

7. Zone of *Cyclognathus micropygus*, Linnrs.
6. " *Peltura scarabeoides*, Wahl.
5. " *Leptoplastus stenotus*.
4. " *Parabolina spinulosa*, Wahl.
3. " *Beyrichia Angelini*, Barr.
2. " *Olenus truncatus*, Bronn.
1. " *Olenus gibbosus*, Wahl.

(1, 2). In the typical section of Andrarum, the basal zones 1 and 2 appear to be only dubiously separable, judging from the carefully prepared section and tables of Dr. Tullberg.¹ They are unitedly about twenty feet in thickness, and contain throughout the well-known *Agnostus pisiformis* of Linnæus. The included species of *Olenus* (*O. truncatus*, Bronn, and *O. gibbosus*, Wahl., *O. attenuatus*) appear to occur together in the central horizons. (3.) The succeeding five feet of shale, with *Beyrichia Angelini*, Barr., *Agnostus cyclopyge*, Tullb., and forms of *Olenus* and *Ceratopyge*, may be assigned to the third zone. (4.) The fourth zone, distinguished by the possession of the remarkable *Parabolina spinulosa*, Wahl., is about ten feet in vertical extent. (5.) Zone 5 is about the same thickness, and is individualized by the presence of *Leptoplastus oratus*, *L. stenotus*, *Eurycare angustatum*, Ang., *E. camuricorne*, Ang., and a form of *Sphærophthalmus*. (6.) Zone 6 is one of the best-marked zones in the series. It appears to be about twelve feet in thickness, and is characterized by *Peltura scarabeoides*, *Agnostus trisectus*, Salt., *Ctenopyge pecten*, Salt., sp., *Ctenopyge bisulcata*, Phill., sp., etc. (The fossils of this zone have been recently described by Linnarsson in a valuable memoir that will be noticed later on.) (7.) Finally, we have a terminal zone about eight feet in thickness, containing *Cyclognathus micropygus*, Linn., and forms of *Acerocare* and *Orthis*.

(To be continued in our next Number.)

NOTICES OF MEMOIRS.

I.—ADDRESS ON THE AGE AND RELATION OF THE SO-CALLED "FOREST-BED" OF THE NORFOLK AND SUFFOLK COAST.²

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AFTER referring to the many conflicting opinions expressed on the subject, Mr. Blake called attention to his paper "On the Age of the Mammalian Rootlet-bed at Kessingland," and continued as follows:—I stated it marked an horizon of considerable importance with respect to the correlation of the beds in Norfolk and Suffolk, and occurred at the upper part, or thereabouts, of what is generally known as the Cromer Pre-glacial Forest-bed Series, and beneath the Lower Glacial Series of Messrs. Wood and Harmer.³ This line is a line of denudation, and indicates in places a true land-surface, proved by rootlets *in situ*, observed by myself at the extreme ends and in

¹ Tullberg, *Agnostus-Arterna* vid Andrarum, pp. 8, 9, etc.

² Abridged from the Proceedings of the Norwich Geological Soc., vol. i. pp. 137-160.

³ GEOL. MAG. Dec. II. Vol. IV. p. 299.

numerous intervening places. It is a divisional line that for many reasons, in my opinion, marks the boundary between the Pliocene beds and the Drift or Glacial formations.

Much black peat and compressed wood occasionally occur in places along this horizon; sometimes immediately lying on the surface of the rootlet-bed, at others lying in basin-shaped hollows scooped out of this same deposit, which in places contains freshwater shells and freshwater beds associated with it, such as the well-known *Unio*-beds, etc. Drifted wood and other vegetable matter occasionally occur in the formations above and below this line, in considerable quantities in certain localities, as at Bacton and elsewhere.

Again, Mammalian remains are to be found in abundance in this rootlet-bed, in some of its associated freshwater black-beds, and in the beds underlying, down to the chalk, but never (or hardly ever—never so far as my actual observations have gone) in any of the Bure Valley beds overlying. A few have been recorded as having been found at the base of the Bure Valley beds in some inland pit-sections around Norwich and other parts, immediately overlying the denuded surface of the Chillesford clay. These may have been derived from the beds beneath, or the denuded rootlet-bed, if it ever extended so far inland. However, the rule is, to find them where I have stated, and previous searchers and writers corroborate my investigations and remarks in this respect. To speak generally, this divisional line, which I consider marks the top of the Pliocene beds, occurs about midway between the base of the Cromer-Till (which, as a rule, is a very marked line) and the Chalk, or, more strictly speaking, a little nearer to the Chalk; and inasmuch as the greatest thickness of the beds between the Cromer-Till and the Chalk is seldom so much, and nowhere more than from about 26 to 30 feet (which is about the maximum thickness of them in some places in the neighbourhood of Sherringham and Runton), the Pliocene beds, or what remains of them, are consequently but about 13 to 15 feet in thickness, and rarely to be seen so much as that.

