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"It will 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.

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ASIATIC SOCIETY.

PART II.—PHYSICAL SCIENCE.

No. I.—1867.

EXPERIMENTAL INVESTIGATIONS *connected with the supply of* WATER *from the Hooghly to* CALCUTTA, *Part II, being Supplementary Observations; by* DAVID WALDIE, *Esq. F. C. S. &c.*

[Received 28th September, 1866.]

In the preceding remarks I have directed attention to the discrepancies between my own results as to the quantity of organic matter by weight in the Hooghly water and those given in Dr. Macnamara's Report, and I have also made some pointed observations on the very doubtful accuracy and unsatisfactory nature of the results generally given by chemists respecting organic matter in waters, except some of the most recent. For though I have found that the process detailed in the previous part of my paper is older than I then supposed, having been recommended by Mr. Dugald Campbell in 1856 as suggested by Dr. Clark,* and that an analogous plan was given by Abel and Bloxam in 1854,† though imperfect, yet these plans seem either to have been little known, or neglected, or imperfectly carried out. Some analysts indeed of later date do not even attempt to estimate the amount of organic matter at all, apparently despairing of reliable results. But the process given, I believe, yields the most trustworthy results hitherto obtainable, if properly performed.

* Journ. Chem. Soc. Vol. IX. 1856, p. 51.
† Handbook of Chemistry, 1854.

But if the estimation of the organic matter in waters is to be of any value at all as a means of judging of their salubrity, it is essential that it should be done accurately. If it is to be a fundamental datum on which Municipalities are to choose or reject certain waters for the supply of large towns, that sanitary boards are to draw conclusions from as to the healthiness of certain localities for the residence of troops or other collections of human beings, and on which medical men and hygeists are to reason respecting the origin of disease or the maintenance of health, it is unnecessary to say that it ought to be ascertained in a reliable manner.

In the case of my own results, differing so widely from those referred to, the question occurs, is there no way of accounting for them or reconciling them? One cause has been suggested to me independent of correctness of method of analysis or of accuracy in its execution, namely the age of the water when examined, that is the length of time which had elapsed since the water was taken from its source. High chemical authority has been adduced for the necessity of setting about the analysis with the least possible delay, on account of the chemical changes which the water would undergo by keeping, which would result in a diminution of the quantity of organic matter present. The validity of the caution I am not disposed to deny, neither am I prepared to deny that in my own operations this point was not always sufficiently attended to. Indeed it had not particularly attracted my attention; except as regards gaseous constituents the point had not been particularly noticed either in text-books or monographs I had seen, and the consideration that the organic matter collected by rivers had already been freely exposed to decomposing agencies, so that probably what remained was not readily decomposible, confirmed as this was by my own observations while operating, led me not to attach much importance to it. Still it appeared that there might be a change of considerable amount shortly after collection which had passed unnoticed, while afterwards the water remained less liable to change. A small change, experiment shewed, did occur speedily, but the present question did not refer to a small change but to a large one, and it was desirable if possible to ascertain to what amount it might extend. The question principally concerned the waters of the hot season and of the rainy season.

So far as general observation could go, having been engaged in collecting and examining the river water from 1st May to 14th June for the purpose of ascertaining the amount of tidal contamination, I had abundant opportunities of judging of the physical characteristics of the water and observed nothing particular except a comparatively slight, somewhat fetid smell, which contrasted distinctly with the very decidedly worse smell of the water after the rains had come on, and of which the personal use of the river water gave me a vivid illustration. Other differences I have already noticed in the earlier part of the communication, all suggesting the greater proportion of organic matter in the water of the rainy season, at least in the earlier part of it. Moreover looking to the absolute weight of organic matter, I had only found even in the worst of the tanks, when their water was low and putrid, four or five grains in 100,000 fluid grains of water, equal to rather less than three or four grains per gallon; while the river water at any season was much superior to these in smell and colour, even during the rains, that is after the mud had settled.

Yet as these observations might not be sufficiently precise, experiments were instituted to endeavour to determine the question. The oxidation of the organic matter by permanganate of potash offered the readiest and easiest way of examination, and was applied to various samples of water, more particularly to determine the rapidity of change after collection. And it did indicate a rapid change even in course of a day or two, indeed the greatest amount of change took place within the first 24 hours. But it has already been pointed out that this test indicates the proportion only of certain kinds of organic matter, and gives no information as to the total amount. It may even indicate more oxidizable matter after the amount by weight of organic matter has diminished, as was really the case in some of the experiments made. This will be seen in the case of the mixtures in the succeeding table, in which the proportion of oxidizable matter diminished for the first few days, and then increased decidedly, afterwards diminishing again. In No. 3 mixture it increased to a large extent up to time of writing this, and no doubt would diminish afterwards. The great extent of change in this case is accompanied by a great diminution in weight.

The question at issue, however, was the amount by weight of organic matter present. It was impossible of course to get the hot season water in its original condition, but experiments could be made with river and tank water, and with mixtures intended to imitate the real or supposed peculiarities of hot season water. These could be examined to ascertain the amount of change produced on them by keeping. Accordingly experiments were made the results of which are exhibited in the following table.

Date of collection or preparation.	*Date of Expt.*	*For 100,000 fl. grains W.* *Organic matter. Grains.*	*Oxygen reqd. Grains.*
	Calcutta Sewage Water.		
13th Sept. 1866,	13th Sept.		2.300
	14th		2.040
	15th	21.80	
	17th		1.470
	27th	10.75	
	Mixtures of River Water with Sewage.		
No. 1, containing $\frac{1}{4}$th Sewage.			
10th September.	10th Sept.	5.44	.535
	11th		.480
	15th		.422
	24th	3.63	
	25th		.624
	*2nd October,		.203
No. 2, containing $\frac{1}{12}$th Sewage.			
11th September.	11th Sept.		.245
	12th	2.18	
	15th		.163
	24th	1.88	
	25th		.441
	*2nd October,		.353
No. 3, containing $\frac{1}{8}$ Sewage and $\frac{7}{8}$ Barn. Tank Water.			
18th September.	18th Sept.	6.05	.420
	26th	2.65	.725
	*2nd October.		1.938

* Introduced after date of paper.

Date of collection or preparation.	*Date of Expt.*	*For 100,000 fl. grains W.* *Organic matter.* *Grains.*	*Oxygen reqd.* *Grains.*
	Cornwallis Square Tank W.		
14th May, 1866.	June	5.15	
	21st May,		.209
	20th June,	4.40	
	11th August,		.155
	6th September,	4.37	
	Baranagar Tank W.		
15th September.	15th Sept.		.350
	17th	2.38	
	29th	2.16	.256
	*2nd October,		.228
	Dalhousie Square Tank.		
18th September.	19th Sept.	1.59	.100
	29th	† 1.89	.070
	River Water.		
8th August.	17th August,	1.08	
	25th Sept.	1.01	
18th September.	18th		.085
cleared by	19th	1.69	.044
Acid	29th, more than	‡ 1.36	.046

The Mixtures were composed of river water of the hot season three or four months old and of recent river water with a little Salt Lake water, No. 3 containing also Tank water; with these were mixed the specified proportions of sewage water which had been collected on 8th September, and, as tried on the 9th, contained 27.33 grains organic matter in 100,000 fl. grains.

It will be observed that in the organic matters oxidised by the permanganate of potash there is a distinct diminution early, even by the lapse of a single day, as indicated by the smaller quantity of oxygen

* Introduced after date of paper.
† Evidently an error of Expt. The organic matter could not increase.
‡ Exp. faulty. Enough of Carb. Soda had not been used. Result could not have been less, but probably would have been greater, had it been correct.

required subsequently; afterwards the diminution is slower, or in some cases even an increased quantity of oxygen may be required from changes taking place in the water causing the production of a larger quantity of readily oxidisable matter. This therefore gives no indication of the weight or actual quantity of organic matter present. The weight of organic matter ascertained by experiment however, indicates in some cases a rather rapid diminution at first. But this is only to a small amount, except in the case of highly decomposable or putrefying liquids, such as sewage or mixtures containing much sewage. Calculation will show that the loss of weight of organic matter in mixtures Nos. 1 and 2 is less than would have been sustained by the constituent proportion of sewage water in them. In No. 3 probably the vegetable matter of the Tank water added caused the more rapid and extensive decomposition.

The loss of weight in the mixture No. 3 is 3.4 grains in 8 days, being fully more than half of the original amount; in Nos. 1 and 2 it is only only 1.8 grains and 0.3 grain respectively.

But the river water at no time could contain anything like the proportion of sewage that these mixtures did, such as one-fifth, one-eighth or even one-twelfth of sewage, the smell alone of such mixtures, makes the supposition quite inadmissable; besides a comparison of the size of the river with the amount of drainage of the town would show that such a proportion was quite impossible. The amount of liquid discharged by the drains compared with the volume of water in so large a river must be insignificant.

But instead of citing results of my own, which if incorrect may be supposed to be all equally incorrect, it may carry more weight to quote the results of others. The older determinations of organic matter are generally of no value whatever, and I shall refer only to the most recent and trustworthy. I have already quoted Dr. Frankland's results with the London waters, but as all these are of water filtered for distribution they may be considered not quite comparable. Another example I shall adduce from the paper of Lawes and Gilbert in the Journal of the Chemical Society already quoted. They give tables of the composition of the Rugby sewage from May 1862 to October 1863, shewing that it contains in solution from 7.6 to 8.35 grains per gallon, and also a statement of the amount in the River

Wandle before receiving the Croydon sewage which is 1.44 grains per gallon, and after receiving it which is 2.08 grains per gallon. According to this the estimates of organic matter to the extent of 8 or 10 grains per gallon in the Hooghly water during May and June shew that it contains fully more than the liquid part of the Rugby sewage, and this in a tropical country.

I do not wish it to be understood that I maintain the perfect accuracy of my own results. The oversight in not examining the samples speedily enough after collection must be admitted, though from all that I have been able to learn from the experiments instituted for the purpose, the error cannot be a great one. There was no great delay in examining the water of the hot season,—about ten or twelve days, and this caused by the time and attention taken up in examining the influence of the tides in numerous samples. There was greater delay with the water of the rainy season, probably about a month with the first samples in July, about a week or 10 days with those of August. This was caused by waiting for the settlement of the very finely divided clay, the presence of which was very unfavourable to the accurate estimation of the organic matter. Recently I have found that the addition of a small quantity of hydrochloric acid causes the mud to settle so rapidly that the water may be filtered clear in course of a few hours: solution of potash or soda and milk of lime do the same, but the water cleared by these reagents seems to contain a different proportion of organic matter than that cleared by simple subsidence. It is of less importance, as the question at present is not respecting the water of the rainy season. The samples of December and February water circumstances prevented me from proceeding with, and they were preserved in stoppered bottles and probably not much done with them till April. The results are consequently more doubtful, though I do not suppose that they are very wide of the truth. As the season advances, should circumstances admit of it, I shall not fail to repeat the analyses, in order to get unobjectionable results.

The observations made during the last month enable me to add a little to my former statements respecting the effect of the change of seasons on the river water. The increase of organic matter from the rains seems to be chiefly of the more soluble and putrescible kinds; as the season has advanced, the fetid smell has materially diminished. This is indeed to have been expected: the soil has been washed comparatively clean, and there is less of such matter to wash away.

The only possible way in which my results as to the small quantity of organic matter in the water of the hot season (supposing there is no great error in the analysis) can be reconciled with the results of those analyses that give it as equal to 8 or 10 grains per gallon, would be to suppose that the water at that season contains a large quantity of organic matter having no very offensive smell, but capable of very rapid decomposition, so that about $\frac{7}{8}$th to $\frac{9}{10}$th of it would be lost during the first two weeks. Without denying the possibility of this, I can only say that I know of nothing that makes it probable that such is the case, while I have already given reasons for believing that no such state of matters exists. Further observation and experiment can alone decide the question beyond doubt; while I may remark that if such be the case, it will be a fact well worth noticing and establishing.

It may also be observed, that as in the case of supplying towns the water must always be stored for a time in tanks or reservoirs, it is a point of some importance to note the changes which it undergoes by keeping in these circumstances. I have made some observations in the course of these enquiries suggestive of further investigations on this subject, and which may also have a bearing on the purification and preservation of such waters, a subject which has lately been occupying much attention in England. It is obviously a possible thing that one water may be putrefying but its putrescibility nearly exhausted, while another may be highly putrescible, and yet its actual putrefaction may be only about to commence. As regards the preservation of waters too, it is one thing to keep them in stoppered bottles, and another thing to keep them in tanks. It seems to me questionable if they improve in tanks as they do in glass bottles. It is by following out such inquiries that advance in knowledge of such subjects is attained, and in the present case the activity of chemical changes produced by the high temperature and the regularity of the seasons are in no small degree favourable for carrying them to a successful result.

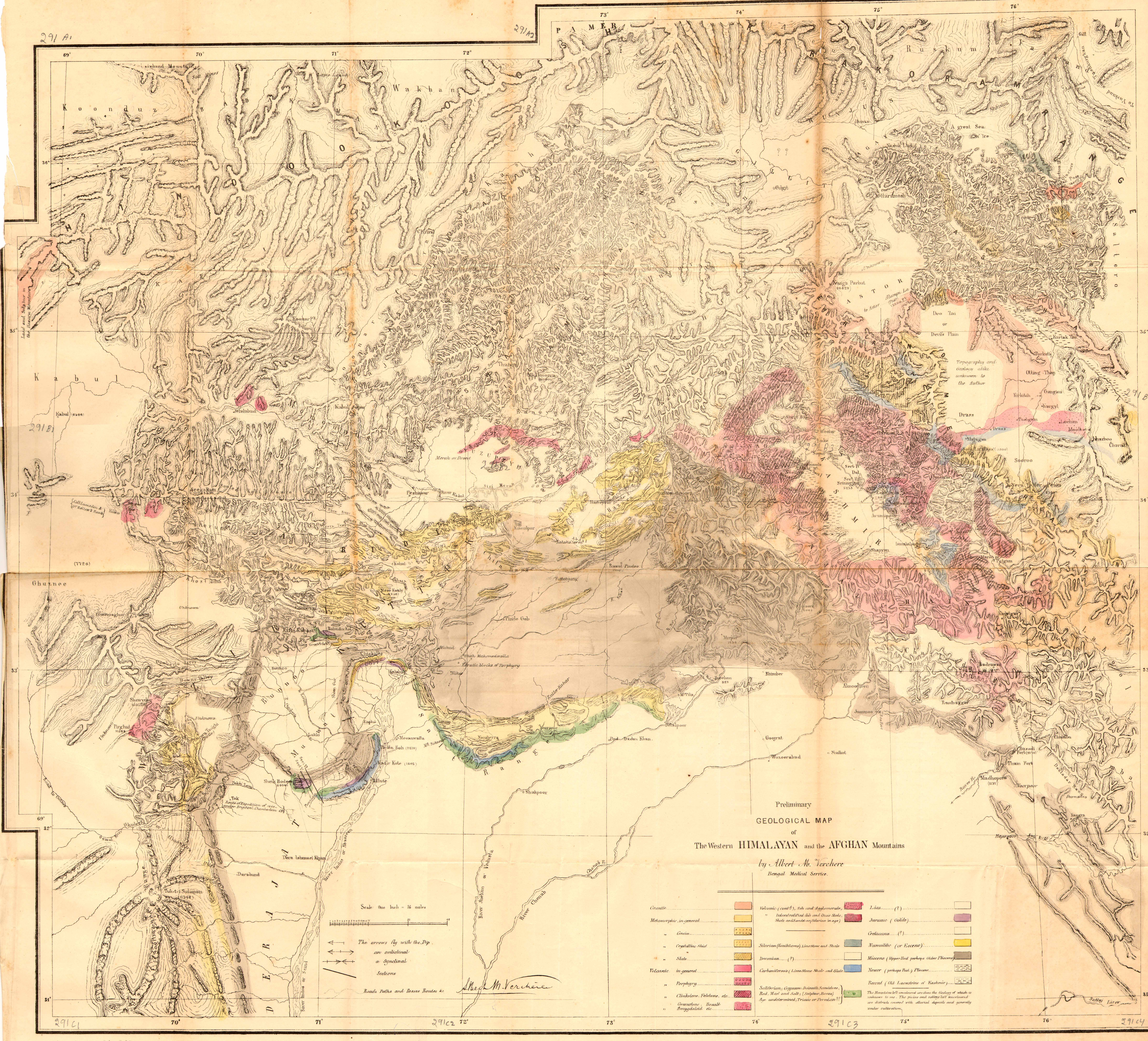
Kashmir, the Western Himalaya and the Afghan Mountains, a geological paper by Albert M. Verchère, *Esq.*, M. D *Bengal Medical Service, with a note on the fossils by* M. Edouard de Verneuil, *Membre de l' Académie des Sciences, Paris.*

(Continued from page 203, of No. III. 1866.)

Chapter III.—*Cursory Survey of the several chains of the Western Himalaya, the Afghan mountains and their dependencies. Preliminary geological mapping of the Western Himalayan and Afghan Ranges.*

59. It is intended, in this chapter, to give, in as few words as possible, an idea of the general geology of the several portions of the Western Himalaya, the Afghan mountains and their respective dependencies. In doing so, I have availed myself of all sources of information which have been opened to me; I have, however, been sadly in want of the help of a more extended library, and I have never seen some excellent works which would have much improved this chapter, if they could have been consulted. I need therefore hardly say that it is a most superficial of surveys; but I hope nevertheless that it may be found to contain a few interesting observations and some new matter yet unpublished. Such as it is, it will enable us to sketch at least the first preliminaries of a geological mapping of the Himalayan and Afghan Ranges; and also to attempt, in the last chapter, to draw the history of the mightiest mountainous mass of our globe.

By reference to the map and and to the long Section (Sect. G) it becomes evident that the Himalayas are a succession of more or less regularly parallel chains, having a general N. W. to S. E. direction. Between the chains are situated valleys which are elevated above the sea in proportion as one nears the centre of the mountainous mass: thus the Rawul Pindie plateau, between the Salt Range and the Sub-Himalayan hills, is about 1700 feet high; Poonch valley, between the Sub-Himalaya and the Pir Punjal chain, is under 4000 feet; Kashmir between the Pir Punjal and the next chain (called in the map Ser and Merchain), is above 5000; Ladak between the Ser and Mer chain and the Kailas chain is 10,000 to 11,000; Nubra and the valley of the Shayok,



On transfer paper by S. Ismail. &c.
LITHOGRAPHED AT THE SURVEYOR GENERAL'S OFFICE, CALCUTTA FEBRUARY 1867.

between the Kailas and Korakoram chains is a plateau nearly 15,000 feet high. It is probable that on the other side of the Korakoram chain the elevation diminishes and that the Aksai chain and the valley of the Yarkandkash river, between the Korakoram and Kuen-Luen chains, are about 10,000 feet high; beyond the Kuen-Luen is the province of Kotan which has been satisfactorily determined by its vegetation to be no more than 5000 feet high.

We have therefore a series of steps rising from the plains of the Punjab to the high plateau of Little Thibet, and descending from Little Thibet towards Turkish China. These steps are supported by parallel chains or walls which tower by some thousands of feet above the plateaux which they support. These chains offer a considerable impediment to the flow of rivers towards the plains, and most rivers have a considerable course parallel to the direction of the chains, before they can find a gap to pass through.

The Afghan mountains present the same arrangement as the Himalayas; the direction is from the N. E. to S. W. the direction of parallel chains is less well marked than in the Himalaya, but this is probably due to the little which is correctly known of the topography of these mountains. The plateaux are similarly graduating: Bunnoo being about 1200 feet above the see, Kabul 7000 feet, Kaffiristan higher, whilst the plateau of Koonduz, on the other side of the Hindoo Koosh, slopes gradually towards the west. This arrangement by plateaux is the same as is seen in the Andes with their high central chain and their plateau between that chain and the Cordilleras.

From the hypothesis, advanced in the next chapter, of the manner the Himalayan and Afghan mountains were upheaved, we will deduct which of the lower hills belong to the Afghan and which to the Himalayan mass, and I will therefore not discuss this subject here, as it would but lead to useless repetitions. I shall begin with the hills which one first meets crossing out of the alluvial plain of the Punjab, as he travels north from Mooltan; and I shall take the parallel regions of the Himalaya one after the other, noticing as I go on whatever little I know of the geology of the Afghan mountains in the same latitude.

60. In latitude 32° 10′, longitude 70° 50′ to 71° 20′ rises the double chain of the Kafir Kote range or Rotta Roh and the Sheikh

Bodeen range. A small valley, the Paniala valley, separates the Rotta Roh range from the Sheikh Bodeen range, and the direction of both small chains is from the N. E. to the S. W. as far as the highest summit of Sheikh Bodeen, whence westwardly the Rotta Roh altogether disappears, and the Sheikh Bodeen range is continued by a small and low ridge of hillocks directed towards the W. N. W. and supporting the plateau of Bunnoo. (See map.)

The Rotta Roh is mostly composed of carboniferous limestone. The Zeawan bed is well developed, but extraordinarily disturbed; it is a yellowish rock, often very sandy. It forms the base of the hills on the E. and S. E.

Dr. A. Fleming sent home some fossils from Kafir Kote, which were ascertained by M. de Verneuil to belong to the following species:—

Productus cora (D'Orb.); *Productus costatus* (Sow.).
Productus Humboldtii, (D'Orb.) *Spirifer ?*
Dentalium ingens, (DeKönig).

All the species of which I have given drawings in Pl. I, III, and V, were found in the Rotta Roh limestone, with the exception of the Spirifer like *S. trigonalis*.* Several species of corals, either not found at all or very rare in Kashmir, were found abundantly in the lower beds of the Rotta Roh; but altogether the fauna of the Zeawan bed in Kashmir and in the Rotta Roh is so very similar, that it can be called identical.

The limestone rests† on a quartzite rather peculiar in some localities. It is composed of opaque white quartz in which are imbedded plates of pearly white mica half an inch wide; these plates of mica are arranged in tufts; there are also some irregular nodules or granules of black augite (?) quite lustreless (see fig. 74, pl. IX). There can be

* A distinct species of Sp., according to Mr. de Verneuil.

† I failed to find the bed of quartzite in situ; my examination was much more superficial than I could wish. But it is hardly to be wondered at that the quartzite beds are not found in situ, if we consider the wonderful state of confusion the beds are in. The limestone is in an extremely shivered condition, having been thrown into stray arch-like anticlinals separated by numerous faults. The shivering of the beds often goes so far that it is difficult to ascertain the dip and strike of the beds. In such convulsions as those which must have taken place in these hills, the brittle and fragile beds of quartzite must have been entirely broken, and are therefore not to be seen in situ at their outcrops, but are only indicated by the fragments into which they were reduced. In several localities the ground is covered with angular pieces of quartzite, either with mica as described in the text, or plain and opaque.

no doubt that this micaceous quartzite represents the bed of quartzite which we have seen invariably underlying the Zeeawan bed in Kashmir. The beds of volcanic ash which it probably covers are not exposed in the Kafir Kote Range.

The Zeeawan bed of limestone is capped by very extensive and thick beds of Weean limestone rich in goniatites, in mussel-like anthracosiæ, in *Aviculo-pectens* and other characteristic fossils. I found some blocks of the sandy limestone in which the *anthracosiæ*, *solenopsis* and *A. pectens* are generally found, containing one specimen of *Productus semireticulatus*, several *Athyris subtilita* (Hall) and *A. Royssii* (L. W.), and also the *P. Bolivicutis* (D'Orb.) mixed up with the *anthracosiæ* and *A. pectens*, a mixture of Zeeawan and Weean fossils which I never saw in Kashmir. Some very large bivalves of which debris had been found in Kashmir and resembling an aviculoid inequilateral *pecten* were also found; the transverse diameter is 7½ inches. Fine *nautilides* and spines of *cidaris* six inches long were also found. In the Rottah Roh the difference between the Zeeawan and Weean beds is not everywhere so well marked as it is in Kashmir, as I have just exemplified; generally, however, the assemblage of fossils given in the plates as characteristic of the beds is the same as it is in Kashmir.

In the northernmost end of the Rottah Roh, the Zeeawan bed does not appear, and is only represented near Kumdul by a few small mounds of debris rising through the sandy plain close to the foot of the hill. As we travel south and approach the Kafir Kote river, the Zeeawan bed appears under the Weean, and can be traced without interruption as far as the southern end of the hill a few miles from Paniala. It is impossible to give the dip and strike of the Zeeawan bed, as not a hundred yards of it keeps the same direction; the broken fragments of the bed are more like packed ice in the polar seas than like courses of rock in a hill. The Weean bed above is much less disturbed, except the deepest beds which rest immediately on the Zeeawan; it dips generally N. W. with a very trifling angle varying from 20° to 8° or 9° with the horizon; occasionally the dip becomes W. and even S. W.

I have not seen any beds in the Rottah Roh similar to the Kothair bed of Kashmir.

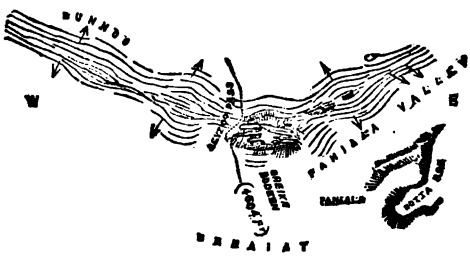
At the northern end of the Rottah Roh, the carboniferous limestone is immediately covered in by a Miocene sandstone and conglomerate. A little further south, some beds of reddish limestone and some sandstones, grey and bituminous, are either the top of the carboniferous or possibly Permian or Triassic beds. The fossils are very scarce and mere debris. The sandstone contains thin layers of a shale which is full of carbonized remains of plants, and from the sandstone, near the shale, a black bitumen oozes out. It is a mineral pitch or impure petroleum; the quantity is insignificant.

As we continue to travel south and west, we find the Weean bed forming the top of the hill the whole way; with here and there patches of gypseous marls, red marl, grey sandstone and variegated thin-bedded non-fossiliferous limestone, or rather dolomite, which are in all probability Triassic, but which will require much more careful study than I have been able to give them, before they can be satisfactorily classed. I believe them identical to the red marl and gypsum of the Saliferian formation of the Salt Range. Close to the village of Paniala these supposed Triassic beds are well developed, and from them issue some saline hot springs. Near Gunga, at the other (northern) extremity of the little Range, a patch of these same gypseous sandstones and marl appear at the end of a fault in the carboniferous limestone, and from these supposed Triassic beds two or three small hot and saline springs issue. It is a remarkable fact that everywhere in the Himalaya and in the hills of the Punjab, where these gypseous marls, red marls, sandstones and dolomites appear well developed, they are generally accompanied by saline springs, usually hot.

At the northern extremity of the Rottah Roh, over the village of Kundul, we have seen that the Weean limestone forms the bulk of the hill. Under it, at one place, is found a feldspathose sandstone invaded by tortuous veins of quartzite; it has acted powerfully on the limestone near it, this being much metamorphosed, cellular, traversed in all directions by thick bands of crystalline carbonate of lime, and all fossils being obliterated or changed into a lump of spar. The feldspathose sand has the appearance of having been forced between the broken ends of the beds of limestone which is thrown into an anticlinal; it is generally white, occasionally coloured

red in patches; it is not stratified, but mammilated, globular, irregular, and branching like a dyke. This intrusion of a feldspathose solution or paste took place before the final upheaval of the Himalayas, as there is evidence that some of the beds have been redisturbed by this upheaval, and as the Miocene conglomerate which partially fills the fault is unconformable to the limestone. A full description of this locality would be complicated, and I have no intention of giving here such a description. I merely want to point out that we have here Weean beds disturbed and baked by a geyserian action, similar to that which we have seen at Ishlamabad and at the Manus Bal.

61. The Sheikh Bodeen Range is mostly composed of miocene sandstone, clay and conglomerate. These beds are thrown into an anticlinal, the south-eastern and southern slopes dipping to the S. E., and the S. and the north-western and northern slopes dipping N. W. and N. One can see, from the top of the highest summit, that deeper rocks have endeavoured to push their way through the miocene, the beds of sandstone and conglomerate being arranged in semi-theatres on both sides of the points where an underground mass has endeavoured to break through. But everywhere these underground masses have failed to find a way to the surface except at one point, *viz.*, the Sheikh Bodeen summit, in the centre of the Range. This summit is 4604 feet above the level of the sea, whilst the Miocene range does not reach higher than 2800 feet and is generally very much lower. There is evidence that the Miocene was at one



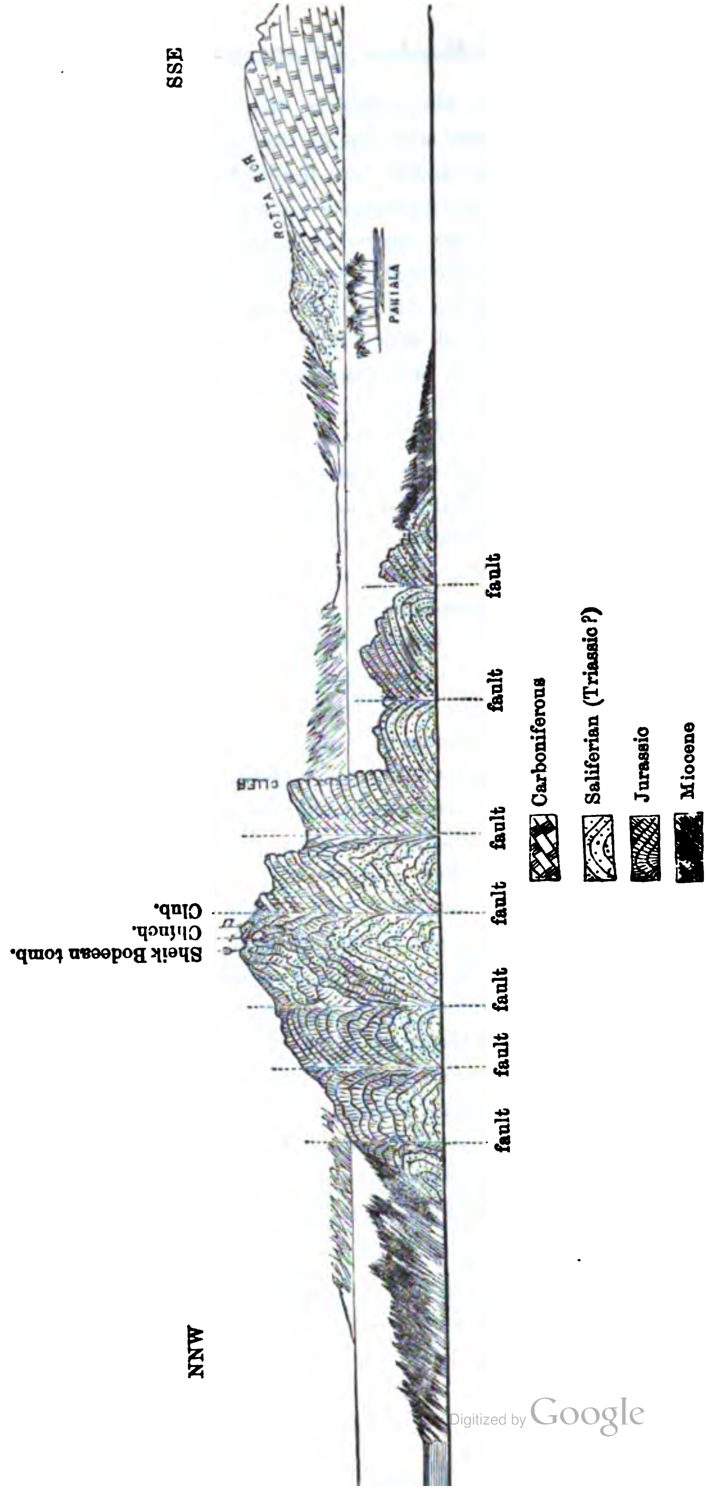
Horizontal appearance of the Miocene beds, Sheikh Bodeen range.

time much higher and reached to within 8 or 900 feet of the summit of Sheikh Bodeen. But the friable sandstone and loose conglomerate disintegrate very quickly, whilst the limestones of Sheikh Bodeen summits decay but slowly; hence the Miocene portions of the Range have become low hills, whilst Sheikh Bodeen summit has nearly retained its original height, and appears therefore to stand now as an isolated summit in the middle of insignificant, low, barren and crumpling sandstone and conglomerate hillocks.

Sheikh Bodeen hill (not range) is mostly composed of Jurassic limestone, excessively shattered from having been thrown into a succession of very sharp anticlinals. The anticlinals are separated by faults which run from W. S. W. to E. N. E. The following diagram sections are from the N. N. W. to the S. S. E.

Sections V and VI General Map.

The section in the distance is about a mile north of the section through Sheikh Bodeen Hill. Jurassic limestone is at least 800 feet thick; it is rich in fossils which are, however, seldom well preserved. The lower beds contain Belemnites, Ostreæ, Rhynchonellæ and Terebratulæ in great abundance, especially in and near some ferruginous sandy beds. Shaly beds are full of petrified branches of trees. The limestone is sandy and impure; along the great cliff facing the S. S. E. and formed by the removal of half the arch of an anticlinal (see section, marked cliff) some very fine specimens of ripple-marking are exhibited on a large scale. *Ammonites* are also found, but very much broken. *Cariophyllides* and an *Astræa* are the commonest corals. Two or three species of *Pholadomya* are tolerably abundant. In the uppermost beds I have found a *Nerinæa*, very likely the *N. Bruntrutana* (*Thuma*) of the coralline. In both the lower and upper beds the mineral characters appear to be identical, and many species of fossils are common to both, especially *Rhynchonellae*, of which no less than ten species are abundant. In the lower beds I have found eight species of *Terebratulæ* with short loops, or true *Terebratulæ*. The *Belemnites* are three or four species, of which a thick one like the *B. sulcatus*, a grooved species like the *B. canaliculatus*, and a *hastate* species like the *B. hastatus* are the most abundant. Gasteropods are extremely abundant in some beds, most especially a species of *Acteonina*; a few encrinite stems were found, but no heads.


