A BRIEF SKETCH OF THE WEALDEN BEDS OF THE ISLE OF WIGHT, AND THE HISTORY THEY REVEAL.

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The Isle of Wight is traversed by two great anticlines, or ridges—one running from Carisbrook to Sandown, whence it passes out to sea, and the other by Brook and Brighstone. They both take an east to west direction. The Wealden strata are exposed in Brighstone and Sandown Bays, in the Isle of Wight. Here they have been raised into domes by the earth-movements which elevated these anticlines. These domes have their steepest flanks to the north. They are exposed through denudation. The southern flank of the Brighstone dome has been destroyed by the sea, and that at Sandown has very nearly suffered the same fate. The Wealden are the oldest strata seen at the surface in the Isle of Wight. In the mainland of Hampshire they are not exposed, nor has any boring, or well, been sunk sufficiently deep to reach them. In the Isle of Wight they are found to be over 1,000 feet thick, and this does not include the whole of them, for the base is not visible. They are well developed in the district known as the Weald in Kent and Sussex, from whence they derive their name. They extend north and south about 100 miles, and spread for at least 200 miles east and west. As they have not been discovered along the line of outcrop of the Lower Greensand in Dorset, Wilts, and Berks, they must thin away westwards and northwards somewhat rapidly. They have suffered much from denudation.

The Wealden beds display two characteristic groups of strata. A lower, comprising red, purple, drab, mottled, and variegated marls and clays, with beds of sandstone; and an upper of blue shales, with laminæ as thin as paper, and traversed by sandstones and thin bedded limestones. These latter, however, are by no means constant, a bed commencing with an attenuated point gradually thickening and dying out, or passing into shale or clay.

A very prominent bed of sandstone rises from the beach at Shepherd's Chine, Atherfield, and outcrops at Barnes High. Wherever borings have been made in modern deltas alternations of mottled marls, clays, sandstones, and conglomerates have been passed through. The two groups of strata occur in the cliffs of both Sandown and Brighstone Bays; but in Compton Bay these two series are found to be repeated, that is, the cliff section shows first the mottled marls and sandstones of the lower, followed by the shales of the upper. After this, in natural sequence, as proved by the sections at Sandown and Atherfield, and Punfield in Dorsetshire, should be found the Lower Greensand formation. Instead, of this, however, red mottled marls and sandstones are repeated, overlaid by shales, and then the Lower Greensand. Most geologists who worked this district explained the fact by regarding it as the result of a fault, or dislocation, of the strata; but the exact locality where the line of fault, if present, should be discerned was so hidden by talus that it could not be actually proved. In 1906, however, the cliff here was washed clear of debris, and the fault was apparent, the red and mottled group lying against shales, which were contorted and displaced by the thrust of these lower beds over them. On the visit of the Geologists' Association of London, last spring, it was my privilege to point this out.

The fossils found in the Wealden beds of the Isle of Wight belong to terrestrial, fresh water, and estuarine forms, with an intermingling of marine types as the uppermost beds are reached. Many of the sandstones show current bedding, and in the marls are found pebbles of quartz, jasper, crystalline limestone, chert, and other rocks; all those capable of becoming so are beautifully polished on every

face, owing to the attrition of a journey along a muddy bottom. The pebbles of a shore are smoothed, but not polished. There are no beach deposits, no shingle, or gravel. It is true, conglomerates composed of small quartz pebbles, and calcareous rocks are found, but they speak more of a deposit on the bed of a stream than a beach. Although it has been sought to prove that these beds were laid down in lakes and lagoons, yet the lower group in the Isle of Wight point to deposition in a delta, and the upper, with a complete change in the nature of the sediment laid down, reveals a gradual subsidence of the district, with an intermittent influx of brackish water, until its level was sufficiently low to permit of the Neocomian Sea—which all the while had been outlying its area—to encroach completely over it, enabling marine crustaceans, molluces, and sharks to make it their habitat.

