THE

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OF

THE ASIATIC SOCIETY

OF

BENGAL.

VOL. II.

THE

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OF

THE ASIATIC SOCIETY

OF

BENGAL.

EDITED BY

JAMES PRINSEP, F. R. S.

SECRETARY OF THE ASIATIC SOCIETY.

VOL. II.

JANUARY TO DECEMBER,

1833.

"It wiil flourish, if naturalists, chemists, antiquaries, philologers, and men of science, in different parts of *Asia*, will commit their observations to writing, and send them to the Asiatic Society at Calcutta; it will languish, if such communications shall be long intermitted; and it will die away, if they shall entirely cease."

SIR WM. JONES.

Calcutta:

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1833.

PREFACE.

On completion of this second volume of the Journal of the Asiatic Society, the Editor feels it to be due to his subscribers, as well as to himself, to lay before them as briefly as possible, the results of the arrangements which he contemplated carrying into effect at the conclusion of the last volume;—more especially as a somewhat erroneous estimate of the cost and circulation of the Journal found admission into a late notice of the Indian Periodical Press, drawn up by the Editor of one of the morning papers. The Journal is not published, as there stated, by the Asiatic Society, but solely at the cost and responsibility of the Secretary, who was Editor of it before he enjoyed the honour of an election to that office. Since there never has been the least view to profit, either in the Gleanings or in the present work, there can be no object whatever in concealing any information respecting its publication; and it may be useful hereafter to find on record a note of the expences of printing, and the difficulties against which a Journal exclusively scientific has had to contend, as well as the advantages which it has enjoyed, in India at the present time. The following particulars have therefore been extracted from the accounts of the two years now terminated.

The amount of subscriptions to the Journal at one rupee per number, including two extra numbers, in 1832, was .... Rs.		5148 8
From this, deducting 20 per cent. commission paid to Messrs. Thacker and Co. for circulating it, ...		1028 11
There remained net subscriptions available, Rs.		4114 13
The Baptist Mission Press charged for printing and stitching 500 copies,	Rs. 3742 10	
And the 15 plates cost with printing,	416 5	
	Total	4178 5

The result of the first year exhibits a sufficient accordance between outlay and return. Of the amount subscribed however, only Rs. 3786 13 have been collected up to the present time, so that in fact there was a deficit of Rs. 392 2.

The alterations which the Editor proposed and completed for the second year were :—

1. The saving of nearly half of the commission paid for the mere circulation of the work (without responsibility), by undertaking that duty with the aid of his establishment as Secretary of the Asiatic Society;

2. As a return for this favor, he proposed circulating the Journal gratis to such of the paying members as should express a desire to take it in.

The effect of this scheme has been as follows :

Fifty members of the Society have availed themselves of the privilege, which has made a deduction to the same amount from the monthly receipts. The number of copies circulated, including those sent to subscribers and societies in Europe, is about 450.

The number of paying subscribers on the list, is 320, which at 1 R. per month, (including one extra number of Buchanan,) would give Rs. 4480.

The expenses of printing 500 copies, of 670 pages,

at 4-5 per page, may be stated at ..... Rs.	2,890	
144 pages of Buchanan, at 4-8 per page,.....	648	
Covers, table work, &c. charged extra, ...	250	
40 pages of Appendix, at 5 Rs.....	200	
28 plates (18 lithographs, 10 engravings*), ...	480	
Establishment for circulation, ...	600	
	——	5,068

Leaving a loss on the year of Rs. 588, or nearly as much as the subscriptions of the members exempted from paying.

But it must be mentioned, and mentioned with a degree of disappointment which is almost disheartening, that of the flattering list of sub-

* For these the cost of printing and paper only is charged.

scribers above given, 70 have not paid any part of the year's subscription, and as many more are still in arrears; so that a balance of Rs. 1321-8 still remains to be collected. The actual state of the concern is therefore by no means so favorable as could be wished, for it leaves the Editor out of pocket upwards of 2000 Rs. as the reward of his labour for two years! B əq ɟnwill not for a moment suppose that the balances outstanding are not recoverable: on the contrary the principal difficulty lies in the distance, and the supposed want of a mode of remittance.—Many subscribers are not aware, that letters containing hoondees for the amount may be transmitted *post free* to the Editor.

It will be remembered, that the Bengal Government were pleased to bestow the privilege of free postage on the GLEANINGS and on the JOURNAL, on condition of the publication of the late Dr. Buchanan's Statistical Reports. Under the impression (justly formed) of a corresponding increase of circulation, consequent upon this liberal boon, it was resolved not to incorporate these records in detached notices in the JOURNAL, nor to diminish from its original matter*, but to publish them as a separate work; and one volume has accordingly been completed, containing 356 pages, which at 4-8 per page have cost Rs. 1,602

And a reprint of the first 108 pages, which became necessary on the subsequent extension of the edition from 300 to 500 copies, 216

Total, Rs. 1818

This expence has been incurred therefore on account of Government, in return for the postage saved, not to the work, but to the subscribers of the JOURNAL. On the completion of the first volume of BUCHANAN, a second extra volume of an official nature on the Monetary System was commenced, of which 50 pages have been printed with 3 plates, being in fact an expence of more than 300 rupees not included in the above estimate. The Government meantime placed the remaining volumes of Buchanan in the Editor's hands, with an intimation of its "desire that the printing of these records should be continued." It was therefore with no small feeling of mortification that

* Originally 32 pages only were given in each number, latterly 64.

the EDITOR perused the following letter, announcing that the privilege of free postage should cease from June next, especially after having been honored, on an explanation of the nature of the work, with an extension of the same privilege to the Madras presidency, in addition to that formerly bestowed by the Governors of Bombay and Ceylon.

To JAMES PRINSEP, Esq.

Genl. Dept. Editor of the Journal of the Asiatic Society,

Sir,

I am directed to inform you, that the Governor General in Council has resolved, that after six months the exemption from postage, which is now enjoyed by the Journal of the Asiatic Society, shall be discontinued.

I have the honor to be,
Sir,
Your most obedient servant,
G. A. BUSHBY,
Offg. Sec. to Govt.

Council Chamber,
2nd Dec. 1833.

It may reasonably be feared that many subscribers at distant stations may be unable to continue their support to the work, when its cost shall be enhanced by postage; but (should it be impossible, on a proper and respectful representation of the circumstances, to avert the imposition of postage) every means will be taken of lessening the burthen by sending the monthly numbers by the bangy instead of the regular dâk.

On the contents of a volume which has already been perused by nearly all to whom it circulates, it would have been obviously needless to make any remark, were it not desirable to prove that the favors hitherto conferred upon the work by the Government of the country had not been altogether misapplied.

Independently of the volume of Dinajpur Statistics, which forms a model for the use of public officers engaged in collecting similar information, the GLEANINGS and the JOURNAL have been the means of bringing to notice many of the mineral resources of our vast Indian Empire, and of leading to fresh discoveries by the announcement of what had already been found: coal may be adduced as an example,—of which twenty or more different localities have been brought to our knowledge through its pages, where only two were before known. Of the native mineral productions, iron, copper, gold, &c.:—Of the native arts and manufactures, salt, nitre, turpentine, dyes, mills, &c. numerous original ac-

counts have been inserted : catalogues of woods, medicinal plants and drugs : experiments on materials, wood, iron, cement ;—Statistical reports ;—descriptions of newly explored countries and people :—in fact, it would be difficult to open a number of the JOURNAL without finding some information which must possess value in the eyes of a government. Contributions of a more exclusively scientific nature have, in the mean time, continued to multiply, and the objects pointed out as desiderata at home in the geography, meteorology, geology, and natural history of this country, are in the course of rapid and systematic elucidation. So numerous for instance have been the registers of the weather offered for publication, that space could only be found for abstracts of many. There has hardly been time for the collection of materials regarding the tides of the Indian coasts, suggested in the Rev. Professor WHEWELL's circular, (inserted in page 151,) but the attention of those who have opportunities of eliciting the information required, is again solicited to this object.

As a proof of the benefit conferred on science by the free and extensive circulation of a periodical devoted to such objects, the Editor feels pride in alluding to the ardour which his plates of ancient coins have inspired in many active collectors, and above all to the reward bestowed ou himself by the munificence of General VENTURA, the most successful pursuer of antiquarian research in the Panjáb, who has presented to him all the coins and relics discovered on opening the celebrated Tope of Manikyala. They are now on their way to Calcutta.

That extracts and analyses of European science have not been more frequent must be attributed once more to want of space and want of leisure. The Editor would recommend all who seek for knowledge of the progress of science in Europe to procure a copy of the Reports of the British Association for 1832, in which they will find every branch discussed by the philosopher best able to give it illustration. To attempt to shorten those admirable essays would be mutilation rather than abridgment ; yet unfortunately most of them are too long for the pages of a monthly journal.

On the subject of orthography of native words, the Editor is driven to make one concession, for which he fears the learned Societies at home

will denounce him as an apostate to the system of their leader. Every communication, with hardly any exception, which comes for publication, adopts the Gilchristian mode of spelling, or that modification of it which has been *ordered* to be used in all Government records, surveys, &c. An attempt has been made hitherto to conform the whole to Sir William JONES' method, but necessarily there have been continual omissions, and the contributors in most cases express themselves but ill pleased to see their words transformed into shapes but ill accordant with ordinary *English* pronunciation. The Editor has therefore resolved to adopt the middle course followed in HAMILTON's Hindustan, namely, to print all Indian names and words in the ordinary roman type as they are usually written and pronounced, and to place in italics all such native terms and proper names, as are corrected, and spelt according to the classical standard of Sir William JONES : in many cases the latter may be inserted in brackets after the ordinary word.

Where contributors have occasion to illustrate their papers by plates, it will be a great convenience to the EDITOR to have the original drawings prepared of the same dimensions as the printed page of letter press, to save the trouble and expence of reducing them.

The EDITOR will not allude in this place to the severe loss he has sustained in the death of some of the most able and constant supporters of his work, and the departure to Europe of others in the course of the past year ; since he hopes that a more worthy channel will be found for the record of their meritorious labours for the cause of Science in India, in the Proceedings of the Asiatic Society, to which their names belong, and in which their reputation must ever be cherished with fond remembrance.

1*st January*, 1834.

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I.—*On the Restoration of the Ancient Canals in the Delhi Territory. By* Major Colvin, *Engineers.*

[Extracted from that Officer's Report to Government as Superintendent of Canals.]

I. THE CANAL OF FEROZ SHAH.

The original branch of the canals lately re-opened, to the west of the *Jamna,* was excavated under FEROZ SHAH, about the middle of the fourteenth century. The neighbourhood of *Hissar* was his favorite hunting ground, where he evidently must have passed much time, attended by his court, if we may judge from the extensive ruins of buildings and tombs still existing, and occupying a space of several square miles, all attributed to that period; the advantages of an abundance of good water for so large an assemblage, in a country of such extreme aridity, where the wells are 130 feet deep, and the springs often salt, may have been the principal incentive to this great undertaking.

Probability and tradition point out the head of the original canal to have been where it now is, immediately at the point where the *Jamna* issues from the lower range of hills, and nearly opposite to another hunting seat of the same emperor, marked in the maps as *Bádsháh Mahal;* from whence it was apparently conducted along one of the many old water-courses of the *Jamna,* till it fell into what was then the mouth of the *Súmbe* river*. This channel, under the operation of time and floods now become the western branch of the *Jamna,* was then probably

* A mountain-torrent nearly dry, except in the rains, when it receives the drainage of the mountains south-east of *Nahun,* and of the plains east of its course, nearly to the *Jamna,* from which and a strong fall, its floods are most violent and sudden in their effects.

of more moderate dimensions, and, to turn the water into the cross-cuts formed, must have been closed below *Fattehgarh*, probably by an earthen dam renewed annually, no remains whatsoever of any permanent work remaining in that vicinity. By one or other, or all of the channels, the remains of which now exist, the water was conveyed across a tongue of land into what is clearly another old channel of the *Jamna* under *Búrya*, being a wide hollow, skirting the high ground to its north and west, which is continuous, though with numerous and deep indentations, from the hills along the right bank of the *Súmbe* river, and then following this water-course as far as *Karnál;* towards the hills rising little short of 100 feet, and sinking south of *Karnál*, near *Uncha Sumáná*, (where the canal enters on the high land, and diverges from the *Jamna,)* to about 15 feet. Above this point the land on the left bank is uniformly low, extending to and forming the *Kádir* land of the *Jamna*, a most fertile tract, almost entirely under cultivation, and from its composition, and the closeness of water to the surface, almost independent of irrigation.

From *Uncha Samáná*, a canal must have been excavated, at first of great depth, but gradually diminishing as it approached *Suffídon*, near which it opened into a branch of the *Chítang* river, said to come from near *Teraúrí* by *Baród*, a few miles east of *Suffídon**, along which the canal was led with partial excavations, of which the remains exist, in some places more, in others less, (as would be the case in clearing out a river bed,) until it rejoined the other branch of the *Chítang*, at *Dhátrat*. From *Dhátrat* the marks are more apparent of its having been an ancient river bed, simply cleared out to pass on a stream of water to *Hissár*, and a few miles beyond the latter, apparently with a view to provide an escape for the surplus water of the canal into the old bed of the river; as within a few miles of *Hissár* all trace of former excavation ceases, whilst the river bed is continuous; latterly, winding among the sand hills of *Bhikanír*, or more properly speaking, along the northern bounds of the sandy desert†, until the bed unites with that of the *Ghaghar* river, near *Badhopal*, and about 22

* Of this branch all I am aware of is, that in heavy seasons of rain great floods pour into the canal near *Baród*, said to be consequent on the destruction of the earthen dams of the *Chítang*.

† The grounds of this remark are, that south of the bed of the *Chítang* the country is merely a succession of hills, and swells of sand, in some parts rising 200 feet, whilst to the north the sand is chiefly in detached ridges and patches; the subsoil, when it gets clear of the drift sand, being a hard flat, covered with low tree jungle, totally different from the sandy desert of *Bhikanír*.

miles south-east of *Bhatnír*, whence it has been traced by Mr. W. Fraser to open on the valley of the *Satlej*, north-east of, and about 20 miles from *Baháwalpúr* ; thus securing an outlet for the waters, should such ever be needful: but as the *Ghaghar* river, which receives the drainage of the hills from *Náhan* to *Plassía*, and generally of the country between the *Jamna* and the *Satlej*, does not in the heaviest season pass in force beyond *Bhatnír*, no stream by the *Chítang* is likely to effect the junction, and the period when this river ceased to flow as one is far beyond record, and belongs to the fabulous periods of which even tradition is scanty.

It may not be out of place here to advert to the causes which are even now operating to destroy the utility of the *Ghaghar* and such rivers, and tending to extend the limits of the desert, which forms our north-western boundary in this quarter. What the country about and west of *Ráneah*, now inhabited by the *Bhattís*, has been, may be inferred from the numerous sites of towns and villages scattered over a tract, where now fixed habitations are hardly to be met with. I allude only to the vicinity of the bed of the *Ghaghar*, with which I am personally acquainted;—when the depopulation took place, I am not prepared to say; it must have been long since, as none of the village sites present one brick standing on another, above ground,—though, in digging beneath it, very frequent specimens of an old brick are met with, about 16 inches by 10 inches, and 3 inches thick*, of most excellent quality: buildings erected of such materials could not have passed away in any short period. The evident cause of this depopulation of the country is the absolute absence of water, most probably the effect of the system now in use in the Sikh states, through which all these rivers pass from the mountains;—namely, the erection of dams of earth across the streams at all favorable points, to raise the water so high as to flow over the face of the country and irrigate it, the surplus escaping by the sides till stopped by other dams, and so on, it might almost be said, ad infinitum.

It will easily be conceived, that in forming this string of lakes, the consumption of water by absorption and evaporation disposes of the greater portion, whilst the irrigation takes a very small share, which could be equally well, though more expensively, drawn off by small canals from the main stream, leaving the latter open to proceed onward

* Such bricks were all found marked thus ३ evidently by a revolution of the fingers extended with the thumb as a centre, and gradually drawn round and up to the thumb. Similar bricks of an age anterior to the Mahomedan conquest, have been excavated at *Hansí*.

as far as it would go, and such an unincumbered stream would by being in constant action prevent the accumulation of impediments in the river bed, which, under the system of damming, have eight months of each year to accumulate, and in a country liable to drift sand, any vegetation in the bed is sufficient to collect and stop it, and form banks, which from the effect of the next rains is spread and deposited in hollows, gradually raising the bottom, and thereby widening the water way, and diminishing its power of sweeping clean the channel—an operation which with an open river would have been constantly going on, as no particle of water passes onwards without moving somewhat nearer to its final receptacle some portion of the river silt. In the *Ghaghar*, the outlet no longer existing, the operation is that of a gradual filling up from the tail of the river upwards, and the consequent shortening of the point to which water reaches from its source. At present the stream in the dry weather reaches to *Dúndhal*, and it is only in the rains that any portion of water reaches our provinces when heavy floods sweep along the bed of the *Ghaghar*, sometimes as far as *Bhatnír*, and convert all the hollows into lakes, which are gradually shoaling, by the amount of silt in the water filled into them. The bed of the river, thus saturated and aided by irrigation from the patches of water, yields the most splendid crops of wheat in the neighbourhood of *Ráneah* (a space several miles wide)—a benefit our landholders must lose as the river retrogrades, but which might be much extended, as was shown the year we occupied the *Bhattí* country, when, a number of the lower dams being cut, the floods of the rains reached and passed *Ráneah* in abundance, where they had hardly been for years previously. The most beneficial effect of insisting on a right to a share of the waters which do not rise in, but only pass through, the Sikh states, would be in affording a sufficient supply of water for the *nala* or canal from the *Ghaghar*, at *Múnok*, into it again near *Ráneah*. The general line of it is shown on the map passing by *Fattehábád*, and being in a great measure within our frontier, it would be an extension of the benefits of irrigation from the *Ghaghar* to our own subjects, who now derive so little from the vicinity of what the acts of our neighbours make but a nominal river nearly. This old water-course is well defined at its head, and so far open that, in the rains, the freshes send down a supply of water for the rice cultivation near *Fattehábád*. FEROZ SHAH is said to have made a canal from the *Ghaghar*, and it is possible that this is the channel alluded to. The advantages of its being re-opened (only however after the *Ghaghar* river shall have been cleared of dams, for at least 100 miles up) should not be lost sight of. The only thing further I have to say on the canal of

Feroz Shah is, that as no marks of irrigation channels exist along its banks, it is natural to suppose no system of extensive irrigation had time to take root, and that, with the decease of its founder, it fell into neglect, and discontinued flowing; had it flowed long enough to get up any system of irrigation, the remains of water-courses would not have been utterly obliterated, whereas there are no traces of them west of *Suffidon.*

ALI MARDAN KHAN'S, OR, THE DELHI CANAL.