SSE
ROTTA ROH
PANIALA
fault
fault
fault
fault
fault
fault
fault
Club.
Sheik Bodeean tomb.
NNW
Carboniferous
Saliferian (Triassic?)
Jurassic
Miocene

From this fauna it appears therefore that the limestone of Sheikh Bodeen* is equivalent to the Oxfordian formation of England, and that the uppermost beds are contemporary to the English Coral Rag or rather to the *Calcaire a Néimaes* of the Zena. We shall see presently in the country of the Wuzeerees, beds which are, in all probability, the equivalent of the Coral Rag. Some of the Oolitic shells collected by Dr. Gerard in Spiti are represented in Dr. Royle's Illustrations of the Botany and other branches of the Natural History of the Himalayan mountains; the drawings are by T. Sowerby and are remarkably good. The form numbered 17 in Royle's plates and described as an Arca or *Cucullœa* is found at Sheikh Bodeen; the *Rhynchonellœ* 20 and 21, described as *Terebratulæ* or *Atrypæ*, are common at Sheikh Bodeen; the two species of *Ammonites*, figs. 22 and 24, are also found at Sheikh Bodeen, as well as the two species of *Belemnites* represented figs. 25 and 26 and fig. 27. The fig. 23, called a *Delthyris*, has also been found at Sheikh Bodeen, I believe, but I do not possess a specimen of it.

The *Rhynchonella* represented by Royle and which is common at Sheikh Bodeen, has also been found in Rukshen by Captain Austen.

The Jurassic limestone of Sheikh Bodeen rests in variegated dolomitic limestone without fossils (?), red marls, gypseous dark marls, and feldspathose white sandstone extremely friable; and this formation appears identical to the Saliferian formation of the Salt Range. From these lower beds issue a few small springs of brine, and it is, probable that masses of salt exist here and there in the marl, as it does in the Salt Range, but nowhere does the salt crop out. Some beds of massive gypsum occur on the southern side of the hill near its base, but are not extensive. The Oolitic and Saliferian formations conform in all their folds, faults and twistings most perfectly, but there is a slight nonconformity between the Saliferian and Oolitic beds and the Miocene sandstone and conglomerate. The Saliferian and Oolitic formations had been upheaved to some extent before the Miocene began to be deposited, as boulders of gypsum and Oolitic limestone are found in the Miocene conglomerate in company with boulders of volcanic rocks, of nummulitic limestone, of carboniferous limestone, and with rolled *Producti* brought from the Bilote Range. But the

* A few fossils of Sheikh Bodeen are sketched at Plate XI. figs. 2 to 6.

hills formed by the first upheaval were so low, and their beds probably so near the horizontal position, that the non-conformity of these beds and of the Miocene beds is not now very apparent, both sets of beds having been redisturbed to a great extent by the final great upheaval of the Himalayan mountains.

62. In the country of the Wuzeerees, lat. N. 32° 15′ to 32° 45′ and Long. E. 69° 45′ to 70° 15′, we find the continuation towards the north of the Soolimanee Range to be formed of a chain of mountains of which the Pir Gul (11,583) and the Shewy Dhur (10,998) are the highest summits. These high summits were not ascended by the expeditionary force against the Mosood Wuzeerees in 1860, but the army marched along the fine plateau of Rusmuk (7,000 ft.) which skirts the main chain; and by collecting the pebbles of the torrents which descend from these high peaks I was enabled to estimate to a certain extent the mineral nature of the central ridge. These pebbles were all volcanic, trappean and metamorphic, and none of a granitic nature were found. The following specimens of rocks were collected in ravines descending *directly* from the Shewy Dhur: basalt, having the appearance of hard jet; it is divided by joints and by innumerable cracks filled with carbonate of lime. It fuses quietly before the blow-pipe into a black bead. Some varieties do not shew the cracks filled with carbonate of lime, but are schistose in appearance, and the joints, which are large, are lined by quartzite. Half inch thick plates of volcanic ash, composed of a central layer of a pale dirty-greenish and compact mineral, and external layers of a brownish granular substance. The central layer fuses very easily before the blow-pipe, boiling up into a swollen and blistered surface; it has the appearance of tremolite, the outer layer appears to be a mixture of tremolite with grains of augite; the augite here and there forms little masses, and these fuse partially, the assay becoming studded with minute dark globules. Hornblende rock with grey mica. The paste appears to be an intimate mixture of felspar and hornblende, and is invaded by irregular and small plates of grey mica; the rock is divided by a series of well-marked joints, an inch apart. An augitic porphyry; the paste is perfectly black and apparently composed of chatoyant augite; it is invaded by closely set and minute prismatic crystals of dull white albite; it is more like a porphyritic lava than like a true prophyry.

A metamorphosed micaceous limestone, schistose, the foliation being extremely wavy. It has the appearance of a thin-bedded micaceous and calcareous shale which had been both crumpled and highly metamorphosed. It is nearly entirely composed of exfoliating mica imbedded into grey bands of magnesian (?) carbonate of lime, which effervesces feebly, and other bands of white felspar. The felspar forms bands by itself, a quarter of an inch thick and free of mica. The rock exhibits a foliation or stratification which is thin-bedded and wavy. Greenish, soapy, spotted chlorite schist. Jaspery flint, bluish and transparent, with veins and patches brownish and opaque, and occasionally threads of milk-white quartz. Quartzite with well formed crystals, six-sided prisms, at one end terminated by a six-sided pyramid.

These rocks are therefore mostly volcanic; the four last are, however, metamorphic, and such rocks are not seen in Kashmir; but they are extensively developed in the most northern portion of the Himalaya, as in Skardo, Zaskar, &c.

63. Between the range of the Pir Gul and Shewy Dhur and the plains of the Derajat, is a thick belt of low hills which are nearly entirely made up of nummulitic limestone, slate and shales, and of Miocene sandstone and conglomerate. At Palusseen, however, (see map) under the nummulitic limestone is discovered a rock of a very hard and dirty appearance and not forming beds, but huge masses of flesh-coloured limestone which are imbedded either in a grey sandstone or in the lower beds of the nummulitic limestone. These masses are most evidently old coral reefs, once rising from the bottom of the sea and ultimately covered by sand and calcareous mud; they are a confused agglomeration of corals of many species, imbedding shells, but unfortunately neither corals nor shells are in a good state of preservation. I am not sufficiently familiar with the forms of the Coral-Rag of England to say whether this bed is its representative in India, but it is not unlikely to belong to secondary strata, for the following reasons.* 1. It is situated under the sandstone, which generally forms the base of the nummulitic formation. 2. It does not contain any of the

* A coral reef formation, apparently closely analogous both in lithologic characters and mode of occurrence, occurs at the base of the Ootatoor division of the cretaceous rocks in Trichinopoly. See Mem. Geological Survey, Vol. IV, Pt 1, pp. 52-72.—*Ed.*

fossils found in the nummulitic limestone above. 3. It appears much disturbed and dislocated by local movements, whilst the nummulitic limestone is to be seen in regular, though much tilted-up beds above it. 4. It rests immediately over beds of red marl and gypsum which are always found, in the Punjab, where Oolitic beds occur much disturbed. 5. Some of the corals appear identical with some species found near Maree on the Indus, in a limestone containing the same fossils as those of Sheikh Bodeen which is decidedly an Oolite.

I have therefore, in consideration of these reasons coloured these beds as Oolitic, but there is a doubt about it. The country was so dangerous at the time we were encamped at Palusseen, that I could collect but very few fossils, and I have not yet had the good luck to discover a similar bed in British territory.

These coral reefs reappear in many places in the country of the Wuzeerees: at the entrance of the plateau of Rushmuk a great quantity of this bed was again seen, but the rock was different, though the fossils were identical; the limestone was extremely impure, full of small rounded grains of gravel, and so much invaded by iron that it is often quite brown, and often also spotted by the iron forming little dark nodules in the mass.

Again, near the hot spring of Sir-Oba, similar beds were seen resting on red marl, with here and there masses of gypsum. This gypsum is opaque, white and compact, and contains a great number of crystals of quartz, very fine in their form, and terminated at both ends by a six-sided pyramid. The same crystals occur at Maree and Kalabag in the gypsum which accompanies the rock-salt of these localities, and are there collected and sold to natives as ornaments, under the name of Kalabag diamonds.

One of the members of the nummulitic genus in the Wuzeeree Hills requires notice on account of its economical value. The Wuzeeree iron is obtained by the smelting of a brown shale, extremely rich in brown hæmatite; the beds of the shale are situated under the nummulitic limestone, and seem to replace the extensive beds of slate, with nummulites, seen in other localities. The quantity of the ore is enormous, whole ridges being formed of it. It is not quarried, as far as I could discover, but merely broken off the surface of the beds. It is first roasted, and becomes black and highly magnetic. It is then worked either with nummulitic limestone or pieces of the coral-reefs and smelted with charcoal in small furnaces identical to those seen in Kashmir. I found at Mackeen a house with two of these furnaces and heaps of charcoal, of iron-ore and of limestone, evidently collected for smelting, and I could thus identify the ore used by the Wuzeerees, though no information was to be obtained from the people. I have had, since, pieces of ore brought to me, at Bunnoo, by the Wuzeerees engaged in trade and who bring the pig-iron to the plains for sale, and it is exactly the same ore which I had seen at Mackeen, and which I had observed in situ as one of the members of the nummulitic formation. This shale is heavy, generally covered with a rusty powder; it varies in colour from reddish-brown to nearly black; it soils the hand, it is not calcareous, and the richest parts of it have a tendency to form concretions, or at least to assume a sort of concentric slaty cleavage. It is only smelted to a paste, not to a fluid, and is refined by hammering. The iron produced is soft and fine-grained, but apt to exfoliate, a defect which is evidently the result of the metal being half worn-out by the extensive hammering to which it is submitted.

The carboniferous limestone was found in situ in Wuziristan. But that such rocks do exist in the hills between the British border and round the central chain of the Afghan mountains, is proved by the boulders in the rivers which drain those countries. Major Vicarey found boulders of limestone containing carboniferous fossils in the streams near Peshawur; Dr. Fleming found "*Productus*-limestone" in the ravines which drain the Solimanee chain towards the east; and I have found in the bed of the Korum, a torrent which drains the southern slopes of the Sufed Koh, boulders of a black limestone containing *Productus cora* and *P. Humboldtii.*

64. In the Salt Range the carboniferous limestone is well developed and attains, according to Dr. A. Fleming, a thickness of 1,800 feet. It begins near Noorpoor in Long. E. 72° 30′, as a thin bed, which increases as it goes towards the west, and attains its maximum of development near Vurcha, in Long. 72°. It decreases again towards the Indus, and is not seen at all near Maree and Kalabag; but on the right bank of the river it reappears about six miles west of Kalabag, and is continued in the Chichalee range and the northern

end of the Speen or Lowa Gur. It appears to be identical, in fossils and in lithological characters, to the limestone of Kashmir. Dr. A. Fleming does not mention its ever resting on quartzite or volcanic ash, but supposes on the contrary that it rests on the Saliferian formation, which he, in consequence of this view, calls Devonian. Whatever little of the carboniferous limestone of the Salt Range I have myself seen, is too much disturbed to allow me to form an opinion; I certainly never saw any quartzite underlying the limestone in the Salt Range; but such quartzite exists in the Rottah Roh, and it is evident that the Rottah Roh carboniferous limestone, and that of the Salt Range are one and the same sheet of deposit, broken and separated by convulsions of a posterior age. This, however, does not prove much either way.

The long controversy about the age of the salt and gypsum in the Alps bids fair to be repeated in the Punjab. The Saliferian of the Salt Range has already been placed by successive observers in nearly every formation from the Devonian to the Miocene! In the Alps, geologists appear to have once become desperate at the fight, and M. Sismonda published in the *Comptes rendus de l'Académie des Sciences de Paris (Vol. III. p.* 113*)* the somewhat startling hypothesis that "in the Alps the shells of the Lias lived at the same time as the carboniferous plants" !!!... It is not a little curious resemblance that in the Maurienne, in Savoy, (the great field of contention,) the gypsum, quartzite, marl, &c., are much disturbed by local foldings and bendings, and appear to be placed under the carboniferous rocks *(terrain houiller)*. Fortunately a thin, but very persistent and well-characterised bed, the *Infra-lias*, has enabled the geologists who have best studied this locality, to fix the position of the red marl, red and green shale, quartzite, gypsum, &c., in the Trias, and to show that the apparently inferior position of these Triassic layers was due to such great disturbances and reversions of strata as one may reasonably expect to have accompanied the surging up of mountains like the Alps. Less fortunate or less industrious than they of Europe, we have not yet found the *Infra-lias* in India, and we have not therefore got hold of the thread which led so successfully the Swiss and French geologists to a true understanding of the Alpine Saliferian.

I wish that I could have determined satisfactorily the age of the salt of the Punjab, before forwarding this paper to the Society; but I see at present but little chance of my being able to visit again and study the Salt Range within a reasonable time. My own impression, from what I have seen, is that the Saliferian of the Punjab is Triassic or Permian.

This Saliferian formation, (whatever its age may be,) plays a very important part in the economy of Upper India, and may possibly be made a great deal more of than at present. It gives a supply of salt which pays to the State a handsome revenue; it has been the original source of the Reh or Kullur of the soil, an impure and effervescing mixture of saltpetre, of soda and chloride of sodium, which renders fields barren and thus causes very serious losses to that same revenue. There can be little doubt that it contains some at least of the numerous minerals discovered in the Russian salt mines of Stassfust-Anhalt, and it is very possible that it will one day give some fertilizing material which will more than repay the loss caused by the Reh. It is a fine field for research, and only wants work bestowed upon it to yield valuable results.

Any one who has visited the Saliferian of the Punjab must have been struck by the much disturbed state of the beds. These appear as if they had been raised into a succession of small cones or "boursoufflures," and suggests at first sight the idea of the Saliferian having been at some time or another violently dislocated by eruptive gases and sublimated minerals. This is so marked in some localities that Dr. A. Fleming advances, as a possible hypothesis, that the salt may be of volcanic origin. But the stratification is generally so well defined (the courses of salt being separated by thin layers of red marl or of cellular gypsum) that we cannot regard the salt as intrusive; it is decidedly sedimentary. That the disposition of the salt gypsum, bipyramidal quartz crystals, &c., &c., took place under the influence of heat, due probably to hot springs, is pretty certain. For Charpentin and de Beaumont have shewn that the gypsum was first deposited as anhydrite, and this anhydrite must of necessity have been precipited from hot solutions; neither do we see how sea water could deposit gypsum, unless submitted to a high temperature; whilst, high temperature being admitted, the precipitation of gypsum becomes easily explained, if we remember Mr. David Forbes's observation in Peru:

" The quantity of sulphates and more especially of sulphate of lime, " included invariably in these deposits, might, at first sight, appear to " the observer too great to suppose it due only to the evaporation of " the sea-water; but I believe that this impression will be dissipated " when he sees the enormous amount of gypsum removed in the form " of hard white cakes or sedimentary crust, from the boilers of the " large distilling machines in use along this arid coast, for producing " from the water of the sea a supply of fresh water for the maintenance " of the inhabitants, beasts of burden, and even the locomotive engines " of the railways along the coast. It appears not necessary to suppose, " as has been put forth, that the sulphates present have been formed " by volcanic exhalations acting upon the bed of salt."* What induces us readily to admit of the existence of very numerous and extensive hot springs during the Triassic epoch in the Punjab is, that even now-a-days the Saliferian formation is remarkable for the great number of hot springs it contains; indeed hardly a hot spring in the Punjab and the Himalaya is to be found unconnected with the Saliferian, and whenever we find Saliferian beds, we generally also find hot springs. This is true of the Salt Range, of the Rottah Roh, of Kangra,† of Rukshu in Thibet, &c. We may therefore conclude from these remarks that the salt, gypsum, &c., is sedimentary, though deposited under peculiar circumstances, viz., the presence and influence of hot springs. How then to account for the very disturbed state of the Saliferian beds, for these limited, local, fragmentary disturbances which give to the beds so elastic an appearance? Two ordinary causes appear to me sufficient to account for this: one is the transformation of the anhydrite into gypsum by absorption of water, a phenomenon which continues to take place now-a-days. This absorption of water and the consequent increase of volume of the gypsum brought about the swelling up of the beds in cones and " boursoufflures." Then the

* "The Geology of Bolivia and Peru," by David Forbes, with notes on fossils, by Professor Huxley and J. W. Saller, Esq., published by Taylor and Francis, Red Lion Court, Fleet Street, 1861, communicated to Geological Society in 1860.

† The saline springs of the Towala Mookhi and of Kangra-basa, in Kangra, issue from Saliferian ranges immediately covered by Miocene beds. Mr. Marcadieu has found that the water of these springs contains Iodine, in addition to the usual saline matter of the springs of the Saliferian formation in Upper India. Vide Report, No. 84, by M. Marcadieu. Sketches of Correspondence, Punjab, 1860.

second cause of disturbance began to act: the beds of salt are often dissolved and removed by water infiltrating through cracks in the rocks; a cavity is thus formed under the vault of rocks which covered in the salt and one day the vault falls in.

This process is to be seen now-a-days in actual existence, on a small scale, in the hillock of Maree on the Indus.

Thus, from the swelling of the gypsum by its transformation from anhydrite to common gypsum, and from the falling in of the vaults formed by this swelling, the beds of the Saliferian formation in the Punjab have a most broken and turned-over appearance.

Add to this that these beds have participated in the convulsions produced by the great final upheaval of the Himalaya, and you will have no difficulty in understanding how difficult it is to make out with certainty the stratography of these rocks, and how it is that the Saliferian appears here and there inferior to the Palæozoic beds. Before quitting the Saliferian formation, let us notice that the beds of it appear to have suffered very great denudation. We can easily understand that the red marl was very easily denuded, when we see how it crumbles into a powdery, friable, fluid earth, after a few days exposure to the atmosphere. It is on account of this denudation, on account of the very considerable amount of material which this formation gave to the Miocene and to the alluvium deposits of Upper India, that the presence of Reh or Kullur in the soil of the Punjab and the North-West Provinces is to be credited to the Saliferian. I shall say a few words about this again, when we explain how the Miocene was made up, in the next chapter.

As there is yet such incertitude about the age of the salt, I have called the formation "Saliferian," without entering it on the Map as belonging either to the Palæozoic or to the Mezozoic epoch.*

The carboniferous limestone is covered in, north of Vurcha, by an Oolitic formation of trifling thickness and containing Oxfordian forms.

* I have purposely avoided insisting on the mineral characters of the Saliferian formation of India, as it is now-a-days the fashion to undervalue very much these characters; but it may be as well to remember that in the Salt Range we have beds of gypsum full of rock-crystals of a bipyramidal shape; that the layers of gypsum are separated by calcareo-magnesian bands, having a cellular disposition (Cargneule of the Swiss, Rankwacke of the Germans) and that the salt is accompanied by a bright red marl without fossils. These several characters are found in the *Triassic* salt and gypsum of Switzerland, of Savoy and of Spain, and, I believe, in no other formation.

4

As the carboniferous limestone thins out in approaching the Indus, the Oolitic formation increases in importance and forms much disturbed hills, all the way from Moosa Khel to Kalabag. It is continued west of the Indus in the Chichalee Range and the northern end of the Speen Ghur; a little above Moola Khel it disappears under the alluvial, and does not reappear till Sheikh Bodeen, where, as we have seen, it attains a considerable thickness.

65. The salt and gypsum is continued on the west side of the Indus, in the hilly country of the Kuttuks, but it is there much covered by tertiary clays and sandstones. It crops out near Bahadoor Khel and along the course of the Teeree Towe. At the first named place the Saliferian forms an anticlinal arch; the salt, above fifty feet thick, is the lowest bed seen, and is very regularly stratified; above it is a thin bed of red marl, another of grey sandstone, also thin; then gypsum, about twenty-five to thirty feet thick; then a thin band of a limestone with minute debris of fossils, and which resembles lithologically the Oolitic bed of Kalabag and Maree on the Indus; then the dark, brown, sandstone which often forms the base of the nummulitic formation; some coarse and crumbling shales without fossils; and finally, a bed of limestone rich in nummulites, volutes, veneridae, &c., and about ten to twelve feet thick. This is at last covered by the marly lumpy clayey beds of Miocene. A fault running approximately W. E. through the Soordak Pass, has caused an upthrow of the beds on its southern side, and there the nummulitic limestone, much tilted up, forms a pretty high hill.

Along the Teeree Towe the Saliferian is immediately covered by Tertiary. As far as Lachee the rocks seen are Miocene sandstone, clay and conglomerates; thence to Peshawur the country is entirely covered by nummulitic limestone and shale, and the Miocene sandstone is only seen here and there in small detached beds and patches, which are evidently the remains of layers which have been mostly removed by denudation.

66. North of the Salt Range we have also a great extent of Tertiaries. Nummulitic limestone, shale and sandstone first covers in the secondary layers in the western portion of the range, but rests directly on the salt marl and gypsum in the eastern half of it. It attains a great thickness, where well developed, (4500 feet,) and forms

the summits of nearly all the highest hills of the Salt Range. It is continued to within two miles of Maree on the Indus where it thins out, but reappears near Kalabag, and is very well developed in the Chichalee Range and in the Speen Ghur. Near the Indus, all the beds of the Salt Range, excepting the Saliferian marl itself and the secondary strata where much locally disturbed, dip towards the N. E. On the western bank of the Indus, that is in the Chichalee Hills and the Speen Ghur, the dip is W. N. W. or N. W. This last dip is generally that of all the strata of the Kuttuk hills.

The nummulitic formation appears in the Salt Range as a thick belt which, beginning at the Mount Tilla near Jheelum, is continued to near Maree on the Indus, where it disappears for a little space, but reappears on the other side of the river, and is to be seen forming the bulk of the Speen Ghur to near Esokhel. The formation keeps a remarkably similar aspect the whole way. It is, from below upwards, composed* of — 1. Sandstone often coloured by iron, but generally dirty white or pale grey. 2. Very arenacious, thin bedded or lumpy limestone, with gasteropods, few and small nummulites and innumerable debris of oysters or grypheæ. 3. Shales of various colours, with beds of lignite and of alum carbonaceous shales. The alum shales are only developed where the lignite is situated close to the Saliferian formation, and appear to be patches of lignite metamorphosed. 4. Argillaceous limestone, full of large nummulites, chama, cardita, crassatella, ostrœa, many gasteropods, very large echinodermata, &c., &c. 5. Shales often replaced by a clay-slate containing nummulites. The shales contain sometimes lignite and Rol (alum-shale), but the seams are made less well defined than in the lower shales. 6. Argillaceous limestone, extremely white in some places and containing the same fossils as layer 4; in the eastern portion of the Range it contains flints; it is often fœtid. 7. Chert, hard limestone, weathering rough and pitted; pale yellow or flesh-colour, brittle and

* Occasionally a bed of white soft fragile limestone is seen to form the base of the nummulitic formation. It is characterized by a planorbis which is tolerably abundant; but it contains neither nummulites nor any other fossil. It is found in lenticular beds of little extent, and rarely more than two or three feet thick. It suggests to the mind beds formed in pools or creeks among sandy islands and promontories at the mouth of a river. Whenever it occurs, I have found in the nummulitic limestone above it a great number of teeth and bones of fishes (sharks).

splintery. Shells fewer, nummulites small, but very abundant, especially the *N. variolaria*, whilst the flat and irregular *N. pushi* and *N. lævigata*, so abundant in beds 4 and 6, are not to be found here, or are at least rare. A nummulite about the size of the *N. pushi*, but thicker, is, however, found pretty abundantly, though not in swarms like the *N. variolaria*. A ribbed cardita is the only bivalve which appears tolerably abundant.

67. Resting on the nummulitic formation of the Salt Range are thick beds of Miocene sandstone, clay and conglomerate. I have described in chapter I. how these sandstones form a great plateau between the Salt Range and the foot of the Maree Hill, and indicated that thay may be considered as the upper Miocene Bed, whilst the Maree Hills and the whole of the mountains between the Jheelum and the Pir Punjal chain are to be regarded as lower Miocene. The upper bed is rich in mammalian fossils, and is identical to the Sewalik formation. The lower bed is devoid of fossils,* containing only a few debris of plants, rootlets, small stems aud occasionally small niduses of lignite. The upper Miocene has probably been a great deal denuded; remains of the bed are, however, to be seen in the valley of Poonch; they are there rich in very well preserved fossils, teeth of elephants being common and very perfect.

68. The sandstones and conglomerates just mentioned form a great belt from the E. N. E. to the W. S. W. (see Map) and to the north of it appears another belt, having a similar direction and composed of nummulitic limestone and slate. It begins in Hazara in Lat. 34°, and forms all the superficial covering of the Hazara mountains as far as the Sirun river and as high north as Mausera, being about thirty miles in width as the crow flies. It proceeds from N. E. to S. W. towards Attock, keeping the same width and extending in that district from the Indus to Janika Serai. Crossing the Indus, it forms the whole of the Akora Kuttuck and Afreedee hills between Peshawur and Kohat, extending about sixteen miles south of Kohat. It has been followed as far as longitude E. 70°. The beds of this nummulitic formation have a general dip to the N. W. A similar

* It is said that one or two bones have been found in the lower Miocene, but this is doubtful; if they exist, they are at any rate very rare. Mr. Medlicott has pointed out a non-conformity between the lower and upper Miocene; he makes three beds of the formation.

nummulitic tract follows the foot of the Himalayan ranges along the southern versant of the Pir Punjal chain and its continuation to the S. E. It begins in the valley of Poonch; it is seen north of Rajaori, and the pebbles of the streams near Rajaori are often nummulitic limestone, though the parent-beds have not yet been discovered. I cannot say whether nummulitic beds are to be seen to the north of Tummoo, Basaoli, and Noorpoor or in Kangra, but they appear near Subathoo in long. 77° lat. 31°, and have further been just discovered by Captain G. Austen on the east of the Ganges in Kumaoon. But this nummulitic along the foot of the Himalaya is either much denuded or much covered up by Miocene, and does not make such a show on the surface as the other belt which follows the direction of the Afghan mountains.

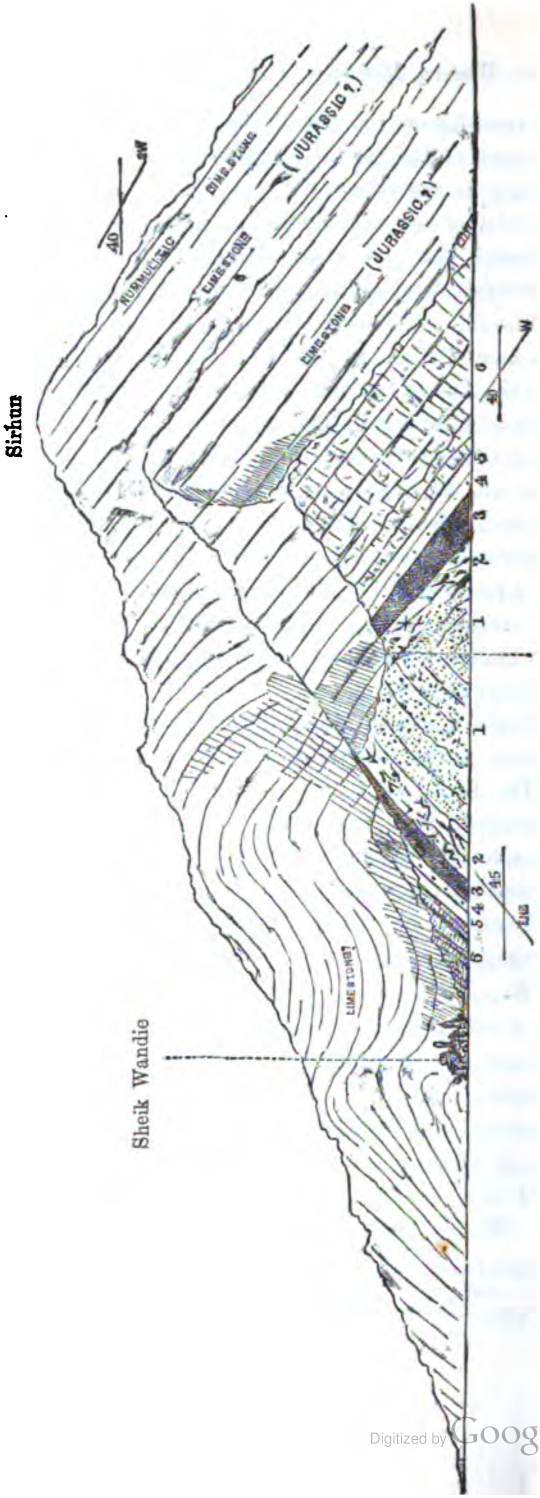
To the north of these zones of nummulite we meet the volcanic hills, which I have described in the first chapter.

69. The stratum of nummulite in Hazara, occasionally broken through, or faulted or denuded sufficiently to allow of older rocks making their appearance.

At the northern end of Mount Sirbun near Abbottabad, carboniferous limestone resting on volcanic rocks is quarried for building purposes. The limestone belongs to the Weean and Kothair groups and is thin-bedded, arenaceous, marly and occasionally conglomeratic. It is of considerable thickness and immediately covered in by limestone, the lower beds of which are so poor in fossils that it is impossible to identify them, the upper being nummulitic.

The following is a section near the small village of Sheikh Wandie, from E. to W.

(Section VII. of General Map.)



Level of the Abbottabad valley about 4700 ft. above the level of the sea.

Section of the Northern extremity of Mount Sirbun, near Abbottabad, from E. to W. bearing S. (not drawn to scale.)

1. Very compact and very hard Cornean rock, composed of a paste of white feldspar and grey hornstone in intimate combination. The joints and exposed surfaces are smooth and have a quartzy glimmering. In the paste there is often a partial separation of white feldspar in spots of a dull white colour. Splinters of the white spots can be rounded on their edges before the blow-pipe, but the grey paste of the rock appears to be more refractory, though there is certainly a softening of the mineral compound and a slight smoothing of sharp edges after long exposure to heat. It is a bed of very considerable thickness, stratified and much jointed.

2. White quartzite in a brecciated state, the pieces being recemented together by a grey feldspathose paste. It appears as if the bed had been broken after its formation and the fragments reunited by a feldspathose paste.

3. Very heavy, chocolate-coloured, clay-stone, with bands of quartzite.

4. Indurated clay, with round nodules, the size of a bean, of a black mineral having the lustre of jet, whitening to a milk-white colour before the blow-pipe, and finally melting with difficulty on thin edges; it belongs probably to the hypersthene group. The clay itself is grey, smooth and meagre.

5. Chloritic clay; grey, very smooth and soft to the touch; hardness of slate. It is full of ninute round grains of a semi-transparent mineral, grey like the clay, but a little darker. The clay becomes white and meagre before the blow-pipe; it is unaffected by muriatic acid, and does not form a pasty mass with water, either before or after grilling.

6. Limestone, at first extremely arenaceous and argillaceous, and presenting particles of dirty blue and brown colour. It becomes gradually conglomeratic and at the same time thin-bedded, the layers being made of layers of pebbles of limestone cemented by a calcareous sandy cement; the top of the layer appears to have been worn flat by the action of the waves, before the deposit of the next stratum took place, the pebbles appearing as sections on the surface of the bed. The next layer is a muddy limestone containing a few flat athyris, remarkable especially for three internal raised lines or ribs proceeding from the beak as far as the middle of the valve. But these shells are in a very bad state of preservation. This layer is only two feet thick, and is succeeded by another equally thin and containing numerous debris of gasteropods and corals. Then comes a black, sometimes blue-black limestone, extremely fœtid. The bluer portions are crossed by white lines intersecting each other in all directions and containing only debris of fossils.

The limestone forms altogether a bed of about thirty feet, when it is cut by a fault which causes it to be repeated, and a succession of faults directed W. N. W. to E. S. E. keeps the same limestone on the surface for more than half a mile, it becomes finally covered by nummulitic limestone.

This Mount Sirbun forms the left side of the Abbottabad valley. Following the slopes of this hill, we find beds of quartzite, similar to No. 2 of the above section, reappearing three or four times in short anticlinals; above it are beds of limestone containing a few fossils, principally casts of gasteropods. This limestone is often strongly oolitic in structure, but presents also the very unusual appearance of resembling beds of travertin which had been entombed in a calcareous mud after their formation, so that the cavities of the travertin have become filled up with a limestone less hard than the original deposit. I have usually regarded these beds as fresh-water origin near a low coast, and referred them, in a general and provisional way, to the Jurassic; of course this is doubtful.

70. On the lower road from Marree to Abbottabad, near the village of Sayd Kote, great disturbances are observed, and rocks of a geyserian nature make their appearance about half way between Sayd Kote and the Dowr river. They are principally a chocolate-coloured sandstone, becoming coated by weathering on the surface as well as in the joints, with a shining dark incrustation. It is much jointed and breaks in prismatic blocks. A great quantity of dark boulders of this rock may be seen in the bed of the river Dowr. It appears to be similar to some variety of dust-rock or sandy ash or earthy ash seen in Kashmir. It is capped by a bed of quartzite composed of large, opaque, angular grains of quartz, jammed together and cemented by a feldspathose white paste of which there is very little. Angular grains of black augite are sparingly disseminated in the rock. Under the brown sandstone is seen a thick bed of crumbling clay slate, very dark and foliated. This is the lowest bed seen. These three beds, viz., slate, sandstone and quartzite conform together in their dip and are capped by a patchy limestone of doubtful age, and interbedded with grey soft slate. There is much kunkur near the locality.

