NOTES ON THE GEOLOGY OF THE NORTH-EAST COAST OF THE ISLE OF WIGHT.

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When viewed from the waters of the Solent, the north-east coast of the Island (that is the district bordering on the sea between East Cowes on the west and St. Helen's old church on the east) appears to offer few attractions to the geologist in the way of cliffs or shore sections, the coast-line being fairly regular, trending in a sweep south-eastwards from Old Castle Point, and, with the exceptions of the creek at King's Quay and Wootton Creek, having no important breaks in the shore line. The land appears to slope regularly down towards the shore, and woods and pastures come right down to the beach for nearly the whole distance. Several streams, fed by springs lying inland or carrying off the rainfall from the higher lands, find their way down to the Solent, and the result of their action, extending over a great lapse of time, is seen in the succession of gently sweeping valleys regularly succeeding each other and running back from the coast. The streams are of little importance in themselves, but as factors in the causes which have produced the configuration of this part of the Island, their influence cannot be overlooked. The soft gravel beds and the underlying Oligocene clays and marls have proved an easy prey to the denuding influences of these small brooks. The strata of which this part of the Island is formed are not such as we should expect to find constituting important cliffs, for, when saturated with water in the winter time, many of the clays and marls have a tendency to "settle" or slide down in a body towards the beach, and the only parts of this coast-line where we find

anything in the nature of real cliffs are near Old Castle Point, to the east of Sea View, and in Priory Bay, but even here the great mud streams and the vast amount of soft sliding *talus* precludes the geologist from access to most of the sections. On account of the wasting nature of the strata, and from the fact that for the greater part of the distance private residences abut on the shore, sea walls have been built to stop the inroads of the sea, and the geologist is again shut out from the possibility of examining many workable coast sections. From these several facts very little attention appears to have been given to this piece of shore line by geologists, and the result of personal observations extending over a number of years may possibly be of interest, the more so as, guided by the information contained in this paper, some of the less known and rarer of the organic remains occurring in our Oligocene clays may be sought for and not improbably found by those interested in such matters.

It is not intended to give an exhaustive account of the geology of the north-east coast, but the aim of this paper is merely to point out the best localities for fossils, and to give some idea of the different strata cropping out along the shore. Nor will the usual and more correct custom of treating of the strata in geological order be adopted; but the shore sections will be described in the order in which they come, commencing at East Cowes and working our way along to St. Helen's Church.

We shall find as the result of our investigations that three of the groups of Oligocene beds crop out along this bit of shore—the Headon, Osborne, and Bembridge beds—and at several unlikely looking places interesting examinations can be made of the various strata. It is essential when starting on a geological ramble along this coast to take careful note of the tide, and to arrange our arrival at the starting point at about half-ebb; and this precaution it may be remarked applies equally to most of the coasts of the Island, as at many places it is quite impossible to get along the shore except when the tide is out. Along the district we have selected to examine, many of the sections proposed to be visited are not in the broken ground bordering on the beach, but among the shingle itself and out on the shore towards

low water mark. At high tide, too, it is impossible to pass along in front of the sea walls which, unfortunately, extend for a considerable distance along the coast.

The first locality we will visit is the short length of shore between the town of East Cowes and the square tower which forms the north western boundary of the grounds of Norris Castle. The rough crumbling cliff here is of great interest by reason of its affording the only shore section of the Headon beds (excepting, of course, the section at Whitecliff Bay and those in the Freshwater peninsula). The syncline of the Tertiary beds in the Island is characterised by a number of local indulations, and these produce a rise and fall in the strata which at first sight is somewhat puzzling. The sections along the north shore go, of course, diagonally across the great syncline, and we find the beds, as it were, dipping in two directions at once—southward in the syncline, and east or west, as the case may be, in the direction of the local undulation. To a more extensive undulation than usual is due the rising up near East Cowes of the Headon beds, and before the sea wall at Norris was constructed a very interesting section of these beds could be seen along the shore and also in front of the grounds of Osborne House. A fairly good exposure, however, remains between the square tower and East Cowes, and from the clays and marls many interesting fossils may be collected. A few years ago a big "founder" took place in the cliff close to the square tower, and the great heap of *talus* affords us a good indication of the strata which form the cliff; blocks of Bembridge limestone are mixed up with the sliding mottled Osborne clays, and the whole has come tumbling down on to the shelly finely-laminated Headon marls on the beach. The exact horizon occupied by the shelly marls and clays which crop out in the lower cliffs and broken ground along the beach is a little difficult to determine, but from the presence of the Bembridge limestone in the upper part of the cliff and from the fact that we must allow about 100 feet as the probable thickness of the Osborne Beds, we may fairly conclude that the shelly marls are high up in the Upper Headon beds, and the presence of *Potamomya* and *Cerithium* in abundance adds additional weight to this conclusion. The

junction of the Osborne and Headon beds is, as far as I have been able to make out, hidden under the landslips and *talus* so that no accurate measurements can be taken of the thickness of the different strata here.

