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The Rationale of an Open Sea in the North Polar Region, Considered with Reference to Analogous Developments during Winter in the Interior Lakes of North America

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Source: *Proceedings of the Royal Geographical Society of London*, Vol. 17, No. 2 (1872 - 1873), pp. 133-138

Published by: [Wiley](#) on behalf of [The Royal Geographical Society \(with the Institute of British Geographers\)](#)

Stable URL: <http://www.jstor.org/stable/1799262>

Accessed: 17/06/2014 06:31

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Lieutenants Dawson and Henn crossed the mainland on the East Coast. We now know that Mr. Stanley himself had contemplated the possibility of Dr. Livingstone's pushing on for the West Coast; and the surmise thrown out by Mr. Charles Livingstone on the 21st of March (long before the world knew of the great explorer's safety) that his brother might yet work his way down the Congo has recently received the authority of Captain Burton, who suggests an Expedition from the West Coast to meet him.

2. *On the Rivers Mukah and Oyah in Borneo.* By Lieutenant
C. C. DE CRESPIGNY, R.N., F.R.G.S.

I HAVE been up to Mount Ular Bulu, in search of cinnabar, but found no indications of it, or of any other metal. On the way up the Mukah I stopped at Lelac, where are the remains of a long Milanow-house. The iron-wood posts are still standing, although great forest trees have grown about and among them. Menjanei, one of my Milanow chiefs, who was with me, said that his great-great-grandfather, named Bugud, was the chief of Lelac, and, in consequence of the inconstancy of his wife, he called in the aid of the Kyans and destroyed the place, and all his own people who happened to be at home. The ruins are 96 fathoms in length. The rivers Mukah and Oyah being under my jurisdiction, I hold Court at various Dyak villages. I crossed over to the Oyah River, and at Aniow's house sent for the Pakattans chief Suni. Two years ago the Pakattans built some houses just below Aniow's Dyaks, but getting heavily in debt to the Dyaks, they had shown a disposition to flit. I promised Suni that, if he would leave his wandering habits and live in houses like other people, I would supply him with seed-cocoanuts and other seeds. He promised upon this to bring his people together to the houses they had formerly built.

The Pakattans are an interesting tribe. Although they lead a wandering life in the forests, and do not live in houses, they are by no means the savages one would infer from that fact, although the Dyaks treat them with pity and a little contempt. They tattoo themselves from head to foot in the most beautiful manner. They live almost entirely by the chase. Latterly they have sown padi here and there among the Dyak clearings, but, having sown it, go away into the jungle, and at harvest-time are content to take what the deer and pigs have left them. Their language is quite different to Malay, Dyak, or Kyan, and sounds very much like Tamil. Can they be a remnant of people from India? Although they are wanderers they have their possessions, consisting of gongs and jars, which they stow away in the hills. I am sorry I was so short a time amongst them, that I can give you at present no further information concerning them. As, however, the Pakattans are under my protection, I hope to see and know more of them soon.

3. *The Rationale of an Open Sea in the North Polar Region, considered with reference to analogous developments during winter in the Interior Lakes of North America.* By ALEXANDER C. ANDERSON, Esq.

AFTER a very long interval I resume the consideration of a subject referred to in a Paper which I had the honour of submitting to the Society as far back as the year 1844. I do this, after prolonged experience, under the impression that from the premises advanced, more extended inferences may be deduced; and with the trust that the conclusions at which I profess to arrive, will not be without their interest to the student of physical geography.

To avoid repetition, I, as a preliminary step, invite attention to the tenor of my former Paper; * but for convenience sake I will quote the special passage to which the succeeding remarks will more particularly apply.

