

Remarks on the Snow Line in the Himalaya.—By Captain THOMAS HUTTON.

In the Journal of the Asiatic Society, No. 202, for April 1849, are some remarks on the snow line in the Himalaya, from the pen of Lt. R. Strachey of the Engineers, wherein he endeavours to prove that the observations some years since made by myself and others in the northern tracts of the Western mountains, are erroneous.—[As it appears to me that this gentleman has actually left the question where he found it, I might have been induced to pass by his remarks without notice, had he not in the excitement of an imaginary triumph, thought proper to indulge in a somewhat satirical tone of condemnation].

That Lt. Strachey, after three or four years of scientific researches, has at length been enabled fully to *corroborate* the previous observations of Webb and others in Kumaon, there is no denying,—but as the truth of those observations when applied to that neighbourhood, was never called in question, there appears to have been a waste of time and ingenuity on a laborious endeavour to prove that which was already admitted to be an established fact.—Webb, Hodgson, Colebrooke and the Gerards, are each and all reviewed and in some measure found wanting, and pronounced to be ignorant alike of the true meaning of “the snow line,”—and of the nature of “a glacier;”—shall I then desire a better fate than to be condemned in the company of such arrant *ignoramuses*?

Had Lt. Strachey evinced *more* real anxiety to ascertain and establish,—not a local,—but the general truth,—and *less* proneness to indulge in censure, he might have gathered from my letters in the Calcutta Journal of Natural History, that no attempt was made either by me or by those gentlemen whose opinions and observations corroborated mine,—to refute the facts which Webb and others had observed in Kumaon, but that on the contrary while we admitted those facts to be true, we still thought we saw reason to conclude from what had been witnessed in other parts of the mountains, that they could be regarded only as locally and not generally true.

With regard then to the actual point in dispute, Lt. Strachey has done nothing;—for to prove that his imaginary opponents were wrong, he would have collected his data from the districts in which their ob-

servation were made;—yet, while confidently pronouncing them to be in error,—he ingenuously informs us that he never was in those districts!*

What then is the true value of his assertions and assumptions? Does he imagine that the scientific world will be content to accept his unsupported '*ipse dixit*' in preference to the actual observations of four independent inquirers, each of whom is fully as competent as himself to judge of what he sees?—Did it never occur to him that, that which may be *locally true* in one district is not necessarily true in general when applied to the whole extent of the Himalayan range?—Into some such error did Werner fall when he regarded the geological facts of a limited German district, as an epitome of the geology of the entire globe; and if men are wilfully determined to look no farther than the length of their own noses, such errors must needs be frequent and unavoidable.

The first objection made to my views arises evidently from my opponent's ignorance of the localities spoken of,—he, according to his own acknowledgment in a note at p. 297 of the Journal above mentioned, distinctly stating that *he never was there himself!* Yet he does not hesitate to *assume*, that "the true Himalaya," of which I wrote, was the Bissehir or Southern Snowy range.—Had he possessed any personal knowledge of the country over which I had travelled, he would have seen that all the Passes mentioned in my letters, were situated *beyond* that range and to the north of it,—while, since he admits that "the mountains on which perpetual (?) snow is found, all lie between the 30th and 32nd degree of north latitude,"—a glance at his map would have shown him that the locality of my observations is situated between 31° 30' and 32°, or as completely beyond the Bissehir range, as his own locality is north of Kumaon.

In regard to the mistakes into which I am stated to have fallen, in confounding "the north and south aspects of the individual ridges with the north and south aspects of the chain,"—I have to observe that the mistake is due rather to my readers than to myself, for in stating that "dense forests and vegetation occur along the southern

* Lieut. Strachey has quoted Captain Cunningham's remarks as confirmative of his own opinions, but the latter gentleman, in a recent paper, appears to plead "not guilty"—to the soft impeachment!

slopes, while they are nearly altogether wanting on the northern *face*,"—it is evident that I referred to the true north and south aspects of *the chain*;—whereas my opponents chose to imagine that I referred "to the north and south aspects of individual ridges;"—hence Mr. Batten's objections at page 384 of No. 19 of *Calcutta Journal of Natural History*, where that gentleman says,—he is "convinced that Captain Hutton confounds the singular with the plural number! viz, slope with slopes."—Had he been kind enough to imagine that it was just within the bounds of possibility that the final *s* was a slip of the pen,—he would have been much nearer the truth.—Indeed, he might have seen that such was the case from the immediately subsequent mention of "the northern *face*," in the singular, as contrasted with "the southern *slopes*."