It is necessary to be very careful in the matter of measurements at the different localities among all the Oligocene clays for the strata vary a great deal even in short distances; some of the beds thin out and occasionally disappear, and no fixed measurements would be applicable to all sections. All this is no doubt due to the lacustrine and fluviatile or estuarine origin of most of the Oligocene clays—rendering them additionally interesting to the palæontologist from the local and circumscribed areas occupied by the animals, the remains of which abound in these strata.

The Headon clays and marls at East Cowes are very rich in fossils, and from the strata forming the lower cliffs, and from the fallen masses of clay on the beach, very many interesting specimens may be obtained. In some of the marls immense quantities of *Cypris* of a blackish colour occur, and in the thin layers of shelly marl which crop out in the low bit of cliff to the south-west of the big "founder" many fine ctenoid scales of fish may be found; in the same strata I found a tooth of a shark (*Lamna*) and also a number of fish bones and vertebræ. The usual characteristic fossil mollusca of these beds may be easily collected here, and they are mostly in a good state of preservation—more especially two species of *Cyrena (C. pulchra* and *C. obovata)* and also *Cerithium concavum*, the hard shells of which will be found plentifully among the shingle on the beach. The fallen and water worn pieces of Osborne limestone here will be often found to contain immense quantities of *Charæ*, and in no other locality have I found these seed vessels in such profusion; the *Charæ* must have flourished in great numbers just in the area in which the Osborne limestone of Norris was deposited.

It is not much use attempting to do any geologising between Old Castle Point and King's Quay, as a sea wall extends for a considerable part of the distance, and pedestrians are not allowed to walk along the shore below the grounds of Osborne House. From King's Quay to Wootton

Creek, however, a great deal of interesting work may be done along the beach. The Headon beds have sunk down below the shore line at Osborne, and along this bit of coast the clays of the upper division of the Osborne beds are well exposed, especially below Chapelcorner Copse, where the section below high water mark is exceedingly rich in organic remains. Proceeding along from King's Quay to the eastward, very little of the strata can be seen until after the boat-house at Woodside House is passed, the clays in the sloping cliff being much obscured by underwood, and those out on the shore towards low water mark by a thick layer of soft recent alluvial mud. With the hard-way which runs out from the boat-house this mud ceases, and from here to Wootton Creek an extremely interesting exposure of the Osborne beds may be examined between the base of the cliff and low water mark.

The fossiliferous beds of clay measure probably about 15 feet in thickness, and they dip very slightly to the south—the dip near the base of the broken cliff being much exaggerated, owing, no doubt, to the weight of the sliding *talus* of which the rough cliff is chiefly composed, and which in winter is constantly on the slide down towards the beach. In the upper part of the cliff towards the Creek we may see the Bembridge Limestone—here about three feet thick—appearing as a cream-coloured band under a capping of loam and clay. Under this the following section has been approximately measured :—

IN THE CLIFF.

1.—Marls and yellow grey, and dark red and mottled clays (seen only in landslips)	about	40 feet.

ON THE BEACH.

2.—Grey clay with scattered fish bones, scales, &c.	,,	4 ,,
3.—Hard blue and grey shaly clay with small perfect fossil fish *(Clupea Vectensis)* and a species of prawn *(Palæmon)*	,,	2 ,,
4.—Hard grey clay with matted masses of leaves and lenticular masses of cement stone	,,	3 ,,
5.—Blue clay with many seams of crushed *Paludina lenta* and *Melanopsis carinata*	,,	6 ,,
6.—Unfossiliferous green and mottled clays extending to low water mark.		