Long ago Mantell suggested that these beds must have been laid down by a river rivalling the Niger or Ganges in length and volume. The fauna and flora living on its banks or frequenting its waters, as they "shuffled off this mortal coil," either by natural decay or accident, were carried or rolled along by the river Weald until entrance into the still waters surrounding its embrochure they became entombed by the deposition of sediment. A constant search along the cliffs of the south of the island, where these strata are exposed, will reward the persevering seeker, for he will find their remains preserved by lime and iron.

The characteristic Wealden fern, *Lonchopteris Mantelli*, is not at all uncommon in the shales, and especially is this so in Brighstone Bay. *Pecopteris* and other forms occur. Cones of pines, and fruits of *Cycads*, *Thujites*, and seeds are found in both groups of strata. They may be picked up, after heavy rains, on the talus or at the foot of the cliffs in several places in Brighstone Bay. In the better preserved specimens the structure is well seen.

Mantell records from the beach at Brook Bay *Clathraria Lyelli*, a plant belonging to the *Cycads*, a branch of the *Coniferæ*. The occurrence of this plant in the Wealden series has been doubted, but I believe it does really occur at Brook

I found a well-preserved portion lying in a gutter in the mottled clays. The *Cycads* are tropical plants, revelling in a hot, humid atmosphere, and are found at the present day in Australia, Asia, South Africa, and America.

At Brook Point, lying upon mottled marls between high and low water mark, is to be seen the "fossil forest," which in reality is the remains of a raft of tree-trunks. The trunks of the trees are lying in different directions. In September, 1900, I measured one trunk, which was twenty-four feet long, with a diameter of three feet, and several had a greater diameter than that. At that date the raft could be traced for a distance of fifteen yards north and south and fifty yards east and west. The logs are calcareous and jet black in appearance. On some of them the bark is still found in a carbonaceous state. They are all now covered by fuci, zoophytes, and other organisms of the sea. The trees did not grow here *insitu*, for there are no roots or stumps in the clay in which they lie. They must have been transported from a distance. Some of the large North American rivers bring down from time to time great numbers of tree-trunks, but more especially after floods, which devastate their banks. Many of these arrive at the mouth in an interlaced mass, where, becoming water-logged, they sink, and as the movement of the water has much diminished, they become covered with the clay, sand, or other detritus which is being deposited in the estuary. Sir Charles Lyell, in his *Principles of Geology*, speaks of one in a tributary of the Mississippi ten miles in length, two hundred yards wide, and eight feet deep. The raft rises and falls with the water. They sometimes form natural bridges. Dr. Mantell suggested that these fossil tree-trunks at Brook Point once composed such a raft. "O, earth, what changes hast thou seen!" Long ago, in years that must be reckoned in millions, growing in a country populated only by weird reptiles, and having a tropical vegetation and climate, drained by a mighty river, on whose bosom they eventually were formed into a raft and carried to its delta, where, on sinking to the bottom, they were covered by the sediment, and then through many vicissitudes, in later geological periods, still further entombed by sediment until a mile of strata, or more, must have overlaid them. Then

tangential pressure elevated them, and now by denudation, through the forces of Nature, they are brought again to the light, where they lie at low tide in pools of sea-water, and turned to mineral and stone, enveloped by brown and yellow sea weeds, and bedecked with sea anemone, limpet, and sea shell. Once large reptiles browsed off their leaves or sheltered under them, and the flying reptile *(Pterodactyle)* perched on their branches or screamed over them as he wheeled round. Now it is the harsh cry of the sea bird, as day by day the waters of the English Channel are gradually carrying them away, particle by particle, transforming their likeness, yet not destroying, by laying them down as sediment on the sea-bottom. Thus, everlastingly, the cycles of Nature revolve.

Small fresh-water crustaceans *(Cyprides)* occur throughout the Wealden strata, but are extremely abundant in the shales. On some horizons, however thin you split the shale into laminæ, they are seen literally in thousands.

In the lower group the only mollusca found are of fresh-water species, mostly belonging to the genus *Unio*, the largest and best preserved being the *Unio Valdensis*, found in the marls near Brook Point; elsewhere they occur as casts, or with imperfectly fossilised shells. In the upper group *Unios* are still plentiful, as are such forms as *Cyrena* and *Paludina*, and towards the top, when brackish water conditions were beginning to obtain, *Ostrea*, *Vicarya*, and *Cardita* are found. In the shales Fitton records a derived *Ammonite*, and I found one covered with *Ostrea* about thirty feet below the top of the shales at Atherfield. It is a most interesting specimen.