But although Lt. Strachey has deemed it necessary to lay such stress upon what he imagines to be a grave error,—it is remarkable that he has studiously abstained from accepting the explanation of my meaning, given at p. 380 of *the same number* of that *Journal*, in these words,—“Captain Jack objects to my stating that ‘dense forests and vegetation occur along the southern slopes, while they are nearly altogether wanting on the northern face;’—in making this statement, I referred, *not* to the southern slopes of secondary or minor ranges on the Cis-Himalayan aspect, *but* to the fact,—that forests and dense vegetation are found *on the south of the principal chain or true Himalaya*,—while on the northern aspect of that great range they are nearly altogether wanting.—This assertion will, I doubt not, be borne out by every one who has crossed into Tartary; for while to the south of the great chain, we find superb and stately forests,—on the north there is scarcely a tree to be seen, and the few that are occasionally met with, are either stunted cypresses growing in the moist soil of ravines, or poplars planted round a village by the hand of man, for economical purposes.”

Now, as a mathematician, my opponent should have known that when a man assumes his own data, he ought to be able to prove anything he likes; and assuredly he is bound to establish the point for which he is contending: yet acting on this principle he has somehow only contrived to prove himself in error,—for, knowing nothing of the western Himalaya, and *assuming* that I mean one thing, when I have

distinctly stated that I mean another,—he proceeds to draw conclusions which will not bear a moment's examination. Had he before passing sentence of condemnation, bent his footsteps towards the upper parts of Kunawur, he would have found that forests *are not wanting to the north of the Bissehir range*, and consequently that my remarks could not apply to it as the water-shed.—It is not until the traveller surmounts the passes which lead from upper Kunawur into the Tartar districts, that he beholds on the one hand a wooded country and on the other a comparatively barren waste, and when he has consequently placed nearly the whole of Kunawur between himself and the Bissehir range to the south.

“The doctrine,” says Lieut. Strachey, “which Capt. Hutton attacks as erroneous, undoubtedly is so. But it is a doctrine that was never inculcated by any one. Capt. Hutton having misunderstood the true enunciation of a proposition, reproduces it according to his own mistaken views, and then destroys the phantom that he has raised.”—With all due deference to Lieut. Strachey, he must permit me to remind him that *assertion*, however confidently made,—is neither proof nor argument, and that the doctrine to which I alluded *did exist*, may be gathered from Captain Jack's letter in No. 15, p. 458 of the Calcutta Journal of Natural History, and likewise from Dr. Lord's remarks on the Hindu Kush,* which by the way Lieut. Strachey does not deem it safe to comment upon! Moreover, “*the phantom*” which I and my supporters destroyed, was neither more nor less than this,—that whereas the common doctrine assigned *as an universal rule*, a lower elevation to the southern snow line than to the northern, we showed that it was only *partially* and *not universally* applicable. Lieut. Strachey however, having rejected the explanation of my meaning, as well as everything tending to militate against his own preconceived notions, and having himself misunderstood the true enunciation of *my proposition*, denies to his opponents the right of crediting the evidence of their senses, and leads them to infer that he is unwilling to admit the truth of any fact which he cannot actually see. The erroneous idea, which he has imbibed, that the Bissehir range is *my true Himalaya*, as he loves to call it,—is founded on an

* Cal. J. Nat. Hist. No. 14, p. 276.

assumption arising solely from his total want of knowledge of the localities in which my observations were made.

In quoting from Captain Cunningham's letters to me, Lieut. Strachey is careful to extract only so much as may tend to corroborate his own views; but in theorising on the probable causes which tend to accumulate a greater quantity of snow on the southern than on the northern aspect, and which he thinks he finds in the sudden congelation of moisture-bearing winds from the south, he is pleased altogether to disregard Captain Cunningham's observation that it is the violence of this same southerly wind which actually keeps the southern slopes of Tartary free from snow, and that too at all times.

