

CHAPTER XV.

Imbedding of organic remains in subaqueous deposits—Division of the subject—Phenomena relating to terrestrial animals and plants first considered—Wood sunk to a great depth in the sea instantly impregnated with salt-water—Experiments of Scoresby—Drift timber carried by the Mackenzie into Slave Lake and into the sea—Cause of the abundance of drift timber in this river—Floating trees in the Mississippi—In the Gulf stream—Immense quantity thrown upon the coast of Iceland, Spitzbergen, and Labrador—Imbedding of the remains of insects—of the remains of reptiles—Why the bones of birds are so rare in subaqueous deposits—Imbedding of terrestrial quadrupeds—Effects of a flood in the Solway Firth—Wild horses annually drowned in the savannahs of South America—Skeletons in recent shell marl—Drifting of mammiferous and other remains by tides and currents.

WE have treated hitherto of the imbedding of organic remains in deposits formed upon the emerged land, and we shall next consider the including of the same in deposits formed under water.

It will be convenient to divide this branch of our subject into three parts; considering first, the various modes whereby the relics of *terrestrial* species may be buried in subaqueous formations; secondly, the modes whereby the animals and plants inhabiting *fresh-water* may be so entombed; thirdly, the manner in which *marine* species may become preserved in new strata.

The phenomena which we are now about to notice demand a fuller share of attention than those previously examined, since the deposits which originate upon the dry land are insignificant in thickness, superficial extent, and durability, when contrasted with those of subaqueous origin. At the same time, the study of the latter is beset with greater difficulties, for we are here concerned with the results of processes much more removed from the sphere of ordinary observation. There is, indeed, no circumstance, as we before remarked*,

* Vol. i., p. 81.

which more seriously impedes the acquisition of just views in the etiology of our science, than an habitual disregard of the important fact, that the reproductive effects of the principal agents of change are confined to another element,—to that larger portion of the habitable globe, from which, by our very organization, we are almost entirely excluded.

Imbedding of Terrestrial Plants.

When a tree falls into a river from the undermining of the banks, or from being washed in by a torrent or flood, it floats on the surface, not because the woody portion is specifically lighter than water, but because it is full of pores containing air. When soaked for a considerable time, the water makes its way into these pores, and the wood becomes *water-logged* and sinks. The time required for this process varies differently in different woods, but several kinds may be drifted to great distances, sometimes across the ocean, before they lose their buoyancy.

If wood be sunk to vast depths in the sea, it may be impregnated with water suddenly. Captain Scoresby informs us, in his *Account of the Arctic Regions**, that on one occasion a whale, on being harpooned, ran out all the lines in the boat, which it then dragged under water, the men having just time to escape to a piece of ice. When the fish returned to the surface “to blow,” it was struck a second time, and soon afterwards killed. The moment it expired it began to sink,—an unusual circumstance, which was found to be caused by the weight of the sunken boat which still remained attached to it. By means of harpoons and ropes the fish was prevented from sinking until it was released from the weight by connecting a rope to the lines of the attached boat, which was no sooner done than the fish rose again to the surface. The sunken boat was then hauled up with great labour, for so heavy was it, that although before the accident it would have been buoyant when full of water, yet it now required a boat at each

* Vol. ii. p. 191.

end to keep it from sinking. "When it was hoisted into the ship, the paint came off the wood in large sheets; and the planks, which were of wainscot, were as completely soaked in every pore as if they had lain at the bottom of the sea since the Flood! A wooden apparatus that accompanied the boat in its progress through the deep, consisting chiefly of a piece of thick deal, about fifteen inches square, happened to fall overboard, and, though it originally consisted of the lightest fir, sank in the water like a stone. The boat was rendered useless; even the wood of which it was built, on being offered to the cook for fuel, was tried and rejected as incombustible*."

Captain Scoresby found that by sinking pieces of fir, elm, ash, &c., to the depth of four thousand and sometimes six thousand feet, they became impregnated with sea-water, and when drawn up again, after immersion for an hour, would no longer float. The effect of this impregnation was to increase the dimensions as well as the specific gravity of the wood, every solid inch having increased one-twentieth in size and twenty-one twenty-fifths in weight †.

When timber is drifted down by a river, it is often arrested by lakes, and becoming water-logged it may sink and be imbedded in lacustrine strata, if any be there forming: sometimes a portion floats on till it reaches the sea. In the course of the Mackenzie River we have an example of vast accumulations of vegetable matter now in progress under both these circumstances.