Many remains of fish have been found in these beds. They are closely related to the groups *Lepidosteus* and *Amia*, to which the bony-pike and bow-fin of the North and Central American lakes and rivers of the present day belong. They had small teeth, like rounded knobs or beads. They were covered with quadrangular ganoid scales, and when found are of a brilliant enamelled black colour. They may often be found set in pyrites, or the calcareous rocks around the trunks of the fossil trees at Brook Point. Scattered examples also occur on many horizons. One particularly abundant layer is a bed of conglomerate at Sedmore. To bring to our minds

the style of fish and their habits, we may consider the *Lepidosteus Osteus*, which is now living in North and Central America and in Cuba. They grow to a length of six feet, and are carnivorous. They are armoured with white enamelled bony scales. They hunt for prey amidst floating herbage and river weeds. The other example, the *Amia Calva*, or bow-fin, to which these ancient fishes are allied, is also carnivorous, feeding on smaller fish, aquatic crustaceans, and insects. It breeds amongst the masses of water weeds fringing the lakes. Another fish, *Cœlodus Mantelii*, occurs in the shales at Atherfield. The only portions of the fish that I have found are two halves of the mandibular dentition. The vomerine teeth doubtless occur, but other parts are not likely to be obtained; their rhombic scales were thin, and they possessed no vertebræ. They were deep-bodied, and their teeth were made for grinding. I have discovered several good and interesting remains of *Teleostei*, or bony fishes, in the shales at Atherfield. These have not yet been worked out or described. The fin-spines of a shark *(Hybodus)*, allied to the Port Jackson shark of the present day, a last survival of an ancient order, are not at all uncommon in the shales. The spines supported the fins of the back (dorsal), in the same way as a mast does a sail. The Port Jackson shark does not exceed five feet in length. Not much is known of its habits, but its food consists of molluscs, which their pavement-like teeth are admirably adapted to crush. Teeth of *Hybodus* occur. Sharks are marine animals, but this is no argument against the fresh-water origin of this series of strata, for at the present day sharks live and die at the mouth of the Ganges, and, doubtless, are buried in the sediment brought and laid down by that river in its delta.

The remains of several tortoises have been discovered belonging to the *Chelydridæ* and *Plesiochelyidæ*. The plates of the carapace and plastron of *Tretosternum* occur both in the lower and upper group of strata, but very rarely in the latter, and confined to the lowest beds. They are covered on their exterior surfaces with little pustules, which readily differentiates them from *Plesiochelys*, which has the similar surfaces smooth, or slightly fluted. They are allied to tortoises that live in rivers and swamps, especially delighting

in a muddy bottom. At times they float on the surface, but also frequent the deeper waters. Several species of *Plesiochelys* have been obtained—*P. Valdensis*, *P. Brodei*, and *P. Vectensis*. The latter came into my possession in 1899. The matrix nearly hid the shell, for only the extreme edges of the marginals, the epi, and hyoplastrals, almost to the axillary notch, and portions of the sixth, seventh and eighth costal plates were visible. Carefully chiselling the specimen free of rock, I discovered the almost perfect shell. On examination I found it to be new to science. It was described by me in the Geological Magazine for June, 1900. A plaster cast is exhibited in the Reptile Gallery, Geological Department, Natural History Museum, South Kensington.

Recently I have obtained three more shells of *Plesiochelys*, all exhibiting both carapace and plastron. One specimen is very nearly entire, another minus a thin section of the right side, and the other comprises a diagonal slice from the nuchal bone to the left inquinal region, and is about one-third of the shell. I am in course of working them out, and at a later date hope to show that at least two, if not new species, are strong varieties. All I need say at present is that one approximates more closely to the upper Jurassic forms of the Continent than any of the *Plesiochelyidæ* hitherto discovered in the English Wealden beds.