Contrary to all Lieut. Strachey's views and theories, we find Capt. Cunningham writing from Tartar districts that,—“in January and February, and indeed at all times, the violent southerly winds kept southern exposures free from snow;”—again he says, “no snow whatever on southern slopes within 15 to 16,000 feet; but on northern slopes and in hollows, abundance of snow.” Again—“February 10th and 11th.—In getting up the northern slopes, the snow was, I don't know how deep! On reaching the summit of a pass I found no snow, nor did I find any on the southern slopes, except in hollow portions or tolerably flat bits.—The highest pass on the road is perhaps 13,500, or nearly 14,000 feet.”—[This too, be it remembered, in notoriously the severest month of winter, in these hills!] “The effect,” he continues, “is attributable partly to the violent southerly winds which blow during December, January and February, and partly to the sun's rays. In the beginning of May, in coming from Nako to Chungo in Huangrung, I found no snow on the southern, eastern or western slopes; but on some northern ones which were steep, there was snow three and four feet thick; elevation about 11,500 feet. At Shalkur up to the middle of June, the snow lay on the northern sides of the gullies or ravines of the hills; and when out shooting I had much difficulty in crossing them; elevation 11,000 to 11,500 feet.—I was informed also that the northern slopes of the Huangrung ghat, between Soongnum and Hunge, had some snow until the middle of June. On the southern face it had melted six weeks before, except in hollow places.” And finally, “August 7th.—There is no snow on western slopes of hills 17,000 feet high, but there are a few patches on the northern slopes.”

Thus we have observations made in Tartar regions north of the Bissehir range, between $31^{\circ} 30'$ and 32° north latitude, all of which tend directly to prove that while from December to August snow was always to be found on the northern aspect of every hill or range, there was either little or none at all on their southern exposure.

What, then, has Lieut. Strachey proved by his observations in Kumaon, and by his strictures upon nearly every one who has written on the subject of the snow line in the Himalaya? We appear to be indebted to him simply for proving what was never disputed, namely, that the facts observed by Webb and others in Kumaon are true, as far as regards that district; but with respect to the only point in dispute, namely, as to whether those facts are only locally and not generally true, he has left the question exactly where he found it. Indeed, his *assumption* that my observations were confined to the Bissehir range, in spite of my declaration to the contrary, proves at once that his efforts have been less directed to the elucidation of the truth, than to my personal discomfiture.

But conceding even that the Bissehir or southern snowy range was the locality on which my facts were observed, there still appears strong reason for asserting that the phenomena there visible are directly opposed to the conclusions which my opponent would draw from them; for he declares that a greater quantity of snow must fall on the outer southern face of the range, owing to the interception of heated and moisture-bearing winds from the south, and thus he would account for the prevalence of the snow on that aspect. Supposing then, for the sake of argument, that thus far his views are just, when applied to the southern range of Kumaon, he has still chosen to overlook the fact that in Lord and Gerard's "Tours in the Himalaya,"—a work too, which he has himself quoted,—it is stated that "the line (of perpetual snow) in the latitude $30^{\circ} 30'$ in Asia is fixable at 15,000 feet on the southern or Indian aspect of the Himalaya mountains, and on the northern (not the Tartarie) may be concluded at 14,500 feet."—This appears to me to give the northern snow line of the outer range an elevation less by 500 feet, than the southern one; while Captain Cunningham in a recent paper, even estimates the approximate difference at 3,000 feet.*—The same gentleman likewise states that—"on the

* J. A. S. No. 205, p. 695, for 1849.

Tibetan side of the chain the (approximate) heights will be found to be 20,000 feet on the south, and 18,000 to 18,500 feet on the north face of the same hill."—These observations then appear to establish the fact that from the southern snowy range to the northern or Tibetan one, the snow line is always, on every hill or range, the outer ones inclusive, at a lower elevation on the northern than on the southern slopes.

But Gerard proceeds to tell us, that "the cheeks (of the Borendo pass, on the Bissehir range) are perfectly naked long before this time of the year (August 1822,) and the trough formed by them, although sheeted with snow at the summer solstice, is now (August) bare rock down to the ravine *on the south side*, with the exception of some accumulations, which will be very much diminished before another month; and some seasons, as in the former (1821.) *the whole face of the declivity without a patch of snow*. On the north, *there lies a vast field which never dissolves.*"*

So again, Captain Jack says,—“I crossed the Borendo ghat on the 25th September 1842, and *there was no snow at all on the southern aspect*, or on the very summit of the pass; but descending a few yards *on the northern aspect* to the base of a rock which was nearly perpendicular, we had the pleasure of seeing our baggage, coolies, &c. descending most rapidly by their own gravity *upon an unbroken bed of snow extending 250 to 300 yards in one slope*, forming an angle of about 45°.”