In Slave Lake in particular, which vies in dimensions with some of the great fresh-water seas of Canada, the quantity of drift-timber brought down annually is enormous. "As the trees," says Dr. Richardson, "retain their roots, which are often loaded with earth and stones, they readily sink, especially when water-soaked, and, accumulating in the eddies, form shoals, which ultimately augment into islands. A thicket of small willows covers the new-formed island as soon as it appears above water, and their fibrous roots serve to bind the

* Account of the Arctic Regions, vol. ii. p. 193.
Vol. II.

† Ib. p. 202.
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whole firmly together. Sections of these islands are annually made by the river, assisted by the frost; and it is interesting to study the diversity of appearances they present according to their different ages. The trunks of the trees gradually decay until they are converted into a blackish brown substance resembling peat, but which still retains more or less of the fibrous structure of the wood; and layers of this often alternate with layers of clay and sand, the whole being penetrated, to the depth of four or five yards or more, by the long fibrous roots of the willows. A deposition of this kind, with the aid of a little infiltration of bituminous matter, would produce an excellent imitation of coal, with vegetable impressions of the willow roots. What appeared most remarkable was the horizontal slaty structure that the older alluvial banks presented, or the *regular curve* that the strata assumed from unequal subsidence.

“It was in the rivers only that we could observe sections of these deposits, but the same operation goes on on a much more magnificent scale in the lakes. A shoal of many miles in extent is formed on the south side of Athabasca Lake, by the drift-timber and vegetable debris brought down by the Elk River; and the Slave Lake itself must in process of time be filled up by the matters daily conveyed into it from Slave-River. Vast quantities of drift timber are buried under the sand at the mouth of the river, and enormous piles of it are accumulated on the shores of every part of the lake*.”

The banks of the Mackenzie display almost everywhere horizontal beds of wood coal, alternating with bituminous clay, gravel, sand, and friable sandstone; sections, in short, of such deposits as are now evidently forming at the bottom of the lakes which it traverses.

Notwithstanding the vast forests intercepted by the lakes, a still greater mass of drift-wood is found where the Mackenzie reaches the sea, in a latitude where no wood grows at present except a few stunted willows. At the mouths of the river the

* Dr. Richardson's Geognost. Obs. on Capt. Franklin's Polar Expedition.

alluvial matter has formed a barrier of islands and shoals, where we may expect a great formation of coal at some distant period.

The abundance of floating timber on the Mackenzie is owing, as I am informed by Dr. Richardson, to the peculiar direction and to the length of the course of this river, which runs from south to north, so that the sources of the stream lie in much warmer latitudes than its mouths. In the country, therefore, where the former are situated, the frost breaks up at an earlier season, while yet the waters in the lower part of its course are ice-bound. Hence the current of water, rushing down northward, reaches a point where the thaw has not begun, and finding the channel of the river blocked up with ice, it overflows the banks, sweeping through forests of pines, and carrying away thousands of uprooted trees.

We have already observed* that the navigation of the Mississippi is much impeded by trunks of trees half sunk in the river. On reaching the Gulf of Mexico many of them subside and are imbedded in the new strata which form the delta, but many of them float on and enter the Gulf-stream. "Tropical plants, (says M. Constant Prevost,) are taken up by this great current, and carried in a northerly direction, till they reach the shores of Iceland and Spitzbergen uninjured. A great portion of them are doubtless arrested on their passage, and, probably, always in the same inlets, or the same spots on the bottom of the ocean; in fact, wherever an eddy or calm determines their distribution, which, in this single example, extends over a space comprehended between the equator and the eightieth degree of latitude—an immense space, six times more considerable than that occupied by all Europe, and thirty times larger than France. The drifting of various substances, though regular, is not continual; it takes place by intermittance after great inundations of rivers, and in the intervals the waters may only carry sand or mud, or each of these alternately, to the same localities †."

* Vol. i. p. 245.

† Mém. de la Soc. d'Hist. Nat. de Paris, vol. iv. p. 84.

The ancient forests of Iceland, as Malte-Brun observes, have been improvidently exhausted; but, although the Icelander can obtain no timber from the land, he is supplied with it abundantly by the ocean. An immense quantity of thick trunks of pines, firs, and other trees, are thrown upon the northern coast of the island, especially upon North Cape and Cape Langaness, and are then carried by the waves along these two promontories to other parts of the coast, so as to afford sufficiency of wood for fuel and for constructing boats. Timber is also carried to the shores of Labrador and Greenland; and Crantz assures us that the masses of floating wood thrown by the waves upon the island of John de Mayen often equal the whole of that island in extent*.