The nature of this rootlet-bed can be best studied at Kessingland, where it is well developed, and generally more or less exposed. It mostly consists of a stiff clay of a greenish-grey colour, sometimes mottled with brown; it contains white concretions ("race"), many scattered little black flints, and in places numerous mammalian remains, scattered throughout its mass, and averages from about 4 to 10 feet in thickness, sometimes forming a distinct homogeneous bed of clay, and sometimes containing indications of stratification with sand; thousands of rootlets have been observed by myself in it, in a vertical position as they grew.

The relation of this rootlet-bed to the beds beneath it is of especial interest, and can be best studied at the extreme ends, viz. at Kessingland and Weybourne, where the lower beds rise up. We will first deal with the Kessingland end. During my researches there, I have seen the extreme southern part of the cliff from the road to the flagstaff well exposed, that portion usually being hid by talus and blown-sand. The section exhibited was the rootlet-bed 4 feet in thickness, underlaid by 2 or 3 feet of buff-coloured pebbly sand, and

that by 4 feet or more of laminated grey and reddish-brown clay, ferruginous in places and containing concretions, and also curious contortions in the lower part at the southern end, the total thickness not being shown. This laminated grey clay, with curious contortions in it, is precisely similar to that at the north end of Covehithe Cliff; and after going backwards and forwards from one cliff to the other, on several different occasions, I could not resist the conclusion that it was the extension of the same formation, designated the Chillesford beds. These Chillesford beds, consisting of laminated grey micaceous clay and buff-coloured sand, occur beneath the rootlet-bed in several places at the base of the cliff at Kessingland, and are exposed also on the foreshore after a scour of the beach. I had previously felt inclined to refer these laminated beds to the same age as those to be seen in the next cliff (Covehithe) to the south of it, but was determined to make a thorough investigation, and exhaust the evidence, as far as circumstances would permit, before stating my convictions. When these laminated beds are traced further south to Easton Bavent cliff, it is well known still lower beds come up, viz. the "Norwich Crag," underlying the Chillesford clay, and forming a slight anticlinal. Had a Forest-bed existed at the base of the Chillesford clay, as has sometimes been supposed, we should have anticipated seeing it come up here, but what we see is the "Norwich Crag."

Now we will go to the Weybourne end, and see what is revealed to us there. At about 300 yards to the east of the flagstaff, the following section was seen by myself and my colleague, Mr. Reid, who first pointed it out to me (I having previously requested him to keep a sharp look-out for rootlets along a certain horizon between the Chalk and Cromer Till). The section was a very clear exposure of a lenticular patch of the rootlet-bed immediately underlying the Contorted Drift or Lower Boulder-clay. I minutely examined the deposit, which measured 3 feet in thickness, and found it consisted of its usual character, being an unstratified greenish-grey clay, with numerous small black flints dispersed throughout its mass, and it contained rootlets in a vertical position as they grew. The lenticular patch rested on laminated grey clay, which was 4 or 5 feet thick; beneath which was a little buff-coloured sand, and then 3 feet of Norwich Crag, consisting of a mass of shells resting on the Chalk, the surface of which is very irregular here.

Thus, it will be seen, that the relation of the rootlet-bed to the beds beneath it, coincides at the extreme ends; and there is nothing to be seen anywhere between these two points to interfere with this relation of the beds; but, as they frequently occur on a lower horizon, the lowest beds are seldom well exposed.

It is time now to inquire, where is the Forest-bed? I reply, I know of no other land-surface anywhere round the Norfolk and Suffolk coast, except the one I have described under the designation of the Rootlet-bed, on account of the rootlets *in situ* marking the boundary-line, and having been the means of tracing the line.

