



## LXII. On the odour exhaled from certain organic remains in the diluvium of the arctic circle, as confirmatory of Dr. Buckland's opinion of a sudden change of climate at the period of destruction of the animals to which theft belonged; and on the probability that one of the fossil bones, brought from eschsoltz bay, by Captain Beechey, belonged to a species of megatherium

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LXII. *On the Odour exhaled from certain Organic Remains in the Diluvium of the Arctic Circle, as confirmatory of Dr. Buckland's Opinion of a sudden Change of Climate at the Period of Destruction of the Animals to which they belonged; and on the Probability that one of the Fossil Bones, brought from Eschscholtz Bay, by Captain Beechey, belonged to a Species of Megatherium.* By E. W. BRAYLEY Jun., A.L.S., Teacher of the Physical Sciences in the Schools of Hazelwood and Bruce Castle.

IN Dr. Buckland's very interesting and important article on the occurrence of the remains of elephants, &c., in the cliffs of frozen mud in Eschscholtz Bay, &c. which forms part of the Appendix to Capt. Beechey's Narrative of his Voyage to the Pacific and Beering's Strait, a strong odour of decomposing animal matter which is exhaled from some of the localities in which those remains are found, is noticed several times. Thus, in the notes extracted from the Journal of Mr. Collie, the surgeon to the Expedition, it is stated that "a very strong odour, like that of heated bones, was exhaled wherever the fossils abounded." In the extract from Capt. Kotzebue's account of the same spot it is observed, "We could not assign any reason for a strong smell, like that of burnt horn, which we perceived in this place." And "other observers," Dr. Buckland remarks, "have stated the same thing of the mud cliffs in Siberia, near the mouth of the Lena, which contain similar organic remains."—(Beechey's Narrative, Appendix, pp. 599, 601, 604.)

The odour emitted by burning bones and horn arises from the development of ammonia, mingled or combined with volatile animal substances, ensuing from the decomposition, by the heat, of the gelatine, &c. of the bodies subjected to it. Any decomposition of animal matter, however effected, in which ammonia was evolved in considerable proportion, would produce a similar smell; which may be attributed, in the instances before us, to one of the two following causes, or perhaps to both causes combined.

1st. The intense cold which froze into a mass the diluvium of the Polar Sea and its organic remains, would necessarily arrest the decomposition of many animal combinations in those remains, as well as reduce to a fixed form the volatilizable principles they contained. By this means, the evolution of volatile matters would be prevented, and others would be preserved, which, had the animal remains been exposed to such temperatures as now prevail either in the torrid or in the temperate zone, would have escaped in the volatile form, by the ordinary process of putrefaction. But in the summer, from June to October, as we find from Capt. Beechey's Meteorologi-

cal Journal, the temperature of the air in Eschscholtz Bay, rises to above 70° Fahrenheit, and that of the surface of the sea to above 50°, the solar radiation rising of course still higher than the air; and the cliffs, consequently, during this season, are constantly thawing. This change of temperature would liberate the volatile matters, and permit the further decomposition of the animal substances attached to or contained in the bones, so as to impregnate the local atmosphere with effluvia, which the succeeding winter would have no power to fix again; though it might confine them to the vicinity, and prevent their further production until the next summer.

2nd. Mr. Clift has shown that the bones found in the caverns of the Plymouth limestone, which have lost nearly all their animal matter, have probably been deprived of it by the clay with which they are surrounded having absorbed it. (Phil. Trans. 1823, p. 83.) The partial decomposition of the bones from Eschscholtz Bay may have been produced in this manner, and thus the clay in which they are found, may, during the summers which have passed since the deposition of the diluvium, have become impregnated with their animal matter. Or, the animal matter formerly surrounding and attached to these bones may have been absorbed by the clay in the same manner. And in either case, the animal substances being thus in a state of comparative minute division, mingled with the earthy matter forming the clay, and exposed to the high temperature of the summers, as well as, in the under-cliff, constantly to the operation of the sea-water, would be in the most favourable state for continual decomposition, thus producing the odour in question\*. It may further be remarked, that the rapid alterations of temperature, during the summer months, from the