At Sayd Kote the limestones are wonderfully disturbed: beds having the appearance of Kothair limestone and containing a great number of gasteropods and *cyathophyllides* are seen repeatedly, as the road crosses nearly perpendicular beds which are much faulted. Nummulitic limestone appears to cover in directly the carboniferous (?) beds ??

Again on the upper road from Murree to Abbottabad, at the bottom of the ravine under Doonga Gully, volcanic or rather geyserian rocks are to be seen. They consist of a very white and friable rock composed of acicular minute crystals of albite easily fusible before the blow-pipe and pressed and entangled together; there does not appear to be any cement to bind the small crystals together; the rock has a coarsely saccharine aspect and can easily be crumbled between the fingers. It rises in vertical and contorted bands, from half an inch to two and a half feet thick, amongst sands and disintegrated shales. It assumes very many remarkable colours, being sometimes flesh-coloured or reddish, and at other places azure-blue; its general colour is, however, snow-white; where it is blue, the shales near it are of the same colour. It is interbedded with thin beds of tufaceous limestone which have probably found their way there by infiltration. It is covered in by a rubanneous and dark slate, much disturbed, extremely cleaved and jointed and falling into small angular pieces. This slate appears similar to that seen near Syad Kote, and the feldspathose rock is intrusive. These two rocks are at the bottom of the ravine, on a fault, and form a little mound by themselves. There are no rocks to be seen in immediate relation to them, and the beds of the sides of the ravine appear to be entirely nummulitic.

From the examples given of volcanic rocks in Hazara, it seems evident that that district has participated in the great volcanic accumulation which preceded the carboniferous epoch, and that it has also been disturbed at a later date by intrusive volcanic action of a local and geyserian character.

71. Of Chumba, Kulu and Kunawar, districts which occupy the hilly tracts south of the extension of the Pir Punjal chain towards the Sutlej, I know nothing.

72. Kashmir is continued to the south-east by the highlands of Lahul and Spiti which are situated in the same Himalayan parallel, viz., between the Pir Punjal chain or parallel and that of the Ser and Mer. Spiti has been pretty often visited by geologists, and we know that carboniferous and Jurassic fossils were brought thence by Dr. Gerard. Liassic fossils have also been found there. As for crystalline rocks, M. Marcadieu mentions much granite, and Captain W. E. Hay, granite penetrated by huge veins of ter-sulphuret of antimony and "other metals." Gypsum is reported as extremely abundant in Spiti, forming, it is said, whole mountains; and here I

would mention again that several hot springs are found in close vicinity to these gypseous beds.

But I must draw back here, and leave the ground to Dr. Stoliczka who has been for some time studying the geology of Spiti with great care and is preparing a work on the subject. Dr. Stoliczka has found in Spiti rocks of the following ages: Silurian, Carboniferous, Triassic (?), Liassic, Oolitic and Cretaceous. I have said before that most of the fossils from Spiti represented in Dr. Royle's Illustrations, are to be found in the Jurassic rocks of Sheikh Bodeen.

73. The great chain of Ser and Mer (called by Capt. R. Strachey, between the Sutlej and the Kali, the chain of Snowy Peaks, and by Cunningham, the western Himalaya or central chain of the Himalaya) appears to be, as far as I have been able to ascertain, made up of granite, gneiss, and other rocks of the plutonic and metamorphic groups. From the Nanga Parbat (26,629 ft.) to near the Sojji La pass, (11,300 ft.) the range is, I believe, mostly granite; it is traversed by the road of Skardo viâ Guzais, and Mr. Drew informs me that the range, (which here forms the southern boundary of the Deosai plain) is "chiefly granite, partly schist." The plain of Deosai is a singular plain or steppe entirely covered with debris and loose stones; it is tolerably flat, considering how it is situated, and has perhaps once been the bed of a gigantic glacier. It is surrounded by granitic mountains on the southern and western sides; the north end is bounded by mountains of schist and slate, and the eastern side is closed in by granitic hills which gradually pass, over Drass and Kurgyl, into volcanic rocks.

If we cross the Ser and Mer chain by the Sojji La, from Kashmir into Drass, we find near Baltal, a village on the Kashmir versant of the pass, that the carboniferous limestone ceases and is succeeded by beds of very coarse and micaceous slaty shales, often very sandy and always very thin-bedded. The specimens I possess of this rock show it to be identical with the sandstone and sandy coarse shales seen in the Zebawan and there interbedded with ash, agglomerate and slate. This rock goes on to nearly the top of the pass, where it becomes a dark and hard slate, having a metamorphic appearance. Then limestone reappears and is seen as far as Drass; it rests the whole way, as far as can be seen, on volcanic rocks and azoic slate. It is pro bably continuous, through Sooroo, with beds of limestone seen between Moolbek and Khurbu.

I do not know what sort of rock forms the summit of the Kun Non or Ser and Mer Peaks (23,407 ft.) but their north-eastern slope and spurs are composed of gneiss and schist; these metamorphic rocks extend as far as the Sojji La, where they are graduating into beds of the coarse slaty shales described above; on the north of the road it is continued by beds of slate and of sandstone extremely micaceous and resting on mica-schists, of which some specimens effervesce powerfully with acids. Beds of metamorphic white marble are also seen, but the great bulk of the mountains between Tillail and the Deosai is made up of granite, shist and mica-slate.

Following the great chain to the S. E. we find it crossed by several passes of which the Bara Lacha (16,505 ft.) and the Parung la (18,794 ft.) are the most celebrated and frequented. Mr. Marcadieu describes these passes as being principally through granitic rocks; but unfortunately Mr. Marcadieu does not seem to have enjoyed much his visit to these "*belles horreurs*" and he gives us little geological information, but many complaints, about these "delights of Satan," as he calls the mountains.

South-east of the Sutlej, the chain continues to be mostly granitic. It is studded with noble peaks, Porgyul (22,700, ft.) Baldang (21,400 ft.) Kamet (25,000) and Nanda Devi (25,700, ft.) all of them made up of granite, gneiss, and schist. But I must refer the reader to Captain R. Strachey's paper "on the geology of part of the Himalaya mountains,"* for the mountains south-east of the Sutlej.

74. Having crossed the Ser and Mer Parallel, we find ourselves in the great trough between this chain and that of the Kailas peak (which I shall call for convenience sake the Kailas chain) and we may hardly call this trough a valley, considering that it is a plateau from 10 to 12,000 feet high above the level of the sea; and yet it is a valley between the two great parallels which tower over it by some 10,000 feet more. It comprises the districts of Deosai, Soroo and Drass, Ladak proper, Zanskar, Rukshu and in the S. E. the great plateau of Tibet through which runs the Sutlej and inhabited by the Hundes. This last or south-eastern portion of the trough is toler-

* Proceedings of the Geological Society of London, June, 1851.

ably flat, only a small volcanic peak rising here and there, detached and isolated, through the thick horizontal bone-beds of sandstone and conglomerate which fill up the valley.* But in the other districts, the trough is nearly entirely filled up by vast mountains, which occupy in the parallel valley of Ladak the same position as the catenated chains we have described in Kashmir do in the parallel valley of Kashmir; the chain formed by these mountains has been called by Colonel Cunningham the "Tso Moreri" chain, and has been raised to the position of one of the great parallel chains of the Himalaya, but it will best suit our purpose to consider it as an interparallel mass of mountains.

Deosai has been described already. Drass and Kurghyl are covered with volcanic rocks into which the granite of Deosai gradually passes. Mr. Drew tells me that he found near Kurgyl a rock composed exclusively of mica and felspar, graduating into granite. Some specimens I possess from Tashgam, half way between Drass and Kurgyl, are composed of a dark green hornblende which fuses with difficulty and swelling a little before the blow-pipe. Felspar is not conspicuous, but is probably intimately combined with the hornblende. But rocks undoubtedly volcanic are also seen, such as greenstone and amygdaloid. A considerable bed of limestone reposes on the volcanic rocks and appears to be the continuation of the bed seen near Drass. I do not know the age of this limestone. The Drass bed contains fossils which are, I believe, carboniferous, and I have coloured the bed now under consideration, carboniferous, assuming the continuity of the two beds to be true.

Of the mass of hills traversed by the road from Kurgyl to Le I know very little indeed. They are said to consist mostly of slaty rocks capped here and there by conglomerates and grits.

As we near the valley of the Indus in Ladak proper, near the village Kulsi, interesting beds appear. Resting on a hornblende rock or trap is a series of slate, light-coloured limestone, conglomerate with rolled boulders of the same limestone, sandstone, shales and dark purple indicated clays. The dip is not very great and the several beds appear to conform together. The whole valley of the

* Proceedings of the Geological Society of London, page 306.

Upper Indus from Kulsi to Nodmo (and probably further east) appears to be excavated in this formation and the river flows in a fault of it or more probably in the centre of a denuded anticlinal.* The series of rocks (series of Upper Indus Valley) rest, on the North, against the granite of the Kilas Range. Captain G. Austen, to whom I owe these details, estimates it to be at least 3,000 feet thick, and mentions also its appearance in Rodok at the North of the Pang Kong Cho, resting there unconformably on slate. In the limestone layer of this series (about 150 feet thick or more) Captain Austen found a few fossils which he was kind enough to show me. They were very ill-preserved and fragmentary, but appeared to resemble some forms found in the Kothair bed in Kashmir; some cyathophyllides are certainly not to be distinguished from those represented at figures 56 and 57, Plate VII. Another fossil was supposed to be the radical end of a Calamite. To complicate matters, the fossils were declared by palæontologists at home to be *cretaceous.* The specimens are so bad, that I apprehend that this determination must have rested entirely on the *one* fossil which I took for a Calamite, and which was regarded, I suppose, as a Hippurite. My own impression is, that the limestone is identical with the Kothair bed of Kashmir, and therefore either the uppermost layer of the carboniferous or perhaps the lowest of the Triassic.

Above this Upper Indus series come the nearly horizontal grits and coarse sandstones which form the flats called in Ladak Chang Tang and Rang. The non-conformity between the Indus Series and the Chang Tang beds is not conspicuous, as that dips at a very low angle and these are nearly horizontal. There is also, I believe, a great similarity of lithological character between the two formations, one being merely the resettlement of the other. I conceive that some difficulty may be experienced occasionally to decide where one formation ends and the other begins. A few mammalian bones have been found in the Chang-tang sandstone, and there is but little doubt that this bed is similar to the sandstone and conglomerate of the Great Thibet plateau to the north of the Niti Pass. These high horizontal plateaux of conglomerate and sandstone are also observed

* A very great number of rivers in the Himalaya run part of their course in the centre of a denuded anticlinal.

in the Afghan mountains, where they are called in Pooshtoo Ragzhie. I have examined some of these ragzhies, of which the plateau of Rushmuk in Waziristan is a good example at an elevation of 7,000 feet, and I feel satisfied of their fluvio-lacustrine origin and of their age being posterior to the final upheaval of the Himalaya and Afghan mountains.*

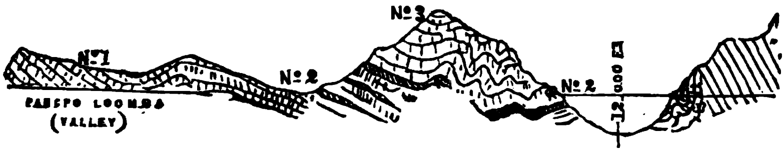
Zaskar and Rukshu or Rupshu are interesting districts, on account of their lakes, numerous hot springs and borax mines. The country is an elevated labyrinth of mountains and valleys, having a mean height of 15,600 feet. The principal peaks are the Korsok Too (above 20,000 feet) and the Napko Gondo ; but there are great many other nameless peaks ; the passes are all a good deal above 17,000 feet. In Zaskar we find a great mass of gneiss and schist which appears to be the eastern extension of similar rocks which begin in Sūrū, and, after entering largely in the formation of the mountains of the highland of Zaskar, are prolonged eastward into Rukshu, where they graduate into beds of metamorphic slate on which rest fossiliferous rocks. The gneiss, schist, slate and limestone are all stratified and conformable together, and they all dip towards the S. S. W. The limestone appears to be the continuation of the bed of limestone seen in Sūru reposing on the gneiss and schist of the foot of the Ser and Mer peaks.

The occurrence of fossils in Rukshu had been noticed by several travellers, but little was satisfactorily known, and to Captain G. Austen is therefore due the credit of having first brought trustworthy fossils from Rukshu, and to him I am indebted for the following details :—

Two of the valleys of Rukshu are the Tso Moreri valley and the Pang-po-loomba ; they are separated one from the other by the ridge of the Korsok Tso, composed of granitoid rocks and of gneiss and schist. From the Pang-po-loomba (valley) one passes into the valley of the Tsa Rup (river) by the Pang-po-la (pass), towards Zaskar. This Pang-po-loomba (valley) and Pang-po-la (pass) are the localities where fossiliferous beds have been noticed. The

* Col. R. Strachey appears inclined to regard these horizontal beds of the Great Thibet plateau as contemporary of the Siwalik hills and a sea-formation. I believe that both hypotheses are untenable.

whole bottom of the valley is uneven and its southern portion is formed by beds of limestone in which both Captain Austen and Mr. Marcadieu found carboniferous fossils (No. 1.) At the foot of the Pang-po-la the carboniferous becomes covered by a muddy sandstone (No. 2) which is, however, not seen in situ on the northern slope of



Section across the Pang-po-loomba (valley) and Pang-po-la (pass) in Rakshu from a sketch by Captain Godwin Austen (approximate).

the Pang Po, but of which numerous debris fill the ravines. Above this sandstone is found Jurassic limestone (No. 3), all the way to the top of the pass, full of Belemnites, Ammonites, Rhynchonellæ and Terebratulæ. One of the Rhynchonellæ collected there by Captain Austen appears identical with a form very common in the middle Oolite of Sheikh Bodeen in the Punjab.

Having crossed the top of the pass and descending towards the Tsa Rup (river), the same bed of muddy sandstone (apparently) again crops out. It is there interbedded with thin beds of impure limestone, and in these beds were discovered a great many Belemnites in fine state of preservation. Mr. R. A. C. Austen, to whom the fossils of these parts were forwarded, pronounced some of them to be *Liassic*, but I do not know whether these liassic forms came from the muddy sandstone bed or from beds inferior to it.

On the other side of the valley of the Tsa Rup, some beds of limestone, much folded and bent, again appear, but they showed no fossils and their age is therefore unknown ; they rest against beds of slate much up-tilted and apparently unconformable to the limestone. At the back of the slate is the great mass of the Ser and Mer chain, attaining immense height and crossed by passes above 16,500 feet high.

75. The Tso Moreri is the largest of many salt lakes which form one of the features of Rukshu. It is 14 miles long and more than 15,000 feet above the sea. Its water is very salt and bitter, though Mr. Marcadieu affirms that it contains only one part of saline matter

in 10,000 parts of water; the saline matter is sulphate of soda and sulphate of lime. Another lake, the Karso-Talao, about 6 miles long, is reported by the same gentleman to contain a great deal of chloride of sodium and sulphate of soda, with a little carbonate of lime and carbonate of soda. These two lakes are said to be surrounded by mountains of crystalline rocks, principally mica-schists and granite. But one of the most interesting subjects connected with the geology of Rukshu is the existence of borax in the valley of Puga. The manner in which it occurs as an efflorescence is too well known to require description here, but one cannot but regret that Mr. Marcadieu's report is not more geological; indeed it can only be regarded as chemical, and the geology of the district is still a work to be done. I have never visited Puga, but, from the several descriptions of it I have read, I am satisfied that the borax ground is the bottom of a dried up lake. The analysis of impure borax collected at Puga shows it to contain, besides borax, sulphate of soda, sulphate of lime, chloride of sodium and carbonate of soda. These impurities are precisely the composition of the Kullur salt of the plains of the Punjab and of the saline matter of many hot springs and salt lakes of the Himalaya and the Salt Range, and it appears to me evident enough that the lacustrine mud which fills up the bottom of the Puga valley, is similar to the alluvial deposit of the Punjab. Boracic acid, which probably once rose freely to the surface of a small lake and was deposited in an uncombined state, is now arrested by the bed of lacustrine mud which fills up the fumarole and combines with some of the salts of soda. It appears therefore much to be regretted that an attempt was not made to estimate the thickness of the lacustrine deposit and that a few wells were not sunk into the borax ground and the waters and gases which might have been collected in these wells carefully examined; possibly such researches and experiments might have led the way to an increase of the present supply, and to a system of collecting the borax or boracic acid sufficiently pure not to require refining.

76. In Ladak, Rukshu, Sooroo and Zaskar, no fossils were ever found, as far as I know, older than those of the carboniferous formation. But if we follow the great valley, between the Kailas Range and the Ser and Mer chain towards the S. E. we find, on the other

side of the Sutlej, great beds of limestone rich in Silurian fossils.* Mr. Salter has recognized the following genera among Captain Strachey's fossils :—

Cheirúrus.	Strophomena.	Cyrtoceras.	Chœtetes.
Lichas.	Orthis.	Litnites.	Crinoid Stems, &c.
Asaphus.	Leptœna.	Tentaculites.	
Calymène.	Lingula.	Murchisonia.	
Illœnus.	Orthoceras.	Ptilodictya.	

Mr. Salter, M. Barrande and M. de Verneuil, who saw some of the fossils collected by Colonel Strachey, agree that they indicate beds of Lower Silurian. We shall see that beds of Silurian also exists in the huge mountains to the north of Skardo and near the Mustak Pass in the Korakoram chain.

But let us first relate what Colonel R. Strachey found in the high ranges south of the Sutlej.

The Silurian above mentioned rests on beds of slate without fossils, and this slate rests on schists, mica-schists and other rocks of the metamorphic group. Then above the Silurian limestone, some beds of carboniferous must exist, though they were not found in situ by the explorer ; *Producti*, *Athyris Royssii* and other well known fossils were found in loose boulders near the Niti Pass. I believe also that some of the shells placed by Colonel Strachey and Mr. Salter in other groups belong really to the carboniferous ; such is the *Chonetes* placed by Colonel Strachey in the Mushelkalk, but transferred to the carboniferous by Mr. Salter ; the *Ptilodictya Fenea* (Salter), the narrow variety, which I have found in carboniferous beds in Kashmir ; (it was naturally placed with the Silurian fossils by Mr Salter, on account of the *Ptilodictya* having been found as yet only in Silurian beds in Europe and America) ; the *Spirifer Stracheyii*, (Salter) placed among the Triassic fossils by Mr. Salter, and which is common enough in the Weean bed of carboniferous limestone in Kashmir ; and lastly the *Spirifer Rajah* (*Spir. Keilhavii*,

* On the geology of part of the Himalaya and Tibet, by Capt. R. Strachey, Bengal Engineers, F. G. S. in Proceedings Geological Society for June 1851, also "Palæontology of Niti in the Northern Himalaya, being descriptions and figures of the Palæozoi and Secondary fossils collected by Colonel R. Strachey R. E." "Descriptions by T. W. Salter, F. G. S., A. L. S. and H. T. Blanford, A. R. S. M., F. G. S.—Calcutta 1865."

Von Buch), which has been removed from the Trias by Dr. Oldham, and declared to belong to beds anterior to that epoch.

There is therefore a strong probability that both the Zeeawan bed (*Productus semireticulatus*, *Athyris Royssii* &c.) and the Weean bed (*Spir.* f. *Stracheyii*, *Spir. Keilhavii*) exist in the ranges near the Niti Pass, but have been much denuded and broken in loose fragments along the section followed by Colonel R. Strachey.

Then comes what Colonel Strachey supposed to be Muschelkalk, and which Mr. Salter refers to the Keuper and Hallstadt bed of the Upper Trias. I cannot refrain from expressing a suspicion that a few of the shells referred to these beds do not really belong to them, and that fossils of various ages have been mixed, either from collecting them, without due care being paid to the strata in which they were respectively found, or from careless packing. There is such a great likeness between the figures of some of the Triassic Ammonites of Mr. Salter and those of the carboniferous ceratites of M. DeKoninck,* (see *Ammonites Blanfordii*, Salter, nov. sp. and *Ceratites Lyellianus*, Dekon. nov. sp.) that one finds it difficult to decide between these two great authorities. The species of ammonites figured in the Palæontology of Niti have nearly all the ceratite-like sutures usual in triassic ammonites in Europe, and therefore much resemble deKoninck's ceratites.

It may be advanced, on the other side, that M. DeKoninck's ceratites belong to triassic beds; but these ceratites are to be seen in the Rotta Roh associated to some of the fossils which I have given as characteristic of my Weean bed of the carboniferous in Kashmir and the Punjab; and a portion at least of this Weean bed would have then to be made over to the Trias. Unfortunately for this view, the mixture of Weean and Zeeawan fossils in some layers of the Rottah Roh (described in para. 60 of this paper), does not allow us to make the Weean anything but carboniferous, unless we are prepared to regard the *Prod. semi-reticulatus*, the *A. Royssii*, the *A. Subtilita* and other such essentially

* "Description of some fossils from India, discovered by Dr. A. Fleming, of Edinburgh." By Dr. L. de Koninck, F. M. C. S., Professor of Chemistry and Geology in the University of Liege—Journal Geological Society of London, Vol. XIX. p. 1.

carboniferous fossils as occasional inhabitants of the Trias!!! If we are prepared to stretch the point so far, we may as well give up at once all idea of successive faunæ.

I have, since writing the above, found in the Rottah Roh, some beds containing a few fossils which appear Permian. I have not yet had time to examine the fossils with care; but should they prove Permian or Saliferian (St. Cassian),—and I have little doubt that they will be found to belong to either one or the other of these formations,—the presence of patches of such a bed on the top of the carboniferous would explain away, in a great measure, the difficulties I have now been considering.

I have said before that I believe the Saliferian of Upper India to belong to the Paikilitic formation, but that it has been found impossible as yet to *demonstrate* that such is the case. The discovery of one or two fossils may settle the question, if they were forms thoroughly well known as characteristic of the Indian Trias. The study of the fossiliferous Triassic beds in India is therefore of the greatest interest; but much care is required lest the mixture of Palæozoic and secondary types should take place in our packing boxes and not in nature, and we thus become accustomed to regard, as characteristic of the Trias, shells which really belong either to the carboniferous, or to the Lias and Oolite.

To Colonel R. Strachey, however, is due the honor of having first discovered fossiliferous Triassic beds in the Himalaya; and we may hope that much light will be thrown on the Indian fossils of that age by Dr. Stoliczka, in his expected work on the Geology of Spiti.

Over the beds last described, Colonel Strachey found Jurassic beds; but the relation between the Triassic and Jurassic beds could not be ascertained, owing to a great fault running parallel to the general N. W.—S. E. direction of the Himalayan ranges. The section exposed by this great fault is at least 5,000 or 6,000 feet in thickness, but the difficulties of the route prevented Colonel Strachey from examining it from top to bottom; the lowest beds were not examined. The *lowest which were examined* gave forms which Professor E. Forbes was inclined to identify with fossils which occur in the fuller's earth and cornbrash of England. No Liassic forms were discovered.

These inferior oolitic beds are capped by dark coloured shales containing belemnites and ammonites, and referred by Professor E. Forbes to the age of the Oxford clay. These shales are therefore the representatives of the several Jurassic beds we have already seen in several parts of the Himalaya and of the Punjab.

The oolitic beds are covered by grits, shales and limestone of unknown age, and finally by the great horizontal bed of what Colonel Strachey considers to be miocene (Siwalik) sandstones and conglomerates. I have said before that the identity of these sandstones, grits and conglomerates to the Siwalik formation is far from established, and that there are more reasons for considering them pleistocene, than for assuming them to be coeval with the deposition of the Sub-Himalayan tertiaries.

77. The Kilas Chain is of less elevation than the Ser and Mer, and its peaks are neither so numerous, nor so well known or so remarkable for their enormous mantles of snow. The principal summit is the Kailas (or Tise) peak, which rises to 22,000 feet above the sea, in longitude 81° 18′, and is therefore far to the S. E. of our Western Himalaya. As it is, however, the only well known peak of the Chain, I have called the whole chain from its name.

The Kilas chain begins near Mount Haramash, N. of Astor and N. W. of Baltistan, and is traversed near Skardo by the Shigar river which cuts a passage across the range. The summit, Mashkulla, (16,919) towers over the alluvial plain of Skardo, Shigar and Kuardo. This mountain is mostly granite ; its spurs show a great deal of metamorphic slate at a high angle of dip ; and the little hill close to Skardo, evidently an off-shoot of the Mashkulla, is composed of an imperfect shist. All along the left bank of the Shigar river, schists of various sorts, especially mica-schists, and micaceous slates, together with metamorphic marbles, form the great wall of mountains that bound the Shigar valley to the N. E. Following the road which leads from Shigar to the Thale valley, by the Thalé la (pass) Captain G. Austen discovered some beds of limestone, resting on the mica-slate, and I have coloured that bed of limestone Silurian in the Map. My reason for believing it to be Silurian is its proximity to limestone beds of similar appearance and position at the Mashabroom, and there, I believe, decidedly Silurian ; and also the fact that the discoverer of the bed found there a few fragments of fossils which he regarded as Palæeozoic, though different from any of the carboniferous forms which we found together in Kashmir. There is therefore presumption that this bed is Silurian, though of course it is merely a presumption. I have also assumed that a bed of limestone, seen to the South of Skardo, between that town and the Deosai (plain), is Silurian. We shall see the bed discovered at the Mashabroom, when we describe the Karakoram Chain.

From Skardo towards the S. E., the Kilas Chain appears to be nothing but a great granitic wall, along the foot of which runs the Indus. Near Lé in Ladak the range is crossed by the Digor La (pass), the road going through a succession of granitic rocks.

78. Between the Kilas and Karakoram Chains, we find the rugged district of northern Baltistan, the valleys of Saltoro, Nubra Shayokh and the Chinese province of Rodok. In the country of the Baltis, the Kilas and Korakoram Chains approach each other to within about 45 miles, as the crow flies, from range to range; whilst on the contrary the chains diverge as we proceed towards the S. E., the Korakoram chain having apparently a less southward direction that the other parallels of the Himalaya. In northern Baltistan, consequently, we find the country covered with mountains, cut with deep narrow valleys and mantled with immense glaciers;* in Radok on the contrary high plateaux are abundant, and form to the north of the Pang Chong Tso (lake) and Pang Chong La (pass) considerable plains, 14,000 to 15,000 feet above the sea, arid and rainless, often not presenting a shrub for several marches; high deserts on which roam a thin population of nomade Turkomans who graze shawl-wool goats on the scarce and far-between Aghil or grassy vales of these inhospitable regions.

There is no doubt that these high plateaux are similar in origin, age, and appearance to the great Thibet plateau through which runs the Sutlej, to the north of the Niti pass, and described by Colonel R. Strachey; and also to the Chang Tang and Rong plateaux of Ladak. All these high plateaux present a horizontal stratification;

* "On the Glaciers of the Mustakh Range," by Captain H. G. Austen, F. R. G. S., &c., read before the Royal Geographical Society, London, on the 11th January, 1864.

and it appears therefore impossible to regard them otherwise than as accumulations of debris washed from the ranges into the great troughs between these ranges, and therefore posterior to the great final upheaval of the Himalayas.

Very little is known of the nature of the rocks forming the ridges, ranges and spurs in Saltoro, Nuha and Shayokh. Dr. Thomson,* on native information (Izzet Ullah), tells us that the rocks of the Shayokh and Nuha valleys are in great part primitive limestone. " The limestone continues towards Rodok and the water of the Pang Gong Tso (lake) hold a sufficient quantity of lime to form a calcareous deposit which cements the pebbles together in patches of concrete at the bottom of the lake." The water of the Pang Chong Tso is sufficiently brackish not to be fit for drink, and it has a bitterness probably due to sulphates of Soda and of Magnesia. From the examination of a specimen of the calcacerous incrustation which is formed on the shore of the lake, I found that Magnesia is about as abundant as lime.

An extremely pretty species of Limnea or rather Physa once lived in the lake, and dead shells of it are abundantly found in the band of tufaceous deposit, a few feet above the present level of the water. These shells no longer exist in the lake (Austen). They have probably been destroyed by the diminution and concentration of the brackish water.

General Cunningham informs us† that the rocks of all the high ranges and peaks of Rodok are granite and gneiss, and this appears to be highly probable. Metamorphic rocks also abound; the mountains near the Pang Chong Tso containing a great deal of mica-schists; and crystalline marble is also found on the shore of the lake, apparently in immediate contact with granitoid rocks.

In the northern portion of Rodok some hot springs exist in a locality called Chong Chin Mo; there water deposits largely a grey tufa which is composed of carbonate of lime, sulphate of lime and sulphate of soda. Such tufa is common near the warm springs of the saliferian in the Punjab. Its composition is also that of the saline impurities of the brackish lake of Tso Moreri in Rukshu, and

* "Ladak," by General Cunningham, R. E.
† "Ladak," by General Cunningham, R. E.

of the efflorescence which accompanies the borax at Puga. From the extensive beds of gypsum and impure salt found in Rukshu, little doubt can be entertained that the saliferian is there well developed, and by analogy it is to be presumed that the same formation is also to be seen in Rodok. Borax is said to be exported from Rodok in large clean crystals, but I do not know whence they are obtained; that it does come from Rodok appears however pretty certain; and that is another resemblance with Rukshu, and another reason for believing that the saliferian is probably well developed in Rodok, and is there accompanied by hot springs and fumaroles exhaling boracic acid.

I have never seen any fossil which had been brought from Rodok, Shayokh or Nuba; it is impossible therefore to say to what age belong the beds of limestone mentioned by Dr. Thomson. The beds are called "primitive limestone;" but as Jacquemont, Vigne, Thomson and others speak sometimes of fossiliferous limestone (such as the Manus Bal limestone in Kashmir) as "primitive," it is difficult to know for certain what is meant by that somewhat antiquated term.

79. The Korakoram Chain is a range of very great extent, beginning at the Pamer Steppes and reaching to the S. E. as far as the centre of Thibet in longitude E. 94° and as low as latitude N. 30°. The plateau near its south-western slope is from 15,000 to 17,000 feet high, and is an arid tract of horizontal alluvian covered with loose stones and supporting very little vegetation; more to the north it is a labyrinth of wild valleys. Near the Mashabroom mountain (above 26,000 feet) the soil of the valleys between the spurs is to a great extent covered by glaciers; where not so covered, it is often an indurated clay strewed with debris of pale limestone a good deal worn and weathered, and with globular cystideæ in very great abundance. Mr. Ryall, of the Great Trigonometrical Survey, gave me one of the pieces of limestone and some of the fossils. The limestone is an argillaceous dolomitic limestone, pale yellowish brown, with a few patches pale blue, weathering like frosted glass, and resembling a good deal of the rocks of the Weean and Kothair groups of carboniferous limestone. The *sphæronites*, however, point to a silurian epoch, these echinoderms having not been found as yet in formations posterior to the Wenlock limestone.

The *sphæronites* of the Mashabroom are probably a new species; they were found in considerable variety, from the size of a small walnut to that of a large orange; the largest were perfectly round and polished like a cricket ball, without warts, spines or facettes, pierced by numerous pores. Some of the smaller have the stems scarcely visible (fig. 6, Pl. VIII), and are covered either with large tracts set well apart or with smaller ones set closer; some spines are depressed or lenticular; all are pierced by innumerable pores, none shows traces of polygonal plates; mouth not to be seen in any of the specimens I have examined. (See figs. 5, and 6, pl. VIII and plate IX fig. 1.) The discoverer, not being a geologist, did not look for other fossils: the cystideæ were so numerous and so curious in appearance, that they gave quite a peculiar aspect to the ground.

The Mashabroom is stratified to its very summit, the beds being limestone and shales, dipping towards the S., at a moderate angle. This stratification is so well marked, that it can be distinctly noticed from a long way off. These sedimentary beds repose on metamorphic layers of mica-schist and gneiss. The limestone is extremely rich in magnesia, principally towards the base of the bed, where it passes into Steatite in patches (Austen). Some of the Serpentine and Jade (compact Tremolite) brought to Srinuggur and there worked into ornamental articles by the stone-cutters of that city, come, I believe, from the neighbourhood of the Mustak Range and of Mashabroom, though the greater quantity is supposed to be derived from the Yarkandkass valley and the Kuen-Luen Chain in Khotan. There can be little doubt that the limestone of the Mashabroom is the parent bed of the cystideæ found in the valley between two of the spurs of that mountain; and at least a portion of the limestone of Mashabroom is Silurian,

The following sketch-section embodies the information kindly given me by Mr. Ryall and Captain G. Austen.

Approximate vertical Section of the Masha Brum mountain, one of the great summits of the Korakoram Chain, from S. to N. bearing W.

1, granite; 2, gneiss and mica-schist; 3, sandy shales and coarse slate without fossils; 4, pale dolomitic limestone containing patches of Steatite; 5, pale ochre-coloured limestone, the probable parent rock of the Sphæronites found at the foot of the mountain.