During five years I have searched in vain for a stool of a tree *in situ*; and the members of this Society are well aware of the result of the investigations of my colleague Mr. Reid, in the same direction,

and also what Mr. Norton, F.G.S., has written on the same subject. If stools of trees ever have been seen *in situ*, it is my firm conviction they were rooted on the same land-surface I have described. . . .

The true stratigraphical position of the Rootlet-bed (frequently called a Forest-bed) is, however, of considerable geological interest. All the evidence, as shown by superposition, etc., in my opinion clearly points to the conclusion, that it immediately overlies the Chillesford clay. The Rootlet-bed in some cases apparently being a freshwater deposit, as at Corton and at Kessingland; sometimes forming a distinct and separate bed one stage more recent than the Chillesford clay, and sometimes apparently passing down into the Chillesford clay, forming, as it were, the uppermost portion of the same; at other times it is to be seen lying on a more or less denuded surface of the Chillesford clay, as at Weybourne. . . .

Now we come to a very important part of the history of this so-called Forest-bed, viz. the true age of the mammalian remains, which are referred to the period of the "Forest-bed" or "Forest-bed Series," and which, as you are aware, are at the present time undergoing a very careful investigation by my colleague Mr. E. T. Newton, F.G.S. (Assistant Naturalist to the Geological Survey). In this analysis, it is all important to know where each specimen was actually found, and from what bed it was derived. If there is any doubt as to the relation of the beds, much confusion must necessarily ensue. Some writers, in giving a history of this so-called "Cromer Forest-bed," have inferred, that the animals whose remains we find round that coast *lived in a forest that existed in that very locality*. Nothing can be more erroneous, in my opinion, the facts being entirely against any such conclusion. Marine or estuarine conditions prevailed at the time, as proved by the numerous marine and estuarine shells, with occasionally a few freshwater intermixed, and in places alternating with the marine, which have been traced by my colleague Mr. Reid along the foreshore from Weybourne, where the formation rests on the Chalk, to Sidestrand, on the east of Cromer, a distance of about ten miles; and they reappear again in the lower part of the cliff, further south, at Easton Bavent, the intervening space lying now at too low a level for them to be observed. . . . The timber may have been derived from a forest; but the forest itself may have been situated miles away from where we now find the remains of it; and so likewise the Elephants, Hippopotamuses, Rhinoceroses, Deer, and other animals may have lived and died miles away from where we now find their scattered and commingled remains, intermixed in places with marine, freshwater, and a few land shells. The term Forest-bed can only be correctly applied to a bed forming a land-surface, and on which a forest grew. . . .

I use the term "Rootlet-bed" in contradistinction to "Forest-bed," inasmuch as up to the present time no reliable evidence of forest growth has been observed *in situ* upon it, and also, as previously stated, because the rootlets have been the means of tracing the land-surface. The rootlets which mark the horizon are all similar in nature; but it has not yet been determined to what vegetable growth they belong;—it is to be hoped some botanist will

come to our assistance. The surface was probably a marsh-land, all the evidence pointing to that conclusion, on which trees may or may not have grown,—*but not necessarily a forest.*

I would therefore draw attention to the fact, that portions of the land-surface, marked by the rootlets, have frequently been called the "Forest-bed." Prof. Prestwich considers the rootlets as evidence of the Forest-bed at Kessingland. Mr. Gunn, on an excursion of this Society on one occasion to Corton, alluded to the "Forest-bed" peeping out at the base of that cliff; which deposit, however, was this same Rootlet-bed.

After these more or less marine, estuarine and freshwater deposits became land, there was apparently a pause for some little time. Then came about the grand subsidence of the whole beneath the sea (as proved by the marine shells in the middle part of the Bure Valley Beds at Runton, overlying the Rootlet-bed, such as *Leda myalis* and *Mya truncata*, both with their valves united, etc. Also by the marine and estuarine shells—which have been sometimes *erroneously* called Crag—that overlie the rootlet-bed at Bacton, etc., etc.). Thus was apparently ushered in the Drift or Glacial period. During the earliest part of this subsidence, the Rootlet-bed (as might reasonably be imagined) was more or less denuded, together with the Chillesford Clay immediately underlying it; then, all the gravels, clays, loams and sands, forming the greater part of the cliffs and land of Norfolk and Suffolk, were piled up more than 150 feet in thickness in places over this old marshy land-surface, flattening and compressing the wood and other vegetable matter that were first scattered over it.¹ Eventually these deposits were upheaved, and the present configuration of the country brought about, with the assistance of subaerial agencies. But the remarkable fact relating to this upheaval is, that the old marshy land-surface, though more or less squeezed and twisted about, was brought up, for the most part, apparently to about the same level with respect to the sea, as it probably occupied when the vegetable matter grew on its surface.