\* The view taken by Mr. Clift of the manner in which the bones found in the caves of the Plymouth limestone, have been deprived of their animal matter, and the important connection which the nature of the mud in which the bones are imbedded at Eschscholtz Bay, may have with the circumstances of their original inhumation, show the utility of geologists', when collecting organic remains, being careful to collect specimens of their matrix, also, and not to leave the nature of that to be determined merely by the inadequate means of portions of it accidentally adhering to the fossils. It will be useful, in future, to notice this subject, in instructions to collectors and geological observers, in a more emphatic manner than has yet been done. Specimens of the matrices of organic remains, it would appear, should be collected, for the express purpose of serving for examination with respect to their influence on the mode of preservation of the latter.

Chemical analysis should also be resorted to on these points. Thus, the clay enveloping the Plymouth bones, if Mr. Clift's conjecture be well founded, would yield evidence of animal matter, and a similar examination of that in which the bones are imbedded, in Eschscholtz Bay, would be of considerable importance in the elucidation of the origin of the smell apparently diffused by them.

freezing

freezing point to above  $70^{\circ}$ , and the great alternation annually, from summer to winter, to which these matters are exposed, would further promote this successive decomposition, would indeed be most favourable to it. So that, upon the whole, the animal matter of the bones in this diluvium, or that of the tissues by which they were once invested, having been preserved by the cold, the circumstances under which they have existed since the production of that cold, have been such as to be most favourable to its constant though slow decomposition, and the necessary production of the peculiar odour perceived in the localities in which the bones are found.

Dr. Buckland, however, reasoning from the fact stated by Mr. Collie, that the odour in question was perceived at the base of another mud cliff, in Shallow Inlet, where there were no bones, thinks that in this case we must attribute it to some cause unconnected with the bones, and probably to gaseous exhalations from the mud itself. And, on this ground, he thinks that we may draw the same inference as to the origin of the odour in all the other cases also; "thus in Eschscholtz Bay," he observes, "where nearly all the bones were collected at the base of the cliff on the beach below high water, how can the presence of two or three bones only, lying half-way up the cliff, account for the odour which is emitted over a distance of more than a mile along this shore? How inadequate is a cause so partial to so general an effect! since, however numerous may be the animal remains that are buried in the interior of the cliff, no exhalations from them can escape through their impenetrable matrix of frozen mud; and even if that fallen portion of mud which constitutes the under-cliff be ever so abundantly loaded with fossil bones, it is scarcely possible that these should undergo such rapid decomposition as to transmit strong exhalations to the surface through so dense a substance as saturated clay; in fact, their high degree of preservation shows that no such rapid decomposition has taken place."—(Beechey's Narrat. Appen. p. 604.)

But the peculiar nature of the odour in question, its occurrence in two distant points where the same fossils are present under the same circumstances, and its absence, so far as has yet been recorded, in all other localities of the Arctic regions, forbid us, I think, to refer it to any other origin than the decomposition of some part of the animal matter of those fossils. The reasoning of Dr. Buckland, upon this point, does not appear to me to be conclusive. In Eschscholtz Bay, the presence of two or three bones only, lying half-way up the cliff, certainly will not account for the diffusion of the odour for a mile along the shore; but a portion of this effect may reasonably be attributed to bones in the situation of those which were actually collected by Mr. Collie, "at the base of the cliff on the beach below high

