

When the well was bored, the tool, after passing through a layer of flints, sunk suddenly, and the water rushed up with a force that (as the late Superintendent expressed it to me) shook the hill. This shows that the spring is connected with an extensive and free reservoir. There are two other wells, at distances of a mile and a mile and a half, in a straight line east of this one, which are evidently connected with the same reservoir; for on Mondays, when the pumps are not at work at the Water-works, the water stands higher than usual in those wells. I conceive, then, that the motion of the water in this subterranean reservoir, caused by the draught of water at these wells, disturbed the equilibrium of the roofing of the chasm at a point where it was barely stable, and caused the subsidence in question.

This is rendered the more probable because it is evident that this natural pit is on a line of subterranean drainage, as is shown by the hole being dry at a level lower than that of the river. The water in the Colchester well stands at about 10 feet below the level of the river; which being more than a mile lower down the stream, would give at Lexden a greater difference between the subterranean and surface-drainage levels.

III.—ON THE CRAGS OF SUFFOLK AND ANTWERP. (PART I.)

By E. RAY LANKESTER, Esq.

THE Suffolk Crag.—There are few deposits in this country which form so admirable a field for study as the Crag* of Suffolk. Unique as to age, the sole representatives in England of the great Pliocene deposits of Europe, it becomes a matter of very high interest to identify them in any way with particular strata in other countries. The lowest of these Crag occurs in small patches over an area of about eighty square miles, and consists of either loose or compact light-coloured sand, alternating with bands of *Polyzoa*, which sometimes form a kind of limestone. From this Crag 299 species of *Mollusca* have been obtained: of these, 148 are extinct, 151 are

* The most important notices and memoirs that have been written on the Crag of Suffolk and Essex are—by Mr. Charlesworth, *Proceed. Geol. Soc.* 1835, vol. ii. p. 195; *Phil. Mag.* 1835, 3rd Ser., vol. vii. pp. 81, 465; *Report Brit. Assoc.* 1836, *Trans. Sect.* p. 84; by Sir C. Lyell, in his ‘*Principles*’ and ‘*Elements of Geology*,’ and in the *Mag. Nat. Hist.* 1839, New Ser., vol. iii. p. 313; Mr. Prestwich, *Quart. Journ. Geol. Soc.* 1849, vol. v. p. 350; Mr. S. V. Wood’s *Monograph of the Shells of the Crag* (2 vols. 1848–56; *Palaontographical Society*), and his paper on the Extraneous Fossils of the Red Crag, *Quart. Journ. Geol. Soc.* 1858, vol. xv. p. 32; and Mr. S. V. Wood, jun., on the Red Crag, *Annals Nat. Hist.* 1864, 3rd Ser., vol. xiii. Besides the *Mollusca*, the *Cirripedia*, *Echinodermata*, *Polyzoa*, *Corals*, and *Entomostraca* of the Suffolk Crag have been figured and described in the *Monographs of the Palaontographical Society*. The Crag of Antwerp were treated of by Sir C. Lyell in the *Quart. Journ. Geol. Soc.* 1852, vol. viii. p. 281, &c.; and several papers on these deposits and their fossils are to be found in the publications of the Brussels Academy, &c. Reuss has described the *Foraminifera* of the Antwerp Crag in the *Proceed. Vienna Acad.*, vol. xlii., 1860, p. 355, &c.