To the north of the great glacier Baltoro is that portion of the Korakoram Range known as the Mustakh and crossed by the Mustakh Pass at an elevation of 18,400 feet. The whole S. Western face of this Mustakh is covered by enormous glaciers through which the rocky spurs of the mountains rise like islands and promontories. These rocks Captain Godwin-Austen found to be limestone dipping to the N. E., but he failed to find fossils in it, though he noticed traces and fragments of organisms. It is so very probable that these beds are a continuation of the limestone of the Masha Brum, that I have not hesitated to colour them in the map as Silurian. Of course, this requires confirmation. Unfortunately the difficulties of reaching even the foot of these gigantic mountains are nearly insurmountable.

80. I could not get any information on the nature of the rocks forming the remainder of the Korakoram Chain. The few European travellers who ever saw the chain, agree, I believe, in representing it as being mostly composed of granite.

On the other side of the chain we find, between it and the next parallel, *viz.* the Kuen-Luen Chain, the valley of the Yarkandkash (river), which extends from the Korakoram or Yarkand pass to Tashgurkhan, and the Akzai Chin or White Desert, which is continued towards the S. E., nobody knows how far. The valley of the Yarkand river and the Akzai Chin are separated one from the other by a low ridge of mountains similar to the masses of mountains found between the other great chains of the Himalaya. All we know of the valley of the Yarkandkash is that some mines of rock-salt occur there, and that both in the beds of the Yarkandkash and Karakash and in the the ravines of the neighbourhood, some pebbles are collected and used for cheap jewellery; and these pebbles are either quartzy stones or rocks decidedly volcanic. There is apparently some analogy between these mountains and those of the centre of Rupshu and of Ladak. The Akzai plain is also very similar to the countries just mentioned, in at least the one character of being an elevated, rainless desert, spotted with small lakes, some fresh, and others salt.

It is superfluous to say that I know nothing of the Geology of the Yarkandkash and Karakash valleys and of the Aksai Chin; neither is there anything known of the formation of the Kuen Luen or Piryukh Chain, except that it is reported to contain valuable copper and gold mines. Another small chain or range, half way between the Kuen Luen and Yarkand seems to be the last parallel of the Himalaya. Yarkand is supposed to be in latitude N. 38° and about 5000 feet above the sea. From the top of the Korakoram pass to the foot of the hills, the distance is approximately 110 miles, and the descent 13,000 feet or about 118 feet per mile, a mild slope for a mountainous country.

(To be continued.)

Contributions to Indian Malacology, No. VIII. List of Estuary shells collected in the delta of the IRAWADY, *in* PEGU, *with descriptions of the new species. By* WILLIAM T. BLANFORD, *A. R. S. M., F. G. S., Cor. Mem. Z. S. &c.*

[Received 14th November, 1866.]

A short visit to Calcutta, and access to various works on conchology which have, for some years past, been beyond my reach, have enabled me to prepare the following list of the species of mollusca collected by me in the Pegu delta during the early portion of 1862. In March and April of that year, whilst engaged in the Geological Survey of the country south of Bassein, I was compelled to traverse the network of creeks which intersect the Irawaddy delta in every direction, and, in so doing, I had many opportunities of searching for the various mollusca inhabiting the channels of brackish and salt water.

The western portion of the Irawady delta south of Bassein is of peculiar character. Instead of the endless alluvial flat which is usually alone met with near the mouth of large rivers, the country is frequently undulating, and even, in places, hilly; the hills being surrounded by plains of alluvial soil intersected by tidal channels. Rock not unfrequently occurs in these creeks, and affords a habitat for many mollusca which are not met with in the usual muddy flats.

The Bassein river itself, one of the numerous mouths of the Irawady, like the Mutlah and other great channels of the Ganges delta, is at present rather an arm of the sea than a river; as it receives no fresh water directly from the Irawady except during the height of the rains. In the cold weather the water is perfectly salt for many miles above the mouth, and marine animals abound. Thus for many days, during the time I was traversing the neighbourhood, the water swarmed with *Medusæ*. The volume of fresh water which pours into the Bassein river can at no time be very large, for the mollusca which inhabit the southern side of Negrais Island, some distance within the mouth of the river, are typically marine, comprising species of *Parmophorus*, *Triforis*, *Trochus*, *Chama*, &c., and not including any of the usual estuary forms *Assiminia*, *Amphibola*, *Neritina*, &c., whilst at Poorian Point and Pagoda Point, the two headlands which form the entrance to the Bassein river, precisely the same mollusca occur as along the Arakan coast near Cape Negrais.* At the mouths of those channels by which the mass of fresh water poured down by the Irawady reaches the sea, I do not think that any typically marine animals are met with, nor could they exist, for, in the height of the rains, I have found the water outside the mouth of the Rangoon river perfectly fresh and drinkable, and yet this is only a minor channel compared to the Chinabuckeer and the neighbouring branches, down which the great bulk of the water pours.

To the greater saltness of the Bassein river I attribute the presence of the numerous marine types mentioned in the following list. It will be seen that a few distinctly marine species were met with; the number, however, was small. There are also in the list two or three genera, forms of which do not appear to have been hitherto found in estuaries, *e. g. Tectura, Sphenia, Scalaria;* whilst, on the other hand, the genus *Scaphula* had previously only been met with in fresh water.

The fauna and flora of the Irawady delta appear to be twofold.† Farther from the sea, where the water is more or less brackish, the creeks are mostly narrow and deep, with steep banks, which are covered at high water, and bordered by an unbroken belt of salt swamp, in which grow high trees, chiefly of *Bruguieria gymnorhiza?* The views along the creeks, with their borders of dense high forest, are often of great beauty. This belt of salt swamp and high trees varies much in breadth, from a few yards to half a mile or more; inside it are either open plains, which, if uncultivated, are covered with high grass, or else rises, usually of gravel, occasionally of rock, which are covered with jungle.

The mollusks of this tract comprise *Neritina depressa, N. obtusa* and *N. Smithii;* the species of *Tectura, Modiola, Martesia* and *Sphenia* named in the following list are met with wherever rocks occur; *Scaphula* is found under stones, *Auricula* and *Cyrena* inhabit the salt swamp. *Teredo* perforates the dead trees. *Neritina cornucopia* is principally met with in this region, but is also found lower down the

* Amongst others, I found species of *Dolium, Ricinula, Ranella,* &c.

† I regret that my want of knowledge of botany and the paucity of the observations I was able to make upon the zoology, prevent me from entering fully into this subject. I can merely point out the fact that a distinction exists between the fauna and flora of the delta nearer to the coast, and that found further inland, and illustrate it in the single instance of the mollusca.

estuaries : *Littorina melanostoma* also occasionally occurs, but its home is nearer the sea.

Lower down where the creeks are broader, the belt of salt swamp is narrower in general, and a broad shelving muddy shore succeeds, the upper portion covered by a thick forest of *Avicensia*, while lower down *Nipa* palms frequently occur. The beauty of the wide creeks is greatly enhanced by the broad fringe of the bright green *Avicensia*, over the tops of which the summits of hills, covered with dense green forest, are frequently visible.* On the sloping muddy shore species of *Potamides*, *Assiminia*, *Amphibola*, *Plecotrema*, *Haminea*, *Stenothyra*; *Arca granosa*, *Nassa planicostata*, and *Columbella Duclosiana* are to be met with. On the stems of the *Nipa* and on the mangrove bushes *Neritina crepidularia* and *N. cornucopia*, *Littorina melanostoma* and *L. scabra* are found in abundance.

I have only included in the present list those shells from the Bassein river which are found above Negrais Island, for the reasons already stated. I regret that the list is not more perfect, and that I am obliged to leave a few specimens undetermined. On the other hand the majority have been carefully compared, and the names quoted may, I think, in most cases, be relied upon. Immediately after leaving Pegu, I was in England for a few months; and owing to the kindness of the late Mr. S. P. Woodward, of Mr. Arthur Adams, and especially of the late Mr. Hugh Cuming, who allowed me to compare my shells with the original types in his unrivalled cabinet, I was enabled to determine, not merely my estuary collections, but also a much more numerous series of marine species from the Arakan coast, in a manner which would have been simply impossible in India.

Unfortunately, during the years which have elapsed since these shells were compared, a few have been mislaid or lost during constant travelling in various parts of India. Still I hope that this list may have some value as a contribution to our knowledge both of the geographical distribution and of the habitats of mollusca. Several of the species named, and some of the genera have, so far as I am aware, never before

* So great is the height of the trees fringing the upper creeks, and so completely do they shut out all the surrounding country, that I was working amongst them for several days in ignorance of the existence of hills nearly 1000 feet high within 15 or 20 miles of me.

been shewn to inhabit the estuaries of India or Burma. Our estuary lists have hitherto been almost as imperfect as our catalogues of marine species; almost all that is known of the molluscan inhabitants of our deltas being due to the labours of Mr. Benson, who has described many of the forms found in the Ganges.

It is, of course, highly improbable that the present list is nearly complete. Only a very small portion of the Irawadi delta was examined, and that imperfectly. Still the number of species is considerable, and probably includes all those which are most abundant. A few forms since found by Mr. Theobald and Mr. Fedden will be noted in their place.

The classification employed is mainly that of Messrs. H. and A. Adams, in the Genera of Recent Mollusca. I have not, however, followed those authors in employing the obscure and forgotten generic terms of Klein, Montfort and others I have only deviated from their arrangement in one essential particular, viz., the transfer of *Assiminia* from the vicinity of *Helix*, from which it differs in every point of structure, to that of *Littorina*, to which it is closely allied. If it be objected that *Assiminia* is as closely related to *Cyclostoma* as it is to *Littorina*, I can only suggest that *Cyclostoma* be also relegated to the same position in the neighbourhood of *Littorina*.

Class GASTEROPODA.

Sub-class PROSOBRANCHIATA.

Family BUCCINIDÆ.

No. 1, **Nassa planicostata,** A. Adams.

Estuary of the Bassein river, creeping upon mud between tidemarks. Scarce.

No. 2, **Purpura bituberculoris,** Lam.

Not common. Found in the lower part of the delta, with the next species.

Family MITRIDÆ.

No. 3, **Columbella Ducloziana,** Sow.

Found in abundance at one spot in the estuary of the Bassein river, amongst stones with mud. The specimens were unusually fine. I also met with this shell on the mud flats of Ramri Island, coast of Arakan.

Family SCALARIADÆ (*Scalidæ*, H. and A. Adams.)

No. 4, **Scalaria,** sp.

A minute species, apparently new. As I possess but a solitary specimen, which is not in the best possible order, I hesitate to describe it. It is one of the smallest forms known, measuring only 3 millimetres in length. It was found under stones in the Myittaya creek.

Family CERITHIIDÆ.

No. 5, **Cerithium (Vertagus) obeliscus,** Born.

A single specimen was found at Port Dalhousie.

No. 6, **Potamides (Tympanotonos) alatus,** Phil.

No. 7, **Potamides (Tympanotonos) euriptera,** A. Ad.

Both this and the last species are met with abundantly on mud between tide marks, not far from the sea. They also occur on the sea coast where it is muddy.

No. 8, **Potamides (Telescopium) fuscus,** Chemn.

Common on mud between tidemarks, where the water is completely salt.

Besides the above, a species of *Cerithidea* has been found by Mr. Theobald in the estuaries of Burma. I did not meet with it.

Family LITTORINIDÆ.

No. 9, **Littorina melanostoma,** Gray.

Very abundant upon "mangrove" trees, close to high water mark.

No. 10, **L. scabra, L.**

Occurs with the last, which appears to pass into it. Two varieties of this form occur, one more coarsely sculptured and more stoutly keeled than the other.

No. 11, **L. zic-zac,** Chemn.

Syn. *L. undulata*, Gray.

This species is frequently found on the sea coast, especially near mouths of rivers. In the estuary of the Bassein river, it occurs together with true estuarine forms. It is met with on stones and dead wood, close to high water mark.

Family ASSIMINIIDÆ.

No. 12, **Assiminia rubella,** W. Blanf. pl. II. fig. 11. 12.

A small roundly ovate, dull red species, which occurs abundantly near Port Dalhousie, on mud between tidemarks. It is a characteristic *Assiminia*, though much shorter and rounder than the Bengal species *A. Francesiæ*, Gray, and belonging in fact to a different section of the genus. It is closely allied to some Singapore species and also to *A. marginata*, Leith, which inhabits Bombay, but may be distinguished from all by the double marginal impressed line below the suture.

The animal is deep red, with a black spot upon each of the lobes into which the proboscis is divided. The eyes are at the top of the short tentacles.

Family RISSOIDÆ.

IRAVADIA, n. g.

Testa imperforata, turrita, spiraliter costata, solida, epidermide tecta: apertura ovata, integra, antice obsolete effusa; peristomate recto, extus variciformi-incrassato, intus dilatato.

Animal? Operculum?

Shell imperforate, turrited, spirally ribbed, rather thick, covered with an epidermis. Aperture ovate, without a canal, slightly effuse in front; peristome straight, not sinuate, with an external varix, and slightly expanded within. Animal and operculum unknown.

No. 13, **Iravadia ornata,** n. sp. Pl. II. fig. 13. 14.

Testa turrita, decollata, subcylindrica, (junior elongato-conica), solida, spiraliter costata, inter costas confertim verticaliter costulata, sub epidermide olivaceâ vel ferrugineâ albida. Anfr. superst. 3-4, rotundati, superi tribus, penultimus quatuor, ultimus sex costis spiralibus ornati, hoc juxta aperturam paulo ascendente. Apertura sub-verticalis, elliptica, intus alba, (in testâ juniori postice angulata), antice subangulata et in testâ adultâ obsolete effusa, in juniori subcanaliculata; peristoma extus incrassatum, nodoso-variciforme, nodis costis spiralibus congruentibus, intus vix expansum. Operc.?

Long. $4\frac{1}{2}$, *diam.* $2\frac{1}{2}$ *mill.*

Shell turrited, decollated (the young shell elongately conical,) thick, spirally ridged, with close vertical costulation between the ridges, white, with a brownish or olive epidermis. Whorls apparently about 6, when perfect, but only 3 or 4 remain in all the specimens collected; body whorl with 6 spiral ribs, of which 4 only appear on the penultimate whorl, and 3 on the upper whorls, the lower ribs being concealed. On all the upper whorls the 2nd and 3rd ridges are the strongest. Those near the suture, both above and below, are less strongly marked, and are occasionally obsolete. On the last whorl the uppermost ridge near the suture is alone fainter than the others. The body whorl ascends a little towards the aperture, which is subvertical and nearly elliptical. The anterior canaliculation is obsolete in the adult, but it is well marked in the young shell. Peristome much thickened, externally variciform, the varix being nodose in consequence of the spiral ribs of the body whorl being continuous upon it. In young specimens the lip is grooved inside, the grooves corresponding to the external ribbing, and slight remains of this grooving may be traced in the adult shell.

I had at first classed this shell as a *Rissoina* on account of the obsolete canal, although it differs in essential characters from any species of that genus. I am indebted to my friend Dr. Stoliczka for calling my attention to the great distinctions which exist between the present form and *Rissoina*, and some of which equally serve to distinguish it from *Rissoa* and all other genera of the group. *Iravadia* differs from *Rissoina* in possessing an epidermis, in having spiral sculpture, in the peristome neither being sinuate above, nor projecting below, and in the columellar margin being simply curved in front and not excavated. From *Rissoa* it is distinguished also by its epidermis and sculpture, by the obsolete channel in front of the aperture, which, in young specimens, is quite as distinct as in *Rissoina*, and by the absence of any tendency to the columellar tooth or fold, which is so conspicuous in the typical species of the genus. The characters of the sculpture, epidermis, and aperture serve equally to separate the present form from *Alvania*, *Onoba*, *Ceratia* and other genera of *Rissoidæ* : *Hydrobia* and *Amnicola* alone have an epidermis, but both are smooth shells without a variciform peristome.

It is unfortunate that no specimen of the operculum has been preserved. The few shells found were collected during a hurried journey in a boat. The species was only met with at one spot, under stones, amongst some rocks in a creek leading into the Myittaya, a branch of the Bassein river. Several specimens were obtained, but when an opportunity was afforded of examining them at leisure, the opercula had disappeared. In the absence of the operculum, I should be disposed to consider the genus as more nearly allied to *Rissoina* than to any other, and such naturalists as may refuse generic rank to *Iravadia*, may perhaps best class it as a subgenus or section of that genus. It may have affinities with a curious species from Peru (*Rissoina sulcifera*, Trosc.) figured by Schwarz von Mohrenstern in his monograph of *Rissoina* in the Denksch. k. k. Akad. Wien, xix, 182, Taf. 10, fig. 83, and the differences between which and all other *Rissoinæ* are pointed out by that author.

The curious little shell dredged by Mr. A. Adams in the seas of Japan and described by him as *Vanesia sulcatina* in the Annals and Magazine of Natural History for 1861, Ser. 3, vol. viii, p. 242, may also possibly have some affinities with *Iravadia*.

No. 14, **Stenothyra monilifera,** Bens. Pl. II, fig. 15.

I found two specimens of this species at Port Dalhousie in the Bassein river. The type was first obtained by Mr. Theobald at Mergui and Rangoon, and the shell has since been found in Cochin China. As the species does not appear to have been figured, I add an illustration of it.

Family NERITINIDÆ.

No. 15, **Neritina Peguensis,** n. sp. Pl. I. fig. 1—16.

Testa globosa, oblique ovalis, solida, confertim oblique subsinuate rugata, interdum spinigera, epidermide fusco-olivaceâ, minute flavo-punctulatâ, aliquando maculis oblongis subcurvatis flavis infra suturam ornatâ, vel fasciis subobsoletis spiralibus circumdatâ, induta, sub epidermide cærulea vel rubella, albido-maculata. Spira vix exserta, plerumque erosa, sutura elevato-compressa. Anfr. circa 3, *superi planulato-concavi, ultimus superne ad suturam appressus, supra peripheriam aut carinatus, spinisque distantibus munitus, vel obsolete angulatus, subtus rotundatus. Apertura intus lactea ; peristoma semiovale, areâ columellari planulatâ, luteolâ v. sordide albidâ, minute denticulatâ, plicâ unicâ majori intrante supramedianâ munitâ, antice edentatâ. Operc. extus planum, albidum, margine externâ nigrâ, intus rubrum.*

Maj. diam. 19, *min.* 15, *alt.* 19 *mill. Hab. in rivulo ad Promontorium Negrais.*

Var. minor testâ magis rotundatâ, spinis omnino carentibus, fig. 13—16. *Maj. diam.* 14, *min.* 11, *alt.* 15 *mill.*

Hab. ad Portum Dalhousie.

Shell globose, obliquely oval, solid, closely obliquely and rather sinuously wrinkled, sometimes bearing spines, covered with a dark epidermis. Colour generally dark olive with minute yellow specks, occasionally with oblong splashes of yellow below the suture; these generally curve backwards, and are sometimes, but rarely, of large size. Some shells are surrounded more or less obsoletely with yellow bands. Beneath the epidermis the shell is pink or bluish spotted with white. Young specimens are frequently pink, with yellow specks, in front of each of which is a black streak like a shadow. The spire is barely exserted, apex obtuse, and generally eroded, the erosion extending frequently down the spire, and often a portion of the outer surface of the last whorl itself is wanting; suture raised, compressed. Whorls 3, the upper ones frequently wanting, but when present, flattened or subconcave. Last whorl concave and compressed against the suture above, then either carinate above the periphery and bearing short subdistant spines, or else obtusely, more or less obsoletely angulate. Below it is always rounded. Aperture milky within, peristome semioval, columellar area flat, yellow or dirty white, minutely denticulate, except in front, and having a prominent re-entering tooth just above the middle. Operculum pinkish white outside, exterior margin black, red inside.

The nearest ally to this form with which I am acquainted in *N. obscurata*, Recluz, which has a more expanded mouth, and more deeply emarginate columellar area, the whorls appear also rather differently shaped above.

The present species is eminently variable. The type occurred in abundance close to the beach in a small stream which descends from the hills close to Cape Negrais; specimens were especially abundant in a brackish pool at the beach, spinous and spineless shells occurred mixed together, and the presence or absence of spines is evidently of no importance. The spineless variety from Port Dalhousie was found in the salt water of the Bassein river, abounding along the strand between tide marks.

To illustrate the variation of this species, several specimens have been figured.

Specimens collected by Mr. Theobald in Arakan illustrate the gradual passage, by absolutely insensible gradations, of this form, into the very distinct *N. retifera*, Bens. of the Ganges delta.

No. 16, **Neritina obtusa,** Benson.

Scarce. I obtained two specimens on limestone rock at Thamandewa in the Bassein river.

No. 17, **Neritina Smithii** Gray.

Less common than in the estuary of the Ganges.

I have another species of *Neritina* belonging to the typical section from the estuary of a small stream running into the sea just north of Cape Negrais. I have been unable to identify it with any known species, and it may possibly be new.*

No. 18, **Neritina (Dostia) depressa,** Benson, pl. I, fig. 17,18, 19.

There are specimens of this shell amongst my Irawaddy collections: I think they are from Rangoon. The species is generally found in fresh or slightly brackish water, while *Neritina crepidularia* and *N. cornucopia* are chiefly met with nearer the sea, where the water is more salt. In Bombay Island, however, I have met with *N. depressa* on the sea shore.

No., 19, **Neritina (Dostia) crepidularia,** Less. Pl. I. fig. 20, 21, 22.

This shell and the next are found rather abundantly upon trees growing in places covered by water at each tide, and especially upon *Nipa* palms. *N. crepidularia* frequently occurs upon the sea shore, as well as in estuaries.

No. 20, **Neritina (Dostia) cornucopia,** Benson, pl. I. fig. 23, 24, 25.

Locally abundant. The shells found by me in Pegu differ slightly from the type, which is scarce in the Hoogly at Calcutta. In the latter, the apex of the shell is very nearly in the same plane as the edge of the peristome, sometimes actually so and touching it. In Pegu specimens, the peristome is free from the apex. The difference is very trifling, and there is slight variation in this character in specimens from the same river. In other respects, the shells appear to agree excellently.

I learned from Mr. Benson some years since that *Neritina melanostoma*, Troschel, is identical with *N. cornucopia*, the latter name having priority.† The figures of the former in Philippi's Abbildungen

* Further examination shews it to be one of the forms already referred to as intermediate between *N. Peguensis* and *N. retifera*, B. It is smooth like the latter.

† *N. melanostoma* was published in Wiegman's Archiv for 1837, p. 179; *N. cornucopia* was described by Mr. Benson in this Journal for 1836. Vol. V. p. 748.

are poor, but the specimens were from Bengal, and they present no essential difference from immature shells of *cornucopia*, so Mr. Benson is doubtless correct. Reeve in Conch. Icon. quotes *N. melanostoma* as a synonym of *N. crepidularia* and ignores *N. cornucopia* altogether. Von Martens (Malakoz. Blätter, 1863, X, 127.) shews that the colour of the columella and lip is sometimes white and sometimes black in several *Neritinæ* of the *Dostia* section.

The fact very probably is, that we have in this case an example of a phenomenon not uncommon in the animal kingdom. Two distinct races spring up side by side, arising from one type, and in the original locality do not change their form, but although they breed truly, they are only distinguishable by some slight constant distinction. As both, however, migrate into distant regions, the difference becomes greater, and at length both become so diverse, that no question can remain as to their being in common natural history talk, "distinct species." Thus while *Neritina cornucopia* and *N. depressa*, inhabiting the Ganges delta, are scarcely distinguishable from each other by any more important character than the colour of the aperture, the same shells in Pegu have varied so much, that each differs from the other at least as much as it does from their congener *N. crepidularia*. In other places the race representing *N. cornucopia* may be perfectly undistinguishable from *N. crepidularia*, as appears to have been observed by v. Martens in Singapore. It is highly probable that the origin of species through variation takes place in space as well as in time. More observations on this question are desirable.

Figures of the three forms occurring in the Pegu delta are added.

Family PALUDINIDÆ?

No. 21, **Larina? Burmana**, n. sp. Pl. II, fig. 1.

Testa ovato-globosa, imperforata, tenuis, castanea, striatula, nitidula. Spira conoidea, apice erosula, sutura valde impressa. Anfr. 5, *rotundati, sensim descendentes, ultimus tumidus, subtus rotundatus. Apertura vix obliqua, subelliptica, superne angulata; peristoma rectum, tenue, marginibus callo tenui junctis, columellari expansâ. ? Operc. corneum. Long.* 11, *diam.* 8 *mill. Apertura* 7½ *mill. longa,* 6 *lata.*

Shell ovately globose, imperforate, thin, translucent, smooth, brownish, horny. Spire conoidal, apex eroded, suture deep. Whorls 5 (perhaps more in adult specimens), rounded, obsoletely striated, regularly descending, the last tumid, rounded beneath. Aperture nearly vertical, subelliptical, angulate above. Peristome thin, straight, margins united by thin callus, columellar margin narrowly expanded.

The operculum of this peculiar species was unfortunately lost, and the animal was not observed. In the hurry of travelling, the specimens were placed in a box and forgotten, until the fleshy portions were too much decayed for examination. About half a dozen individuals were found under stones in the Myittaya creek, in the same place which yielded *Iravadia ornata* and other forms.

Mr. A. Adams, who very kindly aided me in determining some of the species contained in my Pegu collections, suggested that this shell might possibly be a second species of the genus *Larina*, established by him for an Australian shell, the animal of which also is unknown. In appearance this shell somewhat resembles a *Lymnea*. It is not impossible that it may have affinities with *Amphibola*. I have a distinct impression that the shells possessed a horny operculum, or I should have been disposed to class them in the *Velutinidæ*.

Family TECTURIDÆ.

No. 22, **Tectura fluviatilis,** n. sp. Pl. II, fig. 2, 3, 4.

Testa depresso-conica, rotundato-ovalis, tenuis, epidermide fusco-olivaceâ induta, lineis radiantibus, striisque confertis minutis concentricis decussata, intus cæruleo albida, interdum fasciâ concentricâ lacteâ, vel etiam omnino hoc colore versus marginem saturata, ad apicem ferruginea. Apex subcentralis, erosa.

Major diam.	21½	*min.*	20	*alt.*	6
„	20	„	17	„	5½
„	14	„	12	„	4

Shell much depressed, conical, subcircularly oval, thin, covered with a very dark olive epidermis, always eroded at the apex, marked with fine radiating raised lines and with close and minute concentric striæ of growth; inside the shell is bluish white, sometimes with one or more milky concentric bands, or the whole interior is milky, except the apex which is invariably ferruginous, the area so coloured having some correspondence to the amount of external erosion, and the colour being evidently due to a deposition of shell inside to protect the animal as the external portion is corroded away.

This species is found on rocks, rarely on trunks of trees, in many of the creeks near high water mark, in brackish water. It was not met with near the sea, where the water was very salt.

The foot is large, filling the cavity of the shell, muzzle broad, tentacles long and fine, mouth not notched beneath. It does not appear to keep to one place and form a hole for itself like some *Patellæ*, but it is very sluggish in its movements.

Sub-class OPISTHOBRANCHIATA.

Family BULLIDÆ.

No. 23, **Haminea tenera,** A. Ad.

Not common. In Bombay this species abounds upon mud flats. The animal is red.

Sub-class PULMONIFERA.

Family AURICULIDÆ.

No. 24, **Auricula Judæ,** L.

This species is completely blind, as has been noticed by von Martens (Ueber die Landschnecken der Molukken, Malakoz. Blätter; 1863, X. 126) and as is shewn in Eydoux's drawing copied in Mrs. Gray's mollusca. The same is the case with all other species of the same group which I have examined. In some instances, *e. g.* the Bombay species, which has received, I believe, a MS. name from Mr. Benson, the eyes may be detected beneath the skin by looking very carefully. (Von Martens observed this in one instance in *A. Judæ.*) Such eyes can, however, be of but little use as percipient points to the animals. There is, however, one group of true *Auriculæ*, typified by *A. subula*, Quoy and Gaimard, in which the eyes are normally developed, the same as in *Melampus*, *Cassidula*, and other *Auriculidæ*. A small species of this type inhabits Bombay. The forms belonging to this sub-division appear also distinguished by a more elevated spire. Further observations are, however, necessary before a division of the genus can be proposed on these grounds, as there appears great probability that the two forms pass into each other.

I found specimens of *A. Judæ* alive under the bark of dead trees, on muddy banks of creeks, in places overflowed by the tide. Unquestionably, so far as my experience goes, none of the Eastern *Auriculidæ* (*Auricula, Cassidula, Melampus, Pythia, Plecotrema*) are land shells, all are met with in places overflowed by salt or brackish water at every tide. They are in fact true estuary shells.

Some of the specimens of this species collected by me shew an almost complete passage into *A. dactylus* Pfeiffer, as described and figured in *Novitates Conchologicæ* I, 15, pl. V. fig. 15. 16. This species is stated by Mr. Theobald to be found at Mergui (J. A. S. B. for 1857, xxvi. 253.)

No. 25, **Auricula nitidula,** n. sp. Pl. II. fig. 5, 6.

Testa non rimata, subfusiformi oblonga, solida, nitidula, sub epidermide olivaceâ alba, lineis impressis confertis verticalibus minutissime rugata, aliis spiralibus granulato-decussata, sculpturâ infra suturam magis impressâ. Spira conoidea, apice eroso, sutura impressa. Anfr. 5 convexi, ultimus vix descendens, ⅝ longitudinis subæquans, basi rotundatus. Apertura verticalis, plicæ parietales 2, supera parva, profunda, alia obliqua, plica columellaris haud valida, diagonalis : perist. crassum, marginibus callo tenui junctis, dextro superne vix sinuato, intus callo elevato incrassato.

Long. 28, *diam.* 12½ *mill. Apertura c. perist.* 19 *mill. longa, intus* 5 *lata.*

Shell not rimate, subfusiformly oblong, solid, smooth, having a greasy lustre, white, epidermis olive, covered with minute granulations produced by the intersection of vertical and spiral impressed lines, both very close and the former sinuous, the sculpture being most strongly marked below the suture. Spire conoidal, apex eroded, suture impressed. Whorls 5 convex, the last nearly ⅝ of the whole length, scarcely descending, rounded at the base. Aperture vertical with 2 parietal plicæ, the upper one small, far inside; the lower strong, oblique; columellar plica moderate in size, diagonal; the peristome thick, the margins united by a thin callus which is somewhat expanded upon the penultimate whorl, the right margin scarcely sinuate above, and thickened inside.

This species which is found very rarely with the last, exactly resembles it in general form, but has rounded whorls and finer sculpture, besides being of much smaller size. The animal is white, while that of *A. Judæ* is mottled. *A. nitidula* somewhat resembles *A. Chinensis* Pfr. which, however, is much less attenuate below, and differs in the form of the aperture, &c.

But two or three specimens of this form were met with. In Mr. Theobald's lists of Burmese shells, *A. glans*, Bens. is mentioned. I can find no description of this species, and cannot therefore say if it be the present form or not.

No. 26, **Plecotrema Cumingiana,** n. sp. Pl. II. fig. 16.

Testa subrimata, subelliptico-ovata, solida, punctis impressis crebris, lineas spirales confertas formantibus, striisque incrementi obliquis ornata, ferrugineo-fusca. Spira conoidea, lateribus vix convexiusculis, apice erosa, sutura lævi lineari. Anfr. 4 *superst., superi planulati, vix discreti, sulcis spiralibus punctatis* 4 *notati, ultimus ad peripheriam subangulatus, subtus compressiusculus. Apertura vix obliqua, plicis parietalibus* 2, *superiori brevi obliqua, alterâ intrante, extus bifidâ, plicâ columellari subobliquâ; peristoma rectum, pone limbum acutum intus callosum, margine dextro tridentato.*

Long. 5, *diam.* 3 *mill. Apert.* 3½ *mill. longa.*

Shell subrimate, subelliptically ovate, solid, marked with close spiral lines, formed of thickly set punctiform impressions, and with oblique striæ of growth; reddish brown in colour. Spire conoidal, the sides barely convex, apex eroded, suture flat. Whorls 4 remaining, the upper flat, scarcely distinguishable, marked with 4 spiral dotted lines, the last whorl subangulate at the periphery, somewhat compressed below. Aperture very slightly oblique, with two parietal folds, the upper short, oblique, the lower re-entering, externally bifid, the columellar fold sub-oblique; peristome straight, margin sharp, but inside the sharp edge thickened and bearing 3 teeth within the right margin.

This species was rather scarce, crawling on mud in company with *Assiminea rubella.* It is distinguished from its allies, *P. striata,* Philippi, and *P. punctostriata,* H. and A. Adams, by its low spire and minute sculpture. In naming it after the late Mr. Hugh Cuming, I adopt the only means in my power of acknowledging my obligations to that gentleman for the very liberal manner in which he allowed me access to his collections, for the purpose of comparing and identifying my Pegu shells.

Besides the above *Auriculidæ,* I have received a *Pythia* which appears to be a variety of *P. trigona,* Troschel, from Mr. Theobald and Mr. Fedden, who both met with it on the Arakan coast, not far north of Cape Negrais. It is singular that I did not meet with species of either *Cassidula* or *Melampus,* as I have reason to believe that both inhabit the Irawadi delta or its immediate vicinity. Mr. Theobald has sent me *Cassidula aurisfelis,* Brug. from Arakan.

Family AMPHIBOLIDÆ.

No. 27, **Amphibola Burmana,** n. sp. Pl. II, fig. 7—10.