Near the top of the shales scattered teeth of *Plesiosaurus* occur both in Compton and Brighstone Bay. I have found no bones *in situ*, but from a "founder" of the cliff I have obtained portions of humeri, femora, ischia, and vertebræ belonging to the same individual. The head of the Plesiosaurus was small, the neck long, the body large, with limbs resembling the flippers of a whale. The tail short, and furnished with a fin. No armour protected them. Their presence implies estuarine conditions of the upper horizons of the shales, as they were marine in their habits, but this fact we also gather from the presence of oysters and other estuarine forms. Constant influxes of the waters of the outlying Neocomian Sea are proved, which tell of the subsidence of the district.

Mantell was the first in England to give attention to these beds. He energetically sought for vestiges of life, and was successful in discovering many bones, mostly separate, and much rolled by water action. By his skill, aided by that of other natural philosophers of his day, such as Owen and Cuvier, he was enabled partly to build up the skeleton of a reptile to which was given the name of *Iguanodon*, from a resemblance in their teeth to those of the modern Iguana, found in the arboreal regions of Northern South America. A closer examination proved them to differ in important details. A thigh bone discovered by Mantell in the Isle of Wight measured three feet eight inches in length. Other remains were found in the Wealden strata of Tilgate Forest, in Sussex, but only fragmentary parts continued to be found, until in 1878, whilst mining for coal in the carboniferous rocks of Bernissart in Belgium, at a depth of 1,000 feet, a gallery was dug out which cut through mud laid down by a river which had excavated a valley here in the Wealden period, and a herd of twenty-five of these reptiles was discovered, and complete restoration of the skeleton was possible. When set up, one specimen had a length, from the extremity of the snout to the tip of the tail, of twenty-nine feet nine inches, and stood over fourteen feet high. These huge reptiles were terrestrial in their habits, but, doubtless, fond also of the water. Their skeletons show many birdlike features; these are most noticeable in the birdlike attitude, the short fore-limbs, the pelvic region, and the feet. Another peculiarity is a large dagger-like thumb. This thumb appears to have been the only means of defence, for the weighty and powerful tail was, and could be, used (by reason of the mode of articulation of the caudal vertebræ) only as a counterpoise to raise and lower the body.

The extremities of both the upper and lower jaws were enveloped in a horny sheath. The teeth numbered ninety-two, and were constantly replaced by new ones. The unworn teeth are bluntly pointed. They are serrated down their edges from crown to base, like a saw. The anterior side was grooved, forming a series of gouges on the biting line. On the external lateral face the enamel was thickest; the internal, by this means, wore away the quicker; a chisel

was thus always ready to help the saws and the gouges in browsing and masticating the tough palms and other leaves upon which it fed. The character of the teeth show that they could have been of service only to an animal with an herbivorous diet. Teeth of the *Iguanodon* occur, though somewhat sparingly, throughout the Isle of Wight Wealden strata. The pelvic girdle was beautifully adapted and strong. The pubic and ischium bones were of great length, and were probably so elongated to support the weight of the trunk when walking as a biped or to reach high-growing vegetation. I have found two femurs of *Iguanodon* in Brighstone Bay—the smaller, three feet four inches in length, is perfect, and the larger, four feet in length, is less so. The former I discovered *in situ*, and the latter is from a fall of the cliff. Both are from the lower group of strata. They are not water-worn. The limb bones of *Iguanodon* are hollow, and many specimens have this marrow cavity lined with calc-spar. A very interesting feature of the femur is a process of bone called the median trochanter, situated in the middle of the shaft. It was pointed out by Professor L. Dollo, of Brussels, that a similar process existed in the thigh-bone of a duck, and that a muscle extended from the ischium bone of the pelvis to this trochanter, and another from here to the tail. As the action of these muscles produces the waddling motion in ducks, he suggested that the reptile walked in a duck-like manner.

Counter impressions taken from fossil foot-prints in the Wealden of Hastings prove the animal to have walked flat-footed, with a tendency to use the heel more than the toes. These foot-marks manifest that it was a biped, as no trace of the fore-limbs, which had five fingers, are to be seen. The foot had only three toes. It was also noticed that the toes turned inwards, and that the tail was carried above the ground, for no markings caused by dragging are discernible. The tail was long, and, compared with the breadth, the depth was excessive.