Whether the above canal continued to have a stream in any part of its course or not, at the time the Delhi branch was thought of, early in the seventeenth century, does not seem very clearly known; though the expression of Ali Mardán Khán "having brought his canal from *Karnál* to *Delhi*" would imply that, the original canal still flowed as far as *Karnál*, and thence probably into the *Jamna*, from the choaking up and neglect of the excavated portion between *Karnál* and *Suffidon.* Anxiety to take advantage of the ancient canal of Feroz Shah, so far as suitable in direction, probably induced Ali Mardán Khán to follow it as far as *Madloda*, whence turning south, he would fall in with a natural hollow near *Korána*, which is in fact the head of a great drain of the country ending in the *Farkhnagar Jhíl*, about 15 miles S. W. of *Delhi*, and this he unfortunately followed to *Gohána.* Thence diverging south-east, he appears to have pursued a line, the traces of which are most prominent from *Gohána* to *Jatola;* and thence on, or nearly on, the present line, he made his way to *Delhi.* A terrible catastrophe is recorded to have happened on the first trial of the works, when the water, having got into the deep hollow at *Gohána*, could not escape thence by the channel formed, and accumulating, until it overtopped the embankments across this hollow way, destroyed the town of *Lálpúr*, of which the extensive ruins still exist in a low hollow west of the present town of *Rhotak.* The correction* of his error appears to have been made with much judgment, passing closely to the natural ridge of the country, where the land falls off on each side. From *Jatola*, the departures from his old course are of less moment; although, to account for the remains of bits of canal here and there, he must have made another detour near *Bhowána*, where entering on the low ground between that and the rise on which the city stands, he had his most difficult task. He appears to have secured himself, by an outlet, at the upper end of this dangerous spot, sufficient to reduce the level of canal materially in case of accident. Ahead of this point to maintain the level required in the city and palace, the canal, instead of

* By excavating anew from near *Rair* to *Jatola.*

being sunk in the ground, is carried along an elevated mound, in many parts of which the bottom rises much higher than the surrounding country. The lowest portion of this hollow was crossed on an aqueduct of masonry, under which escapes the surplus water of the *Farkhnagar Jhíl* into the *Jamna*. The canal, shortly after entering on and skirting the base of the range of hills west of *Delhi* (the drainage from which crosses over the canal by ancient aqueducts), is finally led directly across the ridge by a channel cut out in the rock, to the depth of about 60 feet at the crest. It then enters the city, and passing through it by an open channel, traverses along another extensive aqueduct into the palace, throughout the whole of which it ramifies, in open or covered water-courses, having outlets to the *Jamna*, thus permitting the passage of constant streams of fresh water. Similar to these, in the space between the range of hills and the palace, numerous underground channels were led off to the various residences of the nobles, and the divisions of the city, yielding to the whole city and its suburbs a supply of good water, from the open well shafts connected with these underground water-courses, and necessary to admit of their being cleared out.

On a review of the ancient works in *Delhi*, connected with the canal, money must have been expended with a most lavish hand, to effect what is known; and much is yet hidden in the ruins of the neighbourhood. The branch thus successfully opened, appears to have been maintained in a state of efficiency, until the year 1760, including a supply down the *Gohána* branch, and another down a portion of FEROZ's canal, in which latter the water ceased to flow at *Suffidon* about 1740. The decay of the canal was probably gradual; and final only, when the power of the emperor was too much circumscribed, and his attention too much engaged by the perilous circumstances of his reign, to attend to such matters: to which may be added the gradual increase in size and depth of what was then the western branch of the *Jamna*, rendering the annual formation of the earthen dam across it in time for the irrigation of the crops, a work of more difficulty and labor, than was compensated by the advantages derived. During the long period that it did flow, the system of irrigation from its waters appears to have been most extensively diffused, judging from the multitudes of water-courses which intersect the country on both banks, from below *Karnál* to *Delhi*: the amounts of the revenue derived from it must however be deemed fabulous, or must be misunderstood;—villages, which have from 12 to 15,000 *bigas* of land, being stated to have paid a lakh of rupees a year—a sum about

equivalent to the gross produce of the land, supposing every part of it yielded one first-rate crop annually, and that the whole of the lands were under irrigation, a matter for which the capacity of the canal was perfectly inadequate. Either the price of produce must have been much higher then, or the village bounds much more extensive; or what is more probable, districts were designated by the names of the principal towns or villages, and thus the rents stated include the total revenues. Certainly no such results are now witnessed in villages of the first magnitude, where irrigation is used to the extent of 1500 Rs. per annum for the use of the water. One such village, *Bhatgaön*, yields the Begum Sumroo 20,000 rupees a year, I believe; and another, *Sissana*, pays, I think, to our Government 16,000 rupees. Another, *Korána*, pays about 14,000 rupees, and is one of our finest villages on the canals, though not so large as others: these villages irrigate extensively*.

THE DOAB CANAL OF ALI MARDÁN KHÁN.

I am less acquainted with the former history of this canal. It certainly bears the name amongst others of ALI MARDÁN KHÁN, and must therefore be coeval with the *Delhi* canal; but having undergone several reparations in parts, its names are various. It was originally led from the *Jamna* shortly above the ruins of *Bádsháh Mahal*, along a *nala* of the *Jamna* to the village of *Nya Shahr*, from which an excavated channel conducts it into a small mountain-torrent near *Raipúr*, in which it proceeds about two miles, and is then led slanting across the beds of two great mountain-torrents, (the *Nyagaön* and *Maskareh Rao;)* on getting clear of which, it was led by *Sahâranpúr*, apparently along the crest of the ridge between the *Jamna* and *Hindan* rivers, from the feeders of the latter leading off from its left or east bank; whilst it is ascertained that several hollow ways lead towards the *Jamna* from its right bank. In its course from *Sahâranpúr* to near *Delhi*, there is nothing particular to notice, beyond the absolute absence of the remains of any trace of ancient bridges or water-courses. Near *Delhi*, it descends into the valley of the *Jamna*, and passing partly direct, and partly through the grounds of a Royal preserve, it rejoins the *Jamna* opposite the city. From the above-mentioned want of traces of ancient works, I conceive the task of maintaining the passage across the mountain-torrents at its head, of which three are first-rate, was found to be so great, that the canal was abandoned almost as soon as formed, and that the repeated attempts at reparation afterwards were only

* In these sums I do not pretend to perfect accuracy: they are noted from recollection. *Bhatgaön* and *Korána* are two of those stated to have yielded a lakh of rupees a year.

efficient for a season, and were overcome by the increasing difficulties. Had irrigation existed to any extent, 100 years could not have obliterated all traces of it; and had the water flowed for any length of time, results analogous to what are now experienced elsewhere would have followed, and must have left a trace behind them. Of the former condition of this canal, I must therefore content myself with these inconclusive remarks.

Restoration of the Canals in the Delhi Territory.

The attention of Government seems to have been drawn to the canals shortly after these provinces came under our dominion. I have understood the first suggestion was the offer of a gentleman (Mr. MERCER) to re-open the *Delhi* canal at his own expence, under the engagement of having secured to him the *whole* benefits resulting for a period of 20 years, which was not accepted; and under orders of Government, a survey and design for the work was completed and submitted for consideration by Lieut. MACARTNEY, of the Cavalry, in the year 1810; this was further followed up, if not preceded, by several reports from other officers on the subject; (Lieut. WHITE of the infantry and Lieut. FORDYCE of the engineers, amongst the number,) whose reports are lodged in the Chief Secretary's Office: and the whole subject seems to have elicited such a variety of opinion from Colonels KYD, GARSTIN, and COLEBROOKE, either as Surveyors General or Chief Engineers, that the matter seems to have fallen into abeyance, until revived during the government of the MARQUIS OF HASTINGS. In the same year, a survey of the *Doab* canal was made by Lieut. TOD, followed up by a notice from Lieut. HODGSON, from which nothing resulted. The canal of FEROZ SHAH is merely incidentally noticed, and appears not to have engaged any attention until the period of Captain BLANE's appointment to the canals. I am unable to give any special notice of what may be called the preliminary measures, from the want of records in my office, where nothing further than the original reports by Lieuts. MACARTNEY and TOD exist.

Restoration of the Delhi Canal, from the Hills to Delhi, 185 *miles in length.*

This subject appears to have early engaged the attention of the MARQUIS OF HASTINGS, although it was not till the beginning of 1817, that Lieut. BLANE of the engineers was appointed to conduct the work; his estimate was framed on the report of Lieut. MACARTNEY: although in the progress of the work, it was found necessary to depart considerably from the ideas of that officer, in consequence of the changes effected by the river in this interval. The work was carried on by Lieut. Blane,

with great zeal and in the face of numerous difficulties, and the water being partially brought down as the work progressed, irrigation commenced from it in 1819, and by the end of May, 1820, the water was brought to the city of *Delhi*, and passing through the main conduits in the palace, rejoined the parent stream.

Lieut. Blane, instead of drawing his supply of water from the river by any of the old heads near *Búrya*, or as pointed out by Lieut. Macartney, from near *Dadúpúr*, (either of which, in the then state of the case, would have entailed the closing up of what had become the western branch of the *Jamna*, either by a permanent work eminently liable to destruction, or by an earthen dam renewed annually, at a great expence and loss of time, besides the almost certainty of its destruction, from the floods of the cold weather,) wisely selected the vicinity of *Chúharpúr*, to draw the supply from, although it entailed the passage of two rivers, one the *Patralla*, of no great moment, the other the *Súmbe*, of considerable difficulty, from its being the sole drain of the mountains south-east of *Náhan* nearly down to the *Jamna:* these two rivers between them drain also the whole country nearly between the *Súmbe* and the *Jamna*, and as their streams united before reaching the *Jamna*, one crossing would be saved. He unfortunately drew his new line of canal from the junction to *Búrya*, too close to the *Jamna*, instead of leading it under *Bellachor* and *Kharwán*, which though much more expensive in the onset, would have proved less so hereafter; it would at least have been much safer, as it has now become necessary to take measures against the encroachments of the *Jamna**, which this season have been to a formidable extent, and may this year, require expensive means, to prevent its continuance, which can only be decided on after the rains. The water led from the *Jamna* near *Chúharpúr* is conducted along a

* The effects of this, supposing the *Jamna* to cut into the canal, may be here noticed: the present bed of the canal *is above* the low-water surface level of the *Jamna;* the fall of the *Jamna* is more rapid than that of the canal, the level of the latter being maintained to attain the upper surface level of the country, and the maximum rise of the *Jamna* would suffice to throw about 12 feet water into the canal at height of floods; this would probably cause much damage in times of heavy floods, and might permanently be injurious by sweeping out the bed, and inclining the river to take this course from its lying direct in the line of current. In such case, it would break into the river again either at *Kanjnún*, or at *Kárnal*, or both, and its strength of current would suffice to clear for itself such a channel as would remedy the evils it could not fail to bring about in the meantime. The superior slope of the bed of the Jumna is likely to prevent this, and means may be devised to lead off the strength of the current from the bank, it has this year so fiercely attacked.

natural channel to *Jhydari*, thence by a new cut into the *Patrálla*, which it follows to its junction with the *Súmbe*, where Lieut. BLANE projected a dam of masonry, but was deterred from its execution by the heavy floods of 1820: the earthen dam then required was in extent 500 feet, now it has extended to a serious work of 1200 feet; the extension is attended with the advantage of the floods attaining less height, as none have reached since within three feet of the height he noted.—From this point an entirely new channel connected this work with the old line of canal near *Búrya*, whence its bed was simply cleared or restored as far as *Delhi*; in the vicinity of which a number of old bridges were repaired and some new ones built, besides which the only other works done were the formation of a new escape dam at *Kanjnún* towards the head of the canal, and the restoration of an old one near *Bowána*, for the tail of it; both works of vital importance, though still insufficient from want of a more centrical escape (as at *Karnál*), to pass off the heavy land floods from the north of *Karnál*, which are added to those of the canal in the rains: the old channel by *Búdakhera* presents a suitable site for such a work. On Lieut. BLANE's unexpected death in June, 1821, the canal was considered finished, and the bills rendered, amounting to somewhat more than half of the estimate—many works noted in them were not even commenced. The canal was however in fact completed, so far as conducting the supply of water then needful was concerned. When this supply came to be increased, and that for FEROZ's canal to be also brought down by the same head, the canal was no longer efficient; to prevent inundation, it became necessary to embank the canal nearly from end to end, and when the water became so deep as not to admit of a loaded hackery (or cart) passing through it, it became necessary to build bridges, so that from within a few years of Captain BLANE's death, the works of the canal, suited to its present purposes, have been in almost constant progress, and upon an enhanced scale, from the canal being kept full of water during their execution; for the irrigating villages had then become dependent on it for the means of paying their revenue. These works are only now drawing to completion.

Restoration of Feroz's Canal. Main branch, Rair to Bahúderah, 151¼ *miles in length; Rhotak branch,* 45 *miles long; Darbah branch,* 32 *miles long; New Supply Head,* 12 *miles long. Total length,* 240 *miles.*

The idea of the advantages of this work appears to have presented itself to the mind of Captain BLANE, when employed on the *Delhi* canal, in its vicinity; but they were first specifically brought to the considera-

tion of government by the civil commissioner Mr. FORTESCUE, through whom I received instructions in May, 1820, to make the requisite surveys and estimates; these added to other duties were not completed till June, 1822, and were then submitted to government, and sanctioned during that year; and I was honored, by being appointed to carry my own ideas into effect. The work commenced in March, 1823; the excavation of the channel was completed, and, a few necessary works of masonry for regulating the water being finished, the water was turned down the canal in May, 1825. This measure may appear precipitate, but water to the country, to which this was destined, was so valuable a boon to both man and beast, and the soil was generally so good, and the canal relatively to the *Delhi* one so small, that the extra expence of working in water was of much less moment, than the benefits of the supply of water to the country. Since that period the completion of original works, as well as the extension of the advantages of the canal, have been progressive.

The original works consisted in the clearance of the old line of canal from *Rair* to *Chaminí*, with the formation of bridges, as detailed in the abstract of estimates. The extensions are of the main line to *Bahúderah*,—of an additional branch into our newly settled frontier towards *Darbah*,—and of the *Rhotak* branch to *Rhotak*, with all the works necessary thereon:—these works like those of the *Delhi* canal are close on completion. In reference to the two canals, which have one common head, I may here allude to the formation of the masonry dam across the *Súmbe*, now in execution, to supersede the earthen dam there, premising that this dam is swept away annually in the end of June, after which, there is no regular supply of water in the canal, and that it is extending in dimensions. With every exertion, it occupies about 25 days in construction, and as it cannot be commenced before the rains are over, it cannot be completed before the 20th October, and in these 25 days, the fall of the *Jamna* is between two and three feet (exclusive of temporary rises from floods), so that although there is an abundant commencing supply for the season without any work in the *Jamna* on the 1st October,—it is no longer so on the 25th, and it takes 10 days further to stop up the escape channels in the *Jamna* near *Chúharpúr* (which can only be commenced after the bunds below are capable of retaining the water); by this time the river is a foot lower, and the channels at the separation of the eastern and western branches have to be cleared out, which brings the full supply into the canal about the 1st December. With the masonry dam, which may be thrown entirely open down to the level of the bed of

the *Súmbe* during the rains*, and which may be planked up to full water level in two days, and sanded in front in three or four; this will be ready for the reception of water on the 1st October, at which period also may be ready a single small intermediate dam, then necessary to bring down water, and the other works may be kept in progress according to the fall of the river, so that the supply, being kept steady from the 1st October, will reach the most distant parts by the 10th, just when wanted, and will not fail, as there will then be leisure to have each necessary work in advance ready at the moment it is wanted; these alone are advantages outweighing a cost beyond what this will be, the temporary work, with all its disadvantages, costing about as much as the interest at four per cent. on the outlay of the permanent one, which supersedes it.

Restoration of the Doab Canal, East of the Jamna. Main branch, 135 *miles long; side branches, about* 25 *miles in progress.*

In July 1822, Lieut. DEBUDE of the engineers was appointed by the MARQUIS OF HASTINGS, to survey and report on the then state of the *Doab* canal. The field work of this duty carried on throughout the rains was completed by the end of March, 1823, when Lieut. DEBUDE was relieved by Captain SMITH of the engineers, appointed 31st December, 1822, to complete the surveys and prepare the estimates of expence of restoration of the *Doab* canal, which preliminaries being completed in May, 1823, the work was authorized in December of that year, and commenced on in 1824; and on this canal the great portion of original work of all descriptions being completed before the water was turned in, it was only opened in January, 1830. The general completion of works being immediately followed by the departure of the superintendent, Major SMITH, for Europe, on sick certificate, the duty devolved on his assistant, Lieut. P. T. CAUTLEY, of artillery, under whom the supply of water has been kept up in the face of difficulties, some of which could not be and others were not anticipated. The deranging causes were, first, the great fall in the upper and lower portions of canal combined with looseness of soil; and next, the many mountain-torrents crossing its course. The first, though from end to end† only equal to that of the *Delhi* canal, was disposed of in a much shorter space, and without the strong soil general in the line of the *Delhi* canal

* Practice in the management of the dam, if ultimately completed according to the *original* design, will admit of its being regularly worked in the rains, so as to keep up a constant supply.

† The separation from and junction with the *Jamna* being at points almost on opposite sides of the river.

to counteract its effects. The consequence has been the displacement of the bottom of the canal at its head and tail, where in consequence of the natural inclination of the country, the great portion of the slope was concentrated. The only remedy for such a defect is, a system of lockage ; this has been applied where of most urgent necessity, and for the completion of which a design is now under the consideration of Government, which if sanctioned will do away with the evil. The second cause of disasters, the mountain-torrents which cross its course, (the *Búdhí Jamna*, the *Nyagaön*, and the *Maskarrah raos*, besides smaller ones,) are now I would fain hope nearly, if not entirely, provided for, by the arrangements which last year's operations have completed, and which, there is reason to suppose, are such as are not liable to be injured to any serious extent : but the power of these mountain-torrents is such, as to defy all calculation ;—unseen, their operation in times of flood must almost appear incredible, and in their progress they are so capricious, it is impossible to provide for every contingency, that a series of years may present. These three great torrents have been each provided with extensive masonry dams, laid open during the rains, but capable of being shut up to supply water when required at that season, besides which, the *Maskarrah*, the most dangerous one, has three extensive openings leading into the *Hindan* river, and each now, at least 100 feet in width ; and so much has altogether been done, that, there is no reason to apprehend any further heavy expenditure on this account, except under some operation of nature, which may destroy any portion of the works. These remedial works, and the completion of portions of the original design, which Lieut.-Colonel Smith was unable to finish, have with a few additional, beneficial, or necessary works, been continually in progress since the canal was opened. One of the heaviest labours has been, that of keeping the embankments of sufficient height to prevent the inundation, which would otherwise occur from the deposit of the silt brought down from the upper part of the canal, raising the bottom of the canal wherever the current was sufficiently slack to allow its subsidence ; this evil and expence will cease, with its cause above noted.

Having detailed as far as could be done the former and present state of the canals, and the original expenditure, incurred thereon, it remains to notice the purposes for which these canals were reopened, the results to the present period, and the current expenditure for their maintenance in efficiency.