In a similar manner the bays of Spitzbergen are filled with drift-wood, which accumulates also upon those parts of the coast of Siberia that are exposed to the east, consisting of larch trees, pines, Siberian cedars, firs, and Fernambucco and Campeachy woods. These trunks appear to have been swept away by the great rivers of Asia and America. Some of them are brought from the Gulf of Mexico, by the Bahama stream, while others are hurried forward by the current which, to the north of Siberia, constantly sets in from east to west. Some of these trees have been deprived of their bark by friction, but are in such a state of preservation as to form excellent building timber †. Parts of the branches and almost all the roots remain fixed to the pines which have been drifted into the North Sea, into latitudes too cold for the growth of such timber, but the trunks are usually barked.

The leaves and lighter parts of plants are seldom carried out to sea, in any part of the globe, except during tropical hurricanes among islands, and during the agitations of the atmosphere which sometimes accompany earthquakes and volcanic eruptions ‡.

* Malte-Brun, *Geog.* vol. v. part i. p. 112.—Crantz, *Hist. of Greenland*, tome i. pp. 50—54.

† Olafsen, *Voyage to Iceland*, tome i. Malte-Brun's *Geog.* vol. v. part i. p. 112.

‡ De la Beche, *Geol. Manual*, p. 477.

It will appear from these observations, that although the remains of terrestrial vegetation, borne down by aqueous causes from the land, are chiefly deposited at the bottom of lakes or at the mouths of rivers, yet a considerable quantity is drifted about in all directions by currents, and may become imbedded in any *marine* formation, or may sink down, when water-logged, to the bottom of unfathomable abysses, and there accumulate without intermixture of other substances.

It may be asked whether we have any data for inferring that the remains of a considerable proportion of the existing species of plants will be permanently preserved, so as to be hereafter recognizable, supposing the strata now in progress to be at some future period upraised? To this inquiry we may reply that there are no reasons for expecting that more than a small number of the plants now flourishing in the globe will become fossilized, since the entire habitations of a great number of them are remote from lakes and seas, and even where they grow near to large bodies of water, the circumstances are quite accidental and partial which favour the imbedding and conservation of vegetable remains. Those naturalists, therefore, who infer that the ancient flora of the globe was, at certain periods, less varied than now, merely because they have as yet discovered only a few hundred fossil species of a particular epoch, while they can enumerate more than fifty thousand living ones, are reasoning on a false basis, and their standard of comparison is not the same in the two cases.

Imbedding of the Remains of Insects.

I HAVE observed the elytra and other parts of beetles in a band of fissile clay, separating two beds of recent shell-marl, in the Loch of Kinnordy. Amongst these, Mr. Curtis recognized *Elater lineatus* and *Atopa cervina*, species still living in Scotland. These, as well as other remains which accompanied them, appear to belong to terrestrial, not aquatic species, and must have been carried down in muddy water during an inundation.

In the lacustrine peat of the same locality, the elytra of beetles are not uncommon; but in the deposits of drained lakes generally, and in the silt of our estuaries, the relics of this class of the animal kingdom are extremely rare. In the blue clay of very modern origin of Lewes Levels, Mr. Mantell has found the *Indusia*, or cases of the larvæ of *Phryganea*, in abundance, with minute shells belonging to the genera *Planorbis*, *Limnea*, &c., adhering to them*.

When speaking of the migrations of insects, we pointed out that an immense number are floated into lakes and seas by rivers, or blown by winds far from the land; but they are so buoyant that we can only suppose them, under very peculiar circumstances, to sink to the bottom before they are either devoured by insectivorous animals or are decomposed.

Remains of Reptiles.

As the bodies of several crocodiles were found in the mud brought down to the sea by the river inundation which attended an earthquake in Java in the year 1699, we may imagine that extraordinary floods of mud may stifle many individuals of the shoals of alligators and other reptiles which frequent lakes and the deltas of rivers in tropical climates. Thousands of frogs were found leaping about among the wreck carried into the sea by the late inundations in Morayshire †; and it is evident that whenever a sea-cliff is undermined, or land is swept by other violent causes into the sea, land reptiles may be carried in.

Remains of Birds.

WE might have anticipated that the imbedding of the remains of birds in new strata would be of very rare occurrence, for their powers of flight insure them against perishing by numerous casualties to which quadrupeds are exposed during

* Trans. Geol. Soc. vol. iii. part i. p. 201, Second Series.