high water," where the action of the sea, combined with the alternations of temperature, would tend continually to their decomposition. We are not called upon to suppose that the fossils are undergoing rapid decomposition, nor that their exhalations are transmitted through dense saturated clay; but that they are, and have been for many ages, undergoing slow periodical decomposition, in mud, a portion of which is always covered by the waves, and another portion covered at high water\*, therefore frequently in a semifluid state, and on that account very favourable to the extrication of gaseous matter†. The considerations already urged, to account for the production of the smell, will equally account for its diffusion along the shore; for it must arise from the fossils in the under-cliff, brought down by the degradation occasioned by the heat of the summer, in the manner explained by Capt. Beechey and Mr. Collie, and acted upon by that heat, in conjunction with the sea. And if the suggestion before made as to the probability of the diffusion of animal matter, by former absorption, among the earthy substances of the diluvium, and the mud resulting from its degradation, be adopted, the great diffusion of the odour will be still better explained, since "gaseous exhalations from the mud itself" would certainly arise from the decomposition of animal matter so diffused. As already observed, *rapid* decomposition would not be required for this effect; the successive exhalations arising from the slow decomposition proceeding for so many summers, retained near the spot by the stilling powers of the intense winter, and the comparative tranquillity of the atmosphere of the bay, would be amply sufficient for this effect.

Since, therefore, an adequate cause for this smell appears to exist in several localities, the just rules of induction seem to require, that we should rather regard its presence in other places, as indicating the existence of the same cause (*i. e.* the presence of fossils) in them, than attribute its production to unknown causes, in those places where the circumstances seem fully adequate to account for it. Although no bones were observed, either at Shallow Inlet, or near the em-

\* In accordance with this, Mr. Collie states that the few specimens taken from the debris on the front of the cliff "were in a better state of preservation than those which had been alternately covered and left exposed by the flux and reflux of the tide, or imbedded in the mud and clay of the shoal."—(Beechey's Narrative, Appendix, p. 599.)

† Capt. Beechey, in relating his examination of the head of Eschscholtz Bay, when describing his approach to the cliff adjacent to the embouchure of Buckland River, in the earth of which he perceived the smell, (as will be stated in the sequel,) observes, "We landed upon a flat muddy beach, and were obliged to wade a quarter of a mile before we could reach a cliff for the purpose of having a view of the surrounding country."—(Narrative, p. 322.)

bouchure of Buckland River, at the head of Eschscholtz Bay, in both which spots, however, the smell was perceived\*, yet we shall not be justified in assuming, from the former circumstance, that no animal remains are contained in the diluvium at these points, resembling as it does, in all other characters, that of the other localities. It is far more likely that future degradation of the cliffs will expose them. In such situations many bones may exist undiscovered; the probability of which is confirmed by the history of Elephant Point. Nearly all the bones obtained both by the Russian and the English Expedition were collected here; but Mr. Collie states that at his first visit to the spot, in July 1826, he "saw no traces of fossils." Now, had Elephant Point not been visited a second time, we might have reasoned on the supposed absence of fossils in that locality, in the manner Dr. Buckland has actually done respecting the cliff in Shallow Inlet. And even supposing that no fossils should at present exist at the last-mentioned place, the mud may contain animal matter derived from them as formerly existing, and now itself suffering decomposition, and resolution into gaseous substances.

I have been thus particular in endeavouring to show how this odour might naturally have been produced from the animal matter of the bones, or of the soft parts in which they were once enveloped, and in combating Dr. Buckland's opinion of its having a different origin, unconnected with the organic remains in this diluvium, because, the fact that such an odour should exist in the places where those remains have been discovered, appears to me to furnish an important confirmation of one of the conclusions which have been deduced by Dr. Buckland, from the entire history of the organic remains in the diluvium of the Arctic Circle.

The conclusion to which I allude, is that of the sudden change of climate of that region, from warmth, to intense cold. For, that such an odour as the one described, should arise from the organic remains in the diluvium of the Arctic Circle, tends strongly to confirm the deduction of the suddenness of the transition from heat to cold, by which the catastrophe destroying the animals, and producing that diluvium, was accom-

\* The latter of these spots, though described as one of those in which the smell was perceived, by Capt. Beechey, is not mentioned by Dr. Buckland. The circumstances under which the odour occurs here, appear to corroborate the inference that it arises, in all cases, from animal remains originally imbedded in the substance of the diluvium; for, speaking of the cliff itself, which is stated to have been similar in appearance to that at Elephant Point, from which the fossils were afterwards obtained, Captain Beechey remarks, that "*the earth*, in parts, had a disagreeable smell, similar to that which was supposed to proceed from the decayed animal substances in the cliff near Elephant Point."—(Narrative, p. 322.)