In 1899 I discovered the largest portion of the skeleton of *Iguanodon Bernissartensis* yet found in England in Brighstone Bay. It consists of ribs, the sacrum, pubis, ilium, ischium,

femur, twenty vertebræ, and portions of other bones. Some of these I dug out of the clift and others from the débris of a fall of the cliff which had taken place here. Those lying in the cliff were perfect, and many of the vertebræ were in their natural position, with their neural and hæmal spines and processes entire. In appearance they were jet black, and truly a fine sight. It took three days to get all the bones out. From these bones, and fragments of others, I am convinced that the greater part of the skeleton was once there, and that the sea has carried away the other remains. The *Iguanodon* belongs to a family to which the name of *Dinosaurs* (terrible lizards) has been given, and is included in the sub-order *Ornithopoda* (bird-footed).

Another great *Dinosaur* is the *Megalosaurus*, which belongs to the *Theropoda* (beast-footed) sub-order, all of which are carnivorous. Its skeleton also shows many bird-like features. It appears to have been a biped, and to have been of a lighter build than the *Iguanodon*, to give agility and activity to its movements. It was about thirty feet in length. The limb bones were hollow. Their teeth were curved, and possessed edges serrated like a saw. The anterior border of the tooth was thick, whilst the posterior was very thin, forming a most powerful cutting tool. Their teeth are the most plentiful of the Dinosaurian teeth to be met with in the Isle of Wight. I have never found one on an horizon higher than the variegated marls. I have two sacrums and a few vertebræ of this reptile from Brighstone Bay.

Bones of *Ornithopsis Hulhei*, a *Dinosaur* belonging to the third sub-order *Sauropoda* (lizard-footed), have been collected in Brook and Brighstone Bays. A small fragment of the vertebræ is the only portion of the skeleton I have come across after many years of search. This reptile is remarkable for the extreme lightness of the bones of the neck and back, combined with great strength. The centrum of each of the vertebræ is composed of bony tissue, arranged like the honey-comb structure of the bones in the head of an elephant. The vertebræ conform to the same type as those of the *Brontosaurus*, from the Jurassic beds of Colorado, North

America. *Brontosaurus* was nearly sixty feet long, was herbivorous and amphibious, and is remarkable for the smallness of the head and brain. *Ornithopsis* was a much smaller reptile. It had blunt and weak teeth. It was also allied to the great land reptile *Diplodocus*, which attained a length of eighty feet. It will be remembered that a plaster cast of this creature has lately been erected in the British Museum, Natural History Sections, South Kensington.

Remains of *Hylæosaurus* have been obtained in Brighstone Bay. No skull or teeth that can be assigned with certainty to this reptile have been met with. The greater portion of the skeleton was discovered in 1832 by Dr. Mantell in the Wealden strata of Tilgate Forest. It is remarkable for its armour of enormous dermal spines, which are laterally flattened. It is closely allied to the *Stegosaurus* of America, which also had a series of huge defensive spines running down the back from the neck to the tail. The smallness of the head, when compared with the size of the body, is wonderful. A sacrum is the only one of its bones I have discovered. The bones of two other Dinosaur were discovered by the late Rev. W. D. Fox in Brighstone Bay—one a small *Iguanodont* named *Hypsilophodon Foxi*. It was unlike the *Iguanodon* in having teeth in the front of the upper jaw, and having four instead of three toes, and the other a *Stegosaurian*, *Polyacanthus Foxi*, which was supplied in an extraordinary manner with defensive armour. Very sharp pointed spines were situated down the back to the rump, which was covered with a bony shield, and this was followed by rows of spines down the tail. The vestiges of these two reptiles are rare. I have not yet had the fortune to find them, although I have often searched along the horizon from whence the Rev. W. D. Fox found his specimens. I have several unworn teeth of an *Iguanodont*, which reveal no serrations down their edges; they probably belong to an unknown variety. Fragments of limb bones, odd vertebræ, ribs, and other fragmentary parts may often be picked up. The foregoing are a few of the Dinosaurs that have been found in these strata in the Isle of Wight, but these are sufficient to give an idea of what was living on the banks of this old river.