1st.—Of the purposes for which the Canals were re-opened.

The original and almost sole purpose of the government in undertaking these works appears to have been to convey a large supply of water from the *Jamna*, for the purposes of irrigation of the crops, 1st, on lines of country where the natural depth of the wells was so great as to render the cost of irrigation from them so heavy as to impede the improvement of the districts, and delay the resettlement of waste villages, as on the *Delhi* canal. 2nd, to supply the means of cheap and easy irrigation to districts, as on the *Doab* canal, where although the wells are not so deep, yet the irrigation from the canal would be so comparatively cheap and easy as to afford the probability of great extension of the benefit: and 3rd, as on FEROZ's canal, to confer the means of irrigation on districts where from the excessive depth of the wells none was heretofore in use, and to convey a supply of good and wholesome water to a country where generally it is brackish or salt; in some districts so much so, as to preclude their occupancy, except for a few months grazing in the rains. To these points alone the general instructions of government tend,—and with such in view, the original estimates of the *Delhi* canal were framed; with the progress of this work, the advantages derivable from water-carriage, brought prominently forward after the water was first turned in, and the means of using the water as a motive power for machinery, of which the late Capt. BLANE, the first superintendent, made a commencement, led to the original designs of the other canals being formed with reference to these ends, which have been followed up on all the canals by further works designed to render one or other of the above purposes more efficient; so that on the completion of the designs either sanctioned or now before government, little further work can be necessary, excepting such as may be for the extension of these various benefits to new parts of the country.

2nd.—Of the results to the present period.

The annexed abstracts will show in a condensed form the results up to the end of the last official year. In elucidation of which, and explanation of comparative small returns, with such works, I may possibly be obliged to be more diffuse than I would have wished, to be enabled to convey a correct idea in regard to both the present results shewn by these papers and the future prospects; and first I have to notice, as having general reference to all the canals, the often repeated declaration of the government to the superintendents, as their main rule of guidance, that, the object of government in collecting a rent through them was

not so much to form a productive source of revenue from the actual price paid for the water, as to give them an efficient control over its expenditure, by making it of value sufficient to prevent its being wantonly wasted; and that they looked alone to the general improvement of the country, as the source from which they should derive the return adequate to the outlay. This announcement completely prevented the superintendents' disposing of the water so far as irrigation was concerned to the best advantage, and led to the settlement of a fixed rate of assessment so low, that it is not sufficient to prevent carelessness, entailing much waste of water; from which it may be presumed, that, the instructions of government have been fully acted up to, and the rates levied are sufficiently moderate. I am unable to state from want of knowledge whether the improvement of the revenue in canal villages has been commensurate with the expense: I know the rents of many have been raised, and that others, which were reckoned highly assessed, have been by the canal enabled to pay their revenue; and I also know, that tracts of *jangal* have disappeared in many parts, and are superseded by cultivation, supported by the canals. This point might be elucidated on the *Delhi* canal by a statement showing the revenue derived from all canal villages for a series of years before 1820, and for the subsequent years, compared with an account of the revenue derived during the same years from villages not irrigating from the canal, and in which the wells were equally deep. The length of leases being considered,—the advantage I believe would be with the canal villages, and the comparative difference would be fairly attributable to the canals; the improvement which would doubtless appear on the inland villages, as well as a corresponding proportion of that on the canal villages, being attributable to the benefits arising from a settled government superseding an unsettled one. On Feroz's canal a similar comparison might be made, commencing with the year 1826; but the *Doab* canal is too recently opened to afford any room for comparison. I may be permitted here to observe a fact which has forced itself on my notice in my constant intercourse with the inhabitants of canal villages, that, wherever a lease is for any long period of years, of 10 or upwards, or even of five years, improvement, and the use of the canal water make most rapid strides; and that wherever the settlement is too suddenly raised, or is for a short period, or from year to year,—the sole object of the cultivators appears to be to deteriorate their lands, often until they fall into a state from which it is difficult to recover them; and to this the deadly epidemic of 1829-30 has much added, by leaving valuable villages without hands sufficient to cultivate their

lands*. The abstracts show that on the *Delhi* canal, an immediate and satisfactory commencement was made by the cultivators, in availing themselves of the benefits put within their reach; on the other canals this is apparently much less the case, the explanation of which appears to me to be simply, that, on the *Delhi* canal and upper parts of Feroz's canal, irrigation from its waters was merely the resumption of an old practice, of which the memory still remained, and the country being intersected by old water-courses, the villagers had merely to follow up their traces to the canal banks, and clear them out with a tolerable assurance that when opened they would be serviceable, and that their money expended on the clearance would not be thrown away†. On Feroz's canal, below *Suffídon*, and the *Doab* canal, the case was totally different; no remains of ancient water-courses existed to point out to the inhabitants the mode of drawing the water to their lands; they had not the recollections of such a system of irrigation having existed, and had to buy all their experience of the disadvantages of adopting what was the cheapest mode, a direct cut from the nearest point of the canal to their lands without reference to level; and it was not until they had bought this experience, and failed, that, they would listen to the advice given them, and lead their water-courses so as to answer the purposes. On Feroz's canal, the system too led to a perfectly new mode of life: instead of continuing a pastoral people, who depended on the periodical rains raising them grain sufficient for their food with little trouble, they early made the discovery, that, with plenty of good water for their cattle, if they used it for irrigation, they must give up a life of idleness for one of comparative labour, and it was only by very slow degrees they acquired the knowledge, that, the advantages derivable from it would compensate them for the labour, and it is only now that the advances are beginning to be rapid, and advice sought as to the best means of availing themselves of the water. It cannot however be expected, that the benefits of the canals in *Hariána* will be developed until the rising generation brought up on the line of canals to labour, forms the majority of the inhabitants; and will not be fully so, until time and good government does away with the recollections of the life of general inactivity, added to the predatory habits, of their forefathers

* This epidemic was not confined to the canals, but extended from *Lúdianah* to *Jaipur*, as also east of the *Jamna*, when the *Doab* canal was not opened. The abstracts will show its effects, from which many places have not yet recovered.

† The expence of clearing out the water-courses, from 100 to 200 rupees per mile, is always incurred by the cultivators, sometimes aided by a loan from government free of interest.

On the *Doab* canal the change is not so great, being only of one system of irrigation for another. It is almost too much in its infancy to allow of comparisons, but the results are consistent with the premises, and the progress of irrigation has been infinitely more rapid than on Feroz's canal, though less so than on the *Delhi* canal; the decrease in the last crop, shown in the abstract, compared with the corresponding one of the preceding year, being solely owing to the excess of rain during the last cold season, diminishing the necessity for water, a cause which has frequently had corresponding results on the *Delhi* canal. It being a clear matter of course that, where rain falls in sufficient quantity to ripen the crops, they will not draw upon the canal for a supply to be paid for.

It was found, chiefly on Feroz's canal, that many villages were inclined to go on as they had heretofore, without employing the water for irrigation, but freely using it for all village purposes, and for the supply of their cattle, saving themselves the expence and trouble of drawing water or maintaining their wells and tanks efficient. As they benefitted considerably by the canal in this way, it appeared reasonable that they should contribute their share to its support; and it was submitted to government, that although villages paying above a certain sum annually (fixed at 100 rupees) in shape of water rent on irrigation, should still have the free use of the water for village purposes, yet that those paying less should contribute to the expences of what they benefitted from, by paying a moderate rate on the number of cattle of all kinds belonging to the village. This rate was fixed at six rupees per 100 head of cattle per annum,—a rate so infinitely below the cost of watering from wells, that, to the westward, cattle are brought to the canal from villages distant many miles. The distinction made in favor of irrigating villages has led to many irrigating up to and beyond the limit, which gives free water to the cattle; and in villages within reach of canal irrigation, this source of income will gradually cease, but will still be continued, and go beyond what it has now attained by the watering of cattle of villages, either so distant, or so situated, as to be unable to irrigate, and it is one so fair and reasonable, that it may safely be continued. The filling of village tanks at certain rates is in fact only a modification of the above, and requires no special notice.

Of the Employment of the Water for moving Machinery.

The only application of the water of the canals for the movement of machinery hitherto put in practice has been of a very simple nature, yet producing what will appear comparatively great results, as a source of revenue. The use of the water is let out to those who

offer most for it, and as the rent offered can never exceed a rate which must be under the cost of other modes of doing the same work, the employment in this way of surplus water, or of streams again returned to the canal for irrigation, is a general benefit to the community, and tends to cheapen commodities for which the demand is constant.

The first introduction of the system was by Captain BLANE, who permitted the erection of three small mills for grinding flour in *Delhi*, on payment of an annual rent of 25 rupees. Since these, mills of superior powers have been erected at the cost of government, which in *Delhi* and its vicinity are rented at rates varying from two rupees to five rupees per day, each mill; according to its power, which depends on the height of head water available at the different sites. The produce of the flour mills in *Delhi* fluctuates considerably, but with the supply of water now becoming annually more constant, the range will become from 25 to 30,000 rupees per annum, beyond which it is not likely to go. Similar mills are being constructed at *Karnál*, the income from which is expected to realize from 9 to 12,000 rupees,—as the large cantonment, added to the city, will probably yield abundance of work, and time and leisure will enable future superintendents to select many advantageous spots for the erection of small flour mills suited to the demand, every one of which may be more or less a productive source of revenue, compared with the expenditure, if due attention be paid to suit the supply of mills to the probable work. On FEROZ's canal, the only mills erected are those at *Hansí*, less powerful than the *Delhi* ones, but as yet too powerful for the demand; their produce however compared with their expence is satisfactory, and in such a rising town as *Hansí*, full employment for them may be anticipated. With exception of the vicinity of *Jhínd*, no other place holds out work for any extensive sets of mills on this canal, and there the slope of the canal appears sufficient to promise a return of about 15 per cent. on the outlay.

The capabilities of the *Doab* canal in this respect, as in many others, are very great. Flour mills have been erected at *Saharánpúr*, and near *Delhi*, and the produce shown in the abstract is the return from them; others are just completed at *Shamlí* : and there are other large towns capable of affording work for many more, some of which are authorized and others contemplated, the waste water from all being available for irrigation below the mill sites. Besides the above, saw mills are about to be tried at *Delhi* and *Karnál*, places which would yield much of such work, being the marts from which the upper part of western India is supplied with timber, from the forests of the *Jamna* and the Ganges. Models of oil and sugar-cane mills have also been prepared, which

promise not only to be successful, but likely to find an abundance of employment, the lines of the *Delhi* and *Doab* canals producing much sugar-cane, with very imperfect modes of expressing the juice.

It will be apparent, that all these modes of employing the water are highly advantageous, and do not interfere with the main purpose of the canals, that of irrigation; the mills being established either where surplus water escapes, or where it is returned below the mills into the canal again, no loss of water is entailed to irrigation, beyond the absorption and evaporation of the mill streams.

Of the Employment of the Canals for the Transit of Merchandize.

This object has as yet been only very imperfectly attained, being chiefly limited to the transit of rafts of timber on the line of canals between the forests of the *Jamna*, from which the rafts enter the canal at its head, to all intermediate places, along the canal of Feroz Shah, as far as *Hissar*, a distance of 200 miles. Down the *Delhi* branch from *Rair*, few if any rafts, except for canal works, have passed down, as they could not reach nearer to *Delhi* than 12 miles, from the obstructions presented by the ancient bridges and reduced dimensions of the canal. It is therefore preferable for rafters to use the *Jamna* for such purposes, conveying their rafts to within a mile of the city, though attended often by great danger in the rains, or delays in the hot-weather.

I do not conceive for these reasons, that the *Delhi* branch will ever come into use for rafting, beyond the demand of the vicinity of the canal, which with so much jungle-wood, available for common purposes, is not likely at an early period to be great. The *Doab* canal, it is probable, will be so employed as soon as the completion of the works intended to rectify the disadvantages attendant on the heavy fall at head and tail of this canal, shall afford means of locking the whole line of strong descent. This canal will ultimately come into use for rafting, not only on account of its safety and more equable depth of water, when compared with the *Jamna*, but because *Saharánpúr* is the general mart for all timber brought from the range of hills between the *Jamna* and the Ganges, and the merchants will doubtless see the advantages of at once rafting direct from *Saharánpúr* to *Delhi* by a safe and expeditious line of water carriage, instead of incurring the cost of a land carriage of 16 miles to the *Jamna*, added to the danger and delays of the river navigation.

In regard to boat navigation, all that has yet effected has been done by the superintendent, in using boats for the transport of lime, from the upper to the lower parts of the canal, which has

been a matter of great convenience, from the difficulty of procuring land carriage; indeed more so than one of saving, on account of the unformed condition of the canal banks for the purpose of trackage. In this respect, the *Doab* canal is well advanced; to make its banks available, nothing beyond a clearance of trees is necessary, when it may become an object to cut them down, on completion of the locks. On the *Delhi* and *Hariána* branches, the necessary work is rapidly progressing, and the last lock necessary is just completed. To establish such a novelty however will, I fear, require the experiment, to be made by the government, of establishing some boats suited to the canals, to ply for the carriage of goods; for instance, between *Karnál*, or *Rair* and *Hansí*, and I think such might shortly be done with advantage. There is at present a most extensive traffic existing across from the *Doáb*, through *Pánípat*, and *Soníp*at to *Hansí*, for the export of sugar; the return being salt, and coarse grain, and *Hansí* being one of the chief entrepôts in that quarter, for the supply of the western states. It appears to me, it would conduce greatly to the prosperity of *Hansí*, if the line of trade could be diverted from *Pánípat* to the canal at *Rair*, where the *Hansí* and *Delhi* branches separate, instead of proceeding direct from *Pánípat* to *Hansí* viâ *Neaulta*, by a land carriage of about 70 miles. From *Rair*, the sugar loaded on the canal boats could either proceed to within 12 miles of *Delhi**, saving about 40 miles of land carriage, or by FEROZ's canal to *Hansí;* on this latter line a return cargo would always be secure; and north of *Karnál*, being a great sugar country, it is probable much would be exported thence, independent of that reaching the canal from the *Doáb*, by *Pánípat*. Another mode in which it is probable such a trade might be established would be the offer of a premium, to the individual who should have conveyed the greatest value of imports and exports by the canal, beyond some fixed sum, up to a stated period. Some mode which would give the merchants a knowledge of the advantages to be derived from water over land carriage, without entailing on them present expence and risk, will I think be necessary, to set the matter going, after which it may be safely left to its own merits.

Of rafting on FEROZ's canal, the knowledge of relative cost and charges was first given, by all timbers for the canal and garrison works at *Hansí* being rafted by the canal; and the result has been, that, the

* At the cost of a single draw-bridge, boats could be enabled to reach within six miles of *Delhi*, and alterations to three old bridges would take them to within two miles of *Delhi*.

import of timber from *Karnál* to *Jhind*, *Hansí*, and *Hissar*, by land carriage, has been completely superseded, the canal being capable of carrying rafts, of the heaviest timbers, including all charges and the canal duty, at a cost of about one-half of the land carriage; and corresponding results may be expected elsewhere, when once the advantages of transport of merchandize by boats is clearly shown. The boats suitable to the canals should be long and narrow, and of burthen from 100 to 200 maunds*, sharp at both ends, and with a falling mast, and sail, to take advantage of the wind so often favorable for a return passage against the stream. The current however is no where sufficient to offer any serious impediment to tracking up.

Of sundry minor Items of Revenue.

With the view of preventing waste, and discontent, or complaints of partiality, it has been made a rule on the canals, that, nothing, the produce of the canals, shall be given free of payment of what is deemed an equivalent, and that whoever chooses to give the equivalent may have the right purchased. This leads to sundry small collections, which individually trifling are collectively sufficient to pay a most considerable portion of the outlay in improving this source of income, by planting timber trees on the canals. In the rains, the canal bounds produce annually a strong growth of various descriptions of grasses, and jungle; these have to be cleared annually to admit of repairs and access to the banks; what is unprofitable is burnt, and what is useful is stacked and sold. The bounds are in many parts covered with trees of natural growth, of which such as would impede the ultimate purpose of trackage are disposed of when wanted in the neighbourhood. Licences are also granted for cutting forage from the canal bounds. These together produce the sums stated in the column of "sale of produce of canal bounds," in the annexed abstracts, which though as yet trifling will ultimately become of material amount, when the useful forest timber trees, now planting on the canals, shall attain value with age, of which an idea may be formed from the canal banks, west of the *Jamna*, affording space for about 200,000 trees to attain maturity; they are planted in such numbers that from 10 to 15,000 get past the age of danger annually, at an expenditure limited to 2000 rupees. At the age of 20 years, the average value of each timber, if only rated at $2\frac{1}{2}$ rupees, would admit

* 1 to 200 maunds of sugar, grain, and such heavy articles would lie inside a boat of three feet depth, of suitable length, and 7 to 8 feet beam, which might be safely loaded to draw two feet water, so as to pass under the bridges freely at common water level.

a similar number to be cut down annually, being in value, at the above average, 30,000 rupees; though when once the regular cutting commences, it will of course only be picked trees which are felled in number suited to the demand for public and private purposes, and which individually will be far more valuable. The produce of the canal bounds may therefore I think be ultimately of considerable importance, and probably much more than I anticipate, from the destruction of the natural forests of the country from want of protection*, and the total absence of any system of plantation in this part of the country.

The only other item of income noticeable as having been one anticipated by Captain BLANE is that, from renting out the fishing of the canal; as yet it is hardly worth notice, and can never be of any moment, if I may judge from past experience.

As a source of revenue fines should not properly be estimated : the object of levying them is to aid in the prevention of waste or wilful misuse of the canal waters ;—to protect the embankment from injury, and thereby save its vicinity from inundation :—and to secure the plantations from depredation and negligence.

NOTE.—The above report concludes with accurate statements of the various items of expence incurred upon the canals, for which we cannot find space ; we have however endeavoured to condense their contents into the following table, under such heads as could be readily separated.—ED.

Abstract of Expences incurred, or estimated, upon Permanent Works of the three Canals, up to the present time.

Denomination of work.	Delhi Canal.			Hariána Canal.			Doab Canal.		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Excavations and embankments,	1,60,309	2	10	3,50,653	3	4	1,76,426	8	0
Overfalls, escape dams, weirs, regulators, and sluices, ...	1,03,113	8	9	26,769	3	2	1,20,656	14	1
Bridges (some with locks), ...	1,02,547	10	9	69,658	15	9	95,315	2	3
Under ground channels, ...	3,099	1	9	6,500	0	0	....		
Irrigation outlets, &c.	4,500	0	0	35,769	14	0	36,234	11	2
Experimeutal works,.....	4,938	14	0	....			....		
Water-mills for saws, flour, &c...	45,538	10	8	6,351	9	4	25,192	14	0
Depôts, choukís, &c.....	4,414	6	0	....			8,195	0	9
Plantations of trees on banks,..	2,281	15	1	2,283	15	3	5,490	13	4
Establishment, ...	52,264	9	11	52,175	8	4	....		
Total of Estimates and Bill for Works,.....	4,83,007	15	9	5,50,162	5	2	4,67,511	15	7

* The forests of the *Jamna* are nearly destroyed from indiscriminate cutting, since they fell under our authority : any one is allowed to cut what he pleases, and where he pleases, on payment of a merely nominal duty, and the whole country resorts here for supplies. Formerly it was not so : the result is, that now there is not a saul tree fit for public purposes, within six miles of the river; no roads exist, and the cost of timber in consequence in my recollection has doubled.