Here then, we have different observers in different years proving that on the Bissehir range, the snow lies deeply and extensively *on its northern face*, even when there is none *on the southern aspect*; we have consequently the very same phenomena apparent, from the outer snowy range up to the northernmost one, proving that the local facts of Kumaon are *not facts* in the western parts of the Himalaya, and showing moreover, since the true southern aspect of *the chain* becomes denuded of snow,—that while there is a snow line on the northern or Tibetan aspect, there is no permanent snow line on the southern face of the Bissehir range.

It is however due to my opponent to state, that I am not aware that the elevation of the passes on the Bissehir range have ever been correctly ascertained, for although Dr. Gerard has somewhere stated the

† Loyd and Gerard's tours in the Himalaya, p. 327.

cheeks of the Borendo pass to be upwards of 16,000 feet, yet the truth of that measurement has been since called in question. It may therefore eventually be found that the elevation of that pass is below the snow line, which would account for the disappearance of the snow from the southern aspect. I am quite willing then to give Lieut. Strachey the benefit of the doubt; while at the same time should I be driven from my position in Bissehir, I shall still take my stand with Dr. Lord, on the Hindu Cush, and maintain, (which is in fact the only point for which I have really contended) that the doctrine on which Humboldt relied as applicable to the whole extent of the Himalaya,—cannot be so accepted.—Feeling satisfied that he had discomfited all former observers in India, and thus converted his local into general facts, Lieut. Strachey next proceeds to run a tilt with Humboldt himself, who had accounted for the greater elevation of the snow line on the north of Kumaon, by supposing that the radiation of heat from the plains of Tibet contributed mainly to produce that effect. With this very simple and natural inference, our author is dissatisfied, and he “therefore attempts to supplant it with a theory of his own. He says, that as radiation from the plains of Tibet *does not* produce the greater elevation of the northern snow line, that effect must be occasioned by the diminished quantity of snow that falls on the northern, as compared to the southern part of the chain.” Now this, if it be intended to apply likewise to the district of Bissehir, becomes a perfect riddle, for if less snow falls on the north than on the south, how is it that there is always snow on the northern long after it has disappeared from the southern aspects of the higher ranges of the western tracts? Are we to believe that the greater the quantity, the sooner it melts?

Even if restricted to the neighbourhood of Kumaon, the theory would be totally unsatisfactory, for the small quantity of snow on the north, if not acted on by radiation of heat from the plains of Tibet, nor melted by the rains of the monsoon, would last at the very least as long as double the quantity on the southern slope, where it is exposed both to the direct rays of the sun and to the destructive influence of the heavy periodical rains; and this appears to be very satisfactorily proved by Lieut. Strachey’s own remarks on the black range, which rising immediately from the plains of Tibet, retains snow on its northern aspect when there is none whatever on the south.—But when to the

effects of the above agents we add the fact that the violent southerly winds of winter have a tendency to keep the southern slopes free from snow and to accumulate it in drift on the north, we appear to have every fact leading to the conclusion that the snow will, as a general rule, be found longer and deeper on the north than on the south; and Captain Cunningham has stated that when (even in winter) there was little or no snow on southern aspects, it was sometimes "four feet thick" on the north!

The very admission therefore that the northern destructive agents exert little influence on the snow, would of itself be sufficient to overthrow thus much of Lieut. Strachey's theory; for if those agents which drive the snow to a certain elevation are removed, it is evident that the snow, whether much or little, must remain nearly or altogether intact.