In the clays numbered 2 in this section many most interesting fossils may with diligent search be found. Occasionally thin lenticular masses of fish bones may be found appearing as if drifted into hollows or pools in the lagoons in which these clays were probably deposited; these little collections of bones require very careful looking after, especially as where they occur the strata are much tilted, and only the edges of the layers of clay can be seen. The bit of shore where one is most likely to find a little layer of these fish bones is just to the east of some posts (part of an old fence) stuck into the beach about a hundred yards east of Woodside boat-house. From these clays I have obtained many interesting remains. The ganoid scales and vertebræ of *Lepidosteus* are abundant, and the following have also been obtained:—Teeth bones and dermal plates of *Alligator Hantoniensis;* bones and plates of *Emys*, *Trionyx* and *Platemys;* incisor and molar teeth of a small rodent *(Theridomys);* a number of snake vertebræ of different sizes; also a jaw of *Lepidosteus*. Among remains drifted together, as these evidently were, rarities may be looked for, and searches among these masses of bones will certainly be well rewarded. The best way to separate the fossils from the matrix is to dig out the seam of bones as it occurs with as little of the surrounding clay as possible. It should then be thoroughly dried. Scalding water may then be poured on the dry clay, and by repeated washings under the tap the dissolved matter may be all removed, and the bones dried ready for examination and sorting out.

Of the strata here (and at other places to be mentioned hereafter) by far the most interesting are those comprised in division 3 in the foregoing section. Most beautiful of all Oligocene fish remains are those of the perfect little *Clupea Vectensis*[1] to be met with in the seam of grey shaly clay. It is possible that some little difficulty may be experienced in finding this seam of clay, and, when found, in obtaining from it any fossil fish; when, however, the characteristics of the fish clay are understood, its features will be found to be so marked that it will readily be recognised at several other localities on the north-east shore of the Island, as well as at

[1] Quat. Journal Geol. Socy., Feb. 1889, p. 112.

Chapelcorner Copse. The seam here occurs just below high water mark, and it is rather harder than the clays above or below; it will usually be found to project slightly through the shingle. The cement stones mentioned in the section are a good landmark to start from, and the geologist will find no difficulty in identifying several of the lenticular masses which are of a brownish buff colour, and below the copse occur just about the base of the shingle beach. About two feet above in sectional measurement, and about six or eight feet lineal nearer the cliff, will be found the fish clay, which is usually about six inches thick. At some places there appear to be two of such layers separated by about a foot of blue clay. It is probable that this mutiplication is only one of the results of the slippery nature of the clay, and is due to the disturbances produced by the landslips of the rough cliff. A well defined transverse jointing renders it easy to remove the clay in lumps, which can then be split up with a knife into thin layers, and, if good fortune favour the geologist's labour, the beautiful little *Clupeæ* may be found split asunder—the one half on one side of the split clay and the other half on the corresponding piece of clay. One thing, however, that is essential in hunting for these small fish is the exercise of a great deal of patience, for they occur in shoals in the clay, and oftentimes a whole day may be spent in a long and tedious search and the result may be nil; while at another time a shoal may be found in a few minutes, and, its horizon being carefully noted and followed out, a number of beautiful fossils may be obtained. Very little has been know by geologists concerning the fauna and flora of the Osborne beds, and more than one new species has recently been added to the list of fossils found in these deposits. Shrimps or prawns, varying in length from half-an-inch to three inches, may occasionally be met with in the fish clay. They are not as a rule well preserved, and have not yet been identified. They probably will be found to be a species of *Palæmon*. The *Clupeæ* are on the other hand usually most beautifully preserved, the fins and tails showing every minute ray and bone. A layer of crushed vegetable remains occurs at the base of the fish clay, and from this I have obtained some fairly good leaves, the identification of

which, however, is not easy. They mostly appear to be remains of rushes and reeds, and are in rather a friable state. Diligent search on this horizon would possibly be well repaid, however, for our knowledge of the flora of the Osborne beds is especially vague. As to the formation of the fish clay we can, of course, only conjecture, but the evidence afforded by its lithological composition, and the exquisite state of preservation in which many of its fossils are found, point to its probable origin in a sudden influx of fine marine mud and marine animals into the tranquil waters of the lagoons or shallow estuary in which the Osborne beds were deposited. The brackish water appears to have smothered the *Clupeæ*, as in nearly every intance we find the jaws wide open as if asphyxiation had been the cause of death.