The total first outlay for the restoration of the system of canals will by this table appear to have been about fifteen lakhs of rupees :—it is impossible on the present occasion to specify the particulars of the various works of engineering skill which the nature of these canals rendered necessary :—one of the sluice dams was described in our number for Oct. 1832 (vol. i. p. 454), and we hope hereafter to select for insertion other works equally novel and interesting to Engineers, from among the numerous plans and designs transmitted by the Superintendent to Calcutta. Meanwhile, we must conclude this notice with a condensed abstract of the revenue of the canals, and the ordinary outlay in maintaining them, also compiled from Major Colvin's statements.

Abstract of the Revenues and ordinary Expences of the several Canals since the period of their restoration.

REVENUE.

From what source.	Delhi Canal, for 23 half years, up to 1830—31.			Hansí or Feroz'sCanal, 11 half years, up to 1830—31.			Canals west of the Jamna, since the accounts were united for one year, 1831—32.			Doab Canal, for 4 half years, up to 1831—32.		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Rent of ground under irrigation, *Rabi* crop,	1,88,070	5	5	38,185	10	6	27,698	3	4	9,559	12	0
,, *Kharif* ditto,..	1,47,522	4	1	30,012	1	3	23,318	1	7	4,074	11	10
Rent for watering cattle,	2,098	5	7	8,334	13	10	4,210	9	7	....		
Rent of water-mills, ..	80,029	14	5	8,332	13	9	19,002	3	7	3,361	6	8
Transit duty on rafts of timber, ...	2,933	4	0	3,957	3	7	2,061	15	0	....		
Sale of produce of canal bounds,.....	4,299	14	9	1,469	13	10	1,810	6	11	1,271	11	9
Sundries—fishing, filling tanks, &c.....	2,250	15	4	1,547	11	11	317	0	1	....		
Fines for breach of canal regulations, ...	15,711	5	9	8,047	11	7	2,463	2	10	1,985	10	0
Total income,....	4,42,916	5	4	99,888	0	3	80,881	10	11	20,253	4	3
Annual income, say, ..	42,000	0	0	20,000	0	0	81,000	0	0	10,000	0	0

EXPENDITURE.

Establishment for superintendence of works, collections, &c.....	3,47,195	7	9	1,51,770	10	0	79,722	14	7	74,715	6	2
Amount of the ordinary repairs, as per monthly bills, ...	69,169	12	4	5,803	6	6	18,342	8	5	10,509	5	6
Total expenditure,	4,16,365	4	1	1,57,574	0	6	98,065	7	0	85,224	11	8
Annual expense, say,....	40,000	0	0	28,000	0	0	98,000	0	0	42,500	0	0

II.—*Abstract of Observations of the Temperature, Pressure, and Hygrometrical state of the Air at Nasírábád. By* Major T. Oliver.

The barometer is the same I used at Delhi, and the observations have been reduced by the same quantity (.055), to make them comparable with those in the Surveyor General's office. The thermometers are also the same. I have not been able to note the barometer at 10 A. M. excepting for two or three months: the daily range appears to be about 0.10. The mean temperature of the day has throughout been taken as the mean of sunrise and 2 h. 30 m. P. M.; and of the night, the mean of sunset and sunrise. I lately obtained from Calcutta one of Daniell's hygrometers, intending to compare its dew-point indications with the wet thermometer depressions in this dry climate; but I cannot procure ether that will produce a depression of more than 5° or 6° below what water will effect, and this of course is useless here, unless in the rains. We have already a sufficient number of comparisons of this sort in moist air, but it would be desirable to have them in the dry air of this part of the country. As the moist thermometer sinks sometimes as much as 40°, some freezing mixture must be requisite to get the dew-point in such cases, where I imagine the best ether would not answer the purpose.

Regarding the Tables I now send, it will be observed, that in Table III, I confine myself merely to temperatures and wet thermometer depressions: these can be reduced at any time into tensions, when the subject may have undergone due investigation: in the mean time, the dew points and mean comparative tensions have been calculated, as in my former communication.

Table I.—*Barometer reduced to 32°; Temperature of the external Air and Deduced Elevation of Nasírábád above Calcutta.*

Year and Month.	Barom. 4 P. M.	Temp. of Air.	Elevation.	Year and Month.	Barom. 4 P. M.	Temp. of Air.	Elevation.
	In.	°	Feet.		In.	°	Feet.
Dec. 1830, ..	28,513	72,8	1435	Dec. 1831, ..	28,467	65,2	1462
Jan. 1831, ..	,510	72,2	1468	Jan. 1832, ..	,483	68,8	1430
February, ..	,398	68,4	1474	February, ..	,365	69,6	1488
March, ...	,338	85,1	1529	March, ...	,312	79,7	1493
April, ...	,230	95,3	1508	April, ...	,218	95,9	1526
May, ...	,117	102,7	1495	May, ...	,161	98,2	1497
June, ...	27,979	99,4	1532	June, ...	28,000	100,1	1526
July, ...	28,003	94,5	1529	July, ...	27,951	91,4	1539
August, ...	,040	87,2	1500	August, ...	28,032	85,8	1425
September, ..	,138	85,9	1493	September, ..	,183	88,3	1504
October, ...	,278	87,6	1444	October, ...	,340	89,2	1466
November, ..	,407	76,1	1431	November, ..	,461	81,3	1473
Means, ...	28,246	85,6	1487	Means, ...	28,248	84,5	1486

TABLE II.—*Mean Temperature of each Month, with the differences from the Mean of the Year.*

Month.	Day.	Diff. from Mean.	Night.	Diff. from Mean.	Sunset.	Diff. from Mean.
	°	°	°	°	°	°
January,	60,3	— 16,3	57,2	— 16,0	65,4	— 14,2
February,	60,0	— 16,6	57,6	— 15,6	64,5	— 15,1
March,	71,7	— 4,9	69,0	— 4,2	77,9	— 1,7
April,	86,0	+ 9,4	82,0	+ 8,8	90,0	+ 10,4
May,	90,5	+ 13,9	86,5	+ 13,3	93,6	+ 14,0
June,	91,6	+ 15,0	86,7	+ 13,5	91,3	+ 11,7
July,	86,7	+ 10,1	83,0	+ 9,8	86,7	+ 7,1
August,	82,1	+ 5,5	79,0	+ 5,8	81,7	+ 2,1
September,	81,4	+ 4,8	78,7	+ 5,5	83,0	+ 3,4
October,	79,3	+ 2,7	75,6	+ 2,4	83,1	+ 3,5
November,	68,7	— 7,9	65,0	— 8,2	73,3	— 6,3
December,	60,6	— 16,0	57,7	— 15,5	64,3	— 15,3
Means,	76,6		73,2		79,6	

TABLE III.—*Temperature of the Air and Depression (D) of Wet Thermometer.*

Year and Month.	Sunrise.		2h. 30m. P. M.		4 P. M.		Sunset.	
	Temp.	D.	Temp.	D.	Temp.	D.	Temp.	D.
	°	°	°	°	°	°	°	°
December, 1830,	49,8	9,5	73,7	19,1	72,8	18,8	67,3	16,2
January, 1831,	50,3	9,6	72,9	17,8	72,2	17,7	68,2	16,4
February,	50,0	5,5	68,9	13,9	68,4	14,0	65,1	12,2
March,	62,5	10,1	85,3	22,2	85,1	22,1	81,8	19,1
April,	74,4	14,7	97,8	29,4	95,3	28,0	90,0	25,0
May,	82,5	16,7	104,6	33,6	102,7	32,9	95,7	26,7
June,	82,7	9,1	100,3	22,9	99,4	23,1	89,2	14,5
July,	78,8	5,1	95,5	17,5	94,5	17,0	86,9	10,8
August.	77,1	2,7	88,6	10,2	87,2	9,6	82,1	5,7
September,	76,2	3,7	87,4	15,1	85,9	10,9	82,6	7,9
October,	69,1	8,5	89,4	22,1	87,6	20,7	82,6	14,9
November,	55,3	7,0	77,4	18,3	76,1	17,9	70,0	14,3
Means, 1st Year,	67,4	8,5	86,8	20,2	85,6	19,4	80,2	15,3
Dec. 1831,	52,6	3,9	66,2	9,3	65,2	9,0	61,2	7,6
Jan. 1832,	47,9	5,9	70,2	16,2	68,8	15,8	62,6	12,5
February,	51,1	7,0	70,4	16,6	69,6	16,7	64,0	13,3
March,	57,6	10,4	81,2	22,7	79,7	22,2	74,0	18,3
April,	73,7	16,0	97,3	32,5	95,9	31,3	89,9	25,2
May,	76,0	14,6	99,0	32,5	98,2	32,3	91,6	27,8
June,	81,3	10,4	101,6	26,7	100,1	26,2	93,3	21,3
July,	79,5	5,5	93,4	16,1	91,4	14,9	86,6	11,2
August,	75,6	3,2	87,0	10,8	85,8	10,0	81,2	7,0
September,	72,7	6,3	89,5	17,9	88,3	17,5	83,3	14,5
October,	67,4	13,5	91,5	28,9	89,2	27,6	83,6	24,2
November,	59,3	10,5	83,8	22,8	81,3	21,5	76,6	18,5
Means, 2nd Year,	66,2	8,9	85,9	21,1	84,5	20,4	79,0	16,8

Table IV.—*Dew point (S), calculated from the Depression in Table* III. *Comparative Tension (T), and Grains of Aqueous Vapour in a cubic foot of Air (G.)*

Year and Month.	S.	T.	G.	Year and Month.	S.	T.	G.
	°				°		
Dec. 1830, ..	31,8	,338	2,37	Dec. 1831, ..	48,6	,683	4,26
Jan. 1831, ..	34,0	,370	2,57	Jan. 1832, ..	36,9	,445	2,84
February, ..	41,6	,528	3,33	February, ..	36,5	,418	2,80
March,.....	45,5	,372	3,74	March, ...	35 5	,299	2,66
April, ...	46,2	,260	3,75	April, ...	38,6	,196	2,84
May, ...	48,9	,224	4,03	May, ...	40,4	,201	3,00
June, ...	67,9	,463	7,53	June, ...	61,9	,379	6,20
July, ...	71,6	,606	8,56	July, ...	71,4	,617	8,52
August, ...	74,4	,759	9,45	August, ...	72,0	,738	8,77
September, ..	70,0	,685	8,21	September, ..	62,4	,533	6,43
October, ...	55,4	,449	5,17	October, ...	35,6	,215	2,62
November, ..	43,0	,438	3,47	November, ..	40,2	,336	3,07
Means,.....	52,5	,458	5,02	Means, ...	48,3	,422	4,50

III.—*Determination of the Constant of Expansion of the standard* 10-*feet Iron Bar of the great Trigonometrical Survey of India; and expansions of Gold, Silver and Copper by the same Apparatus. By* Jas. Prinsep, F.R.S. *Sec.*

When I submitted the results of my former experiments on the expansion of iron, brass, and lead, which were printed in the Gleanings in Science for December, 1831, I ventured to anticipate that the simplicity of the process then contrived for heating the metals would be a recommendation for its adoption in any future researches of a similar nature. The opportunity has not been long wanting; and as it has involved the necessity of a more scrupulous degree of accuracy, from the important purpose to which the results were to be applied, I feel it incumbent upon me to enter into fuller detail in describing the course of experiment pursued. The gigantic scale of the former trials, with bars of twenty-five feet in length, was calculated to obviate most of the errors of observation, as well as any want of extreme delicacy in the measuring apparatus; but on the present occasion, although the bars were of smaller dimensions, the other concomitants were much more satisfactory; and I may confidently maintain that, with the present and the former series, we now possess a more correct table of the dilatations of gold, silver, iron, copper, brass, and lead, than have been hitherto published in works of natural philosophy.

It will be remembered, that the measurement of the base for the great Trigonometrical Survey of India, on the Barrackpúr Road, was conducted with compensation bars of a peculiar construction, each of them ten feet in length, or, bearing near their extremities two minute points, intended to represent that distance without liability to alter by change of temperature. Their construction has been accurately described by Major Everest in the 18th volume of the Asiatic Researches. To prevent the possibility of derangement in all or any of these compound bars, and to serve as a term of comparison for the whole, a standard iron bar was furnished along with them from England, upon which was laid off *at a certain temperature* with all imaginable accuracy, the measure of the English parliamentary standard, to which all the measures of the Indian meridian line should be thus reducible.

After the completion of the Barrackpúr base, the compensation bars underwent a most rigid comparison with THE STANDARD; as did also the steel chains used in measuring the several bases of Col. Lambton's Survey in the peninsula. The particulars of these comparisons, conducted with that most elaborate care and precaution, which has distinguished all the operations of the new survey, will be described by Major Everest himself, when he shall favour the public with the result of his labours. At present it is but one item of these precautionary measures which will come under our review.

The comparisons with the standard bar were made at a temperature differing by many degrees from that at which the latter had been proved in England. It became therefore necessary to apply a correction for its dilatation by heat: but to do this a question naturally arose as to what *constant* should be employed? The expressions given by different experimenters vary from 1.00144 (Troughton) to 1.00118 (Dulong et Petit), or one-sixth of the whole quantity,—a variation either to be attributed to imperfections in the mode of experimenting, or to difference of quality in the metal,—but in either way rendering it advisable to have recourse to a new set of experiments, to obtain the individual expansion of the standard bar itself. The experiments made by myself in Dec. 1831 upon a rod of iron twenty-five feet in length, though nearly agreeing with the results of Lavoisier and Smeaton*, were for the same reason inapplicable to a metal which might be of different quality. It was therefore determined by Major

* Expansion of wire-drawn iron by Lavoisier, ... 1.001235
Smeaton, ... 1.001258
Prinsep, ... 1.001256

Everest to submit the bar to a new inquiry, attended with every precaution to insure confidence.

The process adopted was framed on the principle pursued on the former occasion, namely the employment of a steam-pipe, to heat the metal uniformly to the boiling point. The section of the bar, $2\frac{1}{2}$ inches by $\frac{3}{4}$, prevented its application in the same simple manner, by insertion in a leaden pipe; and it was determined to employ micrometers on the microscope principle of Troughton to read off the expansions;—a new apparatus was therefore constructed by Mr. H. Barrow, H. C. Mathematical Instrument-maker, of which the following description, with reference to the perspective view in Plate VII. will explain the nature.

A double cylindrical case *a b* (fig. 3) was made, 9 feet 11 inches in length, and four inches in outside diameter, the inner cylinder being of copper, the outer case of tin. The space between them was shut in at the two ends, with perforated discs, so as to allow the bar to be inserted freely into the inner tube. The bar was supported in the tube upon two brass rollers, enclosed in the steam-tight square boxes at *c*, *d*, and situated at the same distance apart as the rollers upon which the bar is always supported in its own wooden case. (fig. 1.)

The tubes were pierced through from above in four points *e*, *f*, *g*, *h*, for the introduction of thermometers, the bulbs of two of which (*f*, *g*,) penetrated into deep cavities apparently provided for the purpose in the bar itself; these were filled with mercury, to insure the right reading of the temperature of the bar. The cylinder, *a b*, was supported on two of the brass tripods of the measuring apparatus, technically called *camels*, *k*, *l*, which are provided with vertical and horizontal screw motions to adjust the position of the bar. The steam was admitted from my small engine by a pipe at the northern extremity *b*, and suffered to escape freely from the waste pipe *m* at the other end.

Two micrometer-microscopes, *n*, *o*, were firmly attached by screws to two isolated solid blocks of stone, *p*, *q*, built upon the stone pavement of the laboratory at the requisite distance apart; the focus of the object glasses being adjusted in true verticals to distinct vision of the minute dots on the silver discs of the standard bar, when the latter was itself adjusted horizontally to a perfect level by means of a theodolite placed on the opposite side of the room.

The object of the double cylinder, according to the original design, was, to encompass the bar with a steam jacket, and thus heat it to the requisite point without allowing the steam itself to come in contact with, and thus to corrode, the iron; as well as to prevent its escape from the two open ends, which would incommode the glasses of the microscopes;

Standard 10 feet Bar

fig 1

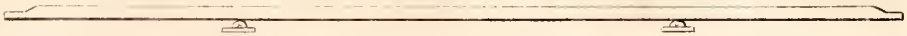
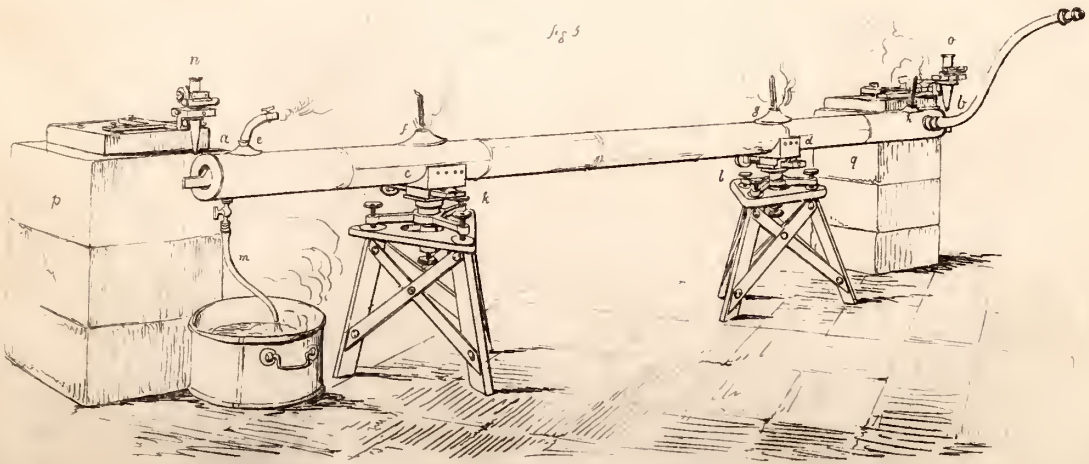


fig 2

fig 3



Apparatus for measuring the expansion of Metals.

fig 4

it was found however at the onset that the heating of the bar in dry air, although surrounded closely by the copper tube, was a most tedious process, whereas it was effected immediately by contact with the steam, which, condensing on the colder surface of the metal, delivered its latent heat, and did not issue from the vent until the whole apparatus had been effectually brought to the boiling point. It was therefore a fortunate circumstance that a leak in the inner tube, in the course of the first experiment, threw open a communication for the steam to the inner chamber: this was afterwards enlarged by piercing a hole through the copper, immediately in front of the steam injection pipe *b*. The only inconvenience produced therefrom was, that a little steam escaped from the two ends where the bar necessarily projected under the microscopes. This was however obviated by packing with cotton, and screening the object glasses with paper. The steam issued in plentiful clouds from the thermometer apertures *f* and *g*.