† Sir T. D. Lauder's Account, Second Ed., p. 312.

floods; and if they chance to be drowned, or to die when swimming on the water, it will scarcely ever happen that they will be submerged so as to become preserved in sedimentary deposits. For in consequence of the hollow tubular structure of their bones and the quantity of their feathers, they are extremely light in proportion to their volume, so that when first killed they do not sink to the bottom like quadrupeds, but float on the surface until the carcass either rots away or is devoured by predaceous animals. To these causes we may ascribe the absence of any vestige of the bones of birds in the recent marl formations of Scotland; although these lakes, until the moment when they were artificially drained, were frequented by a great abundance of water-fowl.

Imbedding of Terrestrial Quadrupeds.

RIVER inundations recur in most climates at very irregular intervals, and expend their fury on those rich alluvial plains where herds of herbivorous quadrupeds congregate together. These animals are often surprised, and being unable to stem the current, are hurried along until they are drowned, when they sink immediately to the bottom. Here their bodies are drifted along, together with sediment, into lakes or seas, and may then be covered by a mass of mud, sand, and pebbles, thrown down upon them. If there be no sediment superimposed, the gases generated by putrefaction usually cause the bodies to rise again to the surface about the ninth, or at most the fourteenth day. The pressure of a thin covering would not be sufficient to retain them at the bottom, for we see the putrid carcasses of dogs and cats, even in rivers, floating with considerable weights attached to them, and they would be still more buoyant in sea-water.

In cases where the body is so buried in drift-sand, or mud accumulated upon it, as never to rise again, the skeleton may be preserved entire; but if it comes again to the surface while in the process of putrefaction, the bones commonly fall

piecemeal from the floating carcass, and may in that case become scattered at random over the bottom of a lake, estuary, or sea, so that a jaw may afterwards be found in one place, a rib in another, a humerus in a third—all included, perhaps, in a matrix of fine materials, and where there may be evidence of very slight transporting power in the current, or even of none, but simply of some chemical precipitate.

A large number of the bodies of drowned animals, if they float into the sea or a lake, especially in hot climates, are instantly devoured by sharks, alligators, and other carnivorous beasts, which may have power to digest even the bones. But during extraordinary floods, when the greatest number of land animals are destroyed, the waters are commonly so turbid, especially at the bottom of the channel, that even aquatic species are compelled to escape into some retreat where there is clearer water, lest they should be stifled. For this reason, as well as the rapidity of sedimentary deposition at such seasons, the probability of some carcasses becoming permanently imbedded is considerable.

One of the most memorable floods of modern date, in our island, is that which visited part of the southern borders of Scotland, on the 24th of January, 1794, and which spread particular devastation over the country adjoining the Solway Frith.

We learn from the account of Captain Napier, that the heavy rains had swollen every stream which entered the Frith of Solway, so that the inundation not only carried away a great number of cattle and sheep, but many of the herdsmen and shepherds, washing down their bodies into the estuary. After the storm, when the flood subsided, an extraordinary spectacle was seen on a large sand-bank, called "the beds of Esk," where there is a meeting of the tidal waters, and where heavy bodies are usually left stranded after great floods. On this single bank were found collected together the bodies of nine black cattle, three horses, one thousand eight hundred and forty sheep, forty-five dogs, one hundred and eighty hares, besides

a great number of smaller animals, and, mingled with the rest, the corpses of two men and one woman*.

In those more recent floods in Scotland, in August 1829, whereby a fertile district, six hundred miles in length, became a scene of dreadful desolation, a vast number of animals and plants were washed from the land, and found scattered about after the storm, around the mouths of the principal rivers. An eye-witness thus describes the scene which presented itself at the mouth of the Spey, in Morayshire. "For several miles along the beach, crowds were employed in endeavouring to save the wood and other wreck with which the heavy rolling tide was loaded; whilst the margin of the sea was strewed with the carcasses of domestic animals, and with millions of dead hares and rabbits. Thousands of living frogs, also, swept from the fields, no one can say how far off, were observed leaping among the wreck †."

We are informed by Humboldt, that during the periodical swellings of the large rivers in South America, great numbers of quadrupeds are annually drowned. Of the wild horses, for example, which graze in immense troops in the savannahs, thousands are said to perish when the river Apure is swollen, before they have time to reach the rising grounds of the Llanos. The mares, during the season of high water, may be seen, followed by their colts, swimming about and feeding on the grass of which the top alone waves above the waters. In this state they are pursued by crocodiles; and their thighs frequently bear the prints of the teeth of these carnivorous reptiles. "Such is the pliability," observes the celebrated traveller, "of the organization of the animals which man has subjected to his sway, that horses, cows, and other species of European origin, lead, for a time, an amphibious life, surrounded by crocodiles, water-serpents, and manatees. When the rivers return again into their beds, they roam in the savan-

* Treatise on Practical Store Farming, p. 25.