As mentioned, with possibly a few trifling exceptions, all the mammalian remains are to be found buried beneath the more or less denuded surface of the Rootlet-bed and the Chillesford Clay. The formations, underlying this marked line of unconformity, being the "Rootlet-bed," with its associated freshwater-beds, the "Chillesford Clay," and the "Norwich Crag"; and in all these formations, mammalian remains with drifted wood are to be found.

Much unnecessary complication and confusion in the classification and nomenclature of these Pliocene or Pre-glacial beds, which occur around the Norfolk and Suffolk coast, has been caused by the term "Forest-bed Series," as introduced in the year 1870 by Mr. Gunn,² and to its assumed stratigraphical position. It is stated by him to consist of a triple subdivision, viz. "the Rootlet-bed," "Forest-bed," and "Soil of the Forest-bed"; which sequence of deposits, however,

¹ Recently at East Dereham—situated in the middle of Norfolk—Glacial Drift deposits, 120 feet in thickness, have been proved by a well-boring to overlie the Chalk; the pre-glacial beds being absent. See Proc. Norwich Geol. Soc. vol. i. page 127.

² Quart. Journ. Geol. Soc. vol. xxvi. p. 553.

I contend—with all due deference—is merely hypothetical, inasmuch as it can nowhere be proved to exist. It, moreover, indicates no age whatever, beyond being placed in the published section in the Quarterly Journal¹ beneath the Chillesford Clay and Norwich Crag; which order of superposition can be demonstrated to be entirely erroneous! Consequently, it is not only desirable, but clearly imperative that a different classification and nomenclature should be adopted.

I therefore propose the following triple subdivision: viz. “the Rootlet-bed,” with its associated freshwater beds, the “Chillesford Clay,” and the “Norwich Crag.” And if it is considered desirable to have a connected series—owing to the very intimate relation of the beds, and the comparatively short period of time involved—I would suggest that the term “Mammalian or Norwich Crag Series” should be adopted, to embrace the three subdivisions above mentioned. This simple classification, I contend, accords with the facts observed, and the nomenclature suggested is amply sufficient, in my opinion, to denote the whole of the remarkable pre-glacial deposits referred to; which together are seldom to be seen anywhere around the coast in direct superposition, more than about 15 feet in thickness.

II.—THE CONGERIA BEDS IN ITALY.²

THE Congeria beds were shown to exist in Tuscany, in 1860, by Professor Capellini, and since then both Professor C. Mayer and Professor Fuchs have called attention to their appearance in various parts of Italy, and much has been written upon it during the last few years as bearing upon the question as to where the division between Miocene and Pliocene should be made in Italy.

The Congeria beds were already many years ago compared with those in the Wallachia and the Crimea, and now the same strata are shown to exist from Bollène (S. France), through Italy, Austria, Hungary, and the south of Russia. These sulphur-gypsum beds or Congeria strata on both sides of the Apennines are now shown to contain similar fossils, and the formation as found near Leghorn, Ancona, and Bologna, is directly compared, and it is shown to be analogous with that of the Piedmont Modenese, Reggiano, and Sicily, and to represent the “Schlier” of the Vienna geologists, the marl of Wieliczka and Wallachia, and perhaps in part the marl of Boom (Belgium), and the exact correspondence between the gypsum of Tuscany and that of the Romagne and the Marche, long known for its fossil flora, is now fully confirmed by means of the fossil fauna. Although the fossils distinctly prove the identical age, yet in almost each locality there are some found not common in others, and this is found to be the case in the Congeria beds of the neighbourhood of Castellina Marittima and the Aconitano.

¹ Quart. Journ. Geol. Soc. vol. xxxii. p. 124.

² Gli Strati a Congerie e le marne compatte mioceniche dei dintorni di Ancona. By Professore Giovanni Capellini, Mem. Accad. Lincei, ser. 3a. vol. iii. 1879.

Gli strati a Congerie e la formazione gessoso-solfifera nella provincia di Pisa e nei dintorni di Livorno. G. Capellini, Mem. Accad. dei Lincei, ser. 3, vol. 1880.