Having thus described the apparatus as it stood during the experiments, I must be allowed to add a few words on the capabilities of the several parts of it: and *first*, of the micrometers. The northern microscope was immovable, bearing fine cross wires in its field, to which the centre of the corresponding dot on the bar was brought by the lateral screw of the camel K. The cross wires of the southern microscope on the contrary had a range of about a tenth of an inch, which it subdivided by 20 revolutions of the centesimally-divided screw-head into 2000 parts. The micrometer was therefore sensible to the 20000th part of an inch, or more rigidly, each division of the index was equal to $\frac{1}{20000}$ inch, and the error of reading did not amount on several trials to more than one or two such divisions.

Secondly. Of the thermometers. There was some difficulty in procuring good instruments with naked bulbs, and it was necessary to remove common ones from their metal scales to adapt them to the apparatus, and to scratch the degrees on the tubes; many thermometers were broken from this and other causes. As the precaution was taken of comparing their boiling points, and their indications at the general temperature of the air, with a standard instrument, no error on this score was to be feared beyond the necessary difficulty of reading off to fractions of a degree, where the instruments were only divided to every two degrees. The *mean* thermometric error cannot however be estimated at more than 0.2 of a degree, which upon a range of 140 degrees will not affect the resulting dilatation more than $\frac{2}{1400}$ths, or about 2 in the sixth place of decimals. The fact is that the bar itself was a much more delicate measurer of the mean heat of the apparatus than the thermometers.

The error of the readings therefore upon a length of 10 feet (assuming it even to a $2\frac{1}{2}$ divisions of the micrometer) will not surpass 0.000001, while the error of the thermometer reading may amount to 0.000002: it will be seen from the tables which follow, that the general run of the experiments fully confirms this estimate of accuracy; at the same time it would be useless to carry the expression of the dilatation beyond the sixth decimal, as is frequently done in cases less entitled to reliance.

The order of each experiment was similar to that described in my former paper. When several readings had been made at the temperature of the room, the steam was let on and kept up for several hours, during which the second readings were made. Cold water was not introduced, as it took a long time to restore an equal temperature, and it was found better to allow the apparatus to cool down gradually by the following morning.

It was only in the third series of experiments that the bar remained quite stationary at the higher temperature for more than two hours. In general it was remarked that the reading of the micrometers gave the metal a maximum dilatation at the first moment of its being brought to the boiling point, gradually falling off even to the extent of 20 divisions ($\frac{1}{1000}$th of an inch), as the steaming continued. This was evidently not attributable to change of temperature in the steam, for the thermometers were not affected. I imagined that it must be produced by torsion or curvature of the bar, from the under part of it being at first less heated than the upper; for, by the construction of the apparatus for steaming, it is evident that, on the introduction of the steam, the upper parts of the tube would become heated first, while the condensed steam collected in the lower part of the cylinder imparted a lower temperature to the under surface of the bar: but this would cause the bar to assume a slight curvature upwards, which, as the supporting rollers were situated in distance one-fourth from the ends, would tend to depress the dots below the true focus of the microscope; the effect of this and of the curvature would be to make the bar *shorter* than otherwise, so that this explanation cannot be admitted.

Some very curious experiments, however, which are described by Captain Kater in the Phil. Trans. for 1830, may serve to afford an explanation of the anomaly. That gentleman found that the error in the linear measurement of a flat bar of 36 inches in length, might amount to .001 inch, simply by its resting upon an uneven surface, and assuming a curvature therefrom, the versed sine of which amounted to no more than .01 inch; now the difference between the chord and the

arc is this case, is less than a hundred thousandth of an inch, and is, therefore, inappreciable; nor is it attempted to explain in what way the effect observed should be one hundred times greater than could have been expected. Captain Kater, it is true, immediately devised a remedy for this anomaly, by seeking the neutral axis of the bar, and imprinting the dots upon ledges formed at the two extremities in this plane. The Indian standard bar was formed on this principle, the parts bearing the dots being two-fifths in vertical height of the remainder of the bar (figs. 1, 2.): but upon a length of 10 feet, we may conceive that a trivial error in the assumed position of this neutral axis may be sufficient to account for the slight anomaly in the readings alluded to. It will be evident that on the slightest slackening in the supply of steam, the upper part of the bar would become cooler than the lower, for the same reason as given above, and a contrary flexure would thus take place to a similar amount. By taking therefore the mean reading of each series of experiments, we need not fear any influential error from this source, which I have the rather pointed out on account of its apparent confirmation of Captain Kater's curious discovery.

We will now proceed to the experiments, placing them in a tabular form according to their dates, and correcting the thermometers, &c. to a common standard.

First Series, 20th November, Standard Iron Bar A.

Number of Observations.	Thermometers. In the steam-pipe.	Thermometers. Inserted in the Bar. North end.	Thermometers. Inserted in the Bar. South end.	Hour of Observation.	Micrometer Readings. Divisions.	Observations.
		°	°			
1		75,3	77,2 ?	Noon	—1067	The indications of the micrometers and thermometers were read off simultaneously at equal intervals of time, to ascertain the ratio of calorific accession, but the opening of a leak prevented the completion of the series. Observers, Major Everest and Captain Wilcox.
2		152,	152,0		— 82	
3		170,8	164,7		+ 113	
4		178,6	169,7	to	+ 211	
5		184,4	185,4		+ 314	
6		190,2	194,0		+ 493	
7		212,0	212,0	4 P. M.	+1157	
8		212,0	broken		+1151	
9	210,6	212,0			+1140	
10	210,2	212,6			+1133	
11	213,3	212,8			+1152	
12		201,2			+1033	
13		188,9			+ 806	
Difference of temperature,		136,0		dilatation,	2213	

Second Series, 21*st November* 1832. *Standard* 10 *feet Bar.*

Number of Observations.	Thermometers. In the steam-pipe.	Inserted in the Bar. North end.	Inserted in the Bar. South end.	Hour of Reading.	Micrometer Readings. Divisions.	Observations.
	°	°	°	H. M.		
1	80,1	77,9	78,0		—1050	Focal distance of micrometer 2,15 inches; barometer 29,97 inches; stopcock of steam-pipe frequently opened and closed during this series.
2	79,9	77,6	77,5	3 49 P.M.	—1071	
3	214,2	212,5	212,0		+1127	
4	214,2	212,6	212,0		+1116	
5	217,2	212,4	212,0		+1099	
6	215,4	212,8	212,5		+1114	
7	212,6	208,2	211,6		+1083	
8	215,1	211,4	211,9		+1089	Readings by Major Everest and Capt. Wilcox.
9	214,8	212,3	212,4		+1101	
10	214,4	212,5	212,1	5 0 P. M.	+1106	
11	71,3	71,3	71,5		—1198	
12		72,7	72,2	7 0 A. M.	—1175	On the following morning Capt. W. and J. P.
13		71,6	71,3		—1185	
Difference of temperature,		rising, 134,6		dilatation	2171	Omitting Nos. 7 & 8.
		falling, 140,6		do.	2296	

Third Series, 22*nd November. Same Bar.*

1	72,7	72,6	72,5	11 0 A.M.	— 860	Barometer 29,99. Wilcox and Prinsep.
2	73,9	74,4	74,5	12 43P.M.	— 829	
3	213,9	212,6	212,7	2 0 P.M.	+1447	The micrometer remained perfectly stationary for half an hour, and the steam-cocks were not touched.
4	212,0	212,4	212,2	to	+1443	
5	212,0	212,4	212,2		+1443	
6	212,0	212,4	212,2	4 0 P.M. 5	+1443	
7	76,3	81,8	80,0	5 0 P. M.	— 774	rejected, not evenly cool.
8	70,7	71,7	71,8	9 0 A. M.	— 926	next morning. J. P.
Difference of temperature,		rising, 138,9		dilatation	2288	
		falling, 131,5		do.	2218	single reading.
		140,7		do.	2370	following morning.

Fourth Series, 23*rd November. Same Bar.*

1	72,9	73,2	73,9	11 57 A.M.	— 897	Barometer 30,02. Wilcox and Prinsep.
2	72,9	73,4	73,9		— 896	
3	212,3	212,5	212,3	12 17P.M.	+1394	
4	212,5	212,5	212,3		+1394	
5	211,9	212,4	212,2		+1387	
6	212,7	212,5	212,2		+1379	
7	212,8	212,4	212,2	1 25 P.M.	+1379	
8	75,5	76,5	76,7	4 15 P. M.	— 872	rejected.
9	72,0	73,4	72,8	11 0 A.M.	— 920	following morning.
Difference of temperature,		rising, 138,7		dilatation	2283	
		falling, 139.2		ditto.	2306	

Fifth Series, 24th November. Same Bar.

Number of Observations.	Thermometers, in the Steam-pipe.	Thermometers, inserted in the Bar. North end.	Thermometers, inserted in the Bar. South end.	Hour of Reading. H. M.	Micrometer Readings. Divisions.	Observations.
1	72,8	72,9	73,2	11 40 A.M.	— 906	
2	72,5	72,9	73,3	11 43 ,,	— 906	Barometer 30,02.
3	73,3	74,1	74,1	0 45 P.M.	— 890	Wilcox and Prinsep.
4	212,3	212,9	212,5	1 8 ,,	+1401	
5	212,5	212,9	212,5	1 20 ,,	+1401	
6	212,	212,6	212,4	1 45 ,,	+1395	
7	211,5	212,7	212,4	2 0 ,,	+1394	
Difference of temperature,		rising, 139,2		dilatation,	2298	
		falling, 139,5		ditto.	2283	taking readings of 26th.

Sixth Series, 26th November. Same Bar.

1	71,3	71,5	71,9	10 A. M.	— 916	
2	72,9	73,1	73,9	11 25 A.M.	— 875	Barometer 30,02.
3	73,3	74,1	74,2	0 30 P.M.	— 865	Wilcox and Prinsep.
4	213,0	212,3	212,3	1 0 ,,	+1418	
5	212,3	212,3	212,0	2 0 ,,	+1405	
6	212,9	212,4	212,2	2 15 ,,	+1400	
7	212,5	212,2	212,1	2 40 ,,	+1388	
Diff. of temp.,		rising, 139,1		dilatation,	2288	
		falling, 139,7		ditto.	2288	following morning.

Seventh Series, 27th November. Same Bar.

1	70,5	71,0	70,9	10 0 A.M.	— 910	
2	72,3	73,2	73,0	noon.	— 875	Barometer 29,92.
3	73,0	73,6	73,5	0 30 P.M.	— 869	Wilcox and Prinsep.
4	212,2	212,5	212,1	1 0 ,,	+1422	
5	211,7	212,4	212,0	1 30 ,,	+1408	
6	212 2	212,5	212,0	1 45 ,,	+1404	
7	212,7	212,5	212,0	2 0 ,,	+1398	
Difference of temperature,		139,7		dilatation,	2293	

The accordance of the observations, particularly of the latter series, was so satisfactory as to render their further repetition superfluous: it now only remains therefore to arrange the data of the several experiments in a tabular form, and to calculate the resulting dilatations according to the usual expression of "the dimensions taken by a bar at 212°, whose length, at 32°, is 1,000000."

Abstract of the results of the foregoing experiments on the expansion of the Standard 10 feet Bar of Iron.

No. of the series.	Range of Temperature Farh.	Divisions of the micrometer.	Total expansion in decimal parts of a foot.	Dimensions of a bar at 212° whose length at 32° is 1,000000.	difference from the mean in millionths
	°				
1 *r*	136,0	2213	.0090980	1.001204	— 14
2 *r*	134,6	2171	.0089253	1.001194	— 24
f	140,6	2296	.0094392	1.001208	— 10
3 *r*	138,9	2288	.0094064	1.001219	+ 1
f	131,5	2218 ?	.0091185	1.001248	+ 30
f	140,7	2370 ?	.0097435	1.001246	+ 28
4 *r*	138,7	2283	.0093858	1.001218	0
f	139,2	2306	.0094804	1.001226	+ 8
5 *r*	139,2	2298	.0094475	1.001222	+ 4
f	139,5	2283	.0093858	1.001211	— 7
6 *r*	139,1	2288	.0094064	1.001217	— 1
f	139,7	2288	.0094064	1.001212	— 6
7 *r*	139,7	2293	.0094269	1.001214	— 4
			Mean of the whole,	1.001218	

The mean of these experiments is 1.001218, but if two of the series (doubtful because they depend on single observations), be struck out, the dilatation will appear to be 1.001213, and the greatest deviation hardly amounts to the one hundred-thousandth part, while the general accordance is much within these limits. The mean of the former experiments upon an iron rod of 25 feet in length was 1.001256, determined by a single heating, and therefore liable to some uncertainty: that of another wrought iron bar to be noticed presently, was 1.001216, which agrees so closely with the above, as well as with the results of Smeaton and Lavoisier, that I am inclined to think there is not so much variation due to the quality of the metal as has sometimes been supposed, and that 1.001215 may be safely employed on all occasions as the *constant of expansion* for wrought iron.

II.—*Expansions of Gold, Silver, and Copper.*

Having concluded the experiments upon the standard bar of the trigonometrical survey, it occurred to me as very desirable to make use of the microscopes, while fixed, to lay off a duplicate of the bar for deposit in my own office. When this had been done, it followed that the constant of expansion might likewise be determined with ease for the new bar by a repetition of the same process;—and further that we might arrange alongside of the iron bar such other metals as were readily procurable in the mint of the desired dimensions.

Captain Wilcox kindly undertook to assist me in this new series, which was conducted in every respect with the same attention to mi-

nute accuracy as before. We prepared in the mint two laminated straps; one of pure gold*, 10 feet two inches long, $2\frac{3}{4}$ inches broad, and about $\frac{1}{8}$ inch thick, weighing about 320 lbs: the other of standard silver ($\frac{1}{12}$ copper alloy), of the same dimensions or a little thicker.

The two ends were cut away, and marked with fine dots as nearly as possible at the distance of 10 feet apart. As the run of the micrometer was only one half of the expected expansion of the metals now to be tried, the precaution was taken of inserting second dots about $\frac{1}{10}$th of an inch within the first, the distance between the two dots being carefully measured under the microscope. I have said that the inner steam cylinder was of copper; all that was necessary therefore to enable us to measure the expansion of this metal along with the rest, was to fix two small tongues to the two extremities of the tube, projecting under the focus of the microscopes, and bearing the marks for measurement.

For consistency I will insert the new series of experiments with the same detail as before, to enable other experimenters to judge of the measure of confidence due to our simple but somewhat tedious investigation.

Eighth Series of Experiments on Expansion.

Day.	Thermometers. In Bar. South.	Thermometers. In Bar. North.	Thermometers. Steam pipe.	Readings of the micrometer. Iron.	Gold. (add 2525.)	Silver. (add 2277.)	Copper. (add 2297.)	
	°	°	°					
Nov.	76,0	76,6	76,4	—904,5	—891,5	—906	—959	
30.	76,2	76,7	77,6					
Noon	211,7	212,2	213,2					
	211,9	212,2	213,2	+ 1290	—758,5	+358	—140	*r.*
to	211,8	212,1	213,8					
	211,9	212,2	214,3	+ 1275				
5 P. M.	211,8	212,1	213,0		—776	+360	—129	
	211,8	212,0	211,2	+ 1269				
	211,9	212,1	212,7	+ 1279	—768	+362	—129	
	211,9	212,0	214,0					
1st Dec	72,9	71,6	71,4	— 1023	—960	—937	—1058	*f.*
7 A. M.	72,4	71,6	71,6					
Ascending range,	135,6		dilatation,	2182	2649	3543	3133	
Descending do.	139,9		ditto.	2301	2718	3574	3222	

Ninth Series.

Dec. 1.	76,0	75,6	76,5	— 967	—913	—864	—979	
Noon	76,2	76,0	76,5					
	211,6	212,2	213,4	+ 1266	—798	+358	—157	
to	211,8	212,1	214,4	+ 1267	—799	+365	—141	
4 P. M.	211,9	212,1	212,2	+ 1254	—805	+364	—197	†
Ascending range,	136,0		dilatation,	2229	2637	3503	3098	

* Of the old gold mohur standard, or 1 car. $3\frac{1}{4}$ gr. Br., which, as far as such experiments go, may be deemed pure.

† Before this experiment, the hole had been pierced through the copper cylinder.

I should have premised, that to prevent the straps of gold and silver from curving within the cylinder, when heated, they were held flat, one on each side of the iron bar, by coils of copper wire at distances of six inches apart—these were not so tightly bound as to impede free motion longitudinally.

At this period of the experiments it was determined to *anneal* the gold and silver bars, to observe what difference would be caused in their rate of dilatation thereby, as well as what would be the permanent elongation due to this change of condition.

To effect the annealment of such long slips of metal in the most equable manner without endangering loss or accident, required certain precautions. They were laid upon a flat bar of wrought iron, supported at distances of a foot asunder by fire-bricks, as represented in fig. 4, Pl. vii. Their whole length was then enveloped in *gobar*, or cakes of cowdung, in the same manner as is practised in heating the felly of a wheel. The heat was thus gradually raised, until the whole length was uniformly of a glowing red. But, not to lose the opportunity which this experiment afforded of ascertaining the relative expansions of the three metals at this higher temperature, an iron stake had been firmly fixed in the ground at one end of the bars, against which all three were made to abut firmly: the other ends were connected by an intermediate brass rod (kept cold) with the nonius of a sliding scale placed on the ground in a line with the bars, so as to measure off their elongation with great facility. The results, and the temperature by Farenheit's thermometer founded on the assumption of an equal rate of expansion throughout the scale of each metal, were as follows.

	Absolute expansion in inches.	Deduced temperature.
The gold, placed uppermost, ...	1.638	1787°
The silver, in the middle, ...	2.008	1655
The iron, undermost, ...	1.240	1609

That the upper position was much hotter than the lower was evident, nor does it seem surprising that the difference of temperature should have been so much as 180 degrees. No knowledge therefore could be gained on the point sought, namely, the relative ratios of expansion; but the method of operating is itself capable of further application, and I hope hereafter to be able to pursue it to more conclusive results.

The absolute elongation of the precious metals, by annealment, was measured by placing them once more under the microscopes at the same temperature as before, (77°.2.) It was found to be much less than was calculated from the difference of specific gravity before and after annealment, shewing that the compression under the rollers was in the gold 20, in the silver 8, times greater in the transverse than in the longitudinal direction. The results were as follows:

Specific gravity			Increase of volume.	Elongation by annealment,	
	hard.	annealed.		in parts of an inch.	in decimal parts of 10 feet unit.
Pure gold,	19,313	19,136	,00925	,01973	,000164
Silver, $\frac{1}{12}$ alloy,	10,404	10,239	,01611	,08244	,000687

To compare the relative expansions, the increase of bulk, or volume, must be divided by three, to reduce it into linear elongation, when, as before stated, the transverse will be found much to exceed the longitudinal expansion.