The seams of *Paludina* and *Melanopsis* in division 5 are numerous, but the shells are usually in a very crushed and badly preserved condition, though a thin dark blue layer of finely comminuted shells at the base of this division will be found spreading out on the shore towards low water mark, and will often yield fish and turtle remains in the form of scales, vertebræ, bones, and fragments of plates. A careful search on this horizon should not be neglected. Below this occur a series of mottled green and yellow clays, which, as far as I have been able to discover, contain no organic remains, and then we come to the seam of cream coloured Osborne Limestone, which will be seen at low water forming a ledge of rocks on the west side of the creek. The Limestone is the uppermost member of the lower portion of the Osborne beds, named by Professor Forbes the Nettlestone Grits, while all above he described as the St. Helens Sands. Low water mark prevents us from pursuing our investigations further down in these beds, but the strata which are exposed at Chapelcorner Copse will be found very interesting and well worth the careful study of the geologist.

Tracing our way along on the other side of Fishhouse, we shall find that the strata have dipped considerably eastward of the creek, bringing the mottled unfossiliferous clays well down on to the beach, with the Bembridge Limestone cropping out a short distance inland from the edge of the low rough wood-covered banks which skirt the shore. Blocks of

the limestone occur all along the beach, and are easily recognised by the fossils they contain. A thick layer of alluvial mud covers the strata out towards low water mark, and prevents any investigations in this direction until Binstead House is reached. Here the strata have risen again, and the fish clay is brought up nearly to high water mark, but the shore here being very wet and muddy, the clay is in bad condition, and, though I have on more than one occasion obtained *Clupea Vectensis* from this place, the section here will not be found so interesting as that a little nearer to Ryde. East of the Binstead Brook the strata rise up still more, and at the point below Player's Copse the fish clay occurs in the cliff itself, though, being hidden under the *talus*, its exact position cannot be determined, and its presence here can only be seen by the isolated lumps of shaly clay which may sometimes be found among the shingle. The rise in the strata brings up the Osborne Limestone which forms the long ledge of rocks running out from the beach; it joins the cliff and rises up into it just below Ryde House. A peculiarity of the Osborne beds at this point is the flaggy arenaceous limestone, often very shelly and frequently most beautifully ripple-marked, though the exact horizon on which this band occurs is not determinable as it only appears in isolated masses in the crumbling cliff. No similar stone has been noticed at the west side of Wootton Creek, though it is probably represented at Norris by the thin layers of limestone containing *Charæ*; at Chapelcorner Copse it is certainly not evident, though it is again found to the eastward of Ryde and forms an important bed near Sea View.

The sea wall commencing at Ashby Cottage and extending to Appley slipway shuts us out from any easy examination of strata. Before the Esplanade was extended at Ryde masses of Osborne Limestone occurred in profusion on the beach, and we can see a continuation of the beds in the great extent of weed-covered rocks in front of the grounds of Appley Towers; the marls and limestone are here *in situ*, and have a pronounced dip of about 20° to the south. The strata here are usually partly covered with a thin coating of sand, though after rough weather they are sometimes laid bare. The only fossils I have noticed here occur in some of

the cream-coloured marls which will occasionally be found crowded with the remains of *Paludina lenta* and *Melanopsis carinata*, and a small *Cyrena* mostly in a state of casts. Both beds of Osborne Limestone are well developed in this district, and we notice it in masses on the beach all along to Sea View, the groynes and embankment at the Salterns being built of this stone, it having been quarried for the purpose from both beds, that obtained from the upper horizon being very arenaceous and shaly and often exhibiting beautifully ripple-marked surfaces. At Sea View both beds of limestone attain their greatest thickness, the lower deposit being eight feet thick, and it is here of a much harder and more durable nature, approaching to a concretionary rock in many places; weathering unequally, it often assumes a honey-combed appearance. The great ledge of rocks in front of the town is *in situ*, and extends for a considerable distance along the coast. On the shore, in front of the big terrace of houses, the clays above the lower limestone may sometimes be seen when the sand has been washed away; and in the angle of the wall immediately to the east of the pier the section, if well exposed, will be found a very interesting one, for it resembles to a great extent those at Ryde House and Chapelcorner Copse, and the fish clay with its *Clupeæ* has been found well developed in this spot. The occurrence of the fish clay here was a matter of great interest to me, as it shows the extent of this deposit which, though clearly a local one, nevertheless extends, there is every reason to suppose, the whole distance from Chapelcorner Copse to this spot—a distance measured in a straight line of five miles. The upper bed of limestone is hidden by the sea wall here, but masses of the rock with its ripple marked surfaces may be seen on the beach.