We are further told that, "the air that comes up from the south, no sooner reaches the southern boundary of the left of perpetual snow, where the mountains suddenly rise from an average of perhaps 8,000 or 10,000 feet, to nearly 19,000 or 20,000, than it is deprived of a very large proportion of its moisture, which is converted into cloud, rains or snow, according to circumstances.—And the current in its progress to the north, will be incapable of carrying with it more moisture than is allowed by the very low temperature to which the air is of necessity reduced in surmounting the snowy barrier, 19,000 or 20,000 feet in altitude, that it has to pass. Nor can any further condensation be expected at all comparable in amount to what has already taken place, as it would manifestly demand a much more than corresponding depression of temperature; and this is not at all likely to occur, for the most elevated peaks being situated near the southern limit of perpetual snow, the current on passing them will more probably meet with hotter than with colder air."

I must confess that this theory does not appear to me to be either conclusive or even probable; for in the first place, we are neither furnished with any *proof* that the air will be *hotter* to the *north* of the high peaks, nor with any approach to data for determining the question; the whole resting upon the unauthorised *assumption* of a *desired fact*, the existence of which is absolutely necessary to give anything like validity to the theory.

Were the upward or northward passage of the moist air effected slowly and gently, no doubt we might expect a heavier fall of snow on the southern aspect of the chain, *provided always* the temperature beyond it was, as Lieut. Strachey supposes, *hotter* than on the Indian side; but *this is not the case*, as is most convincingly proved by the admission that snow always lies longer on the northern aspects of *all hills and ranges*, than on the south, and I need only cite Lieut. Strachey's own black range as an instance of the fact.—He likewise admits that “southerly winds blow throughout the year over the Himalaya,” and “in the winter,” which is of course the season of snow, “*with the peculiar violence.*” This is recorded also by Gerard and by Captain Cunningham, and every traveller can confirm the same. But this very violence of the southern winds must necessarily carry the snow across the southern range and accumulate it deeply to the north, and this is clearly shown to be the case by Captain Cunningham, who relates that while during winter and “indeed at all times, the violent southerly winds kept southern exposures *free from snow*”—“*on the north it was I don't know how deep.*” Moreover, if the temperature of the air was hotter to the north than to the south of the high peaks, we ought as we approach the plains of Tibet to find no snow on the northernmost range; yet the black range, rising from those plains retains the snow on the northern even when there is none on the southern slope,—a fact which, while it militates strongly against Lieut. Strachey's views, tends much to corroborate Captain Cunningham's observations. But granting that Lieut. Strachey were correct in these particulars, does it necessarily follow that what is fact in the neighbourhood of Kumaon, may not be pure fiction when applied to the western tracts? Can the assumptions of one who confesses that he never set foot within the limits of the district where his opponent's observations were made, in any way affect those observations? He is evidently disposed to disregard the question of one of his own supporters, who asks—“how can any facts of one observer in one place falsify the facts of another observer in another place?”* Now I and my supporters have long since received Captain Webb's Kumaon facts *as true*, when applied to the places wherein he observed

* Cal. Journ. Nat. Hist. No. 19, p. 383.

them, and we merely in return claim the right of believing the evidence of our own senses, when wandering over other tracts of the Himalaya.

I repeat then, that as far as the evidence yet goes, the phenomena observable in Kumaon are opposed to those which have been observed to the westward,—and in rejecting Lieut. Strachey's theory as insufficient, I much prefer adhering to Humboldt's until a better is offered. Lieut. Strachey denies that the radiation of heat from the plains of Tibet exercises any but a trifling influence on the snows of the northern aspect; still his denial rests on no better basis than that of an assumption, for no proof whatever is produced in support of the opinion, save that there is snow on the Tibetan face of the black range, when there is none on the southern face.—But this is really nothing to the purpose, for it merely shows that the direct rays of the southern sun, united to the greater humidity of the atmosphere, and the effects of the violent southerly winds, have a far more powerful effect in uncovering the southern aspect, than the heat from the plains of Tibet has upon the snow of the north. The true question however does not relate to the north and south aspect of the black range, but to the aspects of the water-shed; and in regard to it we are told that while on the south the snow line is about 15,000 or 15,500 feet, on the north it is 18,000 to 19,000 feet. Now the height of the northern ranges above the plains of Tibet does not appear, on an average, to be more than 3,000 to 8,000 feet, if so much; while on the south, the peaks rise to 16,000 and 18,000 feet above the plains of India, from which moreover they are separated by a broad intervening belt of wooded mountains, averaging from 6,000 to 8,000 feet above those plains. Consequently it does not appear very difficult to perceive that radiation from the northern plains, must affect the snow more powerfully than from the southern plains, and will drive the snow line to a greater elevation *above the sea* on the northern, than on the southern aspect. Thus Humboldt's theory when applied to the Kumaon and other similar districts, appears to be perfectly correct. But that the physical features of the Kumaon and western tracts are at the antipodes of each other, has been plainly stated by Mr. Batten, who says—"our passes *at once* take us into Tibet, and do not conduct us like those beyond Simlah, into an intermediate and peculiar track, like Kuma-