Having explained the objects and results of this digression, and imagining the bars replaced as before, we will proceed to the remainder of the experiments with the steaming apparatus:

Tenth Series.

Day.	Thermometer, in bar south.	Thermometer, in bar north.	Thermometer, in steam.	Readings of the micrometer. Iron.	Gold (add 2525)	Silver (add 4065)	Copper (add 2297)
	°	°					
Dec. 3.	78,5	78,3		— 937	—449	+865	—965
Noon	79,2	79,2					
	212,1	211,8	211,5	+1279	—383	+224	—240
to	212,0	212,0		+1267	—381	+222	
	212,0	212,0		+1264			
5 P. M.	211,9	211,7					
Ascending temperature, different for each metal, ...				° 133,6	° 133,4	° 133,1	° 132,8
Dilatation (adding space between dots), ...				2207	2592	3423	3022

Eleventh Series.

Dec. 4.	78,4	78,4	....	— 911	—445	+865	—977
10 A.M.	78,6	78,6					
	212,3	212,0	full	+1278	—377	+227	—203
to	212,2	212	steam	+1266	—401	+220	—202
	212,1	212,1	(steam	+1204	—404	+175	—226
3 P. M.	211,9	211,9	less)	+1202			
				°	°	°	°
Range of temper. ascending, ..				133,7	133,7	133,7	133,5
Ditto for last readings, ...				133,6	133,6	133,6	133,5
Dilatation, first readings, ...				2183	2593	3423	3071
Second ditto, ...				2114	2566	3375	3048

In this last series the steam was allowed to run down on purpose to try the effect: and it will be seen that it was sensibly felt by all the metal bars, even while the mercurial thermometer scarcely indicated the fall; for as before remarked, the bars were far more sensible thermometers than the small mercurial instruments.

The expansion however by the last experiment has been purposely calculated, to shew the maximum influence of such a cause.

The general results may now be classed under their respective heads as follows:

	Range of temperature.	Reading of micrometer.	Deduced dilatation for 180 degrees.
Duplicate Iron 10 feet Bar.	135,6	2182	1,001191
	139,9	2301	1,001217
	136,0	2229	1,001213
	133,6	2207	1,001223
	133,7	2183	1,001208
	133,6	2114	1,001171 ?
	Mean, rejecting the last, ...		———1,001210
Pure Gold, rolled hard,.. .	135,6	2649	1,001446
	139,9	2718	1,001438
	136,0	2637	1,001435
annealed,.....	133,6	2592	1,001439
	133,7	2593	1,001435
	133,6	2566	1,001421 ?
	Mean, rejecting the last, ...		———1,001438
Standard Silver, $\frac{1}{12}$ alloy, rolled hard,	135,6	3543	1,001933
	139,9	3574	1,001890
	136,0	3503	1,001906
annealed, ...	133,6	3423	1,001896
	133,7	3423	1,001895
	133,6	3375	1,001869 ?
	Mean, rejecting the last, ...		———1,001904
Copper annealed, but partially hammered in making tube, ...	136,6	3133	1,001697
	141,5	3222	1,001685
	135,8	3098	1,001688
	132,8	3022	1,001684
	133,7	3071	1,001702
	133,5	3048	1,001690
	Mean of the whole, ...		———1,001691

It must be remarked with regard to this series, that, besides other sources of error, the dots, marked with a needle-point by an unskilful hand, were rather difficult to bisect; and further, the continual shifting of the apparatus, to bring each bar successively under the focus of the microscopes, was more than sufficient to account for irregularities greater than are observable in the present results.

In comparing the list with the former one, one is struck with the close agreement between two metals of very different fusibility, namely, standard silver, and brass; a circumstance which permits the application of silver divided circles to astronomical instruments of the latter metal. Platina is by no means so well adapted for such a purpose. The operation of annealing does not seem to have the slightest effect upon the rate of expansion, a fact well worthy of consideration, as it would be at all times difficult to say what allowance should be made on such account, where the degree of hardness of a metal might be uncertain.

The latest determinations of the dilatations of metals (which have reached me since the above experiments were finished), are those of Mr. Daniell; but the apparatus used by him, (a plumbago tube of six inches in length, holding a rod of the metal to be operated on,) however well adapted for approximate measurement of intense heats, is obviously not worthy of trust for minute measures at low temperatures,

I do not therefore insert his table from the Philosophical Magazine now before me, but at once conclude with a general summary of the dilatations which our experiments in India have established, in a manner worthy, I hope, of entire confidence.

Dilatations of metals determined at Calcutta.

Iron,	Standard 10 feet bar of the Trig. Survey,	1,001213	1,001215
	Duplicate of do. of English bar iron, ..	1,001210	
	Wire-drawn rod, twenty-five feet, ...	1,001256	
Gold,	nearly pure, (10 feet long)		1,001438
Silver,	containing one-twelfth alloy, (do.).....		1,001904
Copper,	sheet, annealed, ... (do.).....		1,001691
Brass,	wire-drawn, annealed, (25 feet)		1,001906
Lead,	one-inch pipe, (25 feet)		1,002954

The apparatus used in the foregoing experiments is preserved, in case it should ever become a desideratum to try the expansion of other metals or substances by the same process.

IV.—*Continuation of Dr. J. Gerard's Route with Lieutenant Burnes, from Bokhára to Meshid.*

[Extracted from letters to his brother Captain P. Gerard.]

Mírabád, 31*st July*, 1832. We took leave of Bokhára on the 21st ultimo, and are now in a Túrkoman village, about 36 miles distant, awaiting the arrival of the merchants, &c. who are to form the *Kafila;* but we may be here long enough, as the *Urganj* army is still in our way. Ghos Bég sent for us before starting, and made us over to the Túrkomans and *Kafila bashí*, with every demonstration of good will, and enjoining them to convey us safe to *Meshid* at their peril. * * * *

The weather has been uniformly sultry;—thermometer daily above 100°, even as high as 110°, and our sitting room is but a few degrees cooler, but the extreme dryness of the air counteracts the sensation of heat. The nights have generally been pleasant and the mornings always temperate;—thermometer 66°. Though it is now the middle of August, the climate can scarcely be said to have changed, except that the nights are cooler.

Meshid, 17*th September*, 1832.—Here we are safe in Persia, after a journey of no ordinary difficulty. We left the village *(Mírabad)* so long our prison, on the 16th of August, and crossed the Oxus on the following morning, intending (as we had believed upon faithless resolutions), to accomplish the trip in fifteen or sixteen days. Our first detention commenced at *Sarjué* on the bank of the river, but as this

was not occasioned by any untoward event we cared less. Other *Kafilas* joined us here, and on the 21st we resumed the journey across the desert. The weather had undergone a great change, and was now temperate. We almost immediately entered amongst sand heaps, which succeeded in rising heights, and extended till they bordered the horizon on all sides; and the *Shimal* or north wind sweeping away the loose surface, made it appear like the sea spray, while the heaps themselves represented the waves. The camels trod heavily through the sand drifts, and the horses plunged as if they were fording a river. Several belts of this sort occurred between them, tracts of sand covered with bushes or shrubs, and then a ridge of the desert composed of hillocks or sand waves, which at a distance looked like a vast *roller* just going to break. Scarce any track is visible, the wind defacing the prints of the camels' feet; but there is a general line of route which is followed. The sand heaps are of every size and shape, but have commonly their cliff to the south; deep chasms are formed by the junction of their bases, and basins or cavities which would resemble pools if filled with water. The scene was quite new and magnificent. It was altogether a wilderness. We passed several dead carcases of camels and horses, the drivers of which, having missed the wells, killed some of them for sustenance. Most of the wells were saliferous, but the water answered for our horses and some of the people, who live little better. The climate had evidently turned from its extreme temperature, and in this respect we had not to complain. The nights, contrary to expectation, were very mild. A very long march brought us to a well of bad water, after having been without any except what we brought from a distance. This was a relief the more grateful, as we had nearly missed the spot, and perseverance alone in *feeling* for the road kept us in a proper direction, till the barking of a dog announced our proximity to a Túrkoman camp. On the 27th we reached a baked arid plain, on which was planted a tented village of Túrkomans. Here we were to be taxed by the *Urganj* authorities, who came down to us from the ancient city of *Máwur* or *Myhr*, now almost level with the face of the desert, and no longer an inhabited spot. The *Urganj* army was close upon us, but on their homeward route. On the 28th the collector arrived, and inspected the *Kafila*. The merchants presented him, as customary, with various articles: we sat mute in our camel panniers, and were duly reported as *Musáfirs* upon a pilgrimage to the places of fire worship; our offering to the taxman consisted of loaf sugar and tea. Our prodigality was nearly ruining us; fortunately a Russian merchant (a Mahomedan who traded to Russia, whose avarice

had conquered all pride of self-sufficiency), from a regard to his own interests, checked our liberality, and instead of presenting a couple of sugar-loaves and a handful of tea, broke off the end of one, and with a few raisins made up our *nazar*.

Several of his train peeped into our creels and asked after our business, and were quite satisfied on being told that we were Afghans from *Kabúl :* so little are those people acquainted with the colour and characteristics of Europeans. In this respect, therefore, our faces are real masks, and it was here only the name of our country that we had an object in concealing, since to the services of those in Abbas Mirza's army especially, not a little of the bad feeling between the Khan of *Urganj* and the Persians is owing. Russians and Englishmen are alike their enemies, or rather the *Urganjís* are hostile to both. In the afternoon we ventured out of our camel baskets as the enemy was departing, but as some of his dependents were lingering behind we were warned back. In the evening we got out and laughed heartily at the transaction. In truth we were quite at our ease all the time, not believing that there was an individual in our camp who had any object in betraying us; but it was not long till we discovered that wretches are to be found in every community, and people whose fair faces belie their feelings. We had only a week's march between us and *Meshid,* and we started again with fine prospects.

On the 1st of September we came in sight of the mountains of Persia, and next day arrived at *Shiraks,* a Túrkoman village with a fort. Here we were to be taxed, but misfortunes seldom come single; and if the merchants had to complain of an imposition, we certainly had not bargained for a share of their burdens and a load of our own besides. While in our former embarrassment near *Myhr,* we superadded to it the pleasant prospect of meeting a body of Allemans, whom the merchants of our *Kafila* actually saw marched off upon a predatory excursion to the borders of *Meshid.* The tax-gatherer, who had an interest in the safety of the *Kafilas,* exacted a promise from them, that should they cross our path we had nothing to fear: but a robber's pledge is like lover's vow graved upon some insect's filmy wing, and lasts only till the bait is thrown out. No fewer than seven hundred of those armed ruffians were thus let loose. At *Shiraks* we learnt that the Allemans were still in pursuit of booty, and the *Kafila* took up its position till they should have passed us on their return. Apprehensions were now turned into real horror, at least with me, when we beheld the cold-blooded monsters racing into the village, with their spears poized and their horses almost dead from fatigue in their infernal occupation. They

brushed past our encampment, some of them stopping and conversing with the *Kafila*, and relating their adventures to the merchants, who in pursuance of their trade took a heartless interest in that of the robbers, as upon their success more or less would rest their own security. Upwards of 100 Kuzlbashes were seized for the *Bokhára* market, and a number of camels and cows which they drove off from within sight of the walls of *Meshid*. Their encampment was close to us, and we were almost tempted to take a look at it. Some of the Allemans were disabled, while their horses were scarce able to carry them. Many had returned empty-handed, finding the work too heavy; all those who touched at the village came for refreshment or to visit their friends. This is a strange state of society, yet these intrepid adventurers, when seen in the ordinary relations of life, are not only sociable companions, but even prepossessing in their natural simplicity and easy manners. The guard of Túrkomans we had were the same people, and every individual of it could enumerate his exploits in the inglorious field; but this is perhaps not quite fair, as it requires a considerable share of courage to meet the various perils of their vocation: pillage alone is their aim, and, of all others, human beings are their greatest prize; nor is it much to be wondered at that, amongst people who are naturally prone to rapine, their fellow creatures should be most coveted, as long as the infamous markets of *Bokhára* and *Urganj* offer a premium for the traffic. The Russians have, I believe, succeeded in restraining slavery as regards *Bokhára*: but what reliance is to be placed upon any compact that is both adverse to mercenary interests and religious zeal? There are several hundred Russian slaves now in the dominions of the *Bokhára* dynasty, and as long as Túrkomans offer them for sale there will be purchasers; and what does Russia know of her black population or of her fugitive soldiers, who wander amongst half savage hordes at the extremities of her territory? At *Shiraks* there was a Persian girl of unquestionable beauty who had been in slavery for a couple of years, with the Túrkomans of course; her transfer was delayed in hopes of an enhanced price, and a *Kafila* which followed us, picked her up at what may appear a high valuation, if indeed we can make any estimate of what is in itself unappreciable! But you will excuse me for treating the subject in this loose way, having resided so long in a quarter of our own dominions where female slavery is as notorious as the sun at noon day, and if not quite so glaring, is, I fear, scarcely less remarkable, while it is as genial to the people's feelings as his rays to their frozen solitudes. The Persian girl was sold for upwards of 60 *tilas*, more than 420 rupees, a sum

that would purchase at least a dozen of females in the Himálayan regions. When this infernal traffic is so profitable, can we expect that the hungry Túrkomans of the desert will restrain their cupidity for human flesh ?—but this is a subject for sages in their closet, and not for travellers.

Our detention at *Shiraks* till the roads were cleared of lingering robbers was necessarily prejudicial to us, as we were still in the *Urganj* territories, though virtually subject to Abbas Mirza: but you may judge of his authority by the successful obtrusions of the Túrkomans even to the gates of this holy city. Our protests against imposition on the previous occasion of paying taxes had given umbrage to several of the merchants, who seemed to have leagued together to make what they could of us; and finding us still self-confident, had recourse to the mean tricks natural to the trade, and betrayed us. We were now to be locked up in the fort till the Khan of *Urganj* sent for us; and at first we saw nothing but certain misfortune, slavery at the very least, and we prepared for flight with the evening's twilight at the risk of falling into the hands of the Allemans, or half perishing for thirst in the desert. When thus turning over our thoughts, one of the merchants, a Persian, whose state of health had made him extremely grateful for our curative attentions, relieved us from our suspense, and, together with the avaricious Russian trader, offered to conciliate the Túrkoman chiefs, and pass us off as pilgrims or any other species of wanderers. A couple of *tilas* and a little tea and sugar, with sweet words, satisfied their expectations; but fortune favoured us more than our presents, as it happened that our friend the Persian was a most intimate acquaintance of the very people who pressed us so closely. Having got out of this snare, we divested ourselves of every comfort we might have had over our fellow travellers, sat in the sun or in our creels, and ceased to cook our dinner as usual, as the fire collected a swarm of Túrkomans as a candle does insects. Still delayed, new difficulties arose, a plot to extort money or tea was again begun, and our apprehensions of rumours of our disguise reaching the chiefs of the *Urganj* army were too well grounded. A fresh body of Allemans had issued from *Máwar*, and were approaching *Meshid*; our consternation was further raised on learning that Abbas Mirza's *Elchee* (ambassador) on his way to *Herát* was seized by the very people we were amongst, and was actually a prisoner in irons in the village, so that on every side we were environed by difficulties of one sort or other; at last a *Kafila* from *Meshid* made its appearance, and our irresolute associates got under weigh, much to our satisfaction, after nine days of the most

irksome durance, though we were not entirely without amusement during part of the time, but upon the very threshold of a friendly port such provoking interventions were quite unsupportable. Even here we were obliged to take in a supply of water. On the 11th we resumed our journey, and on the 12th crossed the mountain frontier of Persia or rather Khorasan, which is continuous with the hills which trend along the Oxus and run into *Hindu Kush*. They are about 4,000 feet in height (water boiling at $205\frac{3}{4}^{\circ}$), and support the plains of Persia which have a very considerable elevation.

At midnight of the 12th we were thrown into confusion by a report of an encampment of robbers. The *Kafila* closed up in a great hurry; the camels were instantly squatted upon their knees and packed together; the utmost regularity prevailed; fear having overcome their surprise, both men and beasts were silent; the camels, as if they had been accustomed to such scenes, trembled and sat still. The armed men stood in front waiting the assault. I found myself close to a pair of women who were bustling about seeking comforters, but I felt rather abashed in such company, and making my way over camels' backs and bales of goods got outside, followed by our *Haji Baba*, who though a very respectable man in his calling had no idea of showing fight, and entreated me to make myself snug; but his alarm was soon allayed, for the enemy was not forthcoming, and the people we dreaded were equally afraid of us. They were travellers like ourselves. Had they been Allemans we should have made but a poor figure in the contest, for not half of us would have come to the scratch, as the phrase is, and too surely the remainder would not have kept it up after the first onset. In the evening we were within ten miles of *Meshid*, and before making a final start of it, a custom-house officer paid us a visit, and delighted us by intimating that Captain Shee was at *Meshid*, where news of some kind or other must await us; but as Abbas Mirza was besieging a fort in the neighbourhood, we could not reconcile the report. An hour before day-break on the 14th saw us at the gates of this city, and we are now amongst Persians all gay and courteous, a new scene entirely,—no more Usbeks! We were very fortunate in having met with Mrs. Shee here, who invited us to breakfast and dinner, and shewed us every attention and kindness. There is also a serjeant in charge of the arsenal, who is particularly useful to us; he has engaged to keep a register of the thermometer here for me. We are going out to the prince's camp, 100 miles from this. He has just taken a fort, and concluded his campaign. Lieut. B. will thence go on to *Tehran*, but I must return here and start with a *Kafila* for *Herat*. The road is far from safe, but

I only require to be with the *Kafila* to be protected. This is a fine city: the scene is entirely new. I am forced to make an abrupt conclusion to be ready for the *Chop* (post). * * *

10th October, I have been at the prince Royal's camp, about 90 miles from this. Lieut. Burnes there left me for *Astrabad* and the Caspian. We found Captain Shee, Mr. Brouski and Mr. Beck in camp, all living in the Persian style: they were very kind to us. Captain Shee and I went to the Turquoise mines, and since my return to this I have not been very well. Every body here is also sick. My journey to *Herat* is all fixed. I saw Yar Mohammed Khan, Prince Kamran's minister, who received me extremely civilly, but I am cautious in putting myself under any obligations."

V.—*Proceedings of the Asiatic Society.*

Wednesday Evening, 27th March, 1833.

The Honorable Sir Edward Ryan in the Chair.

The Proceedings of the last meeting were read.

Lieut. A. Burnes, Assistant Resident at Cutch, was elected a Member.

C. Telfair, Esq. President, and Mons. J. Desjardins, Secretary, of the Natural History Society of Mauritius, were on the favorable report of the Committee of Papers, elected Honorary Members.

Read letters from Captain Henderson and Mr. F. J. Halliday, expressing their reluctance in being obliged to withdraw from the Society.