Testa aperte umbilicata, naticoidea, tenuiuscula, castanea, periomphalo plerumque saturatiori, nitidula, subsinuate striatula, infra suturam dense peroblique striata, lineâ unâ elevatâ spirali, interdum obsoletâ, superne haud procul a suturâ signata. Spira conoidea, apice vix obtusa, sutura profunda. Anfr. 4 *rotundati, ultimus tumidus. Apertura ovata, superne recte angulata; peristoma vix interruptum, breviter adnatum, tenue, marginibus approximatis, callo tenui junctis, dextrali superne sinuatâ, basali rectâ, columellari breviter reflexo, umbilicum partim tegente. Operculum corneum, paucispirale, nucleo basali, sinistro.*

Alt. 10, *diam.* 9½ *mill., apertura* 7½ *longa,* 5½ *lata.*

Shell openly umbilicated, naticoid, rather thin, orange-brown, darker around the umbilicus, smooth, marked with subsinuate lines of growth, closely and very obliquely striated just below the suture, with a single raised spiral line, which is sometimes obsolete, on the upper portion of each whorl. Spire conoidal, apex subacute, suture deep. Whorls 4, rounded, the last swollen. Aperture ovate, rectangulate above; peristome scarcely interrupted, free, except for a very short distance, from the last whorl, thin, margins closely approximate, united by thin callus, right margin rather deeply sinuate above, basal straight, columellar turned back near the umbilicus, which it partly conceals. Operculum horny, paucispiral, nucleus basal, sinistral.

This is, I believe, the first instance in which the presence of *Amphibola* has been indicated in the Indian or Burmese seas or estuaries; nevertheless, it is very common. I found, in Mr. Cuming's collection, specimens of the same form as that above described, which were collected in Malacca by Dr. Traill, and a smaller form, scarcely separable as a race from the above, abounds in Bombay harbour.

The present species is nearly allied to *A. fragilis*, Quoy and Gaimard, but is thinner, with a lower spire. It was found abundantly crawling on mud, between tidemarks, in company with *Assiminea rubella* and *Plecotrema Cumingiana*. The animal was difficult to make out, as it consisted of an indistinct translucent mass. There were no tentacles, and the eyes were on very short lobate pedicels. The animal differs considerably from the figure of that of *Amp. fragilis*, as copied from Quoy and Gaimard by both Adams and Mrs. Gray.

Class CONCHIFERA.

Family PHOLADIDÆ.

No. 28, **Martesia fluminalis**, n. sp. Pl. III, fig. 1, 2, 3.

Testa ovata-conica, valde inæquilateralis, antice hemispherica, postice sensim acuminata, extremitate membranacea, albidâ, tenuis. Valvæ versus margines epidermide crassâ, coriaceâ indutæ, pagina antica juxta cardinem costulis confertissimis, sinuatis, concentricis, lineisque radiatis elevatis decussantibus pulchre ornata, subtus glabra, postica concentrice striata. Callum trilobato-peltatum, medio divisum. Valvula dorsalis rudimentaria, cornea.

Lat. 12½, *long.* 6, *alt.* 5½ *mill.*

Shell ovately conical, white, thin, inequilateral, anterior extremity hemispherical, posterior regularly acuminate and membranaceous at the extreme end. Valves near the edges covered with a thick coriaceous epidermis, which in places, and especially towards the posterior extremity, extends beyond the margin and forms a membranaceous fringe, uniting the valves more or less. Each valve is divided into two parts by a line passing obliquely from the hinge to the ventral margin and inclined slightly backwards; in front of this line the shell near the hinge is decussated with very close sinuate concentric and subdistant radiating costulation; near the ventral margin it is smooth. Behind the oblique line the valves are concentrically striated, more or less indistinctly. The callus covering the hinges is trilobate and divided by a fissure in the centre; dorsal valve rudimentary, horny, commencing at some distance from the hinge, increasing in breadth backwards, but very narrow throughout.

This species appears most nearly allied to *M. rivicola*, Sow., which was found perforating floating logs in a river in Borneo. The present species is blunter and shorter, and *M. rivicola* is destitute of the sculpture on the anterior portion of the valves.

M. fluminalis was found boring in soft argillaceous sandstone, in creeks far from the sea, where the water was brackish. The external orifice in the stone is very minute, and must have been made by the shell when very young. Inside, the burrow exactly fits the shell, so that the only possible motion is rotation upon the longest axis of the shell.

The epidermis appears normally to cover the posterior subdivisio of the valves, but it is always deficient, except towards the margins.

No. 29, **Teredo?** sp.

All the dead trees in creeks in the Irawady delta are perforated throughout by a species of *Teredo* (?) I either omitted to take specimens, or else have lost them since, and I can now find none to which to refer. It is possible that this shell may be the *Teredo thoracites* of Dr. Gould,* described in Vol. VI, of the Proceedings Boston Society of Natural History, and on which he subsequently, in Vol. VIII, proposed to found the subgenus *Calobates*, characterized by the "pallettes" (stylets) being "stilt shaped, bony." Dr. Gould's specimens were from Tavoy, but he does not mention if they were fluviatile or marine.

Family CORBULIDÆ.

No. 30, **Sphenia perversa,** n. sp. Pl. III. fig. 4, 5, 6.

Testa oblongo-ovata, parum inæquivalvis, valvâ dextrâ majori, tenuiuscula, alba, concentrice irregulariter striata, antice rotundata, postice acuminata, demum transverse truncata, ad extremitatem epidermide coriaceâ, rugatâ induta; margo dorsalis subrecta, ventralis antice convexa, postice vix concavâ. Processus cardinalis valvæ sinistræ (non dextræ) elongato-lamelliformis.

Lat. 11, *long.* 6, *alt.* 4 *mill.*

Shell oblong, slightly inequivalve, broadest at the umbo, somewhat acuminate posteriorly, and very much more so in young specimens; thin, white, irregularly striated, the posterior end covered with a thick coriaceous epidermis which is vertically furrowed. In the young shell the epidermis covers all the shell except the beaks; it is thin except along the dorsal and posterior margins, where it is thick and vertically sulcated. The dorsal margin is nearly straight, the ventral rounded in front and slightly concave behind in old shells, straight or nearly so in young specimens. There is a lamelliform process in the hinge of the *left valve*, in front of the cartilage.

This shell was met with in burrows in stone, apparently the holes of *Martesia* which had perished, at least they did not appear to have been formed by the present species. It was met with at a considerable distance from the sea, in company with *Martesia fluminalis.*

In every respect, except the position of the lamellar tooth in the hinge of the left valve instead of the right, the shell appears to be a true

* Otia Conchologica pp. 222, 241.

Sphenia. I scarcely think that the exceptional character justifies the creation of a new genus, as the characters of the animal unfortunately were not noted. The practice of establishing genera for single species on insufficient grounds is so objectionable, that it will be better to err in the opposite direction. When the animal has been examined, should it shew distinctions from *Sphenia,* it will be easy to propose a new generic or subgeneric appellation.

No. 31, **Corbula,** sp.

A single valve of a very thin species of *Corbula* was found on mud above Port Dalhousie.

Family TELLINIDÆ.

No. 32, **Sanguinolaria diphos,** L.

This shell lives at a depth of about 4 feet in the mud. I found it abundantly in a marsh overflowed by every tide and where I should never have suspected its existence, had not my Burmese coolies pointed it out and shewn me how to capture specimens. Burmese, being omnivorous beings, are far better acquainted with the hiding places of various animals than the natives of India are; amongst other dainties they eat *Sanguinolariæ,* and the process for catching them which they shewed me was ingenious. The first thing was to cut a very thin slip of bamboo, about 5 feet long and not more than $\frac{1}{8}$ inch in diameter, and to make a small barb at the end. This they thrust down all the small holes in the mud, many of which corresponded to the siphons of the *Sanguinolariæ* below. Now and then the bamboo went through a *Sanguinolaria,* as he lay vertically with his valves open below the mud; of course the bivalve immediately closed his valves upon the intruder, and was ignominiously dragged out by the bamboo, his exit being aided by digging when he approached the surface. The only objection to the plan is, that most of the specimens are slightly injured, as the shell closes with such force upon the bamboo as to break the thin ends of the valves. Some specimens were brought up in which the bamboo had been absolutely thrust down the siphon, thus literally impaling the *Sanguinolaria.* The siphons are of great length, considerably exceeding the shell.

No. 33, **Macoma ala,** Hanley.

No. 34, **Scrobicularia angulata,** Chem.

I find both the above shells recorded in my list. I cannot now come across the specimens, and I am under the impression that they were found dead in salt water marshes on the Arakan coast, and not in the delta, but they are both so common in all Indian estuaries, that it is equally probable that I found them in the Bassein river.

Family VENERIDÆ.

No. 35, **Chione Ceylonensis,** Sow.

I have mislaid my notes as to the exact locality of this species also. I think it was found at Dalhousie. In a backwater on the Arakan coast, I found an allied, but undescribed species of the same genus.

No. 36, **Artemis,** sp.

Of this I have a single immature specimen. It may be the young of *A. excisa*, Chem. but has not the sculpture of that species, nor its angulate posterior slope.

Family CYRENIDÆ.

No. 37, **Cyrena Bengalensis,** Lam.

Mangrove and other salt water swamps along the edges of creeks, amongst roots of trees and brushwood, common.

I am inclined to refer the shells I obtained to the above form, of which I suspect some others since described are merely varieties. *Cyrenæ* vary greatly with age, besides being eminently variable in form. Thus some of my specimens exactly agree with *C. turgida* Desh., but I cannot help believing that they are merely immature specimens of the thicker form which I refer to *C. Bengalensis*.

Family MYTILIDÆ.

No. 38, **Mytilus smaragdinus,** Chem.

Found in creeks below low water mark. I do not think it is generally known that the flesh of this species is very delicious. Some were brought to me along with a quantity of oysters, and the Burmese told me that the mussels were the better eating of the two. Not having much faith in Burmese palates, I preserved the shells and threw away the soft parts of the *Mytili*; but as a trial, I had two or three cooked with the oysters. I found that the Burmese were quite right, though the oysters were by no means unpalatable.

No. 39, **Modiola emarginata,** Bens.

A dwarf variety of this species occurs in salt water creeks.

Family ARCIDÆ.

No. 40, **Arca (Anomalocardia) granosa,** L.

This very common species was only found at one spot in the Bassein river. It was living in mud close to the surface, under stones and roots of plants. The same species abounds in mud, amongst stones, in Bombay harbour, and is collected for food by the natives.

No. 41, **Scaphula deltæ**, n. sp. Pl. III., fig. 7-10.

Testa tumida, perelongato-rhomboidea, sub epidermide crassâ, fuscâ, posticè radiatim liratâ albida, lineis minutis elevatis confertissimis decussata, ante carinam costâ unicâ latâ, planulatâ, aliquando obsoletâ, a natibus ad marginem decurrente, munita, intus cærulescens, antice rotundata, postice oblique truncata, margine ventrali antice convexâ, postice vix concaviusculâ (testæ junioris rectâ). Carina perelevata, acuta, valvas in paginas duas dividens, unticâ tumidâ, posticâ concavâ. Area nitida, sub lente striatula, ligamento rhombeo solum antice induta. Dentes cardinales postici breves, obliqui, ab extremitate remotiusculi.

Lat. 10 *long* 3½ *alt.* 6½.
„ 8 „ 3 „ 5.

Shell very tumid, elongately rhomboidal, (the ventral and dorsal margins being parallel as in *S. celox*) covered with a thick, dark epidermis, which is rather rough and radiately ribbed behind the keel. Beneath the epidermis the shell is white, and decussately very minutely sculptured, one flat broad rib, scarcely raised, and occasionally obsolete in old specimens, passing from the umbones to the margin just in front of the keel. This is scarcely distinguishable until the epidermis is removed. The valves are bluish within, rounded in front, obliquely truncated at the posterior margin; the ventral margin is convex anteriorly, subconcave posteriorly, being straight for the greater part of its course in young shells, but becoming slightly concave, at the spot where the byssus passes out, in old specimens. The keel is very high and sharp, separating the valves into two subdivisions, the anterior of which is tumid, the posterior concave. The area is polished and striated rather obliquely, the ligament diamond-shaped and covering only the anterior portion, about ⅛ to ⅙ the length, of the area. The hinge teeth are oblique, but less so than in either *S. celox* or *S. pinna*, and the posterior teeth are much farther from the extremity of the shell than in either of those species.

The great distinction between this species and the other two previously described is in the far greater tumidity of the valves, which are nearly twice as broad in their diameter from side to side (of the closed valves) as they are from the dorsal to the ventral margin. The proportion of the two diameters in the present species averages about 12 : 7. In *S. celox* it is 12 : 10½ and in *S. pinna* 12 : 9½.* The last named species is of a totally distinct form, being much wider posteriorly than in front, so that it is sub-trigonal in shape instead of rhomboidal. Its posterior hinge teeth, also, are near the extremity, and so oblique as to be almost parillel to the hinge line, while in its smooth, thin epidermis, marked concentric sculpture, and convex posterior subdivision of the valves, it differs widely from *S. deltæ*. The ligament of *S. pinna* covers a greater proportion of the length of the area, (about ⅜,) than does that of *S. deltæ*. It is much narrower in proportion to its length, as is indeed the entire area, corresponding to the smaller tumidity of the valves. *S. celox* approaches more nearly to the present species, but is thinner and much less tumid, has its posterior hinge teeth more oblique and nearer to the extremity, and differs widely in sculpture.

S. deltæ was found under stones in creeks, adhering by a byssus. It was not met with near the sea. It is the first species of the genus that has been found in brackish water, both of the forms described by Mr. Benson being from large rivers far above the influence of the tide.

Mr. Benson mentions the occasional occurrence of a raised rib in front of the keel in *S. celox*. I have several specimens, which I received from Mr. Theobald, shewing this peculiarity. It differs entirely from the flattened subobsolete rib of *S. deltæ*.

Figures of all 3 species are added to illustrate the difference between them.

Family ANOMIAIDÆ.

No. 42, **Anomia**, sp.

The specimens of this shell have unfortunately been mislaid. I only obtained two or three specimens, and it is extremely difficult to make out the species of this genus.

No. 43, **Anomia (Ænigma) ænigmatica**, Chem.

Occasionally found adhering to stumps of trees in salt water creeks.

Family OSTREIDÆ.

No. 44, **Ostrea**, sp. (? 2 sp.)

A large form occurs in the creeks below low water mark. A smaller kind is met with between tide marks in mangrove swamps and creeks, attached to wood or stones. I unfortunately omitted to take specimens of either.

* Measured from authentic specimens of each species.

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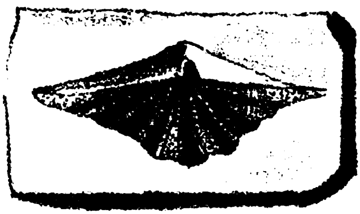

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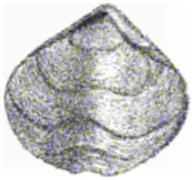

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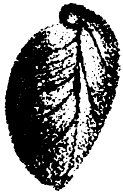

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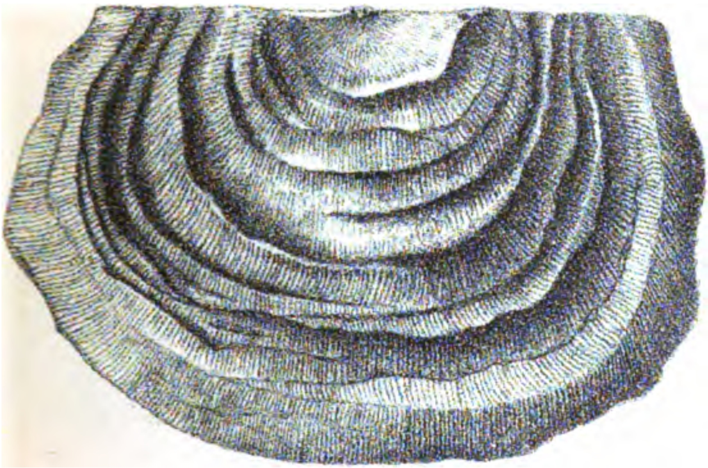

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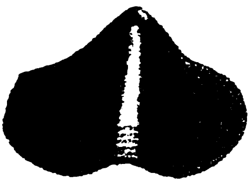

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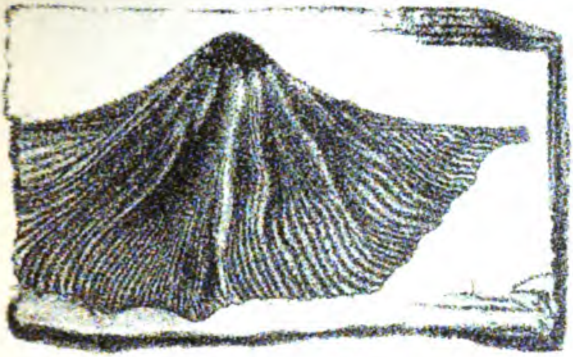

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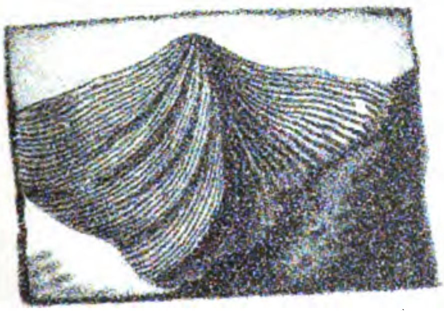

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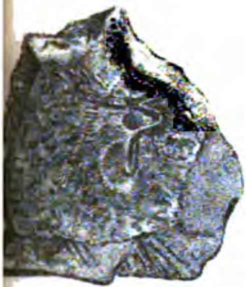

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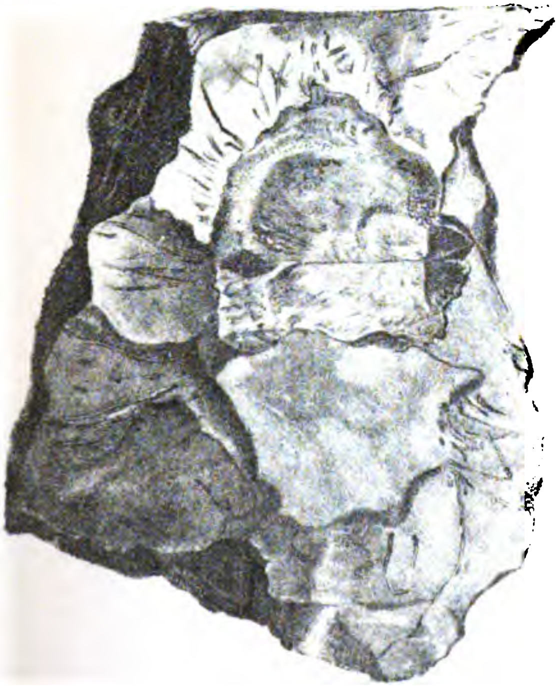

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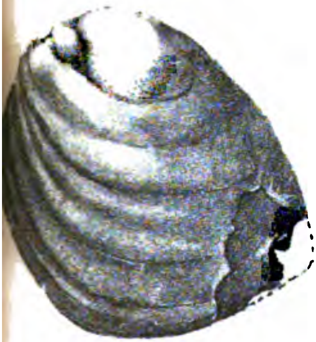

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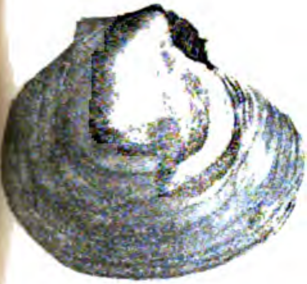

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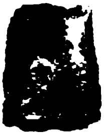

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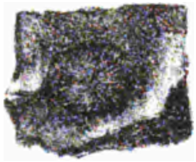

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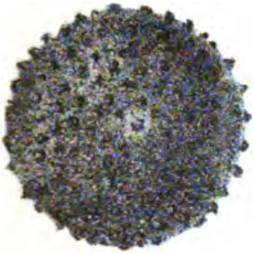

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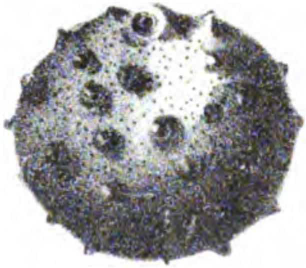

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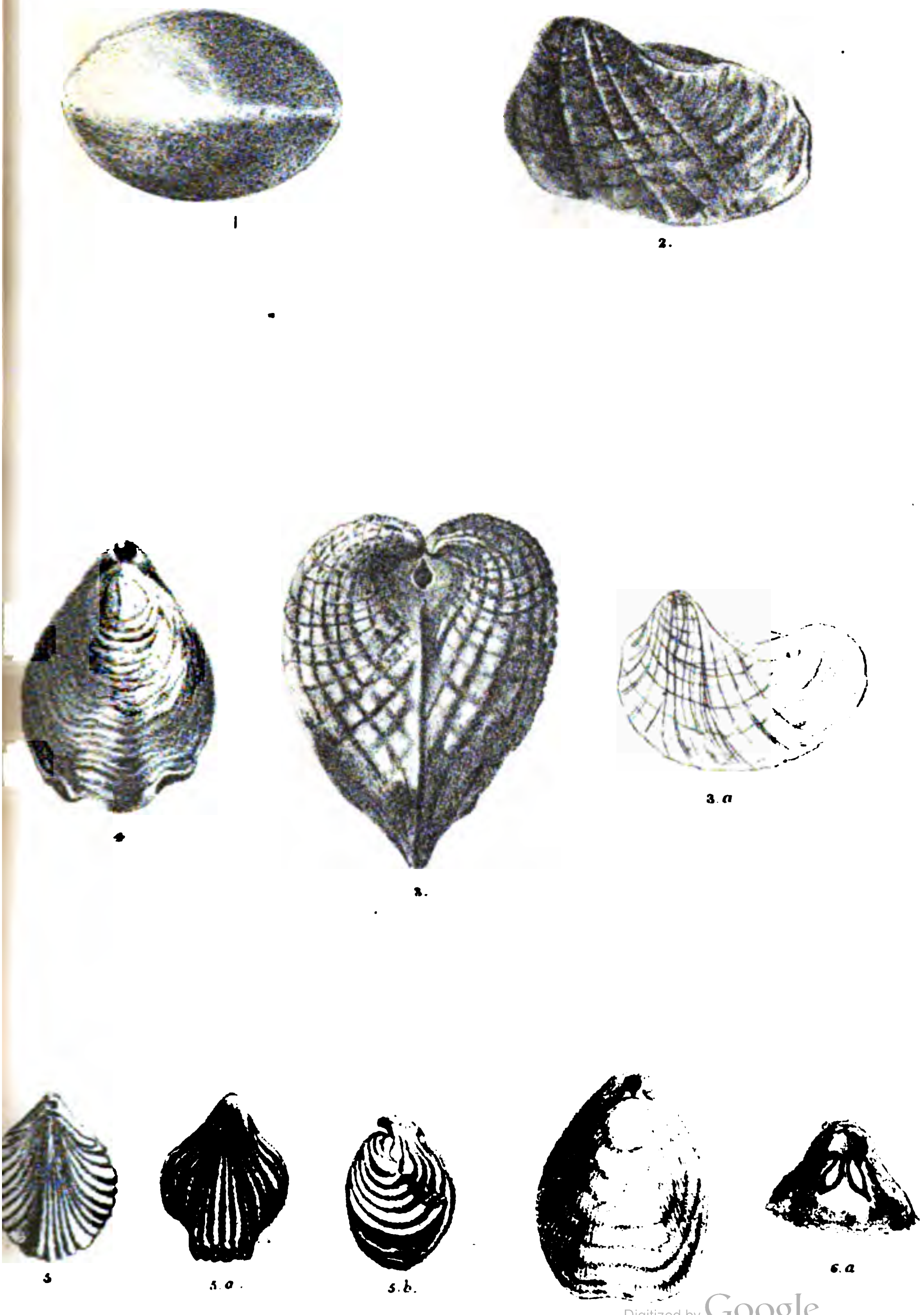
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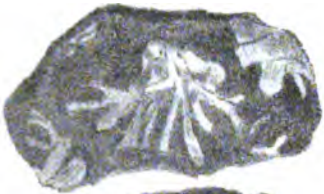

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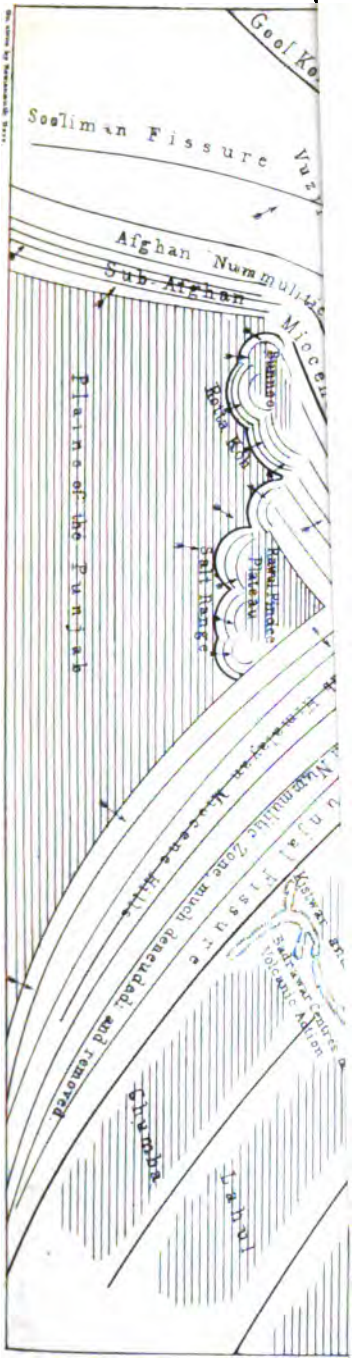


LITH AT THE SURVEYOR GENERAL'S OFFICE CALCUTTA JANY 1867

JOURNAL

OF THE

ASIATIC SOCIETY.

PART II.—PHYSICAL SCIENCE.

No. II.—1867.

On the Jungle products used as articles of food by the Inhabitants of the districts of Manbhoom and Hazaribágh.

By V. Ball, Esq. B. A.

Geological Survey of India.

It is perhaps not generally known that throughout Manbhoom and Hazaribagh, as well as in many of the adjoining districts a considerable number of the poorer classes of the people depend solely upon the jungle to supply them with the means of subsistence for from two to three months of every year. In time of famine the number so dependent is of course greatly increased.

In some of the more jungly parts of these districts, where the cultivation round the villages is very limited and deficient, nearly the whole of the inhabitants who have survived the past famine, can have had little else but the roots and fruits of the surrounding jungle upon, which to subsist. While passing through some of these villages last season, I was told that but few deaths had occurred in them.

On the whole I am inclined to believe that people living in such villages are more independent and less affected in every way by famine than those, who residing in the centre of cultivation, have no jungle readily accessible. Were a census to be taken, it would probably be found that the relative proportion of deserted houses and villages, the result of the famine, to those still inhabited, would be much greater in the open, cultivated parts of the district than in the densest jungles. Indeed the jungles may be regarded to a certain extent as the saving of the lower races of the population; did they not afford nutritious food in abundance, the result of a famine like that of 1866-7, would probably be not merely decimation, but utter depopulation throughout extended areas.

It is not to be supposed that even those who are in the habit of using this description of food regularly, for a greater or less portion of every year, regard it as in any degree an equivalent to rice. Many have spoken to me of eating *Mhowa*, which is by far the best of these products, as being only better than suffering from absolute famine, and they always consider themselves legitimate objects of charity, when they can say they are living on it alone.

The list which is appended to this paper, includes nearly 80 distinct species of plants which furnish articles of food. Owing to the difficulty of identifying the fragmentary specimens which were all that I could in some instances obtain, it has been impossible to make it fully complete. I believe, however, nothing of importance has been omitted.

To S. Kurz, Esq. curator of the Herbarium in the Botanic gardens, I am indebted for considerable assistance which has enabled me to bring forward this paper sooner and in a more correct form than would have been otherwise possible.

The species mentioned are of course of varying importance, some being merely edible, and in a few cases injurious if eaten in large quantities; while others, as the *Mhowá*, *Sál*, *Bier*, *Bur*, *Pipál*, *Singárá*, *Chehúr*, various roots of the species of *Dioscorea*, and many of the varieties of Sag (leaves) may be considered as *boná fide* staple articles of food.

Bassia latifolia, Roxb. *Mhowa*, H. & B.

The *Mhowa* is found in Bombay and Bengal; those who have not visited the more remote portions of one or other of these presidencies, can hardly realize the importance of this tree as a source of food to the poorer classes of the natives, more especially to such improvident races as the Bheels, Coles and Sonthals.

In the districts of Manbhoom and Hazaribagh, *Mhowa* groves as well as stray trees in the jungle are on the whole abundant. All the trees, with the exception of a few in the neighbourhood of roads, are the property of the zemindars, and are rented out by them at prices varying chiefly with the bazaar *nirik* or price of rice.

As the crop of *Mhowa* approaches ripeness, the corollas, becoming fleshy and turgid with secreted juices, gradually loosen their adhesion to the calyx and fall to the ground in a snowy shower. The duty of collecting the fallen blossoms is chiefly performed by women and children*; at dawn they may be seen leaving their villages with empty baskets, and a supply of water for the day's use.

Before the crop has commenced to fall, they take the precaution to burn away the grass and leaves at the foot of the tree, so that none of the blossoms may be hidden when they fall. The gleaners generally remain under the trees all day, alternately sleeping and collecting the crop; the male membèrs of the family, visiting the trees once or twice during the day, bear off the produce in *banghys*.

It often happens that the people who collect come from a considerable distance, in which case they erect with the branches of *Sál* a temporary encampment of huts in which they live until the crop is all gathered in. In front of each of these huts a piece of ground is made quite smooth and hard, for the purpose of spreading out the crop to dry.

When perfectly dry, the blossoms have a reddish brown colour, and in size they have lost three-fourths of their original dimensions and about half their original weight. It is the custom with some of the natives, before spreading them out to dry, to pull off the little ring of foliaceous lobes which crowns the fleshy corolla.

It is very difficulty to collect trustworthy statistics regarding the amount of yield of the *Mhowa* trees. I have been told, and it has been repeated to me several times, that a first class tree will yield as much as thirty *cutcha* maunds of 12 chittacks to the seer, or about $\frac{6}{7}$th of a ton; in other words, an average daily fall of two maunds is said to continue for 15 days. This estimate I believe is more than double what it ought to be.

The rent of the trees varies much with the abundance of them in the district, the quality of the previous rice crop, and various other circumstances affecting the demand and supply. In parts of Hazaribagh, I have known ten small trees to be let for a rupee, while a fine large one would sometimes alone bring that amount. In Manbhoom I have been pointed out trees for which a sum of from two to three rupees was charged, but I have also heard of trees being hired in the same district for four annas.

As do the trees, so the saved crop varies much in price, the limits being, as far as I can make out, from 2 to 8 maunds for the rupee; but when, as is perhaps most frequently the case, the exchange is in kind, the mahajuns only give a small quantity of salt and three or four seers of rice for a maund of *Mhowa*. In parts of Manbhoom, I have been told that during the famine, the price of *Mhowa* was from 12 to 20 seers for the rupee.

Two maunds of *Mhowa* are stated by some to furnish a months' food to a family consisting of a father, mother and three children. It is, however, seldom eaten alone, being much more frequently mixed with the seeds of *Sál*, SHOREA ROBUSTA, *Roxb.*, or with some of the leaves of the plants mentioned in the accompanying list which are collectively called *Ság*. The cooking is performed as follows. The *Sál* seeds, having been previously well dried in the sun, are roasted and then boiled alone; the *Mhowa* flowers are then also boiled, and the water is thrown away; so far having been cooked separately, they are then mixed and re-heated, sometimes a small quantity of rice is added. It is the custom to cook but once in a day, and each member of the family helps himself whenever he feels hungry.

When fresh, the *Mhowa* has a peculiar luscious taste with an odour somewhat suggestive of mice; when dried, it possesses some resemblance to the inferior kinds of figs. Cooking renders it vapid and utterly devoid of flavour. On distillation the newly dried flowers yield an highly intoxicating spirit called *darú;* this, before being sold, is diluted with ten times its quantity of water, and is then sold at the rate of two pice for about a quart.

Considering the really useful nature of this tree, it would be most desirable that whenever new lines of road are being made through any of the districts in which it thrives, it should be planted on either side, so that the poorest might avail themselves of the crop without having to pay rent to a zemindar or landlord.

If the yield of an average tree amount to 6 maunds, that is to say, enough to supply a small family with food for three months, there can be no question of the immense amount of food which in time of famine a row of trees planted along a road passing through the country would afford. Although the natives rigorously protect such trees as exist, I am not aware that they do anything to increase the number.

SHOREA ROBUSTA, Roxb. *Sál*, H. & B.

Under the head of *Mhowa*, the seed of this tree has already been alluded to. Where possible, the *Mhowa* and *Sal* are mixed in the manner above described, but in some places even *Mhowa* is not to be obtained, so that the *Sal* seeds are roasted and eaten alone. With many of the Sonthals, *Sal* is probably a regular article of food, and not merely a "*dernier ressort*" to be used in such a year as 1866-7.

FICUS INDICA, Roxb. *Bur*, B. & H.—F. RELIGIOSA, Linn. *Pipal* B. & H.

The figs of both these species especially those of the former are eaten every year by the poorer classes of natives. In one place last year I observed a number of wretched half-starved ill-clothed women and children, with a few still more wretched men, picking up the figs which had fallen from a banyan tree: they did not even knock the fruit off the tree, but were become so poor-spirited by hunger, that they were contented to collect the windfalls.

ZIZYPHUS JUJUBA, Linn. *Bier*, B. & H.

The fruit of this tree though not at all to be compared in importance with *Mhowa* as an article of food, is nevertheless much used in parts of these districts where *Mhowa* is not abundant; it may frequently be seen spread out to dry on the roofs of cottages. There are two varieties at least of *Bier*; one is a small bush with the appearance of which few who have travelled in India can fail to be familiar; the other is from the same original stock, but has been vastly improved by cultivation and is always found near villages.