† Sir T. D. Lauder's Account of the Great Floods in Morayshire, August 1829, p. 312, Second Ed.

nah, which is then spread over with a fine odoriferous grass, and enjoy, as in their native climate, the renewed vegetation of spring*.”

We find it continually stated, by those who describe the Ganges and Burrampooter, that these rivers carry before them, during the flood season, not only floats of reeds and timber, but dead bodies of men, deer, and oxen †.

We have already referred to the effects of a flood which attended an earthquake in Java in 1699, when the turbid waters of the Batavian river destroyed all the fish except the carp; and when drowned buffaloes, tigers, rhinoceroses, deer, apes, and other wild beasts, were brought down to the sea-coast by the current, with several crocodiles which had been stifled in the mud ‡.

On the western side of the same island, in the territory of Goulongong, in the regencies, a more recent volcanic eruption (1821) was attended by a flood, during which the river Tjetandoy bore down hundreds of carcasses of rhinoceroses and buffaloes, and swept away more than one hundred men and women from a multitude assembled on its banks to celebrate a festival. Whether the bodies reached the sea, or were deposited, with drift matter, in some of the large intervening alluvial plains, we are not informed §.

We might enumerate a great number of local deluges that have swept through the fertile lands which border on large rivers, especially in tropical countries, but we should surpass the limits of this work. We may observe, however, that the destruction of islands, in rivers, is often attended with great loss of lives. Thus, when the principal river in Virginia rose, in 1771, to the height of twenty-five feet above its ordinary level, it swept entirely away Elk Island, on which were seven

* Humboldt's *Pers. Narr.*, vol. iv., pp. 394—396.

† Malte-Brun, *Geog.*, vol. iii., p. 22.

‡ See ante, vol. i., p. 444.

§ This account I had from Mr. Baumhauer, Director-General of Finances in Java.

hundred head of quadrupeds,—horses, oxen, sheep, and hogs,—and nearly one hundred houses*.

The reader will gather, from what we have said in a former volume respecting the deposition of sediment by aqueous causes, that the greater number of the remains of quadrupeds drifted away by rivers must be intercepted by lakes before they reach the sea, or buried in fresh-water formations near the mouths of rivers. If they are carried still farther, the probabilities are increased of their rising to the surface in a state of putrefaction, and, in that case, of being there devoured by aquatic beasts of prey, or of subsiding into some spots whither no sediment is conveyed, and, consequently, where every vestige of them will, in the course of time, disappear.

In some instances, the skeletons of quadrupeds are met with abundantly in recent shell-marls in Scotland, where we cannot suppose them to have been imbedded by the action of rivers or floods. They all belong to species which now inhabit, or are known to have been indigenous in Scotland. The remains of several hundred skeletons have been procured within the last century, from five or six small lakes in Forfarshire, where shell-marl has been worked. Those of the stag (*Cervus elaphus*) are most numerous, and if the others be arranged in the order of their relative abundance, they will follow nearly thus: the ox, the boar, the horse, the sheep, the dog, the hare, the fox, the wolf, and the cat. The beaver seems extremely rare, but it has been found in the shell-marl of Loch Marlie, in Perthshire, and in the parish of Edrom, in Berwickshire.

In the greater part of these lake deposits there are no signs of floods, and the expanse of water was originally so confined, that the smallest of the above-mentioned quadrupeds could have crossed, by swimming, from one shore to the other. Deer, and such species as take readily to the water, may often have been mired in trying to land, where the bottom was soft and quaggy, and, in their efforts to escape, may have plunged deeper into the marly bottom. Some individuals, we suspect,

* Scots Mag., vol. xxxiii.

of different species, have fallen in when crossing the frozen surface in winter, for nothing can be more treacherous than the ice when covered with snow, in consequence of the springs, which are numerous, and which, always retaining an equal temperature, cause the ice, in certain spots, to be extremely thin, while, in every other part of the lake, it is strong enough to bear the heaviest weights.

As the bones of mammalia are often so abundantly preserved in peat, and in such lakes as we have just described, the encroachments of a sea upon a coast may sometimes throw down the imbedded skeletons, so that they may be carried away by tides and currents, and entombed in subaqueous formations. Some of the smaller quadrupeds, also, which burrow in the ground, as well as reptiles and every species of plant, are liable to be cast down into the waves by this cause, which must not be overlooked, although we believe it to be of comparatively small importance amongst the numerous agents whereby terrestrial organic remains may be included in submarine strata.