Read a letter from J. C. Morris, Esq. Secretary to the Madras Literary Society, &c. requesting that copies might be made for the use of Cavelly Venkata Lachmia pundit, formerly in the employ of Colonel Colin Mackenzie, of the English Catalogue of the late Colonel's collection of inscriptions.

Ordered that such information as can be given, regarding the Translations of Colonel Mackenzie's collection of inscriptions, be forwarded in reply to the Mad. Lit. Soc.

The Secretary announced that materials were collected for another volume of Researches, and that it was for the Society to determine whether it should continue to publish in the same form as heretofore.

The Native Secretary submitted a memorandum on the subject, of which the following is the substance:—

The first five volumes were printed by the Calcutta Gazette Press on its own account, and copies supplied to Members at 20 Rs. each, after which the Society took the responsibility of publication. Until 1810 a charge was made for the volume; thenceforward Subscribing Members received their copies gratis.

The sale of the Researches either in India or in Europe has been very limited. The cost of printing, gradually reduced from Rs. 10,000 to Rs. 4500 per volume, has

amounted from the time that the Society became its own publisher to,			Rs. 82000
While the return by sales has been	in England, Rs. 3200		
	in India,	6000	9200
leaving a balance of loss on 13 volumes,			Rs. 72,800

Baboo Ram Comul Sen proposed that in future the matter for publication should be transmitted to Europe, where a printer may be found to print it on his own account, Mr. Wilson kindly correcting the press*.

After some discussion a Committee composed of Dr. J. Tytler, Major Benson, Dr. J. T. Pearson, and Mr. J. R. Colvin, was appointed to consider on the best mode of publishing the continuation of the Researches.

Extract of a letter from J. F. Royle, Esq. to the Secretary was read, announcing the intended publication of his "Illustrations of the Botany and Physical Geography of the Himalaya mountains and Kashmere."

Library.

The following books were laid on the table:—

Transactions of the Royal Society of Edinburgh, vol. xi. 2nd part, and vol. xii. 1st part—*presented by the Society.*

Professor Buckland's account of the animal and vegetable remains and of rocks collected in Ava by Mr. Crawfurd—*by the author, through Dr. Wallich.*

Ditto on the occurrence of the remains of elephants, &c. in the frozen mud of Behrings Straits—*by ditto.*

Proceedings of the Royal Asiatic Society at the Anniversary Meeting of Saturday, 7th June, 1832—*presented by the Society.*

Proceedings of the Mauritius Natural History Society, for September and October, 1832—*by the Society.*

Journal Asiatique, No. 56, August, 1832—*from the Asiatic Society of Paris.*

Meteorological Register for February—*from the Surveyor General.*

Syr-ul-Mutakherin, 1st volume—*presented by the publisher and editor, Mulví Abdúl Mojíd.*

Anglo-Persian Anecdotes, translated by Krishnachundra Ghose.—*Presented by Raja Kálikrishna Buhádur.*

The following works, received from the Oriental Translation Fund of Great Britain and Ireland.

Fraser's Annals of the Turkish Empire, from A. D. 1591 to 1659, 1st vol.

Stewart's *Tezkereh al Vákiát,* or Private Memoirs of the Moghul Emperor Humáyún, 1 vol.

Klaproth's *San Kokf Tsou Ran To Sets,* ou Aperçu general des trois Royaumes, with a volume of plates.

Stenzler's *Raghuvansa,* Kalidasæ Carmen, Sanskrité et Latiné, 1 vol.

The Geographical works of *Sadik Isfahani,* translated by J. C.

Julièn's *Hoei Lan-ki,* ou l'histoire du cercle, de craie, drame en prose et en vers, 1 vol.

* This is however hardly a fair way of stating the case: the members are in fact the purchasers of the Society's volumes, which they pay for by their subscriptions. Publication is the main object and the main expence of every literary association; without which it would be of comparatively little utility or interest to the world.

Col. Brigg's *Siyar-ul Mutakherín*, a History of the Mahommedan Power in India during the last century, 1st vol.

Atkinson's Shah Nameh of Firdausí, translated in verse and prose, 1 vol.

Fourth Annual Report of the Oriental Translation Fund.

The following books received from the book-sellers:

Gray's Indian Zoology, part xii.

Lardner's Cyclopedia, Spain and Portugal, vol. 4.

Natural History.

1. Dr. Wallich, Superintendent H. C.'s Botanic Garden, presented in the name of Professor Buckland, specimens of the *coprolite*, or fossil *album-græcum*, from the *lias* of Lyme-regis, Dorset.

Some of these fossils are in their rough state, some are cut and polished, and there are plaster casts of other specimens in Dr. B.'s collection.

2. A fragment of fossil bone, brought by himself from Jabalpúr, was presented by Major Benson.

This fragment is enveloped in a hard greenish siliceous coat, which has also penetrated into the pores of the bone in many parts, and has taken the place of its animal matter, probably by the same process of infiltration which is observed in fossil wood from the same part of India.

3. A further selection of the fossil shells of the Himalaya were received from Captain P. Gerard, on the part of his brother, Dr. J. Gerard.

Several of these shells differ from those depicted in the Rev. R. Everest's paper in the Physical Transactions, and will form the subject of a supplementary plate.

Read extract of a letter from Lieut. Burnes, presenting specimens of Asbestos found between Pesháwar and Kabúl;—

Ditto Native Muriate of Ammonia from the province of Hissar, north of the Oxus;—

Ditto of the sand or silt suspended in the river Oxus;—

Ditto of sand from the Kharasm Desert between the Oxus and the Caspian.

The President communicated the following circular, with a request from the Rev. W. Whewell of Cambridge, for any information which Members of the Asiatic Society might be able to supply on the subject of the tides of the Indian Coasts.

Suggestions for Persons who have opportunities to make or collect observations of the Tides.

"It was shewn by Newton, nearly 150 years ago, that the fact of the Tides and several of their circumstances, resulted from the law of the Universal Gravitation of matter. But in this interval of time scarcely any thing has been done which might enable us to combine into a general view the phenomena of the Tides as they take place in all the different parts of the world; and at very few places have good and continued observations been made and published. It is conceived that by collecting such observations as have been made, or may easily be made, the connexion and relation of the Tides of all the parts of the Ocean may be in a short time clearly made out; and that persons may be induced to make such careful observations as may serve to be compared with the theory. In this hope the present paper is circulated.

The most useful Observations with reference to our general knowledge of the Tides are the following, beginning with those which are most easily made :

1. The Observation of the Time of High water at a known place, on any day, and especially at new and full moon.

2. The Observation of the Time of High water on several days in succession at the same place.

3. The Observation of the Height of several successive Tides at the same place.

4. Observations of the comparative Time of High water on the same day at different places in the same seas.

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1. An observation of the TIME of High water at a given place on *any* known day may be useful.

If the Time of the *Moon's southing* on the same day be noted, this will facilitate the use of the observation, and will furnish an additional evidence of the correctness of the date.

The Time of High water on the days of *New and Full Moon* is more particularly useful than on other days.

Observations of the Time of High water may be made with sufficient accuracy without a tide-post. A place ought to be selected where the water is tolerably smooth.

2. If there be opportunity at any place, it is desirable to observe the Time of High water *every day for a fortnight.*

If it be ascertained that the two tides on the same day occur at regular intervals, *one* of them only need be observed.

But there are often irregularities in the relative Times of the morning and evening Tide ; and these irregularities are different for different ages of the moon. In this case *both daily Tides* should be observed.

3. A single observation of the Height of the Tide is not of much value. But a *Series* of Heights *for a fortnight* is valuable, especially if accompanied with observations of the times.

The morning and evening Tide are often unequal, and this inequality sometimes varies considerably from one fortnight to another.

In observations of the Height of the Tide, the *difference of High and Low water* ought to be taken.

The channel of a river is *not* a good situation for such observations.

4. The usefulness of tide observations will be greatly increased if those made at places in the same seas can be compared so as to shew the RATE *at which the Tide wave* TRAVELS :

For example, the time which it employs in passing along a certain line of coast, or across a sea, or round an island, or up a bay.

N. B.—The Tide wave is the elevation of the waters by which High water is produced in many places at once. It is not observed as a visible wave, but is found by drawing a line upon the globe through all the places at which it is high water at a certain moment. The rate and direction of its travelling are known by comparing the position of such lines at successive times.

N. B.—The RATE *at which the Tide wave* TRAVELS is quite distinct from the rate at which the stream of ebb or flow *runs.*

N. B.—Also the DIRECTION in which the Tide wave travels is quite distinct from the direction in which the tide *ebbs* or *flows.*

The most proper observations for determining the rate and course of the Tide wave are those of the Time of High water *on the same day at different points* (not too near nor too remote) on a continued line of coast or sea.

This may often be done by a person residing in any country by making enquiries of persons conversant with the coasts, or by directing corresponding observations to be made at different places for a few days only.

If the places differ much in longitude, this ought to be noted, that allowance may be made for the difference of the absolute time of noon.

If there be any uncertainty as to the rate and course of travelling of the tide between two places, the doubt may best be removed by obtaining observations at some intermediate point or points.

It is necessary to distinguish the Time of High water at the *mouth* of a deep bay or sound, from the time of High water further in. The former is to be taken in all such comparisons as are here spoken of.

Large islands and long promontories much disturb the regular progress of the Tide wave.

Comparative Observations of the *Height* at different places in the same seas, especially if combined with those of the Times, may also be of great value.

All communications concerning any observations of the above kinds made or to be made in any part of the world will be thankfully received. They may be addressed to the care of the Sec. Asiatic Society, or direct to

The Rev. W. Whewell, Trinity College, Cambridge ;
or, at the Royal Society, London ;
or the Astronomical Society, London."

The President read a letter handed to him by Dr. Strong, addressed to Major Benson, Mil. Sec. to the Right Honorable the Governor General, describing the progress and present condition of the borings in Fort William, with the opinion of Sergeant Reid upon the causes of the repeated failures ; and suggesting that the Government should continue the experiment upon its relinquishment by the Society: Major Benson explained that the present reference to the Society had for its object to obtain their opinion as a body upon four essential points before recommencing operations ;—the probability of ultimately finding a spring ;—the expediency of making the further attempt ;—the mode of avoiding such accidents as have hitherto impeded the auger :—and the estimated expense.

After some discussion, the following members were nominated a Committee to draw up a report with advertence to these points. Dr. Mill, V. P. Dr. Wallich, Dr. Langstaff, Mr. Seppings, Captain Forbes, and Dr. Casanova.

Antiquities.

Read extracts of a letter from Lieut. A. Burnes, presenting to the Society eleven of the coins collected by himself in his recent visit to Manikyala.

Two or three of these coins are in excellent preservation, with very decypherable Greek inscriptions, and are thus proved to be of Bactrian fabrication :—they bear the several devices of the equestrian figure ;—the man in the tunic ;—the elephant ;—&c. and agree in other respects with the coins described in Mr. Wilson's paper

plate II. Nos. 25, 26, 27, 28, &c.) : there are others of a pure Hindee character ; but as Lieut. Burnes will soon be in Calcutta with the remainder of the coins procured by him, any further notice may better be deferred until his arrival.

Literary.

A paper was read on the marriage rites and usages of the Jâts of Bharatpúr, by J. S. Lushington, Esq.

The marriage of Balwant Sinh, the present Raja of *Bharatpúr*, to the daughter of the Bechore Raja, in May 1832, afforded the author an excellent opportunity of witnessing the numerous ceremonies punctiliously observed in its solemnization at Deeg. Mr. Lushington describes the betrothal—the *tika* or marriage present—the settlement of a fortunate day by the pandits, and the consequent transmission of the *lagan patrí*, or bride's horoscope, to the bridegroom, which is considered to close the marriage. Connubial feasts and concerts are then given in the parents' houses. The youth is anointed with jasmine oil, and makes pooja and offerings to the family *potter's wheel*, to *Sítla* the goddess of the small-pox, and to the *gohra* or place in which the filth of the palace is deposited : this is said to typify the increase of progeny, as the heap of rubbish continually augments! The ceremony of the *bhat* succeeds, in which *rice* and other presents, of horses, elephants, &c. are given to the *parohits*, the Raní and Rajâ and their attendants, by the brothers and other male relations. Deputations from foreign courts succeed. The *Barát* or marriage procession starts from the temple of the bridegroom's *mahant* or head priest (he had not a family *gúrú*), and is attended with much splendour. Upon its arrival at the bride's house the ceremonies of *táran* and *hom* take place. The former consists in striking the image of a bird with a sheathed sword ;—the latter, the burnt-offering and adoration of water, are described as the most interesting parts of the performance—they are followed by the *Kanyadán* or giving away of the bride—the *Pradakshana*, the *Aghuna*, and the marriage hymns.

The bride is then carried home, when feasting and curious games, resembling " snapdragon and bran-cake," amuse the young couple.

After three days' residence with her lord, the bride returns to her parents for three or five years, when she is brought away with the ceremony of *gona* or *gaman*—but this may be dispensed with by the performance of *phir-pattah*, or changing the stools of the bride and bridegroom when the *hom* is celebrated.

VI.—MADRAS LITERARY SOCIETY.

General Meeting held at the College on Saturday, 26th January, 1833.

The Hon'ble Sir R. Palmer, President, in the Chair.

The Secretary (J. C. Morris, Esq.), laid before the Meeting a statement of the funds of the Society in both its branches.

Captain Chase, Lieut.-Col. Coombs, A. Robertson, Esq. and Capt. Rowlandson, were elected the Committee of management.

W. Hudleston, Esq. and Capt. Rowlandson, were added to the Committee of papers.

Donations of various books from individuals and societies,—of a Baudha image and a gold coin, were announced.

Seventeen new members had been elected since the last general meeting, and fourteen had retired and gone home.

Read letter from Messrs. Arbuthnot and Co., stating that they are prepared to receive the model of a pagoda the property of John Hodgson, Esq., which that gentleman has requested may be transferred from the Madras Literary Society to the Royal Asiatic Society.

Ordered that the model of the pagoda in question be forwarded to Messrs. Arbuthnot and Co., and that a letter be addressed to the Royal Asiatic Society, explanatory of the delay which has occurred in its transmission.

Read letter from Lieutenant Chalmers, forwarding a translation from the Persian of the 1st volume of the Akbar Namah of Abool Fuzl.

Resolved, that Lieutenant Chalmers be informed that on receipt of the second volume, the Society will be prepared to submit his work to the favourable notice of the Oriental Translation Committee of the Parent Society in England.

Read letter from the Baron De Ferussac, requesting to be furnished through the medium of the Society with some information regarding Minerals and Shells, in order to enable him to finish a work he is engaged in on these subjects.

Resolved, that the Baron De Ferussac be informed, that the Society will use their best endeavours to meet the views and wishes expressed in his letter.

Read letter from Cavelly Venkatah Lutchmiah, submitting a letter from Sir Alexander Johnston, and requesting assistance from the Society.

Resolved, that Cavelly Venkatah Lutchmiah's letter be referred for the consideration and report of the Committee of Papers.

Read list of books presented to the Society by a Jain Priest.

Ordered to be referred to the Committee of Papers.

Read letter from the Honorary Secretary to the Royal Asiatic Society, acknowledging the receipt of several communications, and returning the Society's thanks for the same.

Ordered to be recorded.

Resolved, that all letters and communications which either from inadvertence or other causes may hitherto not have received answers, be immediately replied to, with suitable apologies; and that it be publicly notified that all communications, however short, which may in any way tend to elucidate the history and sciences, arts and customs of the natives of India, whether Hindús or Mahomedans, will be thankfully received by the Society, will receive ready attention from the Committee of Management, and will be read at the quarterly meetings of the Society.

Resolved, that with the view of increasing the efficiency of the operations of the Society by stimulating its supporters to exertion, regular meetings be held on the second Thursday of the months of February, May, August and November, for the purpose of reading the several communications which may be received, and of selecting such as may be most deserving of publication.

Proposed by Lieutenant-Colonel Coombs, seconded by Mr. McDonell, and carried by acclamation—

"That this meeting hail with peculiar satisfaction the presence of The Right Honorable Patron of the Society, and beg to return him their grateful and respectful acknowledgments for his promised countenance and support."

The thanks of the meeting were unanimously voted to the Honorable the President, for his able conduct in the chair.

VII.—*Miscellaneous.*

1.—Indian Botany.

Extract—Proceedings of the Linnæan Society, 5th June.

The East India Company have presented to the Linnæan Society their magnificent Herbarium, containing the plants collected between long. 73° to 114° E. and lat. 32° N. to the equator, by König, Roxburgh, Rüttler, Russel, Klein, Hamilton, Heyne, Wight, Finlayson, and Wallich. It includes about 1300 genera, more than 8000 species, and amounts, in duplicates, to at least 70,000 specimens,—the labours of half a century.

For many years a large portion of these vegetable riches were stored on the shelves of the India House, without any one sufficiently conversant in Indian Botany to arrange and render them subservient to the cause of science. On the arrival in this country of Dr. Wallich, the distinguished superintendent of the Company's Garden at Calcutta, in the year 1828,—who brought with him an immense accession to the Herbarium from various parts of India, especially Nipal and the Burmese Empire,—the Court of Directors instructed him to make a Catalogue of the aggregate collection, and to distribute duplicate specimens to the more eminent Societies and naturalists throughout Europe and America.

This immense labour has occupied Dr. Wallich for the last four years; and it is the chief selection from these various Herbaria, destined for the museum of the India House, which the Court of Directors have, with princely munificence, presented to the Linnæan Society.

The liberality of the East India Company has been duly appreciated througbout the wide circle of science. It has been acknowledged by letters and addresses from the different Societies and individuals honoured by their patronage; and this last act of their bounty will endear them still more to the promoters of Botany, by placing the treasures they possessed along with those of Linnæus and Smith.

The Linnæan Society purchased, two years ago, at an expense of 3000*l.*, the collections of Linnæus and of the late excellent Sir J. E. Smith; and since that, the Herbarium of the Society having been further enriched by the treasures of the East, it forms collectively one of the most interesting and important in Europe.

The East India Company have set an example of a wise and liberal policy, which will be followed throughout the world, not only by Societies, but by those enterprising individuals who have, to their own honour, made large collections of the objects of natural history; and it is a source of national congratulation that at this moment the naturalists of Europe feel indebted to this country for the most extensive contribution that was ever made to their botanical collections. We owe this general feeling of respect towards us to the enlightened conduct of the Court of Directors, who have done more to diffuse a knowledge of Botany than was ever done by any Government or association of persons on the globe.

A deputation from the council of the Linnæan Society, headed by the President Lord Stanley, waited on the Chairman of the Court of Directors, on the 26th instant, with an address expressive of the high sense the Society entertains of the honour conferred upon it by the liberality of the East India Company.

Dr. Royle's Collections.

We are happy to perceive by an announcement made at the last meeting of the Asiatic Society, and which we have inserted in the advertisement sheet of the pre-

sent number, that Mr. F. J. Royle is about to give to the world the fruits of his laborious researches in the Botany and Natural History of the Hills and the upper provinces of India. We trust that his work will meet with a full portion of the public patronage, without which it would be ruinous to attempt the publication.