This fruit is sold in the bazaars, and when not quite ripe, has the pleasant acidity of an apple.

Bauhinia Vahlii, W. & A. *Chehur* B. & H.

The pods of this gigantic creeper which, passing from tree to tree, forms the festoons peculiar to tropical jungle scenery, are most eagerly sought for by the natives, so much so, indeed, that it was with difficulty that I succeeded in obtaining botanical specimens. They are plucked just before they become ripe; so that in order to open them, it is necessary to place them in a fire; on being sufficiently heated, they open with a loud report, and the carpels at once twist into curls which no amount of pressure can remove. The seeds are easily detached and are eaten at once.

Trapa bispinosa, Roxb. & T. quadrispinosa, Roxb. *Singhárá*, B. & H. *Punboje*, Sonth.

Both these species of *Singhárá* are well known to many Europeans. With the natives they form a favourite article of food. I have frequently seen from 20 to 30 persons, men, women and children groping in a half dried up tank for *Singhárá*, *Paludinas*, and small sluggish fish, which latter are caught by dragging on shore the weed in with they lie concealed. From the produce of a morning's collection of these miscellaneous substances a *tarkári* is made, which is perhaps the only food upon which a family have to subsist for the day.

In drawing up the following list, two systems of arrangement were possible, either to enumerate the species under their respective natural orders, or under headings indicating the part of the plant used; this latter form has been adopted, as it renders the list more accessible to those not familiar with botanical terms. The order in which the species are arranged is approximately that of their relative importance.

List of Jungle products used as articles of food.

SEEDS.

Names.	Bengali.	Hindustani.	Remarks.
Shorea robusta, *Roxb.*	Sál.	id.	Much used by the Sonthals; occasionally roasted and eaten alone, but more frequently boiled up with the dried flowers of *mhowa.*
Bauhinia Vahlii, *W. & A.*	Chehúr.	id.	Sometimes stored, but more frequently roasted and eaten close to the spot where found.
Mucuna imbricata, *D. C.*	Kusee.	id ?	
——.— prurita, *Hook.*	Alkússa.	Kiwách.	
——.— nivea, *Buch.*	Khamach ?	?	Sometimes cultivated.
Terminalia Bellerica, *Roxb.*	Bhæra or Bora.	?	Kernels if eaten in excessive quantity are said to produce intoxication.
———— Catappa, *Linn.*	Bádám.	id.	Seeds used as a substitute for almonds.
Fuirena ciliaris, *R. Br.*	Band-kobi.	id.	Seeds of this used as a sort of meal and are probably sometimes ground into flour before use.
Cassia fistula, *Linn.*	Bunderlati.	Amultás.	Placentæ between the seeds used to make sherbet.
Nelumbium speciosum, *Willd.*	Moolum Puddoo.	Bansera.	
Ventilago calyculata.	?	?	Seeds eaten in the same way as those of Sal.

FRUITS.

Names.	Bengali.	Hindustani.	Remarks.
Bassia latifolia, *Roxb.*	Moul or Mhowá.	Mhowá.	The fruit is dried in the sun and eaten in times of scarcity, and the seeds yield an oil which is used as a substitute for *ghee.* (See flowers.)
Buchanania latifolia, *Roxb.*	Piál or Piár.	id.	Fruit collected and sold in bazaars.
Mangifera Indica, *Linn.*	Am.	id.	Tree occasionally found wild in the jungle; use of fruit well known; seeds softened by steam and eaten in times of famine.
Spondias mangifera, *Pers.*	Amará.	id.	Fruit eaten raw when ripe; pickled when unripe.
Zizyphus jujuba, *Lam.*	Bier.	id.	Is dried and stored. A cultivated variety yields a much larger fruit.

Fruits—continued.

Names.	Bengali.	Hindústani.	Remarks.
Zizyphus Œnoplia, *Mill.*	Siá-Kol.	Makoi.	A small black fruit having a slightly tart taste.
——— rugosa, *Lam.*	?	?	
Ficus Indica, *Roxb.*	Bur.	id.	Are much eaten in time of scarcity by the very poorest Sonthåls and Coles.
—— religiosa, *Linn.*	Pipal.	id.	
—— glomerata *Roxb.*	Doomur.	?	
Carissa carandas, *Linn.*	Kurumea or Benchi.	Karroná.	Is capable of much improvement by cultivation.
Trapa bispinosa, *Roxb.*	Páni-phul or Singhárá.	Singhárá.	Are procurable in large quantities in some of the tanks. They furnish a very wholesome food.
—— quadrispinosa, *Roxb.*			
Eugenia Jambolana, *Lam.*	Jamún.	id.	Fruit is collected and sold in the bazars.
Diospyros Melanoxylon, *Roxb.*	Keond or Kaned.	id.	Ditto.
——— exsculpta, *Ham.*	?	?	
——— embryopteris, *Roxb.*	Makúr-kendi.	?	
Olax scandens, *Roxb.*	Koko-aroo.	?	
Ægle Marmelos, *Corr.*	Bael.	id.	Chiefly used for making sherbet, but are also prepared in other ways.
Feronia elephantum, *Linn.*	Kuthbel.	Koet.	
Tamarindus Indica, *Linn.*	Tetal or Tentar.	Emle.	Dried and exported in large quantities.
Alangium decapetalum *Lam.*	Bágh-ankúra.	id.	Fruit somewhat astringent.
Flacourtia sapida, *Roxb.*	Katái.	id.	
———— cataphracta, *Roxb.*	Páni-zali.	...	
Phyllanthus emblica, *Linn.*	Ourá.	id.	Used for making pickles.
Bauhinia variegata, *Linn.*	Catchuá.	id.	
Mimusops elengi, *Linn.*	Bohl or Bakal.	Moulsere.	
Semicarpus anacardium, *Linn.*	Bellá.	id.	Acrid, except when perfectly ripe.
Erycibe paniculata, *Roxb.*	?	?	

Schleichera trijuga. *Willd.*	Khusm.	id.	Both ripe and unripe fruit are eaten.
Boswellia serrata, *Colebr.*	Sálgá.	?	
Karivia umbellata, Arn.	Rakhalsusa.	?	
Coccinia grandis, *W. & A.*	Tela-kúcha.	?	
		FLOWERS.	
Bassia latifolia, *Roxb.*	Moul or Mhowá.	Mhowá.	Extensively used throughout the district. Is generally cooked with *Sál* seeds. Price varies from 10 seers up to 8 maunds for one rupee.
Bauhinia variegata, *Linn.*	Catchná.	id.	Used in *tarkáris*, or vegetable curries.
Butea frondosa, *Roxb.*	Pulás.	id.	Stamens and young pods occasionally eaten.
		LEAVES (*Ság.*)	
Antidesma diandrum, *Tul.*	Muttá.	id.	Trees or shrubs.
——— ghœsembilla, *Gartn.*	Umtoá.	id.	
Flacourtia sapida, *Roxb.*	Benchi.	Katái.	
Tamarindus Indica, *Linn.*	Tetul or Tentár.	Emle.	
Bauhinia purpurea, *Linn.* ?	Koinár.	Purenposi.	
Olax scandens, *Roxb.* ?	Bhadwilá or Koko-aroo.	?	
Cassia Sp. ?	Chakúra.	...	
Oxalis corniculata, *Linn.*	Amrool.	Umtha.	Herbs.
Marsilea quadrifoliata, *Linn.*	Susné.	id.	
Amarantus viridis, *Linn.*	Batwá.	?	
——— spinosus, *Linn.*	Kántá.	?	
Alternanthera sessilis, *R. Br.*	Sáronchi.	?	
Trichodesma Indicum, *R. Br.*	Hetmurria or Chota Kulpa.	?	
——— Zeylanicum, *R. Br.*	Burra Kulpa.	?	
Mollugo spergula, *Linn.*	Ghíma.	?	
Spermacoce hispida, *Linn.*	Burdmutta.	?	
Polygonum plebejum, *A. Br.*	Myá or Kaet.	?	

LEAVES.—*continued.*

Names.	Bengali.	Hindustani.	Remarks.
Colocasia antiquorum, *Schott.*	Kachú.	Ulwa.	Herbs.
Cissampelos, Sp. ?	Poe.	?	Herbs.
Marsdenia tenacissima, *W. A.*	Herina.	?	Herbs.
Jussieua repens, *Linn.*	Dhabnee.	?	Herbs.
Leucas Sp. ?	Dhurup.	?	Herbs.
Polycarpon depressum, *Kurz.*	Cheera.	?	Herbs.
		STEMS.	
Bambusa stricta, *Roxb.*	Karáil.	Kopar.	Base of stem and young shoots are eaten. The native names given are those of the stem, not of the plant itself.
Phœnix acaulis, *Buch.*	Jungly-kájúr.	...	Interior of stem (sago.)
Nymphæa Lotus, *Linn.*	Salúk.	Sirke.	Leaf stalks. And underground stems.
Vitis quadrangularis, *Wall.*	Hurjora.	...	Young shoots.
		ROOTS.	
Dioscorea, Sps. ?	Bengo-aloe Dola-aloe Dudha-aloe Kondre. Genti.	?	These roots furnish considerable nutriment and are extensively used throughout the country.
Nelumbium speciosum, *Willd.*	Moolum Puddoo.	Bansera.	These are capable of being ground up into a useful flour.
Scirpus Kysoor, *Roxb.*	Kesúr.	id.	These are capable of being ground up into a useful flour.
Cyperus rotundus ?	...	...	
Curcuma, Sp. ?	Kewa.	?	
		FUNGI.	
Geaster, Sp. ?	Kukúri-Chatú.	?	
Agaricus, Sp. ?	Kanchutak.	?	

Kashmir, the Western Himalaya and the Afghan Mountains, a—
A Geological paper, by

Albert M. Verchere, Esq. M. D.
Bengal Medical Service, with a note on the fossils by
M. Edouard de Verneuil,
Membre de l'Académie des Sciences, Paris.
(Continued from page 50, of No. III. 1867.)

Chapter IV.—*General Remarks, Geognostic History, and Conclusion.*

81. In the preceding chapters I have often insisted on the parallelism of the several chains of the Himalaya; this parallelism is at once evident by reference to the map. Between the great parallels, we have seen that smaller, catenated chains make their appearance, filling up, as it were, with their spurs and branches, the great troughs formed by the principal parallel ridges. All the peaks and sinuosities of these catenated chains appear to present the same arrangement, viz. a highly crystalline and porphyritic variety of volcanic rock, passing gradually into others less crystalline, such as Trachyte, Felstone and Greenstone, and finally covered by ash, cinders, agglomerate, laterite, and compact azoic slate: these beds of ejecta, together with their interstratified layers of slate and sandstone, are all conformable to the fossiliferous strata by which they are covered, and have behaved like those at the final upheaval of the great system. But the more crystalline rocks, the several porphyries, the hornblende rocks, &c. do not appear to have been displaced laterally in any way to the same extent as the stratified layers; they rather seem to have been upheaved from underground as a solid mass, breaking through the beds of superficial trap and of volcanic ejecta. A similar disposition is likewise usual in granitic mountains, the granite supporting gneiss, schist, metamorphic slate and marble, and these being covered by fossiliferous rocks.

To explain the cause of this arrangement, let us consider what is the section of a volcano, as far as it is known at present from a study of active and extinct ones. We have under the surface of the country, in which the volcano occurs, enormous masses of trachyte, becoming more and more crystalline and prophyritic as we proceed deeper, and probably passing gradually into granite. In some volcanoes this mass is perhaps upheaved during their activity, but what is upheaved above ground is certainly but a small proportion of what remains underneath. This mass is covered by the materials which have flowed out and have spread themselves on the surface, either under the sea or in the open air. A great deal of this fluid material does never reach the surface, but finds its way into the cracks and fissures of the trachyte and porphyry. The portion which flows on the surface, whether in the air or under water is a lava; on the top of and interbedded with the lavas, scoriæ, ashes, cinders, dust, broken rocks and mud, thrown into the air or into the sea by volcanic discharges, are arranged in gentle slopes on the sides of the volcanoes and in flat strata further off. Now, let us suppose that the volcanic activity becomes dormant or ceases: we shall have under the spot where the volcano once broke out, great masses of melted and metamorphosed matter solidifying into various sorts of trappean rocks, while on the surface, stratified and fossiliferous beds will be deposited on the top of the lava and ashes. Should then the whole district be submitted to an expansive force acting from within outwards, this force will be first and most intensely felt by the great mass of underground porphyry and trachyte, which will be forced up and break through whatever covers it; the beds of basalt and amygdaloid through which it is forced, will be displaced and thrown aside or on their flank, dragging with them the stratified beds of cinders and fossiliferous strata. If instead of one volcano, we have many, situated not very far apart, we shall have the superficial rocks thrown into endless confusion by the upheaval of the many masses of porphyry and trachyte, which once formed their bases. The surging up of these masses of crystalline rock will of course diminish very materially the space occupied by the lavas, the cinders and the fossiliferous rocks at the time of their deposition; and these have therefore no other alternative but to be broken in pieces, and these pieces to be raised more or less towards a vertical position, according to the quantity of rocks to be packed in a given space. Thus, for example, near the Kaj Nag range, we have vast deposits of felstone well hemmed in, on the south, by an enormous thickness of passive tertiaries. When the huge mass of porphyry of the centre of this system of mountains received its last upheaval, it took possession of a great extent of ground formerly covered by the felstone; and this in its turn did its best to push the tertiaries further south, but this it only partially succeeded in doing; and as there was much felstone and little room for it, the bed broke into pieces and these pieces became packed edgeways.

82. Granite may be considered as the solidified matter of a volcano seated so far from the surface of the earth, that it never broke through its covering while the minerals were in a fluid or viscid state. It is the remains of a "blind volcano." Humboldt has described volcanic action, "the reaction of the interior of the earth on the external crust." This crust has to be broken through to allow of the escape of some of the internal matter; where the earth's crust resists the upward pressure, no crater is formed, no true volcano appears; but the melted matter remains imprisoned under the crust, and there gradually solidifies under great pressure. The solidification will necessarily be made more slow at a great depth, than it would be near the surface and near a rent which allows of the evaporation of the intermolecular water to take place; and it is the slowness of the cooling, the pressure sustained during the period of cooling, and the retention of intermolecular water and gases which cause the melted minerals to crystallise as granite and not as porphyry, greenstone or basalt.

83. In regard to their geographical disposition, volcanoes can be classified into "central" and "linear." The "central" are those which arise by themselves and appear not to be connected with any other volcano; the "linear" are several outlets arranged along a probable fissure in the earth's crust, and the fissure is often parallel to one or many other fissures similarly indicated by a line of volcanoes; or two fissures may cut one another obliquely, as we see in the Lipari Islands.

84. Applying the above general remarks to the volcanic rocks of Cashmir, we first notice that previous to the carboniferous epoch, there existed linear volcanoes arranged in a direction parallel to the present general direction of the Himalaya, viz. N. W. and S. E.; these volcanoes are now represented by the summits of Kaj-Nag and of the Kistwar and Badrawar and the peaks of the catenated chains of Cashmir. These volcanoes vary much in importance, but no doubt can be entertained of their general great activity, if we remember the enormous amount of ejecta which they have thrown out. The well

stratified arrangement of these ejected materials, especially those which are ejected in a loose and fragmentary condition, the amygdaloidal nature of nearly all the ash-rocks and some of the slates, and the existence of these slates interstratified with the volcanic rocks, justify the idea that some of the volcanoes were islands and others subaqueous craters, in a sea of moderate depth, and it requires no great effort of the mind to picture to ourselves an archipelago of fire-emitting islands in the Silurian sea.

At what time the volcanoes first out broke out, it is not at present possible to determine; they appear to have subsided at the beginning of the Carboniferous epoch; and though phenomena related to volcanic power, in the most general acceptance of that term, were not wanting during and after the Carboniferous epoch, yet it is certain, as far as we at present know, that no regular volcano ever existed in the western Himalaya after the great Silurian volcanoes had become extinct.

85. It has been remarked in many parts of the world that, when a volanic district is, after the extinction of all craters, so disturbed that fissures are formed in the crust of the earth, these fissures do not pass through the old volcanic accumulations, but rather at a little distance from them. This has been explained by supposing that the masses of porphyry, trachyte and other once melted rocks, which have been ejected in the original volcanic fissures and amongst the rocks near this fissure, have so much strengthened the crust of the earth in the site of that fissure, that a new fracture takes place anywhere rather than across or along the old crack. If instead of one old crack we have many parallel cracks, the new fissures will then naturally take a direction parallel to the old fissures and will be situated between them. This has been the case in the Himalayas, and the great lines of fracture which were formed at the last upheaval, are none of them along the catenated volcanic chains, but between and parallel to these chains. But the catenated chains or lines of linear Silurian volcanoes determined the direction of the great lines of fracture which were formed at the last upheaval. We see therefore in the Himalayas great lines of fracture running N. W. and S. E., these fractures present a downthrow on the S. W. and the beds of rocks north-east of them form the great parallel chains of the Himalaya. The general dip of all these chains, and indeed of all the

great beds of rock in these mountains, is towards the N. E.; an explanation of the cause of this dip will be given hereafter.

86. We have said that granite may be considered as the consolidated materials of "blind volcanoes;" that is, the cooled down masses of fluid or viscid matter propelled by internal tension towards the surface of the globe, but not with a force sufficient to overcome the resistance offered by the earth's crust. The soundness of this hypothesis appears supported by the metamorphic influence of granite over immense tracts of country: the conversion of shales, limestone, and sandstones and other rocks into gneiss, schist, marble and quartzite can only be explained either by supposing these shales, limestones, and sandstones to have been plunged deep into the bowels of the earth, there to be metamorphosed,—or else to have been the lid, covering and keeping under waves of fluid mineral matter. Now, the first supposition necessitates the assumption of very great disturbances of the earth's crust, of such disturbances as we cannot conceive or imagine by the analogy of anything we now see in the rocks of the surface of the globe. Neither is the idea of superficial stratified beds being plunged to a great depth into the earth, agreeable to the universal observation of a forcing-out power acting from the centre to the surface. The other supposition does not present the above-named objections: immense masses of melted matter may have approached sufficiently near the surface to have imparted great and continued heat to the deepest stratified beds, and may have underlaid great tracts of country, without disturbing, to a very great extent, the position of the strata which they metamorphosed. Hence do we find beds of gneiss, schist and marble retaining great regularity of stratification for very many miles; so much so, that it has been possible to classify these metamorphic rocks in regularly superposed formations, and to ascertain non-conformity between these beds, proving beyond a doubt their successive deposition.* It is impossible to understand how these beds could have preserved their relations, over a great extent of country, if it had been submitted, at one time, to a "*bouleversement*" so terrific and complete as to have plunged them under the solid crust of the earth, and, at another time, to the great upheaval necessary to bring them up again to the surface.

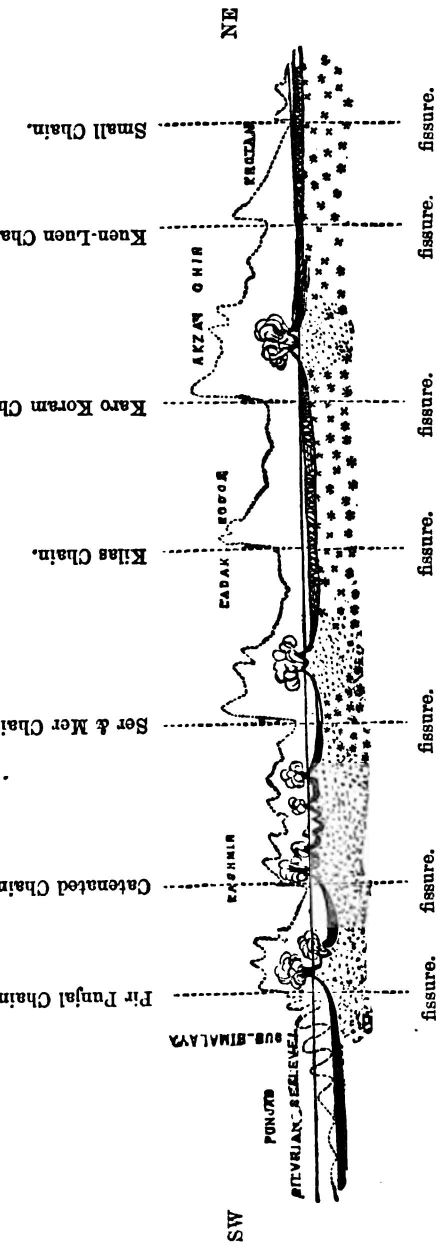
* The great example of this is Sir W. Logan's Laurentian formations in Canada.

It is hardly necessary to add that the rolling of this great wave of melted minerals, under a certain part of the earth's crust, would set all the deep-seated waters to boil, would sublimate certain metals and elements, and that steam at a great heat, and occasionally impregnated with various vapours, would add its metamorphic influence to that of the heat disengaged from the molten granite underneath, and would here and their percolate and alter certain distant beds which would have otherwise escaped metamorphosis.

It has been advanced that steam alone was sufficient to account for the metamorphism; to me it appears inadequate to the work, when we come to consider the extensive beds of metamorphic rocks seen in several parts of the world. No Geyser, ever so hot, has yet been reported to have changed shales in its vicinity into gneiss or crystalline schists, though, I admit, the influence is often evident enough in beds of limestone. On the other hand, we know that dykes of greenstone, of basalt, or of amygdaloid have often converted sandstone into hornstone or quartzite, and slate clay into flinty-state or jasper. It appears therefore evident, that heat is one of the most powerful, if not the principal agent of metamorphism; it appears also necessary that the heat should be long sustained to produce such a great extent of metamorphosed beds as those we are considering, and that it should be equally and uniformly distributed. It does not appear likely that this persistent and uniform heat was supplied by bursts of vapours, nor indeed have we any analogy in the present days of large tracts of country being sensibly modified by the permeation of steam. The slow cooling of a mass of molten mineral under pressure would be admirably adapted to the work of metamorphosing the superincumbent crust, over several hundred square miles of country.

If the hypothesis advanced just now be accepted, we have no difficulty in understanding the graduating of granite into volcanic rocks; it is indeed what we would naturally expect to see, wherever subsequent upheavals have exposed extensive granitic and trappean regions.

To facilitate the application of these remarks to the Himalaya mountains, let us make a theoretical section from the south-west to the north-east across the Silurian Archipelego of Kashmir and the sea to the north-east of it.



Theoretical Section for the S. W. to the N. E. across the Silurian Archipelago of Kashmir.

This theoretical section shows us a succession of volcanic islands or maritime or sub-aqueous volcanoes of which the base is a mass of melted matter, destined to solidify as porphyry, trachyte and other volcanic rocks, whilst the melted materials situated further from the vents are to solidify as granite. Over the granite, we find the crust more or less intact, though metamorphosed into gneiss, schist and marble; over the porphyries and trachytes we find that it has been removed and torn up by the ejecting power of the melted mass making its way to the vents. Over and between the volcanoes, we find a very thick bed of ashes, broken stones, agglomerates and lavas. Over the granite we find, after the gneiss and schists, stratified deposits of Silurian shales and limestone. After the extinction of the volcanoes, we find the whole sea-bottom covered with the fragments of animals of the Carboniferous period; and thus do we see in Kashmir the Carboniferous limestone resting conformably on the volcanic rocks, and not disturbed by their intrusion.

Of course many changes, oscillations, denudations and depositions took place between the extinction of the Silurian volcanoes and the great final upheaval of the Himalayas; but these changes do not appear to have been on a sufficiently grand scale to have affected, to any great degree, the lithological features of the earth's crust, in the portion of the globe we are considering. At the final upheaval, a series of new fissures were formed and are represented in the diagram above, and the position assumed by the several slices, between these fissures, is represented by the dotted outline. There are many more parallel fissures, I have no doubt, but they did not cause a great upthrow of one of their edges, and have therefore little to do with the general configuration of the Himalayas.

The position of the fissures, *between* the old volcanic lines, and not *on* them, has produced the phenomenon that nearly all the highest peaks of the Himalaya are not situated on the chain to which they belong, but a little distance from it. The fissures, taking place in the weakest parts of the crust, followed the old valleys between the lines of volcanoes, and the volcanic masses are therefore superior to the chain formed by the edge of the fissure by the height these volcanic masses originally possessed. It is also reasonable to admit that the movement of upheaval was more powerfully felt by huge masses of prophyry, trachyte, granite, gneiss, &c., which cannot be easily compressed or folded, than by the flat beds of dusts, slates, lavas, ashes and fossiliferous rocks.

87. Glancing now at the Afghan mountains, we find that their chains have a steady direction from the north-east to the south-west. We find also that, as far as has been ascertained, the dip is invariably N. W. or W. N. W.; that is, presents the same phenomenon as in the Himalaya, of the beds of rock rising towards the plains of India. This dip is that of all the rocks of the trans-Indus districts; it is that of the beds in Verziristan, and of most of the nummulitic strata in Hazara, and indeed, wherever it has been possible to examine it, it has been found to be north-westerly. We cannot therefore refuse to admit, that the strike of the Afghan mountains meets the strike of the Himalayas, and the dip of the latter being North-easterly and that of the former North-westerly, we are justified in concluding, that the whole of these huge mountains forms one and the same system of upheaval; that a tremendous dome or swell did surge up in the region of our Silurian volcanic archipelagoes, and that the Himalayas on one side and the Afghan mountains on the other are faulted slopes of a gigantic oblique anticlinal!

A true anticlinal it cannot be called; it is more properly the result of an incalculable force pressing outwardly the crust of the earth and endeavouring to raise it into a dome; and as such a dome could neither be raised nor settled down again without much fracturing of the crust of the earth, the lines of fracture followed the direction of the old volcanic lines, and on one side ran N. W.—S. E. (Himalayas) and on the other N. W.—S. E. (Afghan mountains).

No good explanation has yet been advanced of the general N. E. dip of the Himalaya; none has even been attempted of the N. W. dip of the Afghan mountains. By placing the axis of the dome between these two masses of mountains, and considering these mountains as the opposite jambs of an oblique anticlinal, the singular dip of both is satisfactorily explained.

88. Pl. XI. is intended to give an idea of the great fissures of the Afghan-Himalayan system of mountains.

We must not forget that the fissures went through portions of the crust, having a much greater power of resistance in some places than in others, being here brittle, there tenacious, here rigid and there easily bent; and we must not expect too much regularity in the fissures, but be prepared for occasional deviations from the general direction. The Miocene beds, which present the greatest uniformity of formation, have everywhere the most regular strike, in spite of their numerous foldings and faults; the great beds of felstone are also tolerably regular in their general dip, and so are the great beds of Carboniferous limestone in Kashmir, though of course the smaller beds, especially those close against high summits, have a local dip and strike. The interminable masses of metamorphic schists, described by travellers in several parts of the Himalayas, have also a steady N. E. dip, and Captain R. Strachey tells us that in that portion of the Himalayas which he examined, the N. E. dip was the general one. On the Afghan side of the oblique anticlinal the Miocene again presents the greatest regularity, and the Nummulitic formation nearly equals it; the dip of both these formations is very steadily towards the N. W.

Another cause which has no doubt contributed to break the uniformity of the parallelism of the chains is the pressure, in some places, of such enormous accumulations of volcanic porphyry as we see at the Kaj-Nag and in Kistwar and Badrawar. These centres of volcanic rock appear to have been very huge; they were undoubtedly solidified long before they became upheaved, as they were formed during the Silurian epoch, and did not receive their upheaval until the Tertiary period had been nearly run out. They were, therefore, raised up bodily as solid masses, and they had been too huge to arrange themselves in the general parallelism of the fissures. I have represented them in the plate as huge centres of volcanic action, regarding them as too enormous to be displaced by even the force which has uplifted the great dome of the Afghan-Himalayan system; they were merely forced up. The Sufed Koh and the Koh-i-Baba in the Afghan mountains occupy a similar position in relation to the parallel chains; the first named is probably a volcanic mass, and I have assumed that the other is likewise a porphyry centre. It is probable that certain granite masses have acted in a like manner; but it would be of little profit to speculate about those masses, knowing at present nothing positive regarding them.

The fissures just described being once formed, we have no difficulty in understanding how the slices of crust between them were compelled to remain in an oblique position, viz. dipping N. E. and N. W. respectively, when the settlement took place, if we remember, that a great deal of granite, lignite, porphyry, trachyte, &c. buried under the surface before the upheaval, had now been forced up and occupied a great portion of the room; unable to find space enough to resume a horizontal position, these bands of the earth's crust became impacted in the position we now see them.

89. Coming down from the high regions of the Himalaya and of the Afghan mountains to the Salt Range and the hills of the district of Bunnoo, we notice the interesting phenomenon of the tilting up of the angular extremity of the piece of crust that had been broken off, between the converging fissures of the Sub-Himalaya and the Sub-Afghan hills. This crop-fracture is just such as we see near the point of an angular piece of a window-pane which has been starred by a blow. The dip of the Salt Range and the Bunnoo hills is consequently disposed in a somewhat converging manner, such as is indicated by the arrows in Pl. XI.; the crop fracture is not a straight line; it is a succession of segments of a circle, and the dip of each segment is converging more or less towards the centre of its circle.

It is, however, possible that this breaking of the tip of the triangular piece of crust is only apparent, and that the segmentary and converging dip of the beds may be due to a complexity of resultant forces, at the place where the N. W. and N. W. dips meet.

To the south of the Salt Range extend the vast plains of the Punjab, Ajmeer and Marwar, covered mostly with clay and sand, often a desert without a hill or even a mound to relieve the monotony, and with hardly a pebble to be found for some hundreds of miles. So far south as Lat N. 27° these great plains extend without a break, and then we find the volcanic rocks of Central India, supporting here and there beds of sandstone with mammalian bones* similar to those which are so well developed in the Sub-Himalaya and Sub-Afghan ranges. Whether the whole, a portion, or none of the volcanic rocks of Central India are contemporaneous to those of the Himalaya, I know not,

* Bones of extinct mammals have been found in the Valley of the Nerbudda. South of Lat. N. 21°, no Miocene has ever been found.

though it is highly probable that some at least belong to the same epoch. I think it would be a most interesting point to study, whether the Central Indian Mountains participated in the great upheaval of the Afghan-Himalayan system, and to what extent they did so. Such a subject is not, however, to be discussed here, *en passant*. We must know more of what is buried under the alluvial sands and clays of the Punjab and the desert of Ajmeer, before we can decide on the relations of the Himalaya and Central Indian Mountains. The study of the Miocene beds appears the most likely sort of research to lead to interesting results. Could we once show satisfactorily that the plains of Northern India have been one day, and that not long ago (geologically speaking) a rugged country covered with Miocene hillocks and ridges, we should soon get an insight into the participation of the Central Indian Mountains in the great Afghan-Himalayan upheaval, and also into the nature of the soils and sub-soils of Upper India.

90. Let us now endeavour to sketch a geognostic history of the Afghan-Himalayan system of mountains, in accordance with the observations and hypotheses recorded in this paper.*

In the days of the Silurian epoch, the centre of Asia may be assumed to have been a sea uniting the Arctic to the Indian Ocean. In the middle of this sea, an archipelago of volcanic islands and subaqueous volcanoes existed, displaying great activity and ejecting into the sea an immense quantity of matter.

The position of these volcanoes and subaqueous vents is now represented by the porphyritic masses of Kaj-Nag, of Kistwar and Badrawar, by the summits of the catenated chains of Kashmir, &c., &c. The volcanoes were linear in their arrangement; one line, that of Kaj-Nag, Badrawar and Kistwar being continued far towards the south-east; and it is probable that the peaks of Chor, of Dodatoli and others in the same districts, are volcanic peaks on the same fissure. Another line or rather series of lines is that of the catenated chains in Kashmir, with a probable S. E. extension in the range of mountains which separate Lahool from Chumba. Another line again is that of Drass and Karghyl, at the back of the Ser and Mer

* A few unavoidable repetitions which occur in this portion of the paper will, I hope, be excused.

chain, and which is continued far towards the S. E., forming numerous and considerable volcanic mountains which appear as islands and promontories above the flat plain of the great Thibet plateau, through which the Sutlej runs.

These lines or fissures had a direction N. W.—S. E. and were all parallel, but the activity of the volcanoes was not the same on all the lines or in different parts of each line. Thus, in the line of Kaj-Nag and Badrawar, Chor and Dodatoli, the north-western end of the line is eminently distinguished and marked by very numerous and very long volcanoes, whilst the eastern one only gave passage to a few vents separated from each other by considerable intervals. On the other hand, (on another line) in Ladak, the volcanoes appear to have been small and few, whilst the eastern ends of the fissures appear to have been marked with many volcanoes of great size and activity. No volcanoes appear to have existed in that portion of the Silurian sea, where we now have the high mountains of Kailas and Karokoram; but where the Kuen Luen chain was at a later age to appear, it seems, that one or two lines of linear volcanoes did exist at the beginning of the Palæozoic epoch.

How long, how many thousands of years these volcanoes kept at their work, it is impossible even to guess. Their activity was immense, and it appears that in the waters which bathed the shores of the volcanic archipelago, too many outlets kept continually pouring out hot ejecta and noxious vapours to have allowed life to be present. We have seen that there is considerable evidence of the sea-bottom having been frequently heated enough to become cellular and amygdaloidal, and a reference to the section of the Tukt-i Suliman in Kashmir will, I think, leave little doubt of the frequency, the violence and the abundance of the discharges of lava, of lapilli, of ashes, and of hot liquid mud, We therefore find no Silurian fossils in Kashmir, and the slates and sandstones which are interbedded with the volcanic ejecta are completely deprived of fossils. This want of organic life did not, however, affect those portions of the sea which were sufficiently distant from the subaqueous craters and volcanic islands to escape the destructive effects of ejected materials; and we find, therefore, in the Karokoram chain and also in the Himalaya, between the Sutlej and the Kali, large beds of Silurian rocks with the usual fossils. These rocks are, as we have seen, slates and shales which have until now proved azoic, but covered in by limestone rich in forms of the older Palæozoic period.