"The open spaces occurring upon the frozen surfaces of rivers, are by the Canadian voyagers called *Mares*; a name applied likewise to another variety of these openings, whose origin is in reality very different, though upon superficial observation they are apt to be confounded. The latter variety is generally, I ought perhaps to say invariably, met with at the outlet of lakes, or at the spot where a tributary enters; and frequently in deep streams, whose current flows sluggishly, and other positions where the inducing causes similarly prevail. Subaqueous springs are in these cases the obvious source. These *mares*, or pools, though perfectly quiescent, are not affected by the most intense cold, if we except that their dimensions are somewhat contracted upon its prolonged continuance; but with the relaxation of the cold they quickly recover their original dimensions.† . . . In the Rocky Mountains, from Lat. 50° to 55°, where the mean annual temperature is comparatively low, these conditions are even more conspicuous than in more genial positions lying at a lower level; and in crossing these mountains by the passes between the heads of the Athabasca and Fraser rivers, at different times from October to February of several years, I have witnessed the *mares* in their usual condition, whether under the influence of the early frosts, or when subjected to the intense cold of mid-winter."‡

To convey the apprehension of the nature and conditions of these *mares* more definitely to the reader, I will describe one; and for this purpose I select that at the discharge of the Nâh-cal, or Stuart's Lake, ordinarily styled Nâ-causlay. This lake, in length about 75 miles, with a breadth varying from 3 to 5, is situated in British Columbia, its outlet being in Lat. 54° 26', Long. 124° 30' w., its waters thence flowing to Fraser River by the Stuart Branch. The general depth of the lake—confined as it is in most parts by steep mountainous shores—is great; ranging, perhaps, from 50 to 75 fathoms or more; but at the outlet it becomes shallow, the depth there, in winter, not exceeding some 10 or 12 feet. The first severe cold in December serves to cover the lake with ice, save only the *mares* or vacancies referred to. That at the outlet, to which I more particularly confine myself, has an approximate extent within the lake, varying from 500 to 700 acres, according to the circumstances of the weather; the open water continuing afterwards for some distance down the discharging stream. So soon as the severe weather relaxes, by which the *mare* may have been contracted to its narrowest limits, a gradual enlargement commences, caused evidently by the flux towards the outlet of water issuing from springs seated within the depths of the lake, and consequently of a mean temperature considerably above the freezing-point. The product of these hidden springs, as compared with the amount discharged at the outlet, may be assumed to be equal to the complement of the quantity emitted from the several tributaries, the pressure of the accumulating snow on

* Article on the "Freezing of Streams, &c., in North America," 'Journal of the Royal Geographical Society,' vol. xv., 1845.

† P.S. 1869. By *cold* in this passage is intended the ordinary winter's temperature of the western verge of the Rocky Mountains in lat. 54° or 55°, in the vicinity of Fahrenheit's Zero. By *severe cold*, the occasionally recurring intervals when the thermometer may range from - 20° to - 35°, or - 40° of the same scale.

‡ P.S. 1869. Instance the following. Traversing the range on snowshoes in January, 1836 by the Tête Jaune Pass (sometimes recently called the Milton and Cheadle Pass) there were extensive *mares* both in Cowdung and Moose Lakes, as well as on the issuing branch of Fraser River. Upon the river lower down, within the limit of canoe navigation, there were numerous similar vacancies in the ice, some of them several miles in length, originating from springs, partly, but chiefly from unequal stoppage of the autumnal drift.

the ice being allowed for; since hence alone could the waters of the lake be maintained at their mean winter level. As spring advances, the *mare* rapidly increases in dimensions, eroding the ice on all sides: but it is only early in May that the final disruption of the main body takes place, under the influence of the wind acting on its weakened surface.

It suffices for my purpose to confine the description to this *mare* at the outlet of the Nâh-cal: the corresponding vacancies which occur at the mouths of the tributary streams, if individually of smaller dimensions, may, with some variation of circumstance, be accounted for on principles essentially similar. We are next, however, to consider that this particular lake is only one out of a thousand or more, each under the like conditions, which stud this portion of British Columbia, pre-eminently a land of lakes. Most of these sheets of water are, of course, much inferior in size to the Nâh-cal; but two, at least, are larger. If, then, we consider the amount of the *mares* dispersed throughout, an area of open water may be conceived of, in the aggregate, of enormous magnitude.