wur."* Now it seems to me by no means improbable that this very difference in the features of the two tracts may be sufficient to account for the difference in the phenomena observable in each, and that if Humboldt's theory of radiation from the plains of Tibet is sufficient to account for the retreat of the snow to the heights of the northern face, the want of similar plains† in the western tracts will of course preclude such radiation from acting on the northern face of the western mountains, and thus the greater heat of the southern side, added to the periodical rains and to the violence of the winds in winter, will leave snow on the northern long after it has disappeared from the southern aspect.

Lieut. Strachey admits that the rains have a powerful effect in melting the snows, but his want of knowledge of the localities to the westward has led him into an error when he supposes that the monsoon does "not extend up the Sutlej beyond the point where the Buspa falls into it;" the truth being that Chini, which is itself farther up and situated in the gorge where the Sutlej breaks through the outer snowy range, is full within the monsoon, as both Captain Jack and I experienced; beyond this point the rains are light and uncertain, but they nevertheless extend to the head of the district, for clouds and vapours pass onwards through the valley of the Sutlej even to the upper parts of Kunawur, and exercise great influence in clearing the southern slopes of their snow; and although Lieut. Strachey has *assumed* that clouds protect the snow, by warding off the direct rays of the sun, he overlooks the fact that such clouds betoken a humid atmosphere, which is quite as inimical to the duration of the snow as the sun's rays, and he might at least during his scientific researches in Kumaon, have learnt the fact that thaws are more rapid in cloudy weather, than in a dry and unclouded atmosphere, such as that which he acknowledges to be the general characteristic of the northern aspect.

Dr. Lord's remarks on the Hindu Cush coincide apparently with mine to the north of the Bissehir range, and since Webb's observations in Kumaon are found to be only locally true, there can be little doubt

* Cal. Journ. Nat. Hist. No. 19.

† Captain Cunningham seems to doubt the existence of any plains at all!—Vide J. A. S. 205, for 1849.

that Dr. Lord's surmise relative to the effect of heat radiating from the high plains of Cabul and Koh-i-damun is correct.

In regard to "*perpetual snow*," Lieut. Strachey has rightly understood me, and I again repeat that *there is not and cannot be* any such thing, and that any assertion to the contrary must necessarily convict its author of being utterly ignorant of the well known fact, that nothing in nature is perpetual or everlasting. All matter is ever undergoing change; the very rocks are crumbling down beneath the force of atmospheric agents; the atmosphere itself is constantly undergoing change and renovation; the water and the snow alike return to it in the form of vapour. Where then is there a sign of perpetuity? My opponent should have remembered, when he undertook to censure my supposed illogical reasoning, that there is a wide difference between a hill covered with *perpetual snow*, and one that is *perpetually covered* with snow!—"The mere continuance of snow on any spot," says no less authority than Professor Forbes, "does not suppose that snow never melts there; were that the case a progressive and unceasing accumulation would be the result; the position of the *snow-line*, or what is often erroneously called *the line of perpetual congelation*, is determined solely by this circumstance, that during one complete revolution of the seasons or in the course of one year, the snow which falls is just melted and no more."*

Thus Lieut. Strachey's observations, although useful in corroborating those of Webb and others, in reality leave the question precisely where it was, namely, that while in Kumaon the elevation of the snow line is greater on the northern aspect than on the southern; the truth, on the Hindu Cush, and as far as observation goes, in the Tartar districts north of the Bissehir range, is actually the reverse; proving as I long since stated, and now repeat, that the facts on which Humboldt relied as applicable to the whole extent of the Himalaya, are found to be purely local, and dependent altogether on the physical features of the country to the north and south of the water-shed.

* Forbes' Travels through the Alps, p. 18.