I need hardly say that the azoic slates, shales and sandstones which are interbedded with the ashes and amygdaloids in Kashmir are of Silurian date; if we wish, therefore, to colour a map of Kashmir solely in regard to the age of the rocks, we should have to colour all the ashes, slates, &c. Silurian. As the volcanic ejecta much predominate in quantity over the azoic slates and sandstone, I have not coloured the mass solely by age, but rather in view of the nature of the rocks.

But the Himalayan lines of insular volcanoes were not the only ones in that portion of the Silurian sea which we are considering; other linear volcanoes were directed from the N. E. to the S. W. in the longitudes and latitudes where we now find the great Afghan mountains. We know very little of these mountains: we have seen, however, that volcanic rocks of a granitoid appearance form the ranges of hills between Yeusofzaie and Bonneyr, and that clinkstone, granular and porphyritic, is quarried at Jellalabad. Dr. Bellew also tells us that he noticed volcanic rocks amongst the southern spurs of the Sufed Koh.* He also mentions that sharp earthquakes are frequent in the valley of the Korum, and it is reported by the Povindas who trade through the Gulwaira Pass, that a city situated at the back of the Suliman chains has been destroyed by a terrific earthquake. I need not point out the usual relation of severe earthquakes with accumulations of volcanic porphyries, in countries where no active volcanoes have been known to exist for several geological ages past. Then we have seen that the summits of the main chain of mountains, in the Vuzeeri country, are mostly composed of volcanic rocks; but the greatest amount of evidence is

* After crossing the hill-pass of Hazrah-Shutur-Gardan, the road lies through a gorge, and a stream or rivulet flows to the westward; in the bed of this rivulet pebbles of porphyry, hornblende and syenite (?) were seen; the surface of the soil was also covered with similar pebbles............Near the top of the Shinghai Kothul, the volcanic rocks were again seen: Dr. Bellew says: "The surface was strewed with great blocks and fragments of porphyry and syenite, the latter was of various shades, from yellowish-green to greenish-brown, and its fragments shone with a vitreous lustre and broke with a similar fracture." *Chapter II. Narrative of a Mission to Kandahar.* The above description of syenite does not look much like syenite, it is nearly certain that the rock observed was a hypersthene rock.

derived from the boulders brought down by torrents and from those formerly carried down and now imbedded in the Miocene conglomerates which fringe the base of the Afghan mountains. These boulders and pebbles are mostly greenstone, felstone, trachyte, and porphyry identical with the Himalayan hornblende rock; and that peculiar variety of amygdaloidal greenstone, pierced with gas-vents, which has been described at No. 4 of the section of the Tukt-i-Suliman in Kashmir, para. 18, occurs in great abundance. (See also Pl. x. figs. 1. 1*a*.)

There can be, therefore, no possible doubt that the Afghan mountains were at the Silurian epoch an archipelago of volcanic islands and subaqueous volcanoes; indeed, they were merely another group of the same great archipelago; but the fissures or lines on which the vents were situated had a direction N. E., S. W.

Towards the end of the older Palæozoic epoch, the volcanoes appear to have subsided in violence, and allowed the waters of the neighbouring sea to cool. They did not do so, however, until they had ejected so much lava, scoriæ, lapilli, ashes, and debris of the inside of the earth that a great bar, a bar going from the North-west to the South-east and studded with the island-cones of half extinguished volcanoes, had been formed across the sea. A similar bar was produced by the Afghan group of volcanoes, directed N. E., S. W. and the two bars formed a gigantic V, with the angle pointing to the north. On these bars the sea was shallow; neither was it likely to be very deep between the two branches of the V. The end of the great activity of the volcanoes appears to have been marked by the breaking out of a great number of fumaroles or hot springs, depositing an immense quantity of silica, and forming thick beds of quartzite, sometimes pure and clear as glass, sometimes white and opaque as porcelain. We must not forget also, that all analogy points to a general rising of the sea bottom at the north-east of the Himalayan volcanic bar, not as a break, but as a gradual and slow upheaval of the earth's crust under the pressure of viscid granite.

But even these last efforts of the great volcanoes, these bursts of vapours and hot waters, became rare and intermittent, and animals made their appearance in the creeks and bays of the sea between the islands. It was then the dawn of the Carboniferous epoch, and all over the great bars of volcanic debris a calcareous mud was deposited, teeming with the remains of animals, with the glimmering shells of the *Producti*, with large flat *Orthidæ*, and innumerable *Bryozoa* and numerous *Encrinites* which grew luxuriantly on the half chalky, half clayey, fœtid bottom of well protected island seas, gulfs and channels. And so it went on for years and years, until the sea became too shallow for *Producti* and *Orthidæ* to live in, and too easily disturbed to its very bottom to suit the delicate *Bryozoa*. These animals retired to greater depths on either side of the great bar, and in their stead appeared small *Cucullæ*, globular *Terebratulæ*, with here and there, on sandy banks, colonies of large *Cardiniæ* or *Anthracosiæ*, gibbose and smooth *Aviculo-pectens*, or radiated ones of great size. In calm waters, flat and large species of *Goniatites* basked in the sun in company with small *Orthoceratidæ* and large species of *Bellerophon*. Earthquakes were, however, frequent and terrible, raising and depressing large tracts of sea-bottom, folding and undulating the newly formed beds of limestone, so that most of the shells are found broken, and many of them are deformed to a wonderful extent.

Many changes occurred in the sea: clay and sand had been brought down in large quantities from the volcanic islands, and many of the creeks and inland seas were turned into swamps. Long shelving coast-lines extended from island to island, and many groups of the great archipelago were probably united by a low land into larger insular countries. The genera *Cucullæa*, *Cardinia* and *Aviculo-pecten*, and small *Brachiopoda* disappeared; and in their stead myriads of *Gasteropoda*, especially the *Pyramidellidæ*, living with numerous corals, made their appearance. As the islands joined more and more into larger dry lands, and approached nearer to a long strip of land supporting numerous peaks of extinct volcanoes, the rain-fall increased more and more, sand, mud and gravel accumulated in thicker beds at the mouth of the mountain torrents which now became rivers, and on the swampy shores forests of calamites and other trees grew up, whilst, out at sea, the mollusks and other animals continued to thrive at various depths, according to their kind. What has now become of these forests of calamites? Have they been buried in sands by oscillations of the coast and converted into coal? If they have, has the coal been denuded at a subsequent period? or has some portion of it escaped removal and does it now lie concealed under newer formations? There is no doubt that great denudation has taken place repeatedly in the Himalaya and subordinate hills; yet basins nicely protected by eruptive or metamorphic rocks, bottoms of valleys or down-thrown beds might have escaped removal. Not a trace of true coal has yet been found in the Himalayas, the Punjab or the Afghan mountains, excepting (geologically speaking) the few grains of coal which fill in the cellular tissue of the lepidodendron-like plants described in para. 43, as having been found in one of the layers of the Wean group. This is not very encouraging; but any person who has observed what a thick mantle the Miocene sandstones and the old and new alluvia form over the older formations, would not expect to find coal cropping out in a conspicuous manner. If coal does exist, it will be one day discovered, no doubt; but the discovery will be made by patient and careful study, and not by digging at random with a pickaxe wherever something black is observed. It may be said with truth that the means hitherto employed, by Government or persons interested in the search for coal, have been such that not the smallest reasonable chance of success could be anticipated.* But all this is foreign to our subject.

91. The end of the Palæozoic epoch or beginning of the Secondary period was marked by new volcanic action, trifling indeed, if we compare it to the intensity of volcanic power displayed during the Silurian time, but yet highly interesting. I allude to these local outbursts of hot vapours, gases and waters, charged with several minerals, which have taken place in many distant places of the Himalayas and their dependencies. The action is geyserian rather than volcanic, as no true volcanic rocks, that is, no lava, no scoriæ and no ash appear to have been discharged by these vents. The existence of this force is mostly manifested by the metamorphism it has caused in some of the upper beds of the Carboniferous limestone, and by the peculiar way it twisted rocks, then soft, in a manner which appears now incomprehensible, and totally abnormal to the surrounding layers. In some localities, however, it seems that the waters, erupting through the calcareous mud, were so rich in felspars, that this crystallised in

* This remark applies only to the Punjab and the mountainous districts studied in this paper.

minute crystals which now form a sort of intrusive band of a friable incoherent rock.

When this geyserian action subsided, the Palæozoic animals had died out.

92. I now enter upon debatable ground. I have said before, that the salt, gypsum and red marl of the Salt Range—and I need hardly say the gypsum and red marl of Spiti, the gypsum of Rukshu (and that of Rodok ?), and most probably the salt of the Yarkandkash valley, and also that of the Lataband mountains in Badakshan, all belong to the same epoch and have probably a common origin. I have said before that, this Saliferian formation has been placed by Dr. A. Fleming in the Devonian. Dr. Jameson makes it superior to the Carboniferous; Major Vicary and M. Marcadieu believed it to be Miocene or Pliocene; some will have it volcanic, others sedimentary; but nobody gives a good and well defined section of the relations of this formation to the rocks above and below it.* This is much to be regretted, and I will not increase the confusion by discussing here the reasons which make me believe that the salt and gypsum of the Himalayas belong to the Trias or the Permian. My opportunities of observing the Saliferian formation have been few and of short duration, and I have no good section to give in support of my opinion. I shall therefore refer the reader to the note to para. 64, and proceed with the next formation.

93. Whatever had taken place beeween the end of the Carboniferous epoch and the beginning of the Jurassic, it appears tolerably evident that the Jurassic sea bathed the shores of a long strip of land or succession of large islands, very similar to those which the Carboniferous sea had bounded. The Jurassic sea does not appear to have been much deeper than the Carboniferous one had been; the same impurity of the limestone is noticed, the same admixture of sand and clay with the calcareous matter, the same rarity of clean drifted sands, the same prevalence of thin-bedding, false-bedding and continual

* Dr. A. Fleming gives some sections in his Report on the structure of the Salt Range; but only two of these show the relations of the salt marl to the Carboniferous limestone, and in one, sect. No. VIII., a number of more or less theoretical faults are introduced which, if placed at the base of the mountain limestone escapements, would then make this rock inferior to the salt. Another section, No. VII. shows an anticlinal across a ravine, and then the salt marl appears indeed to be placed under the Carboniferous limestone.

change of the nature and weight of materials. All these conditions, and the frequency of ripple marks, indicate a shallow sea easily influenced by heavy outpours of muddy waters from the land. The thickness of the Jurassic rocks vary veries much, and the extent of the beds is limited to very small areas, compared to those of the Carboniferous. This is probably due to the deposition taking place in creeks of a deeply indented coast, and in great part to the oscillations of the land and sea bottom, causing in some localities repeated denudation of materials newly deposited, and in others a steady sinking and consequent thickness of formation. The fossils being frequently much deformed, is a good evidence of these oscillations having taken place.

The Jurassic beds have always been considered conformable to the Carboniferous. I am inclined to believe that this conformity is only apparent. The dip of both formations is generally great, seldom under an average of 45°. In such highly up-tilted beds, a difference of a few degrees is not easily appreciated, unless a careful measurement is taken, and I fancy that most writers have been satisfied with an approximation. However this may be, there is no doubt that the Jurassic limestone presents, in very many places, indeed in most, the appearance of having sustained very sharp local upheavals, soon after the end of the Secondary period, but of little extent; and here again we find the salt, gypsum and red marl always underlying these sharp and dome-like anticlinals. We remember how Sheikh Bodeen is thrown into a succession of short, gothic, arch-like anticlinals; and that under the Jurassic beds the Saliferian are to be seen, perfectly conformable to the limestone and following it in all its oscillations. At Maree on the Indus, a similar appearance occurs: thick masses of salt, gypsum with bi-pyramidal crystals, quartz, red marl and magnesian mud stone more or less cellular, support a very sharp anticlinal of Jurassic limestone; and the Saliferian and Jurassic are conformable not only in general dip, but in all the details of the fold. Moreover, both the Silurian and Jurassic dip S. (2 or 3 degrees E.) and N. (2 or 3 degrees W.) on both sides of the anticlinal dip, which are not the usual ones of the other rocks of that portion of the Salt Range, the Nummulitic and the Miocene dipping N. E.

Whether these local upheavals are merely due to the swelling of the gypseous beds from the change of anhydrite into common gypsum by absorption of water, is more than I can say. The Saliferian beds would naturally break, dislocate and lift up the superincumbent Jurassic when swelling itself into undulations. We should thus obtain undulated beds of Saliferian and Jurassic. Let such undulated layers be submitted to the lateral pressure which must have accompanied the great upheaval of the Afghan-Himalayan system, and we have the undulations folded into arches and sharp bends.

The Saliferian and Jurassic have been very much denuded, their debris being extremely abundant in some beds of conglomerate and sandstone of the Miocene, especially on the western side of the Indus, in the districts of Kohat and Bunnoo.

94. There are but few traces of the deposits which may have taken place between the Oolite and the Nummulitic, and I have never myself seen any cretaceous rocks in the western Himalaya* or the Afghan mountains, neither have I found any pebbles with cretaceous fossils in the conglomerates of the Miocene. From the development of considerable vegetation in the shales near the base of the Nummulitic formation, it is evident that a steady rising of the land went on during the time of the upper Jurassic and Cretaceous periods, and with such a rising we would naturally associate the great denudation of the Jurassic beds, soon after their deposition. Little doubt can be entertained that during the Cretaceous period, the Himalayan and Afghan islands had become united into a continent of considerable extent, traversed by chains of extinct volcanic ridges, and therefore receiving an abundant rain-fall which caused great denudation. We know how quickly volcanic mountains decay, when once they have ceased to receive fresh supply of ejecta. I believe that the cretaceous beds which have been found in and near the Himalaya are very limited in extent, even more so than the Jurassic beds. The small horizontal area of these Secondary beds contrasts widely with the great superficial extent of the Carboniferous, the Nummulitic and Miocene formations; and yet when they do occur, the Jurassic beds at least have considerable power. A continent with a deeply indented coast appears to be indicated by these peculiarities of the Secondary beds.

* Dr. Stoliczka has found Cretaceous rocks in the mountains of Spiti. *Editor's note.*

95. The Nummulitic epoch must have been a long one, if we can judge by the thickness of its deposits. There does not appear to have been any violent volcanic action, nor any great and sudden movement during the period, but there was a great deal of very slow and probably imperceptible oscillation. Thus we first find the base of the Nummulitic to be generally a sandstone without fossils,* this is gradually impregnated with calcareous matter, becoming a sandy, very impure limestone, full of shallow water fossils and containing only a few very small species of Nummulites. This has been therefore a period of slow and trifling sinking of the land, and it is probable that the sea never covered it by more than a few feet. Then the oscillation went the other way, and the land appeared again, and was covered by forests. Another slow sinking brought on a fresh incursion of the sea, which soon covered the forests (lignite) with a layer of limestone, full of large Nummulites and other shells. The depth of the sea was greater than before the growth of the forests, but it probably did not much exceed 20 fathoms. Another movement upwards again exposed the land, and again forests grew and formed thin seams of lignite. Again the land sank and the sea covered in the lignite-beds with calcareous mud. At first the depth was trifling, little exceeding 20 fathoms, but the sinking continued to the end of the Nummulitic period, and the limestone assumes more and more the appearance of a deep-sea formation as we get higher up the series. It is, however improbable that the volcanic mountains of the great bars of the Himalaya and Afghan mountains were ever covered by the Nummulitic sea, as no nummulite has ever been found amongst the central chains;† but that sea filled up the whole of the space between the arms of the great everted V formed by the Himalayan and the Afghan chains, and probably also bathed the outside shores of the arms of the V. This slow, gradual and long continued sinking of the land, during the deposition of the Upper Nummulitic formation, accounts for the appearance of no great depth in rocks which have

* Sometimes a fragile limestone with *Planorbis*, and probably fresh-water. See note to para. 66, chap. iii.

† Dr. T. Thomson reported having observed Nummulitic Limestone in Little Thibet at an elevation of 16,500 feet. But I much doubt the accuracy of the observation, and cannot help imagining that the Thibet nummulites are, like those of Manus Bal, weathered encrinite rings. See "*Introduction*," page ii.

a very considerable thickness; the sinking was, however, greater than the amount of deposit could compensate, and the rocks have therefore the appearance of a tolerably deep sea formation at the top of the Nummulitic series. Then again, we have a long and steady rising of the land, and in consequence a great denudation going on, a denudation which has caused the removal of a great deal of the Nummulitic formation, in localities where sea-currents, high-tides and other unfavourable circumstances assisted in the work of destruction. It is curious to notice on the top of the Nummulitic limestone, how the surface of the rock has been broken by the waves; how the fragments have been rolled and rubbed and then glued together again. This appearance is always seen as a bed of transition between the Nummulitic and the Miocene. A considerable time must have elapsed between the end of the deposition of the bed and the breaking up of it, as we must allow time for its solidification. But at any rate, here, at the beginning of the Miocene epoch, we had the Nummulitic limestone forming a nearly horizontal and far-reaching sea-coast, covered with a very thin sheet of water, rolling and polishing pebbles. But this conglomeratic layer is thin, and we very soon see a large quantity of mud and sand, and pebbles of far distant rocks, brought down to the sea.

96. Let us consider the kind of map we have at the beginning of the Miocene epoch, and we will have no difficulty in understanding the formation of the Miocene sandstone and conglomerates of the Sub-Himalayan and Sub-Afghan chains. We have an immense expanse of sea, north of the tropic of Capricorn, between the latitudes 90° W. and 90° E., for, in these days, the Andes had not yet surged up and most of South America was under water, as well as nearly the whole of Africa, Arabia, Persia and India. There were probably groups of islands where these continents now stand, but the immense, dry, thirsty plains and plateaux of these countries were then under the sea. There was therefore no impediment to the regular play of the Trade Winds, no monsoons or winds deviated by the rarifying power of arid deserts, but especially no chains of mountains to dry the S. E. trade-winds before their arrival at the equator, and their ascending to become upper currents with a direction to the N. E. At the tropic of Cancer, these winds, still charged with the whole of the

humidity they had sucked from the sea in the Southern Hemisphere, descend again and become under or lower currents, keeping their N. E. direction.* Before proceeding far, these winds meet a couple of ranges of mountains forming a great everted V, opening to the south, and on these ranges they poured such a quantity of rain that a denudation began to take place to an amount nowhere else exemplified. The only approach to this rain-fall is that now observed in Patagonia, a high country which happens to be situated in the Southern Himisphere, somewhat in a position analogous to that of the Himalaya in the Northern Hemisphere during the Miocene epoch. In Patagonia "Captain King found the astonishing rain-fall of "nearly thirteen feet (151 inches) in forty-one days; and Mr. "Darwin reports, that the surface water of the sea, along this part of "the South American coast, is sometimes quite fresh, from the vast "quantity of rain that falls."†

We are now therefore prepared to anticipate a formation composed of coarse debris of the older mountains, washed down by violent torrents; we understand how it is that the waters of the sea lost their saltness, and that marine shells deserted these regions, and are therefore not to be found as fossils, or are at any rate excessively rare. The continual and violent rushing of streams, charged with mud and boulders, did not allow of the development of fluviatile animals; and thus we find the lower Miocene a mass of clay, sand and large boulders, in beds considerably false-bedded and totally free of fossils, with the exception, in a few protected localities, of some bulrushes imbedded in salt. These torrents occasionally tore up forests from the mountain sides in their headlong course, and thus it is that we find here and there small niduses of semi-carbonized wood, interred in the sandstone. The masses of conglomerate, accumulated in certain places, are of tremendous size, and probably mark the exit from the hills of the principal torrents of the Miocene Himalaya. The deposit of this coarse debris of the old volcanic chain and of the several deposits which had become gradually accumulated round it, attains a thickness of no less than 5,000 feet, and probably in some places much more. This mass of

* See for a general explanation of the routes of the winds and the causes which alter these routes, the work of Captain Maury, L. L. D., U. S. N. entitled, "The Physical Geography of the Sea and its Meteorology."

† Maury's Physical Geography of the Sea and its Meteorolgy. Page 129

clay, sand and boulders could not fail to convert the sea, which we have seen was shallow, into dry land, and thus we have this overlapping of the Upper Micoene on the edge of the Lower which is represented at para. 11. The Lower Miocene was itself exposed to the denudating influence of the rain, and boulders of Lower Miocene sandstone are common in the Upper Miocene.

The Upper Miocene appears to have been altogether a fresh-water formation; I mean, an accumulation of materials brought down by rivers of large size, which, in all probability, wandered through the flat plains of the lower Miocene, and extended in deltas and marshes and creeks, just as the Ganges and the Indus are observed to do now-a-days. We may fairly imagine these Miocene tracts to have resembled closely a modern Indian plain traversed by large inundating rivers—a thick jungle of high grass and small trees for the elephant, the mastodon, the monkey. and a host of other animals to dwell in, and on the sides of the large meandering rivers, wastes of sand and clay, shallow pools and quicksands for the delight of the crocodiles, the tortoises and the hippopotamus. On sands left dry by changes in the course of the rivers, or piled up in undulating hillocks by the winds, grew thinly planted trees, such as we now see in the sandy tracts of Scinde, to feed and shelter the camel, the giraffe, and innumerable deer of various species; and on intermediate lands, good pasture supported the horse, the ox and sivatherium.

In the districts of Rawul Pindee, of Jheelum, of Bunnoo, of Kohat, the Upper Miocene has a thickness of more than 2,000 feet; but in the Rajaori and Poonch provinces of the Maharajah of Jummoo's kingdom, the bed attains a much greater thickness.

Any one who travels through the plains of the Punjab will notice the great quantity of cows, of oxen and horses seen loose on the sand near every village, and will remark at the same time, that when a stream has cut through the sand and thus exposed a section, not a bone is seen buried under the surface. If, however, he comes to a marsh, such as the one near Guriwall, in Bunnoo, he will observe that the bones will remain perfectly preserved in the thick mud, saturated with *kullur*,* which forms the bottom of the

* Impure Sulphate of soda, with a little carbonate of soda and chloride of sodium, which impregnates, more or less, nearly the whole of the soil of the Punjab, and effloresces on the surface after rain or irrigation.

marsh. Now this *kullur* appears to have existed in the soil of the Upper Miocene, as the sandstones of that age are often covered with an efflorescence of that salt; and, indeed, that now seen in the alluvium is derived from the disintegrating, decaying and washing away of the Miocene beds. The fossil bones are always found either in a dark clay-stone, which has a bitter taste when applied to the tongue, or in a light-coloured sandy claystone. It is therefore highly probable that the existence of a marsh or swamp is necessary to the preservation of bones and their fossilification. This accounts for the bones being found in beds of limited extent, whilst for many miles not one is to be discovered; but it also brings additional evidence that the Upper Miocene was deposited as a growing delta, similar to the Sunderbunds of the Ganges and to the creeks of the mouths of the Indus.

What a singular landscape this belt of land must have presented! If we remember that at least seven different species of elephants roamed in these jungles, some much larger than the living one, and with tusks nine feet and a half long; that the dinotherium had a skull three feet and nine inches in length; that the mastodon was 17 feet long from the tail to the end of the tusks; that the sivatherium was a gigantic four-horned antelope-like animal; that the crocodiles were much larger than they are at present, and that the tortoises had a shell measuring 20 feet across; we may wonder indeed at the strange appearance which the jungles must have presented!!

I have called this fossiliferous formation Upper Miocene. In placing it in the Miocene, I have adopted the general opinion of geologists, but it may be Pliocenic and not Miocenic. I have not succeeded yet in discovering shells in these beds, and without shells it is impossible to fix with certainty the age of the formation.

I have forgotten to notice, that during the whole of the Miocene epoch there was a slow and steady sinking of the land. This sinking allowed of the accumulation of materials to the great thickness I have indicated, but unlike that which took place during the Eocene period, it was not sufficient to keep the country under the sea, the quantity of sand and clay and boulders, deposited by the rivers, being more than adequate to compensate for the sinking. The country, however, by the sinking was kept to a very little height above the sea level, and the inundations of great rivers added continually to the thickness of the deposit.

97. There is no evidence of any violent action having taken place during the Eocene and Miocene epochs. There had been risings and sinkings of the whole country, but these were imperceptible to the senses, and were probably not more active than the same phenomena which now occur in many parts of the world, unknown to the inhabitants. The belt of flat land had increased to a good breadth, and the coast had become sufficiently distant from the mountains to enable the animals to live in peace and plenty, away from the storms and torrents of the hills, when the whole of the portion of the earth we have been considering was raised into an immense vault, by the forcing up of granite assisted by gases. When the gases condensed or escaped, the arch settled down by fracturing its sides, and these faulted sides of the arch are now, what we call the Himalayas and the Afghan chains of mountains.

When the settle-down began to take place, and the sides of the arch or vault were being broken, the direction of the linear volcanoes of the Silurian epoch compelled the new fractures to conform to it. On the eastern slope of the vault, the fractures ran from N. W. to S. E., on the western slope from N. E. to S. W. As is generally the case in an anticlinal, the highest portion of the vault settled down again to a level much lower than the sides, and we have therefore, in the northern Punjab, low hills, whilst on each side we have mountains towering to the sky.

It is not necessary to enter here into all the details of the complications which the masses of porphyry, trachyte, granite and other rocks, which had been cooling ever since the middle of the Palæozoic epoch, caused in the upheaval of the Afghan-Himalayan vault and in its settle-down. These details have already been sufficiently indicated in paras. 81 to 87. But I will insist on the effect of these masses being forced up like wedges through the rocks which covered them, and by their filling up a great deal of the space once occupied by these covering rocks, they compelled these last to be either folded or broken into pieces and packed edgeways.

It is not necessary to imagine that the top of the vault was raised to the same height as we now see the great peaks of the Himalayas

In the settle-down, the parallel zones, into which the sides of the vault were broken, would naturally assume an angle of dip much greater than was that of the vault previous to its fracture, as the sides of the vault, in coming down again, would be submitted to considerable pressure, and therefore much redressed. It is not unlikely, therefore, that it is the effect of this pressure which has caused, in many mountains of the Himalayas, the appearance of younger rocks dipping under older, of felstone under porphyry, of schist and gneiss under granite.

The geologist must naturally expect to find a great many complications amongst these immense mountains. The view I have endeavoured to explain is a general one, and will, I hope, be better substantiated when we know more of the countries of the Afghan-Himalayan system. With a little thought, I entertain a hope that the geologist, in finding apparent contradictions to what I have advanced, will always be enabled to discover the cause of the complication, at first apparently irreconcileable to my hypothesis.

There is one more remark to be made. The direction of the Silurian linear volcanoes of the Himalaya not being parallel to that of the Afghan chains, we have not a true anticlinal, but an oblique one. At the northern end of the axis of this oblique anticlinal, we have therefore a pressing of the sides one against the other, whilst at the southern end, we have a wide divergence of the ridges : at the northern end of the axis, we have the chains abutting one against the other, and thus supported at a great height ; at the southern end we have the central beds unsupported and sunk down very low when the settle-down took place ; hence the high plateau of Pamer at one end and the low plains of India at the other. Again, when the Himalayan slope of the anticlinal was settling down, many of the great masses of porphyry, schist and gneiss resisted the general tendency to dip N. E., and caused a local fault to take place. This fault acted as the axis of an anticlinal for the locality immediately surrounding the mass of porphyry, schist or gneiss ; and we find therefore such huge masses assuming the dip of the western branch of the Afghan-Himalayan anticlinal, or dipping N. W. Hence, the singular phenomenon, long ago noticed by Captain R. Strachey, that some of the great peaks of the Himalayas dip N. W., whilst all the beds round them dip N. E. It is also this same obliquity of the anticlinal which has caused these numerous transverse faults observed in the Himalaya, which have a general direction from N. to S., and with the beds crushed one against the other at the northern end, whilst the fault gapes at the southern extremity.

All these phenomena, and several others which strike the naturalist as he travels through these mountains, appear to me to prove without a doubt, that the upheaving force was not applied at one certain point or along one certain axis, but that the whole country, now covered by the Afghan and the Himalayan mountains, was forced up into an immense dome or arch, which broke along certain lines determined by pre-existing volcanic zones, and settled into an oblique anticlinal, of which the slopes are sliced by a succession of parallel faults.*

98. It is a question of considerable interest to determine, with some precision, the epoch at which the great and last upheaval of the Himalaya occurred. We know that it was after the great mammals had become developed; and the extraordinary number of mammalian species found in the Sewalik hills would naturally induce one to consider a portion at least of what I have called the Upper Miocene as older Pliocene. The Aralo-Caspian formation or steppe limestone, a brackish water deposit, has been placed by Murchison and DeVerneuil in the older Pliocene; and one cannot help thinking that these shallow but immense inland or inter-insular seas must have existed previous to the final upheaval of the great mountains of Central Asia, and that it is indeed movements connected with this final upheaval, which have dried up the steppe-limestone and reduced these great seas to their present dimensions.

On the other hand, we have seen, that there exist in Thibet and in Ladak great beds of horizontal deposits, unconformable to the beds on which they abut, and containing fossil bones. Captain R. Strachey appears inclined to believe these beds to have been deposited previous to the upheaval of the Himalaya; but I think the hypothesis is not tenable, as it is impossible to understand how a "true sea-bottom

* The hypothesis (advanced, I believe, by Professor Ansted in his "Ancient World") that the rising of Central Asia caused a depression in the Indian Ocean, marked by the coral islands of the Lacadives, the Maldives, the great Chagos bank and some others, is ingenious; the depression, however, requires proving by actual observations.

could have been uplifted from under the sea to an elevation of 15,000 feet," without losing its horizontality, whilst not only the beds on which the "true sea-bottom" rested, but the probable contemporaneous beds of the Sewaliks (according to Captain Strachey's hypothesis only,) are dipping N. E. at a high-angle. Captain H. Strachey describes the same bed, where it extends into Ladak, as old alluvium, and mentions its containing fossil bones of extinct mammals. Captain Godwin Austen calls these beds, in Ladak, Rodok and Skardo, a fluviatile deposit. The bed is not limited to the belt of country situated between the Ser and Mer (Snowy Peak Range) chain and the Kailas chain. It is well developed in Rodok, near the Pang Chong Lake and up to the foot of the Korakoram chain, and it is very probable that the great Desert of Aksai Chin is a similar bed. I have said, in another place, that I believe these horizontal beds to be identical to the Ragzaier or elevated plateaux of the Afghan mountains. How were they formed?

In order to answer this question, let us consider what was the physical topography of the Himalayas soon after their final upheaval. There was not much difference in the configuration of the great ocean between the tropics; if we are to believe the geologists who have studied the Andes, these mountains had not yet appeared; the great plains of Africa, Arabia, Persia and India, were still under water; the mountains of the Indian peninsula may have appeared (and did probably appear at the time of the Himalaya's last upheaval) but were separated from the Himalaya by a considerable sheet of water; the great inland sea now represented by the desert of Gobi was not yet dry,—in short, there was little cause to diminish the humidity of the winds which blew from the south, and there was nothing to change their old direction. But the Himalayan and Afghan mountains were very different from what they had been. Instead of low ranges with volcanic peaks which did not probably soar above 5,000 or 6000 feet, we have now an immense wall, some hundred miles broad and 25,000 feet high, with deep longitudinal valleys offering no exit and much embarrassed by detached rocks and debris. The humidity of the winds which produced the tremendous rains of the Miocene period was now deposited as snow. Huge glaciers appeared and filled the longitudinal valleys, and the rivers which ran from them began to deposit a sediment which, in time, formed the great flat plateau of Thibet, Rodok, Aksai Chin, &c. &c. Thus we see the altered physical conditions which were brought about by the difference of elevation of the Himalaya, before and after its final upheaval. Before the upheaval, the humidity was collected as rain, and the mountain debris was washed to the coast by boisterous torrents; but after the upheaval, the humidity was collected as snow, and the mountain debris was quietly collected in the great valleys, under the cover of glaciers.*

All the while, a different action was going on in the outer or low Sub-Himalayan ranges. There the humidity continued to fall as rain and great denudation was the result. The same process of land gaining over the sea, which I have described at the Miocene epoch, began to form the plains of India; this process is still in operation now-a-days, but necessarily its power diminishes in intensity as the sea-coast becomes more distant from the hills and the course of rivers becomes longer. It is the process which is now anxiously watched by the pilots of the Hooghly, and which no engineering skill can avert: the sandbanks advance in the sea, the river-bed fills up, more dry land appears and what was yesterday a dangerous shallow out at sea, to-day is the shore of the delta, and to-morrow will be far inland.