Dispersed as they are over a wide space, it cannot be asserted that these isolated *mares* exercise any very perceptible influence on their adjacent borders; but were it permitted to suppose them collected in one uninterrupted body, it is obvious that an appreciable effect must then be produced upon the climate of the immediate environs. As it is they are generally frequented by a few solitary water-fowl, whose ordinary migration may have been interrupted; and occasionally a belated flock of swans, as I have witnessed in the *mare* at the outlet of the Nautlay, or Fraser's Lake, avail themselves of them as a refuge for the winter—their condition, when sometimes shot during the winter or early spring, evidencing abundant fare, accessible within the shallows during their hybernation.

Having, I trust, conveyed to the reader a notion sufficiently accurate of the nature of these *mares*—these miniature *polynias*, if I may be permitted to employ a term of analogous signification which has recently become familiar—I proceed to the inferences which, from analogy of circumstances, may thence, I conceive, be deduced. It is needless to specify the evidence that has been advanced to show that in the Arctic circumpolar region, at least at a certain season, a vast tract of open water exists. This inter-glacial sea was, I believe, first spoken of in 1806 by the Chevalier Giesecke, upon the report of the natives of Greenland—a source of information in matters purely geographical, locally applied, worthy, as my own experience in other quarters teaches me, of the highest confidence. Suffice it, however, to say, that the experience of Baron Wrangel on the north-east coast of Siberia, of Parry, Ross, and other navigators, goes far in proof; whilst more recently the observations of Dr. Kane not only confirm the previous conclusions, but show that the evidences of a more genial temperature were manifested as he approached the Polar confines.

A glance at a map shows at once the peculiar conformation of the Polar Basin. Surrounded nearly by land, it receives the northern drainage of three great continents, the efflux of many large rivers flowing from the southward, and all converging towards the Pole. I propose, then, to consider this portion of the globe as a vast marine lake, largely interrupted, possibly, by islands, but bearing the same general relation to the surrounding continents as an inland lake to its immediate environs: subject to the same general laws, and influenced on a grander scale by similar causes.

A vast superfluity of water, generated under temperatures of comparative mildness, is thus constantly issuing within the confined area of the Polar Sea; and hence, as has been sufficiently proved by the remarkable experience of Parry and others, the constant efflux by the several passages which connect it with the broad equatorial oceans; and which passages, for the purposes of my argument, I propose to consider as so many marine rivers, flowing towards their several receptacles. By these, analogously with their inland types, the

accumulation of ice is drifted, as from a common centre; and hence may be inferred, by the like analogy, the vast accumulation that takes place upon the verge of the lines of transit.

I have adverted only to the great supply of water ejected from the various rivers discharging within the Polar Sea—the superficial drainage of its confining continents.* But there are other sources of supply, less obvious, but no less surely existing. The agency of deep-seated springs, producing special and well-defined effects, has been noticed in the consideration of the interior lakes. But beneath the subterranean currents thus intercepted and finding exit, we may conceive of other currents, and again of others interlying the successive strata; the existence of some revealed to us by the process of boring for the Artesian well, while others flow at a depth beyond the ken of human ingenuity. Such remote currents, save where some flaw in the upper stratum may permit a partial exit at particular points, can have their final exit only beneath the ocean-bed, at distances varying with the obliquity of the shore, and the consequent distance to which the confining strata may proceed before they are disrupted. A series of subterranean rivers, interleaved as it were between successive strata, and discharging beneath the sea at various distances, may be assumed to exist, issuing in the ocean-bed at all points where there is a continent to supply them. That the numberless submarine springs hence originating exercise, in their general relation with the ocean, important physical agencies, may not be doubted. With these at large, however, I have not to deal. I confine myself to those special effects which, from analogy, they may be assumed to produce, concentrated within a restricted area such as that under consideration. These effects I conclude to be very powerful: I infer so from the analogous effects elsewhere. Thus, if we estimate the amount of water within the limited confines of British Columbia, kept permanently open, in many parts under the severest cold, at some hundreds of square miles, as I believe we may justly do, it is permissible to suppose that the like causes, operating on a grander scale within the area of the Polar Basin, may there produce results of proportional magnitude. In brief, I assume that the inter-glacial sea of the Arctic region is simply the development on a vastly magnified scale of the lacustrine *mare*—formed like it, and like it permanently free from ice.

