On a Piece of Chalk

Source: **T.H. Huxley**, *Collected Essays*, London, Macmillan & Co., 1894-1908
Originally presented as a lecture at a meeting of the British Association in Norwich, 1868.

Thomas Henry Huxley (1815-95), an ardent Darwinian, was the greatest Victorian scientific popularizer. He coined the word 'agnostic' for disbelievers like himself, and his book *Man's Place in Nature* (1863) impressed humanity's ape-origins on the public imagination. Its frontispiece showed a queue of skeletons, with man at the front, and progressively more stooping apes behind. His lectures drew huge crowds — 2,000 were turned away in January 1866 when he inaugurated the 'Sunday Evenings for the People' at St Martin's Hall (Jenny Marx, Karl's daughter, squeezed in and found it 'packed to suffocation'). His most famous moment came at a British Association meeting in June 1860, when he clashed with Bishop 'Soapy Sam' Wilberforce. The bishop inquired whether it was on his grandfather's or his grandmother's side that he was descended from an ape. Huxley retorted that if he were asked whether he would rather have an ape as ancestor, or a man who, possessed of great means and faculties, employed them for the purpose of introducing ridicule into scientific debate, he would unhesitatingly choose the ape. Thirteen years later, when Wilberforce was pitched on his head while riding and killed, Huxley commented, 'For once reality and his brain came into contact, and the result was fatal.'

When the young H. G. Wells won a scholarship to the Royal College of Science, it was the teaching of Huxley ('a yellow-faced, square-jawed old man, with bright little brown eyes') that inspired him. So without Huxley's scientific imagination we might never have had science fiction, the genre Wells virtually invented. 'A Piece of Chalk' was originally a lecture given to working men at a meeting of the British Association in Norwich in 1868.

If a well were sunk at our feet in the midst of the city of Norwich, the diggers would very soon find themselves at work in that white substance almost too soft to be called rock, with which we are all familiar as 'chalk'.

Not only here, but over the whole county of Norfolk, the well-sinker might carry his shaft down many hundred feet without coming to the end of the chalk; and, on the sea coast, where the waves have pared away the face of the land which breasts them, the scarped faces of the high cliffs are often wholly formed of the same material. Northward, the chalk may be followed as far as Yorkshire, on the south coast it appears abruptly in the picturesque western bays of Dorset, and breaks into the Needles of the Isle of Wight; while on the shores of Kent it supplies that long line of

white cliffs to which England owes her name of Albion.

Were the thin soil which covers it all washed away, a curved band of white chalk, here broader, and there narrower, might be followed diagonally across England from Lulworth in Dorset, to Flamborough Head in Yorkshire — a distance of over 280 miles as the crow flies . . .

Attaining as it does in some places a thickness of more than a thousand feet, the English chalk must be admitted to be a mass of considerable magnitude. Nevertheless, it covers but an insignificant portion of the whole area occupied by the chalk formation of the globe, much of which has the same general characters as ours, and is found in detached patches, some less, and others more extensive, than the English. Chalk occurs in north-west Ireland; it stretches over a large part of France — the chalk which underlies Paris being in fact a continuation of that of the London basin; it runs through Denmark and central Europe, and extends southward to North Africa; while eastward it appears in the Crimea and in Syria, and may be traced as far as the Sea of Aral, in Central Asia. If all the points at which true chalk occurs were circumscribed, they would lie within an irregular oval about 3,000 miles in long diameter — the area of which would be as great as that of Europe, and would many times exceed that of the largest existing inland sea — the Mediterranean . . .

Thus the chalk is no unimportant element in the masonry of the earth's crust. . . What is this widespread component of the surface of the earth? and whence did it come?

You may think this no very hopeful inquiry. You may not unnaturally suppose that the attempt to solve such problems as these can lead to no result, save that of entangling the enquirer in vague speculations, incapable of refutation and of verification. If such were really the case, I should have selected some other subject than a 'piece of chalk' for my discourse. But, in truth, after much deliberation I have been unable to think of any topic which would so well enable me to lead you to see how solid is the foundation upon which some of the most startling conclusions of physical science rest.