Passing on from the pier we find the mottled clays cropping out in the broken ground in the cliffs, but no reliable action is shown. The lower bed of limestone is well seen at Horestone Point, and it will be here found to contain a band of *Limnæa longiscata* and also a number of small flint pebbles ranged in irregular lines. The presence of these little flints in the mass of the limestone is curious, and seems to suggest that the denudation of the chalk was taking place

in the remote past when the *Palæotherium* and other similar forms were living denizens of our globe.

Along the bit of coast in Priory Bay, one of the most extensive visible outcrops of the Osborne series is seen in the cliffs, and it was here that Professor Forbes made his detailed section of these beds.[1] In the cliff at the north-western end of the bay are well shown the upper or "St. Helen's Sands" group, and it is remarkable to notice how much more arenaceous in character are these beds here than they were further to the westward. The fourteen feet of "pale green yellowish and white sands" described by Professor Forbes are apparently wanting at Ryde House and west of Wootton Creek. I have not been able to find the fish clay in Priory Bay, though its horizon may possibly be situated behind the sea wall here; it may, of course, thin out before this locality is reached and be confined to the district lying between the two places to the east and west where we have noticed it. No traces of such a bed appear in the section at Whitecliff Bay, and in the new well at Mill Hill, recently sunk by the West Cowes Local Board, and which passed through the entire Osborne Beds, careful examination failed to bring to light this deposit. The Osborne series at Mill Hill bear a closer resemblance to the strata at Cliff End, beyond Yarmouth, than to the fossiliferous beds of Chapel-corner Copse. About half way up the cliff (which will be noticed to have a capping of plateau gravel of considerable thickness) in Priory Bay the Bembridge Limestone, here occurring in three separate bands each about two feet thick, will be seen; it gradually descends in a gentle slope until at Watchhouse Point its position is about nine feet above the top of the sea wall. Six feet or so above the top band of limestone the layer of hard brittle grey clay, which, continued to Gurnard there contains such marvellously beautiful insect remains, will be observed. In the East Medina this deposit has so far failed to yield any fossil insects, though, of course, such remains are not impossible here. Just east of Watchhouse Point the position of the Bembridge Limestone is about eight feet above the beach, and further eastward it soon descends to the shore and stretches out in long ledges of

[1] Mem. Geol. Survey. Geol. Isle of Wight, 1889, p. 155.

weed-covered rocks. It continues across into the Bembridge Peninsula and there extends away into deep water in the form of the well known Bembridge Ledge—only too familiar in its character to many mariners and their vessels which have been wrecked on this dangerous reef of rocks.

We loose sight of the Osborne Beds with the descent of the Bembridge Limestone, and on towards St. Helen's old church, our easternmost boundary, we can do little work as the ruinous cliff is almost entirely hidden under a sliding *talus* of clays of the Bembridge series, in which some of the usual fossil shells may be found (*Paludina lenta* and *Melania muricata*, *&c.*) but no section of any value can be seen.

At first sight the way in which the strata alter and vary their positions in different parts of the coast is somewhat confusing. We should first of all firmly grasp the fact already pointed out, that on the north-east coast of the Island all the beds have a gradual dip to the southward in the great syncline—they dip *into* the cliffs as it were. All along the coast the beds are subject to additional influences, and are thrown into a series of undulations running at nearly right angles to the line of the natural dip, so that the beds rise into the cliffs or sink beneath the beach, and all the while maintain their inclination in the direction of the syncline. This is well shown on a small scale in the case of the fossiliferous clays to the west of Wootton Creek—the fish-clay coming down to the beach and again rising up to the base of the cliff in a short distance. A great arching of the strata takes place about the middle of the coast we have examined, one extremity of this arching being at Ryde House and the other just to the east of Sea View, bringing up the middle of the Osborne series all along the shore line.

The geologist who is bent on examining the strata of a district like the Isle of Wight, should always be on the look out for places where a section may be seen and its details noted. This is so to a greater degree than usual in the case of our north-east coast, for it lies protected from the prevailing winds, and as a natural consequence storms and rough weather coming from any unusual quarter may often clear the beach and shore from its covering of sand and shingle,

and may expose areas of clay and rock, which in the course of a very few tides may again be hidden from sight under the recent shore deposits.

Easy of access, though not geologically inviting in aspect, the north-east shore of the Island, when carefully and thoughtfully studied, will be found to be far from the least interesting part of our shore line. From a picturesque point of view it is often very attractive, with its rough rock-strewn stretches of shore and its pretty hanging woods fringing the beach. The Isle of Wight is truly a paradise for the geologist and a fair and charming region for the artist.