* The water of ice-bound rivers, maintained at certain temperatures by frequent springs, is not materially affected by superficial cold. The thick coating of snow effectually prevents rapid radiation. Beneath it, when of sufficient thickness, the temperature of the icy surface never descends below the limit of congelation. This is proved by the fact that when the water rises above the ice, exuding through unseen fissures on its depression by a heavy fall of snow, the thin sheet of water so forced above the surface is protected from freezing by the superincumbent mass, however severe the cold. Disagreeable consequences to the traveller, whether by lake or river, hence ensue when he crosses a tract thus partially inundated. Sinking beneath the treacherous surface, the wetted snow-shoe and moccasin become almost instantaneously coated with ice on their withdrawal, adding greatly to the fatigue of progress, and occasionally necessitating the changing of the inner *chaussure*, to avoid the penalty of frost-bite. In river *mares*, when the rapid current renews incessantly the emission of the comparatively warm water, its higher temperature is notably exemplified. A thin vapour arises, condensing and becoming rapidly crystallized. The borders of the *mare*, for some feet in breadth invariably devoid of snow, are covered with the shower of crystals then formed as with a beautiful efflorescence. It is probable that under the process of rapid crystallization referred to, a feeble thermo-electric current is established, since the delicate columns, glancing in the light, exhibit peculiar action, less vivid, because possibly elicited under less active force in a denser medium, but not dissimilar in effect from the play of the Aurora. These effects increase in intensity with the increase of cold; nor is it improbable that they bear analogy to the phenomena of the true Aurora, since it is noticeable that the deposition of crystals, in the form of hoar-frost, frequently accompany that eccentric display.

It is needless to dwell on the many proofs that show the very considerable temperature which the deep-seated currents referred to acquire on their passage seaward. The observations of Baer, Erman, and others, and the direct evidence afforded on the sinking of a well at Yakutzk, of which some notes have been published,* show satisfactorily that even beneath the frozen soil of Siberia, variously estimated as extending from 350 to 600 feet in depth, a warm temperature exists, increasing gradually with the descent. Were other evidence wanting, the high temperature of springs liberated by boring might be cited. We are justified, then, in assuming that a powerful influence is exercised on the discharge of these subterranean rivers, exemplified in their effect on the interior waters; but the ultimate effect of which must be manifestly enhanced through the absorption of terrestrial heat, as the course of these streams is prolonged towards the ocean. The origin of these hidden currents may be a matter of conjecture; but, added to other sources pervading the broad surface of the land, it is reasonable to suppose that, in the deep beds of many of the interior lakes, fissures may exist through which the redundant waters are emitted, besides the more obvious outlets—following the same general line of passage, occasionally finding partial issue within the bed of the superficial stream, and discharging eventually at the disruption of the confining strata.

In the paper previously referred to I alluded casually to the influence exercised by the inland *mares*, in their relation to certain classes of the animal kingdom. I am sensible that, in an argument that should be purely inductive from established premises, the consideration of ulterior effects should not be allowed to enter. Nevertheless I am tempted, at least in collateral support, to advert passingly to the importance of this natural provision, indispensable to the inhabitants of the interior waters, and of the various animals that thence derive their subsistence. Extending the analogy, we may infer that a provision there so obviously important, has not been denied to the innumerable warm-blooded animals frequenting the broad waters of the northern regions. Thus we may conceive that a vast nursery may there exist for those varieties of the whale whose breeding-places are yet a mystery; and that within the impenetrable boundary of ice a space exists, free from impediment, and abounding with the food proper for their support, and that of the various amphibious animals of the North. I advance this supposition incidentally; yet, while doing so, I feel that, reflecting on the consistency of the provisions of Nature in all her operations, the consideration is not without its weight.