Teeth, bones, and scutes of crocodiles occur throughout the strata. All the teeth I have found, except one, belong to *Goniopholis*. The odd specimen, instead of having the carina on the anterior and posterior margin, has it on the lateral faces, whilst it is compressed, and not rounded as in *Goniopholis*, it therefore, apparently, is one of the posterior teeth of *Suchosaurus*.

The best find of the associated bones of a crocodile from the Wealden of the I. of W. took me nearly two years to collect, and even now fragments are still coming to hand. They comprise the greater portion of the skeleton of *Goniopholis crassidens*, which I described in a paper read before the Geological Society in November last year. In the late autumn of 1904 a huge mass of the cliff at Atherfield, comprising many thousands of tons of strata, sank. Gradually subsiding, it forced its foot across the beach until it reached the water-line, where it suffered rapid denudation by the sea. In conjunction with Mr. Walter White, the coxswain of the Atherfield Life Boat, I watched this continuously, and obtained a block of rock containing crocodile bones and scutes. As this specimen revealed a clean, fresh fracture, a very careful search was kept along the lowest stratum and the beach, especially at low water.

Fragments of crocodile bones and fish vertebræ now and again were washed ashore. No greater reward was vouchsafed till Whitsuntide of 1905, when a series of very heavy "ground seas" completely removed the foot of the "founder." As the seas lessened, blocks were cast on to the beach, between high and low water-mark. We discerned that they belonged to a different individual from that previously discovered. No further block was found until August, 1905, when rough seas washed ashore two pieces, which, being fitted together, formed a section of a crocodile skull. Shortly afterwards the snout, minus the extreme end of the upper jaw, and one or two smaller parts of the cranium, were recovered. In the middle of September, 1905, I went to Atherfield, and with Mr. White visited the shore, where we had not been more than a few minutes before a huge sea broke, turning over the shore

rubble in its course. On its retreat a rock containing the whole of the skull behind the orbits, became visible in its backwash, although there had been no sign of it after the preceeding waves. The sea had damaged the exposed portions. Since then other blocks and small pieces have been washed up. The gathering in of this unique specimen from the maw of the sea necessitated much time, energy, and expense, but the reward has been great, for our knowledge of the osteology of this crocodile is now almost complete, and the joy of the hunt and the discovery has been intense.

This reptile takes its name, *Goniopholis*, from the angular-shaped scutes of the dorsal region, and, *crassidens*, from its thick and blunt teeth. The head was massive and wedge-shaped, and combined with a heavily armoured and powerful body, must have given the creature extraordinary facility in cleaving the waters. Its hind legs were longer than the fore, denoting swimming capacity and more marine habits than the present day crocodile. In this particular it resembles the ancient *Teleosaurs*, which preceded it in time. Other pronounced features of the skull are the deeply pitted ornamentation of the surface of the bone, the great size of the vacuities (supra-temporal fossæ) situated on the cranial roof behind the orbits, and the position of the eye-sockets, which precluded any but a forward vision. The reptile was splendidly and powerfully armoured with bony scutes, which were also deeply pitted. Those of the back possess a peg on their anterior external angle, which fitted under an overlap of the preceding scute. The posterior edge of these scutes also overlapped the anterior margin of the following, they were thus strongly articulated, and yet at the same time permitting the free movement of the body without becoming dislocated.

On the breast the scutes formed a shield. Here they are different in form and not articulated, but joined together into an immovable plate by suture. The reptile was thus well furnished to resist attacks from Ichthyosaur, Plesiosaur, Dinosaur, or any other of its congeners, whilst with its heavy jaws, lined with its sturdy teeth, it must have been able to render a good account of itself.