panied. It would be, indeed, the natural result of the destruction of animals by a mighty inundation, attended by a sudden change of temperature from warmth to intense cold, and the immediate burial of their remains in the detritus swept together by that inundation. Had the last change of temperature undergone by the polar regions been slow,—had it been a gradual transition, of course occupying considerable time, from their former high to their present very low temperature, the volatilizable substances of the animal remains in Eschscholtz Bay and at the mouth of the Lena, would have been dissipated by putrefaction, long before the freezing of the diluvium and its contents.

The facts of the preservation of the carcasses of the mammoth and rhinoceros, prove the region in which they were found to have been intensely cold at the time immediately succeeding their death; but the odour now diffused by the organic remains in the diluvium of Eschscholtz Bay and of the mouth of the Lena, affords collateral evidence to the same effect; and it is, indeed, the corresponding fact with respect to these remains, which we must suppose to have suffered in a greater degree than the carcasses by the violence of the inundation. “The carcass of a single elephant preserved in ice is,” indeed, “decisive,” as Dr. Buckland observes, “of the existence of continual and intense cold ever since the period at which it perished;” and that the last change from heat to cold was sudden, “is shown by the preservation of the carcass in ice;” but the induction is strengthened by our finding that evidence to the same effect is afforded by animal remains inhumed at the same epoch, but the state of which more nearly resembles that of the contemporaneous fossils in the temperate zone, and the parallelism of whose actual condition with that of the carcasses is not immediately obvious\*.

In Dr. Buckland’s description of the most perfect specimens of animal remains from Eschscholtz Bay, selected by him to be engraved in illustration of his memoir, and stated to be deposited in the British Museum, occurs a notice of a “Cervical vertebra of an unknown animal,” on which the following remarks

\* It is proper, in the investigation of subjects of the magnitude and complexity of that now before us, to notice every fact which can have any relation to them, whatever may be the influence of such facts upon our theoretical speculations. On this account I make the following remark.

Dr. Buckland observes (Narrative, Appendix, p. 610), that too much stress has been laid on the circumstance of the mammoth in Siberia being covered with hair; and cites several examples from among the existing animals of warm latitudes, to show, that no conclusive argument in proof that the Siberian elephant was the inhabitant of a cold climate can be drawn from that fact. But the most important fact I would submit, is not that certain animals

remarks are given: "It has been compared with all the skeletons in the collection at Paris, by Mr. Pentland, without finding any to which it can be referred: he thinks the nature of the articulation more resembles that in the sloth and ant-eaters than in any other animal; but the bone differs from them in other respects, and approaches to the character of the *Pachydermata*. The animal, whatever it was, seems to have differed essentially from any that now inhabit the polar regions of the northern hemisphere."—(Narrative, Appendix, p. 597.)

On perusing this notice, and comparing it with the size (about five inches in extent) of this vertebra, as shown by the engraving, it occurred to me that it may perhaps be referable to a species of *Megatherium*. This supposition is not precluded by the comparison made by Mr. Pentland, at Paris, for there is no skeleton of the *Megatherium*, nor even I believe a single bone of that animal, in the Parisian collection, the skeleton at Madrid being the only one at present extant in Europe. The resemblance of the vertebra, in the nature of the articulation, to the sloth and ant-eaters, accords exactly with the ascertained characters of the osteology of the *Megatherium*; while its approach in other respects to the character of the *Pachydermata*, is in agreement with the relations connecting the *Edentata* and *Pachydermata* in the series of mammiferous animals, which have been recognized by many naturalists, especially by Linnæus and Cuvier. The former naturalist placed all the *Edentés* of Cuvier with which he was acquainted, in his own order of *Bruta*, in which were also included the *Pachydermes* of Cuvier; and the latter, in his *Leçons d'Anatomie Comparée*, makes his tribe of the *Tardigrades* (to which the Sloth and the *Megatherium* belong) the means of transition from the other *Edentés* to the *Pachydermes*; and though he has not followed this arrangement in his later *Règne Animal*, he has in that work repeatedly alluded to the connexion between these groups\*.