A great chapter of the history of the world is written in the chalk . . . To the unassisted eye chalk looks like a very loose and open kind of stone. But it is possible to grind a slice of chalk down so thin that you can see through it — until it is thin enough, in fact, to be examined with any magnifying power that may be thought desirable . . . When placed under the microscope, the general mass of it is made up of very minute granules; but, imbedded in this matrix are innumerable bodies, some smaller and some larger, but on a rough average not more than a hundredth of an inch in diameter, having a well-defined shape and structure. A cubic inch of some specimens of chalk may contain hundreds of thousands of these bodies, compacted

together with incalculable millions of granules.

The examination of a transparent slice gives a good notion of the manner in which the components of the chalk are arranged, and of their relative proportions. But, by rubbing up some chalk with a brush in water and then pouring off the milky fluid, so as to obtain sediments of different degrees of fineness, the granules and the minute rounded bodies may be pretty well separated from one another, and submitted to microscopic examination, either as opaque or as transparent objects. By combining the views obtained in these various methods, each of the rounded bodies may be proved to be a beautifully constructed calcareous fabric, made up of a number of chambers, communicating freely with one another. The chambered bodies are of various forms. One of the commonest is something like a badly-grown raspberry, being formed of a number of nearly globular chambers of different sizes congregated together. It is called *Globigerina*, and some specimens of chalk consist of little else than *Globigerinae* and granules. Let us fix our attention upon the *Globigerina*. It is the spoor of the game we are tracking. If we can learn what it is and what are the conditions of its existence, we shall see our way to the origins and the past history of the chalk . . .

It so happens that calcareous skeletons, exactly similar to the *Globigerinae* of the chalk, are being formed, at the present moment, by minute living creatures, which flourish in multitudes, literally more numerous than the sands of the sea-shore, over a large extent of that part of the earth's surface which is covered by the ocean . . . *Globigerinae* of every size, from the smallest to the largest, are associated together in the Atlantic mud, and the chambers of many are filled by a soft animal matter. This soft substance is, in fact, the remains of the creature to which the *Globigerinae* shell, or rather skeleton, owes its existence — and which is an animal of the simplest imaginable description. It is, in fact, a mere particle of living jelly without defined parts of any kind — without a mouth, nerves, muscles, or distinct organs, and only manifesting its vitality to ordinary observation by thrusting out and retracting from all parts of its surface long filamentous processes, which serve for arms and legs. Yet this amorphous particle, devoid of everything which, in the higher animals, we call organs, is capable of feeding, growing, and multiplying; of separating from the ocean the small proportion of carbonate of lime which is dissolved in sea water; and of building up that substance into a skeleton for itself, according to a pattern which can be imitated by no other known agency . . .

The important points for us are that the living *Globigerinae* are exclusively marine animals, the skeletons of which abound at the bottoms of deep seas; and that there is not a shadow of reason for believing that the habits of the *Globigerinae* of the chalk differed from those of the existing species. But if this is true, there is no escaping the conclusion that the chalk itself is the dried mud of an ancient deep sea.

In working over the soundings [samples of mud from the floor of the Atlantic, collected for Huxley by HMS *Cyclops* in 1857], I was surprised to find that many of what I have called the 'granules' of that mud were not, as one might have been tempted to think at first, the mere powder and waste of *Globigerinae*, but that they had a definite form and size. I termed these bodies *coccoliths*, and doubted their organic nature. Dr Wallich verified my observation, and added the interesting discovery that, not infrequently, bodies similar to these *coccoliths* were aggregated together into spheroids, which he termed *coccospheres*. So far as we knew, these bodies, the nature of which is extremely puzzling and problematical, were peculiar to the Atlantic soundings. But, a few years ago, Mr Sorby, in making a careful examination of the chalk by means of thin sections, observed that much of its granular basis possesses a definite form. Comparing these formed particles with those in the Atlantic soundings, he found the two to be identical . . . Here was a further and most interesting confirmation, from internal evidence, of the essential identity of the chalk with modern deep-sea mud. *Globigerinae*, coccoliths and coccospheres are found as the chief constituents of both . . .