From all the premises, and without reference to the positive evidence that has been produced, it may, I opine, be safely predicated that, within the Arctic limits, a vacancy exists, similar in its nature to the lacustrine *mare*, but on a scale immeasurably more grand. But while, as I conceive, this natural condition may be predicated with regard to the Arctic region, there is no ground to infer that a similar condition exists at the opposite Pole. On the contrary, a conclusion the reverse of this may be argued. There are there no surrounding continents whence the efficient causes should emanate. An ice-bound tract of land, so far as observation has shown, at best exists there; and if, as is to be presumed, partial vacancies in the ice may occur, they are ascribable to other causes than those prevailing ones to which I have alluded; and, among the rest, perhaps, to some extent, to the influence of volcanic action, there, as it seems, largely manifested. This view is sustained by the established fact that, in the higher regions of the south, a lower mean temperature is observable. An ice-bound pole there exerts its refrigerating influence on the surrounding climates; while, conversely, at the antipodes the concurrence of active causes sheds a modifying influence around.

In the consideration of this subject I have attached no weight to the inces-

* 'Athenæum,' No. 540, March, 1838.

sant solar influence during the height of summer. Great as this must be, notwithstanding the obliquity of the sun's rays, the effect must be comparatively insignificant. The grand effects produced must be assigned altogether to causes of a more recondite nature: and the nature of these causes I trust that my previous explanations will tend, at least partially, to elucidate. With the prevalence of these causes I conceive of no cold, even under the long duration of an arctic winter, adequate to overcome their unceasing influence; and, while travelling in bygone days under the frigid winters of the interior, and there witnessing the effect produced, I had long ago imagined the possibility of a similar development, on a more magnificent scale, within the Polar confines. The evidence constantly afforded by the observations of Arctic adventurers, all pointing in the same direction, tends directly to support the conclusion, and to sustain a theory that, abstractedly, and irrespective of the premises on which it is based, might seem vague and untenable.

In fine, I briefly sum the conclusions at which, under the view of the question which I have taken, I conceive myself justified in arriving. 1st. That there exists around the Arctic Pole a tract of open water, surrounded by a vast and apparently impenetrable barrier of accumulated ice, precluding access in the ordinary way. That this open water or "Polynia," interrupted, possibly, by islands, extends probably to the very limits of the Pole, as has by others been conjectured; and that, under constantly operating influences, it is maintained permanently free from ice. 2nd. That this inter-glacial sea, radiating heat through the constant accession of warm supplies, generates a mean climatic temperature, increasing towards the Pole, probably with the remoteness from the barrier that environs it—an inference derived from the positive observation of Dr. Kane before referred to, itself confirmatory of the earlier experience of the Russian navigator Pachtusoff.* Hence it may be inferred that, if the immediate vicinity of the Pole do not present a condition positively genial, its climate, tempered by the circumfluent waters, is at least comparatively mild. Conjecturally I add that this wide area of open water probably abounds with varieties of the cetaceous tribe, there enjoying unmolested rest and abundant food; its shores the resort of walruses and other phocidæ, and, possibly, frequented by branches of the Samoëdic race. Whether the enterprise of civilised man, actuated by the spirit of commercial gain, will ever penetrate these secluded regions to a useful end, may be fairly questioned; but we may reasonably hope that the no less active spirit of scientific research, so often hitherto frustrated, will, ere long—and that, as it seems to me, by no very arduous or deterrent process—solve a problem which, whatever the rational anticipations that may inferentially be indulged in, must still then remain shrouded, as now, in mystery and conjecture.

4. *Notes on the Climate of the Marañon.* By FRANCIS L. GALT, M.D.

It will be seen from an examination of the position of the village of Iquitos that this place is somewhat centrally situated as regards the valley of that portion of the Amazon which passes through the lowlands of Peru, and which is known as the Marañon.

* 'Athenæum,' No. 535, January, 1838, Art. "Russian North-Polar Expeditions." Pachtusoff's observations comprise two series, each extending through more than a year (1832-3 and 1834-5) conducted with scrupulous care at intervals of two hours throughout the whole period. The first series establishes the mean temperature of the south-eastern end of Novaia Semlia at 15° of Fahrenheit; the second, that of a point on the western coast of the same island, two-and-a-half degrees farther north, at 16° 9'. The attempt was made at the time to reconcile the anomaly by reference to purely local causes; but the corroborative evidence of Dr. Kane, derived from a widely different position, leads directly to a more general conclusion.