Not the least strange of the reptiles of the Wealden beds are the *Pterodactyles*, or "flying lizards." A specimen which I have secured from Brighstone Bay has not only the snout with many teeth in both upper and lower jaws, but several other parts of the skull, together with a number of vertebræ from the lower part of the back, the arm bones, including a portion of the wing finger, and other bones. From the size and length of the bones of the arm I estimate the reptile to have had an expanse of wing of about eighteen feet from tip to tip. Their bones were hollow and pneumatic. The limb bones had the bone as thin as the metal of a shot-gun barrel, and many others were even thinner than this. The wing was expanded by the great elongation of the fifth digit of the hand. As the impression of no feathers or hairs is to be seen on any of the specimens from the fine litho. graphic limestones of Solenhofen, which shows the integument of the membrane, it may be concluded that they were devoid of these appendages. These creatures could not only fly, but run on all fours, and perhaps walk as a biped. Their skulls were bird-like in shape, and those from the Wealden strata have lance-like teeth.

No remains have been found that can with certainty be assigned to birds, and no traces of mammals. A small marsupial has been discovered in older beds, as well as birds, therefore hope may be entertained that sooner or later research will be rewarded by a fortunate find.

The whole character of the fossils found in these strata proves the climate to have been similar to that now experienced in the tropics, and that they belong to species that have had their habitat either on the land or in fresh water. This, taken in conjunction with the alternation of the marls, clays, shales, and sandstones, and their current bedding, reveals the conditions when these beds were laid down to have been that of a delta of a river. The Wealden strata have suffered much from denudation, so that the area they once occupied must have been greater than at present. It may have been 20,000 square miles in extent. A vast amount of fresh water must have drained a continent or large island, and found here an outlet, where the currents, checked

by the still waters of the estuary, or bay, permitted the sediment to be deposited. The pebbles found in the strata belong to rocks foreign to the south-east of England. They point to a long journey, and this indication is borne out by their polished condition, and also by the fact that the bones and plant remains are for the most part separated, and rolled as though they came from a great distance. To enable us to appreciate these facts more fully, it will not be irrelevant to recall a few of the phenomena occurring in the delta of the Ganges. The Ganges, descending from the Himalayas, those huge mountains that overshadow the teeming plains of India, is over 1,500 miles long. The head of its delta is 220 miles from the sea, and its base 200 miles broad. The delta has many openings to the sea and numerous creeks, all containing salt water, except those communicating with the principal arm of the Ganges. When the river is low the influence of the tides is felt, even to the head. This influence is overcome during the flood season. During these floods the plains through which the river runs are inundated to a depth of many feet, and as they subside they carry off the spoils of the land, together with vast quantities of mud and sand, so great that the sea, to a distance of sixty miles from the mouth, is discoloured. The banks and islands are soon covered by reeds, grass, and other vegetation, which is inhabited by tigers, deer, crocodiles, and other animals. Human corpses are often carried down. All these become from time to time embedded in the mud annually laid down in the delta; also on the floor of the Bay of Bengal. The Wealden strata are the remains of such a river. Facts suggest that it flowed from the north-west. The mountain ranges of Great Britain can be, at the most, but vestiges of the watershed. We must, in imagination, go 1,500 miles or more from the Isle of Wight, and this distance in a north-westerly direction would take us far into the Northern Atlantic, where there are the remains of this huge continent or island. Do the mighty waters of the lonely North Atlantic Ocean play in calm, or battle in storm, over its denuded foundations? Have its wild waves for ages sung a dirge over the floors of mountains that once reared their proud heads far above them? If so, from

these mountains the river Weald descended into the plains and valleys, through ravines and down cataracts, and again through marshes and its delta, till the waters mingled with the Neocomian Sea. In its waters, or on the mud flats or marshy ground, strange old-world enamelled fishes swarmed, and armoured crocodiles and fresh-water tortoises disported. On its banks palms, cycads, tree ferns, conifers, and ferns flourished, as in the tropics now. Amidst these surroundings reptiles, various in forms and size, some as huge as an elephant, lived and thrived, whilst the air was tenanted with flying dragons. Floods and other natural causes brought their carcases down, together with tree-rafts, and entombed them in its delta, and here in the south-east of England, millions of years after, we read their history from the rocks in the quarry and the sea cliff. As the mind travels back through all known history to these æons of long ago, a vivid sense of our own littleness is felt, and we remember the question which puzzled Job—"Where wast thou when I laid the foundations of the earth."