When we consider that the remains of more than three thousand distinct species of aquatic animals have been discovered among the fossils of the chalk, that the great majority of them are of such forms as are now met with only in the sea, and that there is no reason to believe that any one of them inhabited fresh water — the collateral evidence that the chalk represents an ancient sea-bottom acquires as great force as proof derived from the nature of the chalk itself. I think you will allow that I did not overstate my case when I asserted that we have as strong grounds for believing that all the vast area of dry land at present occupied by the chalk was once at the bottom of the sea, as we have for any matter of history whatever; while there is no Justification for any other belief.

No less certain is it that the time during which the countries which we now call south-east England, France, Germany, Poland, Russia, Egypt, Arabia, Syria, were more or less completely covered by a deep sea, was of considerable duration. We have already seen that the chalk is, in places, more than a thousand feet thick. I think you will agree with me that it must have taken some time for the skeletons of animalcules of a hundredth of an inch in diameter to heap up such a mass as that. I have said that throughout the thickness of the chalk the remains of other animals are scattered. These remains are often in the most exquisite state of preservation. The valves of the shell-fishes are commonly adherent; the long spines of some of the sea-urchins, which would be detached by the smallest jar, often remain in their places. In a word, it is certain that these animals have lived and died when the place which they now occupy was the surface of as much of the chalk as had then been deposited; and that each has been covered up by the layer of *Globigerinae* mud upon which the creatures embedded a little higher up have, in like manner, lived and died . . .

Huxley now turns his attention to the strata above the chalk layer, among them the glacial deposits known as boulder clay and drift.

At one of the most charming spots on the coast of Norfolk, Cromer, you will see the boulder clay forming a vast mass, which lies upon the chalk, and must consequently have come into existence after it . . . The chalk, then, is certainly older than the boulder clay. If you ask how much, I will again take you no further than the same spot upon your own coasts for evidence. I have spoken of the boulder clay and drift as resting upon the chalk. That is not strictly true. Interposed between the chalk and the drift is a comparatively insignificant layer, containing vegetable matter. But that layer tells a wonderful history. It is full of stumps of trees standing as they grew. Fir-trees are there with their cones, and hazel-bushes with their nuts; there stand the stools of oak and yew trees, beeches and alders. Hence this stratum is appropriately called the 'forest-bed'.

It is obvious that the chalk must have been upheaved and converted into dry land before the timber trees could grow upon it. As the bolls of some of these trees are from two to three feet in diameter, it is no less clear that the dry land thus formed remained in the same condition for long ages. And not only do the remains of stately oaks and well-grown firs testify to the duration of this condition of things, but additional evidence to the same effect is afforded by the abundant remains of elephants, rhinoceroses, hippopotamuses, and other great wild beasts, which it has yielded to the zealous search of such men as the Rev. Mr Gunn. "When you look at such a collection as he has formed, and bethink you that these elephantine bones did veritably carry their owners about, and these great grinders crunch, in the dark woods of which the forest-bed is now the only trace, it is impossible not to feel that they are as good evidence of the lapse of time as the annual rings of the tree stumps.

Thus there is writing upon the wall of cliffs at Cromer, and whoso runs may read it. It tells us, with an authority that cannot be impeached, that the ancient sea-bed of the chalk sea was raised up, and remained dry land until it was covered with forests, stocked with the great game the spoils of which have rejoiced your geologists. How long it remained in that condition cannot be said; but 'the whirligig of time brought in its revenges' in those days as in these. That dry land, with the bones and teeth of generations of long-lived elephants hidden away among the gnarled roots and dry leaves of its ancient trees, sank gradually to the bottom of the icy sea, which covered it with huge masses of drift and boulder clay. Sea-beasts, such as the walrus, now restricted to the extreme north, paddled about where birds had twittered among the topmost twigs of the fir trees. How long this state of things endured we know not, but at length it came to an end. The upheaved glacial mud hardened into the soil of modern Norfolk. Forests grew once more, the wolf and the beaver replaced the reindeer and the elephant; and at length what we call the history of England dawned.

Thus you have, within the limits of your own county, proof that the chalk can justly claim a very much greater antiquity than even the oldest physical traces of mankind . . . Evidence which cannot be rebutted, and which need not be strengthened, though if time permitted I might infinitely increase its quantity, compels you to believe that the earth, from the time of the chalk to the present day, has been the theatre of a series of changes as vast in their amount, as they were slow in their progress. The area on which we stand has been first sea and then land, for at least four alterations; and has remained in each of these conditions for a period of great length.