still living. This so-called 'Coralline Crag'* lies on London Clay, and is seldom more than 20 feet in thickness. The 'Red Crag,' so called from its iron-stained appearance, is an irregularly stratified deposit, composed of rather coarse sand and fragments of shells, abounding also in more perfect remains, but very rarely affording the valves of Conchifera, opposed or *in situ*. It extends over a larger area than the Coralline Crag, about 200 square miles, part of which is in Essex. The Red Crag, rarely exceeding 20 feet in thickness, in most localities rests on the London Clay, the Lower Crag having probably been denuded: it is occasionally, however, found resting on the latter. At the base of both Crag, when resting on the London Clay, a deposit of rounded concretionary nodules, derived from and containing the fossils of the London Clay, is found, and is worked for the nodules, which in great part consist of phosphate of lime, and are manufactured into manure. Associated with these nodules, are teeth of *Mastodon*, *Rhinoceros*, and other Mammals,† which have been derived perhaps from earlier Pliocene, perhaps from Miocene strata, and are similar, in some respects, to those obtained at Eppelsheim in Germany. In addition to these, there are the remains of large *Cetacea*, much worn and rolled, as well as the teeth of the large *Carcharodon* and *Oxyrhina*. These are probably the remains of a *former* Pliocene deposit, broken up like the Miocene beds at the beginning of the Crag era. Similar vertebrate fossils and phosphatic nodules are also dispersed at intervals in the higher strata of the Red Crag. Their occurrence here has led to much confusion, since they have been, and still are by many, regarded as indigenous to the Crag.

From the Red Crag 231 species of Mollusca have been obtained, of which 139 belong also to the Coralline Crag; and 92 are found only in the Red Crag. Of the latter group, 42 are extinct, and 50 are still living.

With the Mammaliferous or Norwich Crag, I do not purpose to deal in this paper, as it is a much later deposit.

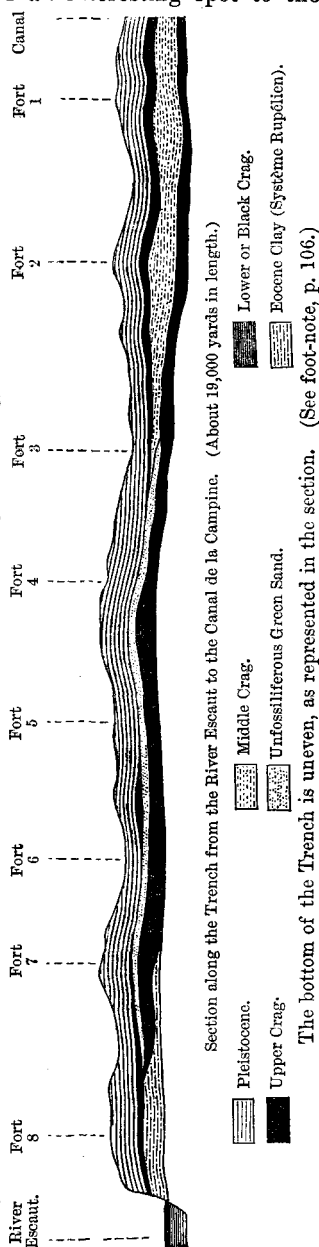
The Coralline and Red Crag, occupy the south-east sea-board of Suffolk and a part of Essex; extending along the coast about twenty miles, and inland twelve miles more or less.

The Antwerp Crag.—If the German Ocean be crossed from Orford on the Suffolk coast in a direction almost due south-east, the mouth of the River Escaut will be reached, on which stands the

* Of the three recognized divisions of the 'English Crag,' the lowest has been known as the 'Coralline Crag' ever since Mr. Charlesworth so named it in 1835, on account of its abounding with little *coral-like* fossils, which, however, when duly studied, were found to be *Bryozoa* (*Polyzoa*); Corals being exceedingly rare in it. 'Bryozoan Crag' ought, therefore, to take the place of this common misnomer; but 'White Crag,' or 'Lowest Suffolk Crag,' are better names for this division, and already in use.—EDIT. GEOL. MAG.

† It appears from the researches of Dr. Falconer, that these fossils are identical with Sub-Apennine forms: others, however, consider them of Miocene age. Whichever is the correct view, there is no doubt that the fossils are *extraneous*, and derived from earlier beds.