2.—Indian Geology.

List of the specimens of Rocks from the Tenasserim Archipelago, situated between the Parallels of 10° 50′ *and* 12° 10′ *N. presented to the Society,* 15*th Jan.* 1831. *By Lieut.* Lloyd, 1*st Assistant to the H. C. Marine Surveyor General**.

No. 1. *Clay slate*, from a small detached islet on the western side of Sullivan's Island, in Lat. 10° 54′ N.

No. 2. *Fine grained granite*, decomposing, from a rock on the western side of the same island, and distant about two miles more to the northward? its top has a very whitish appearance, perhaps from the action of the sun and salt-water.

No. 3. *Quartz rock*, from a rocky islet on the eastern side of Sullivan's Island, immediately opposite to No. 1, and distant from it about one mile, the breadth of the island in that part.

No. 4. *Granitic sandstone*, from a small island of a reddish brown appearance, situated on the western side of Sullivan's Island, in Lat. 10° 58′ N.

No. 5. *Sandstone*, from a point on the western side of Sullivan's Island, near to the last.

No. 6. *Slate*, from a point on the eastern side of an island named by Captain Ross "Lord William Bentinck's Island," in Lat. 11° 40′ N. It does not shew the principal formation of the island, but merely a lump or patch on the point, and very easily separated with the hand, being in regular horizontal layers.

No. 7. *Quartz rock*, from two hill islands situated off the N. end of Sullivan's Island, in Lat. 11° 1′ N.

No. 8. *Granite*, from the Alligator dry rocks, which are situated off the N. end of two islands, called by Captain Ross, "Sir Edward Owen's and Sir John Malcolm's Island."

Nos. 9 and 10. *Granite*, from Sir Edward Owen's Island, the former from the eastern side, in Lat. 11° 13′ N. and the latter from the north side, in 11° 15′ N.

No. 11. *Granite*, from Sir John Malcolm's Island, in Lat. 11° 16′ N.

No. 12. *Limestone*, (similar to that of Elephant rock, in the Quedah country, described by Ward,) from a small round and steep island, in Lat. 11° 16′ N. and situated on the eastern side of Sir John Malcolm's Island.

No. 13. *Jasper conglomerate*, from the Northern Elephant Island, of which there are four large and other smaller ones, between Lat. 11° 32′ and 11° 36′ N. They are from 6 or 700 to 1000 feet high, and resting on small bases, appear at a distance like large peaked rocks: the northern one stands in six fathoms water, its sides project outwards, so as, in parts, to admit of a boat getting underneath, and the rugged pieces of the rock beneath, at a little distance, resemble stalactites, of which the specimens are pieces that have been knocked off.

* This list should have been printed with the proceedings of the same date, but the localities were not at that time known to us; they may now be found immediately by reference to Captain Ross's Chart of the Tenasserim Archipelago.

No. 14. *Quartz* and *micaceous schist*, from the S. side of a small island, in Lat. 11° 47′ N. It is covered with trees of a great variety of foliage, and producing many berries it attracts numberless pigeons of abeautiful cream colour, with wings and tails tipped with black; and from this circumstance it has been called Pigeon Island.

No. 15. *Granite*, from a small island on the south-eastern side of Sir Edward Owen's Island, in 11° 11′ N. This island, when I visited it, was covered with "Tucans."

Nos. 16 and 17. *Limestone* and decomposing *Granite*, from two small islets distant from each other ½ a mile, in Lat. 11° 49′ N.

No. 18. *Micaceous schist*, from rocks that cover and uncover with the tide, near to the last.

No. 19. *Micaceous schist*, from a small island, in Lat. 11° 50′ N. and has only one or two fathoms on its summit, which gives it the appearance of a cap and feather.

No. 20. From an island in 11° 53′ N. It is formed by two hills connected by a narrow sandy ridge, so that, at a distance, it appears like two small islands. The specimen is taken from the south-west point of the western hill, the summit of which has an even and flatish appearance.

No. 21. *Fine grained granite*, from rocks on the western side of Christmas Island, in 12° 0′ N.

No. 22. *Quartz*, from a small island, in Lat. 12° 4′ N. (Hospital Island.)

No. 23. *Quartz*, from the north-east point of an island to the westward of it.

No. 24. *Decomposed granite*, from a small island, in Lat. 12° 9′ N.

3.—Indian Arts and Manufactures.

Mode of dyeing Kharwa Cloth, practised in Bundelkhand. Translated from a Persian account. By Babú Harí Mohun Sén.

To dye—say one bale of cloth, consisting of fifty-two pieces, the first step to be taken is to wash them white in water. Thirteen seers of oil of castor, three seers of impure soda *(khak-ij-zamín-shór*, efflorescence on saline earth), and fifteen seers of clear water, must then be mixed together, and the cloths dipped and drenched in the solution twice a day for four days continually. At the expiration of that time, the same operation is to be renewed for a period of seven days, soaking the same in the liquor, and reducing the operation to once a day. But care should he taken to put into it a little saline earth every day during the process. After this, the whole bale of cloths must be rewashed in clear water, and then steeped over again in another liquid composed of water and three seers of *Halelah* (*Terminalia Chebula*), and afterwards dried. A similar cold solution of water and three seers of alum is then to he prepared, in which the stuffs are again to be steeped, and afterwards well dried. After all these operations are duly conducted, a caldron or large vessel is to be filled with a sufficient quantity of water, in which are to he mixed one maund and ten seers of *Al (Morinda Tinctoria)*, a dyewood, and five seers of *Dháwa* (another wood). The former should be well dissolved previously to the cloths heing submitted to the process of dyeing. After they have taken a deep dye in this liquor, they should be taken out of the vessel, and then washed with soap and water. Then a solution of eight seers of gum is to be made, and the stuffs immersed and washed in it for the last time. They are afterwards to be folded piece hy piece, and rubhed and scoured with a little gum over their surface, and then beaten in order to make them smooth and compressed.

To dye cloths of an Amua-sabz, *or mangoe-green color.*

The cloths require first to be dyed in a solution of indigo; the latter to be used at the rate of two chitaks on an average per piece. Afterwards they must be boiled in water with a mixture of rind of pomegranate in it. In this operation, half a seer of the latter should be mixed for each piece. They are then to be steeped in a strong solution of water and alum, which should be given in two chitaks on an average. After this, a preparation of two chitaks of turmeric dissolved in water should be made, and the stuffs kept dipped in the same for one whole night. In the morning following, they must be washed in clear water, and lastly dyed with the juice of *Kúsum* flower, which when first extracted is naturally yellow, and which is termed " *Pin*" in Hindústaní. They are afterwards to be folded and beaten smooth.

The dyeing of Súrj Pakhí, a red yellow—the color of a bird so called.

A composition comprising ten seers of oil of castor, five seers of impure soda, *(khák-i-zamín-i-shór)* one seer of goat's dung; to be made, and to be all dissolved in a sufficient quantity of water. Twenty pieces of stuff are then to be washed in pure water, in a vessel all separately, and one by one, changing the water every time. This operation is to be kept in continuance for fifteen days. They must afterwards be washed in clear water, and soaked in a solution of alum and water. Twenty-five seers of powder of *Al* should then be dissolved in a necessary quantity of water, in a large vessel, and the cloths steeped and coloured in the liquor. They are thus to be wrought up for the space of six days, and finally dried and folded.

4.—*Note on Lieut. Burt's instrument for trisecting Angles.*

On reading the papers on the trisection of angles, in the number for November last, I observed some inaccuracies, which as they were overlooked in the last number, I now beg leave to bring to notice.

Mr. Burt, in proving the correctness of the instrument, has made the truth of the demonstration depend on a position which is itself in want of proof. He says, (page 500, l. 8), " rad. *bo*-rad. *ao*," but they are not necessarily equal from the construction, and it should therefore be proved that the locus of the point *b* is in the arc *abc*. The demonstration is consequently faulty. I think however the instrument will effect the purpose intended; and perhaps when I have more leisure, I may attempt to prove its accuracy, if not anticipated by some one whose avocations are more in accordance with such pursuits. Mr. B. says that A B the fourth leg of the instrument, may be dispensed with. I do not think it can, but I don't understand this part of the paper, nor do I see how a line can be *parallel* to one or two others, and also pass through the same point with them.

I have not tried to construct the instrument, but I should anticipate some difficulty in applying it, as one may not readily know when the points A and O respectively coincide with *a* and *o*.

I am, Sir,

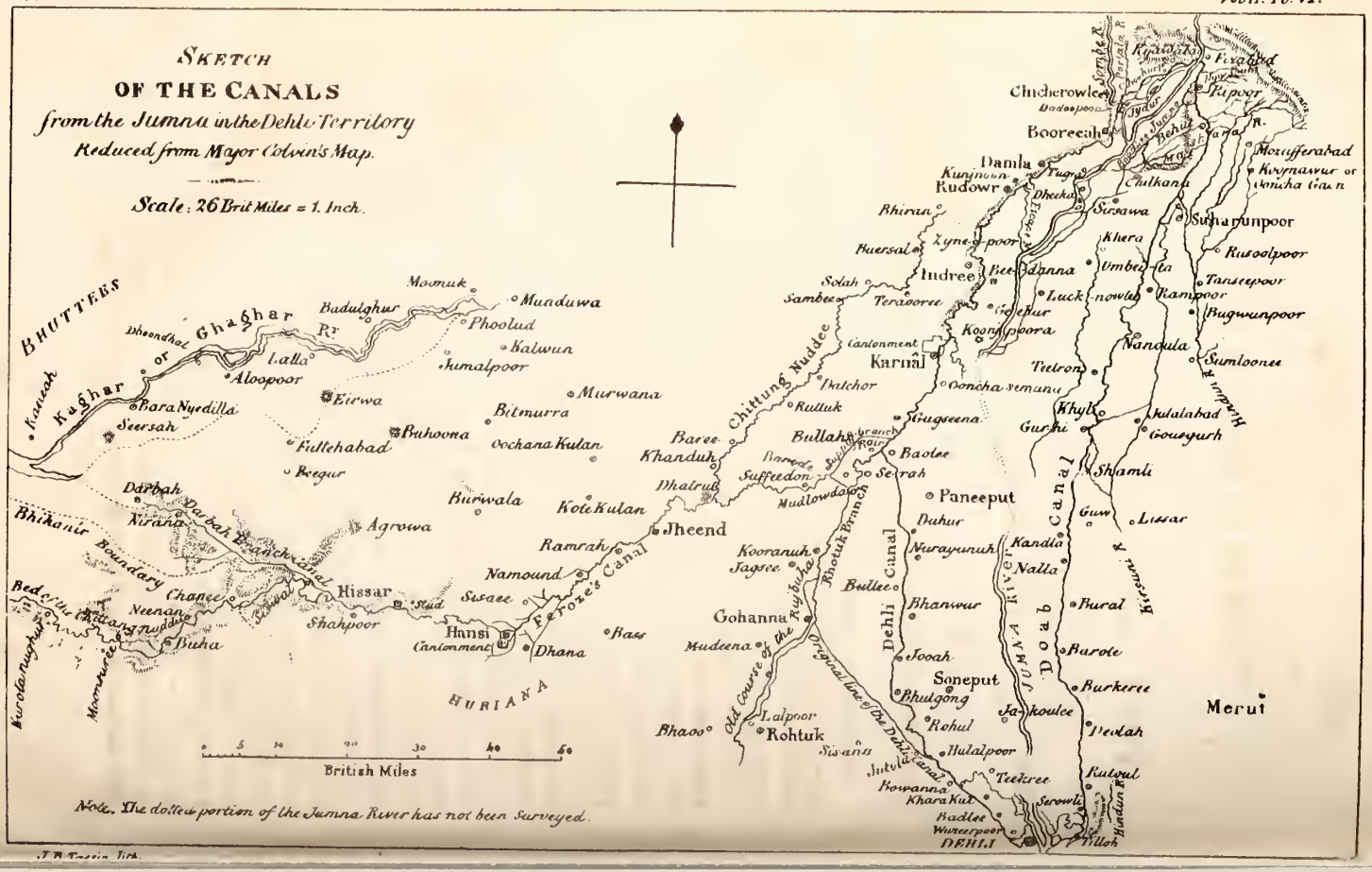
Your obdt. servt.

A. K.

Meteorological Register kept at the Assay Office, Calcutta, for the month of March, 1833.

Day of the month.	Barometer reduced to 32° Farh.				Thermometer in the Air.					Depression of moist-bulb Thermometer.				Hair Hygrometer.		Rain.	Wind.			Weather.		
	At 5 A. M.	At 10 A. M.	At 4 P. M.	At 10 P. M.	Minimum at 5 A. M.	At 10 A. M.	Max. by reg. Ther.	At 4 P. M.	At 10 P. M.	At 5 A. M.	At 10 A. M.	At 4 P. M.	At 10 P. M.	At 10 A. M.	At 4 P. M.	Inches.	Morning.	Noon.	Evening.	Morning.	Noon.	Evening.
1	29,865	,876	,785	,868	72,4	77,7	87,	86,0	72,2	2,4	6,2	20,4	5,9	92	57		o.	w.	S.	stratus.	clear.	o
2	,845	,878	,741	,850	72,1	79,2	82,2	85,7	75,	0,9	5,0	17,9	2,8	94	65		o.	s.	S.	scud. s.	scud.	o
3	,749	,864	,765	,902	72,6	81,5	88,4	88,8	77,	0,9	6,7	18,4	2,9	92	67		s.	s.	S.	ditto.	cister.	o
4	,851	,894	,768	,907	77,2	80,2	88,	87,3	78,2	3,0	5,0	14,0	3,4	93	83		o.	s.	S.	stratus.	cumulus.	o
5	,904	,911	,791	,886	75,0	80,6	88,7	87,5	77,8	1,8	12,2	20,1	4,3	78	59		o.	S.	n. w.	o	o	gathering
6	,853	,874	,770	,890	73,0	83,0	88,	89,4	78,	1,0	7,5	21,6	4,0	92	64		s.	s.	S.	stratus.	cumulus.	scud.
7	,822	,848	,745	,850	75,2	83,3	94,2	87,0	76,8	2,0	8,0	18,	1,8	91	70		S.	s.	S.	o	o	o
8	,818	,880	,774	,856	76,5	84,	92,5	85,2	77,6	1,7	7,0	13,6	4,4	89	75		o.	o.	S.	cirrus	o	o
9	,846	,872	,760	,832	75,5	84,	95,2	87,0	78,	1,7	7,5	15,	3,8	87	72		s.	s.	S.	cistr.	o	steady.
10	,787	,800	,691	,847	75,2	83,2	95,	87,5	79,2	2,2	9,2	17,	3,0	85	71		s.	s.	S.	stratus.	o	bank.
11	,824	,859	,741	,808	76,	82,7	97,2	91,0	77,2	4,0	12,7	18,6	3,0	81	70		S.	s.	S.	ditto.	cirri.	o
12	,755	,758	,595	,697	75,1	81,9	1005	90,2	81,8	1,4	4,3	15,2	5,5	95	75		S.	s.	s. w.	hazy.	haze.	o
13	,691	,768	,657	,767	77,	81,4	94,8	89,3	75,4	2,2	19,1	13,5	7,2	65	56		o.	n. w.	S.	ditto.	o (nwr.)	o
14	,721	,844	,741	,859	73,5	81,9	95,	88,2	77,	4,5	17,2	22,0	3,8	65	58		o.	n. w.	s. w.	o	o	o
15	,804	,887	,776	,890	73,2	85,0	93,6	87,9	77,5	1,2	10,8	13,5	3,3	84	78		s. w.	s.	S.	fog.	o	
16	,843	,864	,752	,865	75,3	82,1	96,1	88,2	78,4	1,6	6,1	14,7	2,4	93	74		e.	s.	S.	o	o	heavy scud.
17	,841	,872	,786	,867	77,0	83,	96,	89,	78,8	1,9	6,2	16,5	4,3	94	73		S.		S.	o	o	o
18	,848	,897	,769	,895	76,	84,0	101,2	92,5	82,	3,5	6,3	21,1	6,2	92	62		S.	s.	S.	o	o	o
19	,818	,836	,720	,766	75,2	85,8	97,	94,0	77,2	2,0	12,2	19,2	5,6	81	70	0,03	S.	n. w.	S.	o	o	storm se.
20	,793	,850	,721	,819	77,8	85,0	98,	91,0	80,8	2,8	7,8	19,5	5,1	89	65		S.	s.	S.	stratus	o	o
21	,795	,855	,721	,800	77,2	85,8	99,	95,0	80,2	6,4	10,3	13,6	4,0	89	60		e.	o.	S.	o	o	o
22	,794	,860	,719	,826	78,	84,7	100,	91,0	80,9	2,0	7,0	19,4	3,5	90	62		S.	o.	S.	cum.	o	o
23	,851	,867	,736	,841	78,	86,2	100,	91,7	82,0	4,0	13,5	16,3	3,7	75	69		o.	s.	w.	o	o	o
24	,829	,870	,760	,826	78,5	85,	101,3	88,	83,2	2,9	14,	16,	6,0	75	70		w.		s. w.	o		bank s. w.
25	,810	,871	,777	,839	80,3	84,6	95,	86,7	78,3	11,6	14,3	16,0	9,9	75	73		n. w.	n. w.	e.	cum.	cirrostr.	cum.
26	,821	,871	,752	,835	74,5	82,4	94,	89,5	79,7	7,5	12,6	16,8	14,4	82	72		n.	n. w.	n.	o	o	o
27	,854	,935	,820	,901	72,8	83,5	92,	89,7	78,2	10,3	15,7	19,1	10,2	72	67		o.	o.	o.	o	o	o
28	,871	,905	,763	,815	73,5	84,5	94,8	89,9	77,0	10,0	11,2	17,1	4,0	83	72		o.	n. w.	s.	o	o	o
29	,787	,842	,720	,813	77,2	85,6	97,	90,8	80,	11,8	8,2	20,5	6,5	89	62		s.	s. w.	S.	fog.	o	o
30	,767	,865	,771	,848	78,9	87,0	95,8	89,6	79,4	2,7	8,0	14,4	1,7	90	77		S.	S.	S.	o	cirri.	circum.
31	,821	,901	,780	,900	77,2	89,	95,	91,	78,4	1,2	15,0	16,	2,5	85	75		S.	s.	S.	haze.	hazy sky.	do.
Means,	,815	,860	,747	,844	75,7	83,5	94,8	89,2	78,5	3,6	9,8	17,3	4,9	85	70	0,03	monsoon.			fine pleasant weather.		

The Instruments for 10 A. M. and 4 P. M. are suspended in the free air of the laboratory, and the Sunday entries are filled in by interpolation. The instruments for 5 A. M. and 10 P. M. are observed daily in the south veranda of a house near the Cathedral—on the 7th these latter were removed to the third story of the same house, in a more airy situation. The Barometer is corrected for the difference of height, it stands ,020 lower than the Surveyor General's instrument.



J. B. Tassin lith.