contain patches of plastic clay, of most of the varieties mentioned in the French strata, as well as patches of coarse limestone, with its accompanying sand and its peculiar fossil shells, such as are found to exist in the corresponding French strata.

The other difference, the existence, in France, of beds of sand and of sandstone above those of gravel, which are the highest strata of this island, is very remarkable. May it not be attributable to the abruption, from this island, of the superior strata or beds of this formation, by that catastrophe, instances of the astonishing force of which have been already noticed?

XXXI. *Report of the National Vaccine Establishment.*

THE Board of the National Vaccine Establishment having learned that great interest has been excited in the public mind, by the occurrence of small pox after vaccination, in the families of the Earl of Grosvenor and of Sir Henry Martin, Bart. have thought it their duty to lay the following cases before the public, accompanied with some observations, and a statement how far, in their opinion, these cases affected the general advantages of vaccination.

The case of the Hon. Robert Grosvenor, third son of the Earl of Grosvenor, was procured through the favour of Sir
Henry