ancient city of Antwerp, which, always an interesting spot to the tourist, has at the present time an additional interest to such as are students of geological phenomena. Immense fortifications are being placed round the outskirts of the city, forming a semicircle some five or six miles in extent; and the deep trenches have displayed a series of sandy and argillaceous deposits, abounding in fossils, and presenting a strong resemblance to the Crag of Suffolk. How the fortifications of Antwerp are to be garrisoned, or what their ultimate utility may be with the small handful of soldiers which Belgium can supply, unless aided by this country, we need not stop to inquire. Let us plunge at once into the trenches, and examine the section,—a proceeding, by-the-by, strictly forbidden by the Government, and but to be accomplished by the payment of a franc to the sergeant on duty. The writer was enabled in this manner, last summer, to examine the strata in a satisfactory manner, and to form a good collection of their organic contents. As in Suffolk, the Crag-deposits rest on an Eocene clay, and are capped by Pleistocene strata, of an age equivalent probably to that of the Loess of the Rhine. The accompanying diagram will show the arrangement of the various beds. The section is taken from the River Escout to the Canal de la Campine, a distance of about 19,000 yards; the trenches in front of the eight detached forts, surrounding the line of works, furnishing the data upon which it is constructed. An admirable little paper (presented to the Royal Academy of Brussels) by M. Ad. De-jardin, Captain of Engineers, gives a description of two sections; one passing by the detached forts, and another along the semicircular line of entrenchment. The annexed diagram is constructed from my own observations, assisted by the excellent drawing of the Belgian Engineer. In many places



there are gaps where strata are wanting; and very rarely do the various beds rest conformably one on another.

Overlying the Rupelian or Eocene Clay, above mentioned, which is rarely exposed in the diggings, is a fine black sand, enclosing a very great number of fossils, which have a grey tint. All the Shells contained in this bed are perfect, many being closed Bivalves; the stratification is very even; and altogether the sand bears indication of having been quietly deposited. The immense abundance of the valves of a variety of *Pectunculus glycymeris*, a common fossil of the Coralline Crag, and represented by a noticeable variety (*subobliquus*) in the Red, is truly surprising; in fact, I have never seen so many Oyster-shells in a fishing-town, as I saw *Pectunculi* here. *Venus casina*, *Cardita senilis* (?), *Astarte*, *Nucula*, and a Volute, somewhat similar to *Voluta Lamberti*, are amongst the most conspicuous *Mollusca*; while *Natica*, *Pleurotomæ*, *Scalariæ*, *Fusi*, and others, are not uncommon. With these is associated a beautiful Coral, of the genus *Stephanophylla*, as well as *Polyzoa* (*Lunulites*, *Flustra*, and others). The Black Crag occupies by far the greater extent of the fortifications, in the formation of which many new species have been discovered. Above the Black or Lower Crag exists a bed of fine green sand, generally unfossiliferous, more particularly developed on the southern side of the works. In certain spots, however, a new species of *Ostrea* and a *Terebratula*, which may perhaps be considered as a variety of the well-known *T. grandis*, *variabilis*, *spondyloides*, vel *Sowerbii*, are found, as well as a few fossils of the Black Crag. This bed must therefore be regarded as a member of the Lower Crag; the change in its palæontological aspect resulting from some corresponding alteration of the level of the sea-bottom. Succeeding the green and black beds, is a grey bed, containing fossils of a much more recent aspect than most of those of the Black Crag, and therefore considered as a distinct deposit. This Middle Crag contains *Cyprina rustica*, *Astarte Omalii*, and numerous *unrolled* and well-preserved Cetacean remains and teeth of Sharks. Above this comes a yellowish-brown argillaceous deposit, of considerable thickness,* containing fossils of yet more recent form.

The yellow or Upper Crag contains *Cyprina rustica* and *Pecten maximus* abundantly, *Astarte mutabilis*, *Cyprina Islandica*, *Nassa labiosa*, *Lingula Mortieri*, and *Voluta Lamberti* of the typical form, also Cetacean and Fish-remains. The teeth of a species of *Phoca* have been described by M. Van Beneden from the Upper Crag also. Above the Upper Crag is a Pleistocene deposit, which forms an excellent parallel to the Pleistocene beds capping the Red Crag of Suffolk.—(*To be continued.*)

* It is impossible to estimate correctly the depth of any of the strata, as the trench varies much in depth itself. It is in most places 9 metres (29½ feet); and a glance at the section will show the relative amount occupied by each bed.