It will probably be difficult if not impossible to decide this point

animals of warm climates, belonging to genera very different from the Elephant, are thickly covered with hair and wool, but that the two existing species of the *Elephant* itself, both inhabiting warm climates, are devoid of such a covering. This seems to be a more direct (converse) analogy, in favour of the supposition that the Siberian elephant was adapted to live in a cold climate, than those mentioned by Dr. Buckland are, in favour of the opposite view of the subject.

I may also observe, in conclusion, that the facts cited by Cuvier, and regarded by him (in the extract given by Dr. Buckland at the end of his memoir) as refuting the hypothesis of the gradual refrigeration of the earth, merely show the *last* change of temperature to have been sudden, and leave the validity of that hypothesis, as to all preceding changes, unimpugned.

\* See Mr. W. S. MacLeay's "Remarks on the Comparative Anatomy of N.S. Vol. 9. No. 54. June 1831. 3 H certain

point without actually comparing the vertebra with the corresponding bone of the *Megatherium*. The comparison of the figure given by Dr. Buckland with the description and engraving of the bones of the *Megatherium* contained in the last edition of Cuvier's *Ossemens Fossiles*, afforded no decisive indication on the subject, either negative or affirmative. Whether a similar comparison with the plates of Pander and D'Alton would lead to a satisfactory determination, I am not aware; and in this deficiency of evidence I mention my supposition, for the purpose of drawing attention to the subject. It is probable that the means of actual comparison with the *Megatherium* will shortly be afforded, by the arrival in England of a perfect skeleton of that animal, recently announced as having been obtained by Mr. Woodbine Parish, at Buenos Ayres\*.

Should this vertebra ultimately prove to have in reality belonged to a species of *Megatherium*, the fact will lead to further interesting results. An important object of inquiry will be, whether the *Megatherium* was co-extensive on both continents, with the extinct elephant, or whether, like the sloths, and the ant-eaters (*Myrmecophaga*, Linn.,) to which it is allied, it was confined to the New World, where, alone, the bones of the *Megatherium* also have yet been discovered†. The localities in which the latter have hitherto been found, including that of the skeleton in the possession of Mr. W. Parish, are included within the parallels of about 40° south, and 40° north latitude; and the remains of the allied genus *Megalonyx* have occurred only between the parallels of 30° and 40° north.

All these remains, I believe, have been found in superficial deposits of clay and gravel, &c., or in caverns; and under circumstances which would have caused them to be referred to the "Diluvial" era, until the recent discriminations on that subject; but their history is at present too little known, to permit us, in the actual condition of science, to point out, determinately, the epoch to which they belong. The view which Dr. Buckland has taken of the mode of destruction of the extinct Elephant, is equally applicable to the *Megatherium*, if they were coexisting animals.

16, St. James's Street, Clerkenwell, May 20, 1831.

*certain Birds of Cuba*," in the Transactions of the Linnæan Society, vol. xvi. p. 25, 27—29, 37—40; and Cuvier, *Règne Animal*, (edit. 1829) tome i. p. 223, 236.

\* See Prof. Jameson's Journal, January—March 1831.

† The remaining fossil animal belonging to the *Edentata* is at present known only from a single ungual phalanx, of gigantic size, found, together with bones of *Pachydermata*, both of extinct and still existing genera, in sand and gravel, at Eppelsheim in the Palatinate. Its living analogue, the Pangolin (*Manis*, Linn.,) is confined to the Old World.—Cuvier, *Ossemens Fossiles*, tom. v. 1<sup>re</sup> partie, p. 193; *Règne Animal*, tom. i. p. 232—233.