Nor have these wonderful metamorphoses of sea into land, and of land into sea, been confined to one corner of England. During the chalk period, or 'cretaceous epoch', not one of the present great physical features of the globe was in existence. Our great mountain ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the chalk was deposited, and the cretaceous sea flowed over the sites of Sinai and Ararat . . .

I must ask you to believe that there is no less conclusive proof that a still more prolonged succession of similar changes occurred, before the chalk was deposited. Nor have we any reason to think that the first term in the series of these changes is known. The oldest sea-beds preserved to us are sands, and mud, and pebbles, the wear and tear of rocks which were formed in still older oceans.

But great as is the magnitude of these physical changes of the world, they have been accompanied by a no less striking series of modifications in its living inhabitants. All the great classes of animals, beasts of the field, fowls of the air, creeping things, and things which dwell in the waters, flourished upon the globe long ages before the chalk was deposited. Very few, however, if any, of these ancient forms of animal life were identified with those which now live. Certainly not one of the higher animals was of the same species as any of those now in existence. The beasts of the field, in the days before the chalk, were not our beasts of the field, nor the fowls of the air such as those which the eye of man has seen flying, unless his antiquity dates infinitely further back than we at present surmise. If we could be carried back into those times, we should be as one suddenly set down in Australia before it was colonized. We should see mammals, birds, reptiles, fishes, insects, snails, and the like, clearly recognized as such, and yet not one of them would be just the same as those with which we are familiar, and many would be extremely different.

From that time to the present the population of the world has undergone slow and gradual, but incessant, changes. There has been no grand catastrophe — no destroyer has swept away the forms of life of one period, and replaced them by a totally new creation: but one species has vanished and another has taken its place; creatures of one type of structure have diminished, those of another have increased as time has passed on. And thus, while the differences between the living creatures

of the time before the chalk and those of the present day appear startling, if placed side by side, we are led from one to the other by the most gradual progress, if we follow the course of Nature through the whole series of those relics of her operations which she has left behind. It is by the population of the chalk sea that the ancient and modern inhabitants of the world are most completely connected. The groups which are dying out flourish side by side with the groups which are now the dominant forms of life. Thus the chalk contains remains of those strange flying and swimming reptiles, the pterodactyl, the ichthyosaurus, and the plesiosaurus, which are found in no later deposits, but abounded in preceding ages. The chambered cells called ammonites and belemnites, which are so characteristic of the period preceding the cretaceous, in like manner die with it.

But amongst these fading remainders of a previous state of things, are some very modern forms of life, looking like Yankee pedlars among a tribe of Red Indians. Crocodiles of modern type appear; bony fishes, many of them very similar to existing species, almost supplant the forms of fish which predominate in more ancient seas; and many kinds of living shell-fish first become known to us in the chalk . . .

There is not a shadow of a reason for believing that the physical changes of the globe, in past times, have been effected by other than natural causes. Is there any more reason for believing that the concomitant modifications in the forms of the living inhabitants of the globe have been brought about in other ways? . . . Science gives no countenance to such a wild fancy; nor can even the perverse ingenuity of a commentator pretend to discover this sense in the simple words in which the writer of Genesis records the proceedings of the fifth and sixth days of the Creation.

A small beginning has led us to a great ending. If I were to put the bit of chalk with which we started into the hot but obscure flame of burning hydrogen, it would presently shine like the sun. It seems to me that this physical metamorphosis is no false image of what has been the result of our subjecting it to a jet of fervent, though no-wise brilliant, thought tonight. It has become luminous, and its clear rays, penetrating the abyss of the remote past, have brought within our ken some stages of the evolution of the earth. And in the shifting 'without haste, but without rest' of the land and sea, as in the endless variation of the forms assumed by living beings, we have observed nothing but the natural product of the forces originally possessed by the substance of the universe.[1]

[1] “On a Piece of Chalk,” in *Eyewitness to Science* edited by John Carey, Harvard University Press, Cambridge, Massachusetts, 1995, pp. 139-147.