As the plains of India extended, the rain-fall of the Himalaya diminished. Even if we suppose the humidity of the winds to have been the same as before, we must deduct from the Himalayan rain-fall the amount of rain which fell in the plains. But we know that the humidity of the rains had also become less; the Andes had surged up and the South-American continent had appeared; the plains of Africa, Arabia, Persia and Central Asia were gradually appearing above the waters, and instead of the trade winds, the monsoons were establishing themselves. There was therefore a great diminution in the snow-fall on the Himalayas, and the glaciers began to decrease and to expose a great deal of the plateau on which they had gradually raised themselves. It is easy to understand how this decrease of snow-fall

* The filling up of the great parallel valleys of the Himalayas by mud and boulders, under the cover of the glaciers, is analogous to the filling up of depressions of the surface by the glacial drift in some parts of Europe. The glaciers of the Himalaya, soon after the great upheaval, were too huge and too general to have had a ploughing and scouring action on the valleys.

must have been very gradual, if we keep in mind what brought on that decrease; and as the glaciers retreated, animals advanced and soon populated the high plateau of the Himalaya. These animals have left their remains interred in the clayey grits of these elevated lands. It may appear strange that elephants once lived at such a great height, and in a climate so cold, but the osseous remains found in the elevated plateau of Mexico belong to true elephants of extinct species,* and the Siberian mammoth which was covered by a warm fur, lived on the leaves of conifers and roamed over the ice-drift. There is therefore no doubt that these animals had a great plasticity of organism, and could adapt themselves to very extreme climates.

The mammals discovered in the plateau of Thibet and Ladak, all belong to extinct species. On the other hand, all the shells which I have been able to collect in the old alluvium found near the foot of the Sub-Himalaya belong to living species, and it is therefore most probable that the older alluvium of the plains of India, and the high plateau of the Himalayas belong to the post-pliocene epoch.

From the above considerations, and the present state of our knowledge, it appears that the Afghan and Himalayan mountains suffered their last upheaval during the pliocene period.

99.—The description of the deposition of beds subsequently to the great upheaval has been given incidentally in the preceding paragraph; the glaciers began to melt, great lakes were formed in several localities. The Kashmir valley is a good example, Rukshu is another, and so is Abbottabad valley. These lakes at first fed large rivers, and both lakes and rivers had a considerable power in carrying mud, sand and boulders, and thus raising their beds by several hundred feet; but as the waterfall diminished, the lakes and rivers diminished also, and the rivers soon began to cut for themselves deep ravine-like beds in the middle of their ancient bottoms, leaving on each side a great river-terrace.

Before the rivers had lost their great volume, however, and while they filled the whole of their original beds, they floated icebergs of sufficient dimensions to carry blocks of stone of great size. The Salt-Range for a time intercepted the free passage of the waters towards the south and a shallow lake filled the whole country between it and the

* Cosmos, Otte's translation, Vol. I. page 280.

Munee Range.* On this lake floated the icebergs brought down by the rivers, drifting gradually to the south, and finally grounding near the Salt-Range or averted by it. Thus we see between Jubbee and Nikkee large erratic blocks, being porphyry, resting on the top of the old alluvium; and we find similar but smaller blocks imbedded in horizontal taluses of debris which have been piled up in horizontal layers against the hills of Maree on the Indus. These blocks are not water-worn, but present either flattened or scratched surfaces; the ground all over that district is covered with boulders of porphyry, greenstone, felstone, &c. but these boulders are well rounded and are easily traced to disintegrated beds of Miocene conglomerate. The erratic blocks are very different in appearance, and have the striking, or somewhat odd and *déplacé* aspect peculiar to erratics. One of them, three miles south of the village of Thrapp, measures 6 feet 4 inches by 7 feet 4 inches and 5 feet. There are four or five smaller blocks near it, but none are rolled; they are all of the gneissoid porphyry of the Kaj-Nag. The largest presents the very singular appearance of having its greatest flat surface (not vertical) marked with a number of cup-like holes of various size, from 6 inches across to the size of a walnut, and from 1½ to 2 inches deep. There are from 70 to 75 of these cups. They resemble wide rounded holes or cups, as water would make by dropping. Whether these cups are a glacial effect, or have been made by a race of men for some unknown purpose, is, what I am unable to decide. I am inclined to the first hypothesis.

Erratic blocks near Thrapp.

100. The oldest indications of Man having become an inhabitant

* The damming of the water behind the Salt Range and the Chitta Range was the cause of that thick deposit of silty mud now cut by ravines, which has been the source of so much difficulty and expense in making the great Trunk Road between Jheelum and Attok. A similar damming occurred in the Huneepor valley and several other localities, but to a less degree.

of the Himalayas is, at present found in the Upper Lacustrine deposit of Kashmir (see note to para. 44). This deposit contains a very great many fragments of pottery, bones of goats, and pieces of charred wood. It is much older than the Buddhist ruins of Avantipoor, and attests the presence of man in the valley during the period which elapsed between the first and the second lake. The Buddhist ruins were not built until after the second lake had been drained. But though we may call the race of men who lived in Kashmir before the second lake historically ancient, they cannot be considered so geologically: a cowry has been found* in the deposit, and this evidence of a currency indicates at once an amount of civilization and trade far removed from the state of the primitive races.

(To be continued.)

Experimental Investigations connected with the supply of water to Calcutta, Part III.

By D. Waldie, Esq.,

F. C. S. &c.

(Continued from page 8.)

[Received 1st March, 1867.]

The present communication is intended to give an account of the results obtained in prosecuting the investigations indicated by the title, the first of which have already appeared in this Journal. To some of the results given in the original paper objections were raised, which were examined in a subsequent article, entitled, "Supplementary Observations, &c.," these being founded on experiments made during the month of September last. Since that time the enquiry has been continued, with the view of more fully examining these objections, of supplying certain deficiencies, of correcting some errors, clearing up some obscurities, and generally rendering the enquiry more complete.

I propose also to endeavour to correct some misapprehensions which seem to have arisen, and indicate points of importance which do not

* The cowry was discovered by Captain Godwin-Austen while we were examining these lacustrine beds together. I saw Captain Austen dig it out of the clay with his penknife.

appear to have attracted the attention that was due to them. I shall also draw my own conclusions from my results, stating at the same time with what amount of confidence they are made.

Inorganic constituents.

In the original communication, on account of an unforeseen and unexpected source of error which vitiated some of the results and therefore rendered the series incomplete, only a general view of the relative proportions of alkaline and earthly salts at the different seasons, taken from the tables in Dr. Macnamara's Report, was given. It may be of interest to state the nature of the source of error, then only hinted at. It occurred in the case of the waters of December and February, greater part of which had been kept in green glass stoppered bottles till the month of April, which, on analysis, gave results so peculiar as to excite surprise. The same peculiarities were found in some of the analyses of the river water of August, in even a more marked degree. After not a little perplexity and trouble, it was ascertained that this arose from the action of the water on the glass, dissolving the glass in such proportion as altogether to vitiate the result as regards the proper constituents of the water; it having been ascertained that the silica, the alkalies, and the lime of the glass were all added in notable proportion to the constituents of the water. It was the very large proportion of the silica obtained that first drew attention to the subject. Not being specially connected with the object of this paper, it is not necessary to notice it more particularly than to observe that there can be little doubt, but that it is due in great part to the increased activity given to the solvent action of the water by the high temperature of the climate, though indeed it occurred to a sufficiently decided degree even during the coolest months. There is probably little doubt that this circumstance has in many cases introduced error into water analyses unobserved. The analyses, in the present case so vitiated, were rejected and new ones instituted as the season gave opportunity.

For the purpose of comparison, the most complete plan would be, to ascertain the amount of each basic and acid constituent and state these in detail. A very general, or rather the general plan hitherto followed by chemists, has been to allot the acids and bases to each other, it may be by some conventional plan or according to some favourite theory, and represent them in the state of neutral salts. And as each chemist may follow his own particular plan, the same analysis may be represented in very different ways. As it is simply impossible to say in what way the acids and bases are united to one another in solution, it is very much better to state them separately; and I was glad to find that Professor Dr. W. A. Miller expressed the same opinion in his paper formerly referred to. But for general purposes a full statement of each constituent is unnecessary, and when numerous samples have to be examined, is very laborious. It is generally sufficient to classify them, or select a few of the most important and characteristic constituents or properties. In the case of the mineral constituents, their total amount, the quantity of chlorine or of sulphuric acid, the proportion of earthy salts, that is, of lime and magnesia to the alkaline salts, are, singly or together, all more or less suitable according to the nature of the water to be examined. The soap test formerly noticed is a very favourite method, from the ease of its execution. I have applied it in some cases, though the nature of my enquiries led me generally to have recourse to other methods.

The following table gives a view of the constitution of the river water at the various seasons, classified in a way that seems to me very suitable for comparing different samples. The principal mineral constituents are the alkalies, potash and soda, and the earthy, lime and magnesia,—soda being the most abundant alkali, and lime the principal earthy constituent. These bases are combined with carbonic acid in much the larger proportion, and in smaller proportion with hydrochloric acid, sulphuric acid and perhaps organic acids. The carbonates of lime and magnesia are kept in solution by excess of carbonic acid, and when the water is boiled or evaporated to dry dryness, by far the greater part, indeed all except a very little of the lime and magnesia, are separated insoluble. These remarks apply to the river water proper; during the hot season, when tidal influence prevails, the constituents of seawater make their appearance; then sulphuric acid is increased a little and magnesia still more; and hydrochloric acid and soda (or chlorine and sodium as common salt) are largely increased in quantity.

TABLE I. For 100,000 fluid grains.

River Waters of	Total Mineral salts.	Alkaline salts as Chlorides.	Earthy salts as carbonates	Silica.
9th June, Chandernagore, above tidal influence, Ebb,	17.04	4.22	14.69	2.53
14th June, at Baranagar, Ebb,	30.00	13.96	15.10	4.00
" " " " Flood,	124.10	112.30	34.25	3.70
6th July, Ebb,	12.63	2.08	5.20	*4.49
31st August, 1865, Ebb,		1.60	7.71	*2.7
21st August, 1866, Ebb,	14.10	1.70	6.60	*5.60
19th November, Ebb,	15.40	2.77	12.62	1.50
9th January, 1867, Ebb,	24.15			
" " " Flood,	25.35			
30th January, " Ebb,	24.95	4.22	20.45	2.16

In Table I. the alkalies are exhibited as if they were all in the state of hydrochlorates of potash and soda, or more correctly chlorides of potassium and sodium, chloride of sodium or common salt being the best type of such compounds, and the one most familiar to us, and practically most important. The earths are exhibited as if they were all in the state of carbonates of lime and magnesia, these compounds being also the most familiar ones. By this arrangement, the relative proportion of these constituents at different seasons can be easily compared. I am not aware that this plan has been used before, but it seems to me a good one, particularly when combined with the results given in Table II.

* Silica mixed with more or less clay.

TABLE II. For 100,000 fluid grains.

River Waters of		Hardness, equal to grains of Carbonate of Lime. Total	Permnt.	Chlorine calc. as chloride of sodium.
21st August,	Ebb,	7.8	*2.9	1.58
10th November,	Flood,	9.6		1.79
19th November,	Ebb,	12.7	1.4	.95
9th January,	Ebb,	18.4	2.1	2.63
" "	Flood,	22.0		4.97
30th January,	Ebb, Deep,	18.5	2.5	1.28
" "	Surface,	20.7	1.7	3.40
20th February,	Ebb.,	20.3		5.63
" "	Flood,	21.6	2.6	11.48
2nd May, 1866,	Ebb,	20.0	2.1	15.50
" " "	Flood,	31.4		55.50

This table shews the indications of the soap test already noticed in the first paper. The total hardness is the effect produced on soap by all the salts of lime and magnesia present, and all the carbonic acid and silica ; the permanent hardness is that left after boiling, and is produced chiefly by the lime and magnesia not separated in the insoluble state, but still remaining in solution. Another column exhibits the proportion of Chlorine calculated as if it were all in the state of chloride of sodium or common salt. The chlorine is in small quantity except when tidal influence prevails.

So far as regards mineral constituents, the water of the Hooghly at Calcutta varies greatly according to the season. Compared with the waters supplying London, the solid contents during the rainy season are much smaller, and the total hardness much less ; and even in January and February, these are somewhat under those of the London waters. As regards permanent hardness, the Hooghly water is very decidedly superior to the London waters probably all the year round, except possibly during the hot season at flood tide, though that latter point is at present somewhat uncertain. But the temporary hardness is easily removable ; and for economical use, except during flood tide

* It must be remembered that these results are for 100,000 grains water. For an Imp. gallon of 70,000 grains multiply by 7 and move the decimal point one place to the left.

of the hot season, as regards mineral constituents, the product of the Hooghly may be considered very good water. It will be compared with the Calcutta tank waters afterwards.

Organic constituents.

The attempt made by experiments with artificial mixtures to imitate the composition of the waters of the hot season, and ascertain the probable amount of change in the organic matter by keeping, as narrated in Part II. "Supplementary Observations," was not continued, partly because all the circumstances of the case could not be imitated, and partly because the plan did not seem to be considered satisfactory to those who objected to the correctness of my results in this particular. It appeared to be better to continue the observations, taking care to avoid delay in the process for estimating the organic matter more particularly. Besides, recently the objections to the correctness of my results have been in a great measure withdrawn,* and it is hardly necessary for me to do anything more in the way of directly answering objections, as it was never my object to criticise the labours of others, but simply to state my own, carefully obtained by methods of procedure the most correct and reliable known, up to the present time.

In the original paper I considered the various methods of ascertaining the nature and amount of organic matter in water, and discussed their several merits; and a few further remarks will now be made on the same subjects. The amount of organic matter by weight came first in order, but I shall at present postpone it, until the plan of oxidation by permanganate of potash has been noticed.

This plan has come greatly into favour, chiefly I suppose from its facility of application, a very valuable recommendation, provided its other merits be assured. In the original paper I gave it a qualified and guarded approval; the result of numerous experiments made since has not increased my estimate of its value, nor has that experience, and reflection thereon, led me to concur in the generally favourable estimate in which it is held. It is said "that it is not improbable that "the substances most readily oxidised, are just those most likely to be "injurious in their effects upon those who drink the water." This is Dr. Miller's remark. Others "believe" that the most pernicious are

* Indian Medical Gazette, Calcutta, 1st January, 1867, p. 14.

those that are most easily oxidized. These, it appears to me, are rather weak grounds on which to found the preference which is at present given to this mode of estimating the degree of organic impurity in water. Others speak of it as indicating the amount of putridity in the water, and this, in my opinion, comes nearer the truth. By this I understand that the amount of oxygen required is in proportion to the amount of certain products of the putrefactive fermentation of the organic matter in the water. This, however, as Dr. Frankland has stated,* furnishes no indication of the amount of organic matter actually present in the water. The offensive smell and other properties of these products make it more than probable that they are injurious to health; but even then it is not certain that there may not be other constituents, equally or even more injurious, but more difficult of oxidation. Nor is it even certain that these products of putrefaction are the only substances which are readily oxidized by the permanganate.

Moreover, a portion of these products are evidently of a very unstable character and quickly disappear, or at least lose their power of deoxidizing the permanganate. This was first brought particularly to my attention by the objections raised to my determinations of organic matter in the original paper, and has been noticed in the supplementary observations. Since then, I have made numerous observations on this point, and give a few selected ones by way of illustration. The details of the mode of observation are given in the original paper.

* Chemical News, March 23, 1866.

TABLE III.

	Time of trial.	Oxygen req. for 100,000 grs.
River water of 5th October, 1866, Ebb tide, cleared by a little hydrochloric acid and filtered, ...		*grains.*
	5th October,	.1430
	7th „	.0440
R. W. of 10th October, Flood, filtered,	10th October,	.1210
	12th „	.0860
R. W. of 10th Nov. Flood, filtered, ...	10th November,	.1210
	12th „	.0860
R. W. of 19th Nov. Ebb, Surface, ...	19th, ½ hour old,	.1390
	20th „	.0357
	23rd „	.0332
Deep, ...	19th, ½ hour old,	.0640
	20th „	.0320
	23rd „	.0345
R. W. 15th Feb. 1867, Flood, ...	15th, 2 hours old,	.1125
	16th, 28 hours old,	.0410
Dalhousie Sq. Tank W. of 9th Oct. 1866,	9th, 3 hours old,	.1425
	10th, 16 hours old	.0860
	2nd November,	.0430
General's Tank, of 6th Feb. 1867, ...	7th, 3 hours old,	.2830
	7th, 26 hours old,	.1155
Baranagar Tank, of 1st Oct. 1866, ...	1st October,	.3150
	2nd „	.2740
Ditto, of 15th Feb. 1867, ...	15th, 1 hour old,	.4755
	16th, 25 hours old,	.3625

This table exhibits very plainly the rapid diminution of the amount of oxygen required, by keeping even for one day, and the more gradual diminution afterwards. I have not observed that any notice has been taken of this circumstance by the English chemists. Dr. Macnamara first directed my attention to it, and since then I have not only made many observations of the fact, but have also made experiments as to the cause. The analyses of the London waters published monthly are of the waters supplied by the water companies, therefore, all probably two or three days old. It is evident that in the recent water, there must be substances possessing active deoxidizing properties, which speedily undergo certain changes by which they lose these properties. I have paid some attention to the subject, but am not at present prepared to discuss it. It will be matter for further examination.

At present, however, it has been brought forward to justify so far the comparatively unfavourable opinion I have expressed, of the value of the permanganate process as a guide to enable us to judge of the quality of a water as respects its salubrity. I could bring forward other reasons and adduce experiments, but as I do not intend to apply the method to the matters under investigation in this paper, only one other instance as an additional reason for rejecting it will be adduced.

I shall extract two or three numbers from the preceding table and place beside them a few others of waters from other sources, namely, from the Circular canal which connects the river at the northern extremity of the town with the Salt Water Lake. This Circular canal receives much the greater part of the sewerage of Calcutta. Reference will again be made to it and to the Salt Water Lake. Dalhousie Square Tank is filled from the river and the water is considered good; General's Tank is filled by the rains and is generally said to be the best drinking water in Calcutta.

TABLE IV.

		Oxygen reqd. for 100,000 grains.
Dalhousie Square Tank Water of 9th October, 1866, ...	16 hours old,	.0860
General's Tank Water of 6th February,	3 hours old,	.2830
1867, ...	26 hours old,	.1155
Circular Canal Water of 23rd November, 1866, ...	20 hours old,	.0832
Ditto of 20th February, 1867, ...	16 hours old,	.0680
Salt Water Lake water, flowing from Canal, 14th February, 1867, ...	20 hours old,	.1780
Salt Water Lake of 18th February, from Canal at Dhappa, ...	19 hours old,	.1475
From the Marsh, ...	19 hours old,	.1690

In his report on the London waters to the Chemical Society on March 13th, 1866,* Dr. Frankland is stated to have expressed surprise that the soft water supply from Loch Katr ne required more of the permanganate than any of the waters of th: Metropolitan districts, but here is something more surprising still. The water of the Canal

* Chemical News of 23rd March, 1866.

which receives the greater part of the sewerage of Calcutta requires less oxygen to destroy the products of putrefaction than the best tank waters of Calcutta; and the water of the salt marsh to the east of the town, called the Salt Water Lake, requires only about as much as that of General's Tank of the same age; for taking the rate of improvement between 3 hours and 26 hours, General's Tank water at 19 hours old would require .1626 grain oxygen. Results like these have led me to set but a small value on this favourite process, and induced me to turn to others promising more trustworthy indications.

The fundamental point with respect to the organic matter is the same as that connected with any other constituent, namely, its proportion by weight, ascertained as accurately as practicable. The method of doing this has already been detailed in the first paper, and I have only to repeat that, with a fine balance, patience, and care, it gives fairly satisfactory results. Attention to details is advisable to procure uniform results. Of the ordinary river or tank waters, I usually evaporate from 10,000 to 40,000 grains, according to the kind of water, contriving so as to have 4 to 6 grains of dry residue, beside 3 grains of dry Carbonate of Soda* added to the water, when put to evaporate. At one time I did not use the soda for some kinds of water, as unnecessary, but now I use it always. It makes the results more accurately comparable. These quantities are sufficiently large for the crucible, which holds conveniently about 200 grains of carbonic acid water, but requires to be twice or thrice filled up. A larger crucible would be more convenient, in which case once might do.

The river water of the cold season of 1865-66 had been kept over from two to four months, and the results as to organic matter therefore were doubtful. These will now be replaced by new determinations, all made without delay. There has been no opportunity yet for making new determinations of the hot season and rainy season waters; but I have already, in the "Supplementary Observations," given reason for believing that the delay of from 9 to 16 days in making these determinations, in the case of the hot season waters, cannot have been productive af any serious error. Additional reasons will be given for this opinion presently. There is greater doubt respecting the July and

* Dr. Parkes in his "Practical Hygiene" recommends 30 grains Carb. of Soda! This is surely a misprint. He also recommends to restore the carbonic acid lost by ignition by adding solution of carbonic acid or carbonate of ammonia, This is a mistake: the results by carbonate of ammonia are totally wrong.

August waters, which stood in most cases about five weeks, to allow the fine clay to settle. This is a special case and will require further remark; but at present, as I wish to present a view of the whole, they will be taken as they are in the construction of the following table. Many more determinations of organic matter were made, particularly of the waters of the rainy season, but these were made for special purposes and with various modifications of the process, so that they were not comparable. Only those are given in the table which were made by the plan already specified, and so far as this is concerned, they are therefore comparable. These variations in plan were chiefly tried in September and October, and so unfortunately no results for these months can be introduced into the table. But as an illustration of these variations, I may instance the case of the water of 6th October, which, cleared by Hydrochloric acid, gave 1.05 grains, and cleared by sol. potash, gave 3.22 grains organic in 100,000 grains of water. The addition of a little of either of these causes the mud to settle, and admits of filtering the water clear in course of a few hours. But as there is much organic matter adhering to or combined with the clay or other earthy matter of the mud, the acid or alkali acts upon this and brings it into solution.

TABLE V.

Shewing the amount of Organic matter by weight in 100,000 grains of the Hooghly water.

			Ebb. Grains.	Flood. Grains.
6th July, 1866,	Neap,	Surface, ...	.80	
8th August,	Neap,	Surface & Deep, ...	.84	
21st August,	Neap,	Deep, ...	.86	
10th November, 1866,	Spring,	....		1.28
19th Ditto	Neap,	.... Deep, ...	.94	
"	"	.... Surface, ...	1.28	
9th January, 1867,	Spring,	....	.88	1.50
30th Ditto,	Neap,	.... Deep, ...	.58	
"	"	...............Surface, ...	1.28	
		Average, ...	.99	1.39
2d May, 1866,	Spring,	....		2.70
30th Ditto,	Spring,	....	.90	2.60
14th June,	Spring,	....	.90	2.20
	Average,	....	.90	2.50

With reference to this table, a few remarks may be made. The rainy season waters were taken during Neap tides at ebb. Probably they would not have differed much, though they had been taken at spring tide during flood. Special remarks will be made on these afterwards.

The numbers attached to the waters of November and January, shew that the surface water contains more organic impurity than the deep, and that there is a very decided excess of this during flood tide as compared with ebb.

The May and June waters are the old ones,—open to future emendation as to quantity of organic matter. But even these indicate a still larger excess of organic matter during flood tide. And comparatively small though the amount of organic matter be, compared with those hitherto generally received, they shew the influence of the tides in bringing up organic matter, as has not been known before.

I have already observed that the opposition, with which my statements as to the small amounts of organic matter originally met with, has been now in a great measure withdrawn; yet it may be desirable to make a few observations on the subject. Having regard to the delay in examining the waters of the cold and hot seasons, I abandoned those in which the water had stood from two to four months, (the cold season samples); but did not think that the delay of from nine to sixteen days would materially affect the correctness of the results from the hot season waters. Reasons have already been given in the Supplementary Observations for this, to some probably not sufficiently conclusive, so I shall in the first place give the results of the examination of another class of waters, which may have some bearing on the subject. These are the waters of the Salt Water Lake and of the Circular Canal.

The Salt Water Lake is a large salt marsh of about one-third of the degree of saltness of sea water, about two miles to the eastward of the boundary of the town. From Entally, near the Circular Road, a canal proceeds eastwards towards it, called the Baliaghatta Canal. At this extremity it forms a *cul de sac*, but is joined about half way in its course by another branch which proceeds from the river at the northern extremity of the town, and in its course, enclosing all the northern part of the town, at length joins the Entally branch. These

Canals, I am informed by the town surveyor, Mr. Rowe, receive by far the largest proportion of the sewerage of Calcutta, the course of drainage, except for a narrow space along the river, being towards the east, or from the river towards the lake; so to these sources of supply I went for specimens of impure water. The Canal water flows eastward or westward according to the relative height of tide in the Hooghly or Bidyadurrea with which it communicates. The following table gives the results of the examinations.

TABLE VI.

For 100,000 fl. grs. filtered water.

Salt Water Lake and Circular canal.	Total solid matter.	Organic matter.
	grains.	grains.
Water flowing from the Circular Canal at Chitpore bridge into the river on 14th February, 1867, Neap tide, ebbing commenced.	471.70	15.30
Water from Baliaghatta canal at Dhappa Toll House, 18th February, 1867, ...	489.50	6.00
Water from the Marsh taken at same time, ...	525.00	6.50
From Circular canal at junction with the Entally canal, water flowing from the river 24th November, 1866. Filtered,	40.40	*1.75
" " Ditto,		2.48
Cleared by per-chloride of iron and filtered, ...	42.60	2.51
" " Ditto,		2.58
From Circular canal at bridge on Dum-Dum road, full tide, 20th February, 1867, ...	32.95	1.78
From the mouth of the canal at same time, ...	34.90	1.53

The most remarkable thing exhibited by the table is the small quantity of organic matter in these waters. The excess in the case of the 14th February water, was, there can be little doubt, owing to the water having traversed the whole length of the circular canal, passing over its putrid mud and carrying with it the sewerage from the numerous drains which enter it. The small quantity of organic matter in the filthy looking water of the marsh, full of gelatinous

* Probably some unobserved error in this case.

looking rank vegetation, is very striking. I got in June last year 20 grains organic in 100,000; but besides that I doubted the correctness of the result, considering it perhaps over-estimated, the difference of season must be taken into account.* Besides this is a strongly saline marsh. The comparatively small quantity in the canal water is also remarkable, and shews how difficult it is to increase greatly the amount in the comparatively pure water of the downward flowing stream.†

And here it may be well to consider the amount of organic matter which the river can receive from the sewerage of Calcutta. First, we have to consider the amount of water carried by the Hooghly, for the data for which I have to acknowledge my obligations to Mr. Leonard. He estimates that at the lowest season, the river, through its tributary affluents, receives only about 2,000 cubic feet per second, but 8 or 10,000 cubic feet more by percolation from its banks, or say from all sources 10,000 cubic feet of water per second, equal to 864,000,000 cubic feet per day. Mr. Clark, in his report on the water supply, proposes to distribute 6,000,000 gallons per day or even ultimately 12,000,000 gallons. Now let us take the highest of these quantities; at a rough estimate this is about 2,000,000 cubic feet, and its proportion to the volume of the river water is as 2 to 864 or $\frac{1}{432}$ part. The greatest amount of organic matter I found in the filthiest ditch in Calcutta at its worst in June was about 24 grains per gallon. Now supposing all this large quantity of water was daily poured into the Hooghly in the state of sewerage of this degree of concentration, it would be only $\frac{1}{432}$ part of 24 grains of organic matter to each gallon of river water or about .05 to .06 grain per gallon. Even supposing that the amount of water carried by the river has been over-estimated, and that it amounts to only one-half or one-fourth of the quantity stated above, the proportion of organic matter added by the sewerage would not exceed one-fourth of a grain per gallon at most, during the hot season.

* Dr. Parkes states that 12 to 40 or 50 grains per gallon is not uncommon. It would be necessary to know how such results were obtained, before admitting them.

† Probably if the water of the canal, instead of having been collected at full tide, had been taken when the river water was beginning to flow into the canal, it would have contained more organic matter. An attempt indeed was made to get such water two days before (18th February), but the proper time was not hit.

It is unnecessary at present to say more respecting the quantity of organic matter in the Hooghly water near Calcutta. It does not appear to exceed two grains per gallon even in the most unfavourable circumstances of season and tide, and during ebb tide is only about half that or less. Dr. Parkes says that it should not exceed one and a half grain per gallon in drinking waters, and the London authorities seem to be endeavouring to reduce it almost to nothing. In view of the difficulty of judging of its nature, it is desirable to have as little of it as possible.

In the original paper I have discussed the nature of the organic matter, and have not now much to add. The season of the year since that communication is the least favourable to the examination of the impurities in the water, as during these months—October to February—all the waters are at their purest. I formerly expressed an opinion on the amount of ammonia being probably a good indication of the impurity of a water, and gave reasons for it. The following are the results of some examinations of the river water, during these months, for ammonia.

TABLE VII.

Showing proportion of Ammonia in 100,000 fl. grs. of water.

		grains.
18th September, 1866, River Water,		.0620
10th November, 1866, Flood tide,		.0065
9th January, 1867, Ebb,		.0160
Flood,		.0145
22nd January, 1867, Shore,		.0260
30th January, 1867, Ebb,	Deep,	.0090
	Surface,	.0160
20th February, 1867, Circular canal at mouth,		.0170
	at 3rd bridge,	.0190
18th February, 1867, Salt Water Lake Marsh,		.0250

The quantities are small, yet consistent enough with the previous observations. Reference may be made to them in remarks that follow.

But the Ammonia is not the only thing to look to in connection with organic matter. As formerly observed, there are the products of oxidation of nitrogenised matter, including that of ammonia itself, namely, nitric and nitrous acids, and there are nitrogenised substances in progress of decomposition, as well as non-nitrogenous substances, usually called vegetable, carbohydrates, and hydrocarbons more or less oxidised. Reasons have been given in the first paper for not attaching very much importance to the estimation of nitric acid, yet the enquiry is interesting, to account for the destruction of the nitrogenised matter. If the nitrogen is oxidised, it ought to be found as nitric or nitrous acid, unless it be supposed that it escapes in some gaseous form. Time has not permitted me to investigate this subject, but the few trials I have made for the detection of nitric acid have not been at all successful,—possibly it may be for want of sufficient care. On the other hand, the test recommended for nitrous acid,—Price's test by starch, acid, and Iodide of Potassium, at once gives indications of that acid. But unfortunately it equally has given me free indications in the distilled water used, though means have been taken carefully to free the water and all the re-agents employed from it. At present I can give no explanation of these difficulties: the point is reserved for enquiry.

The most difficult part of the subject is the estimation of the nature of that more fixed portion of the organic matter which has undergone comparatively little change. The determination of the amount of nitrogen in this is one mode of examining it: I have not at present attempted this, as the waters have during the last four months been in the least favourable condition for such examination, and my time has been occupied with other parts of the enquiry. But I can only confirm what was before stated, that the organic matter evidently varies considerably in its nature: that of the rainy season resembles more that contained in tank waters; that of the dry season is more like that contained in sea water. The former evidently contains more matter of vegetable origin, but so far as I have been able to form a judgment, this only partially accounts for the difference.

But before proceeding to discuss these points, it may be better to have the whole of the data before us, by including the composition of the tank waters as well as of the river water. In the first paper one table exhibited some of the principal characteristics: now, additional information can be given. It will be exhibited by the following tables.

TABLE VIII.

Tank and well waters. For 100,000 fluid grains.

	Date of collecting.	Solid matter.	Organic matter.	Oxigen req. to oxidise.	Ammonia.
		grains.	grains.	grains	grains.
General's Tank, ...	7th Oct.	9.83	2.11		
	24th Jan.	9.05	1.59		.017
Monohur Doss' Tank, ...	9th Oct.	12.80	1.95		
	25th Jan.	12.33	1.24		.026
Dalhousie Sq. Tank, ...	9th Oct.	20.30	1.90		
	21st Jan.	25.38	2.33		.044
Ramdhone Ghose's Tank,	18th Feb.	66.25	4.62		
Baranagur Tank,.........	15th Feb.	46.00	4.05		.045
Well, ...	22d Feb.	105.25	4.56		
Nyan Chund Dutt's Lane Tank, ...	22d Dec.	72.50	6.25	.316	
Well, ...	22d Dec.	97.00	5.20	.060	
Blaquiere's Tank, ...	16th Dec.	107.20	8.00	.172	
Manictollah Well, ...	16th Dec.	187.20	12.90	.200	
Puttureaghat St. Well.,...	8th Dec.	158.01	9.23	.281	.660
Nimtollah Street Well, ..	8th Dec.	278.60	21.23	.882	.700
River water from street aqueduct, ...	16th Dec.	20.80	1.80	.102	

The first three are well known tanks referred to in my first paper; Ramdhone Ghose's Tank, Jaun Bazar, is that also noticed there,* near Mr. Dall's school, the water of which has since become much cleaner, and the Baranagar Tank is also that referred to there, the well being an old one on my own premises.

As to the remainder, some explanation is necessary. I was requested by the Municipal authorities in December last to examine some waters in the northern part of the town, with reference to a proposed public tank to be excavated there, and the results are included in the table. Of these Nyan Chund Dutt's Lane Tank and Well and Blaquiere's Tank are old sources of supply; the three latter "wells" were simply holes dug in the ground 8 or 9 feet deep to collect water for examination: the water from the aqueduct was supplied at my request for comparison.

Another table will exhibit a few more points for comparison.

* Called Dhurrumtollah Tank by mistake.

TABLE IX.

Tank and well waters. For 100,000 gr. water.

	Hardness. Equal to that from Carbonate of Lime, in grains.		Chlorine calc. as Chloride of Sodium.
	Total.	Permanent.	
General's Tank of 18th Feb. 1867,......	6.4	2.1	
Ramdhone Ghose's Tank of 18th Feb.,	29.9	15.1	28.66
Baranagar Well of 22nd Feb.	70.4	12.3	45.40
Nyan Chund Dutt's Lane Tank, ...	33.7	2.9	40.10
Well, ...	69.7	17.1	44.30
Blaquiere's Tank, ...	51.1	14.5	31.60
Manictollah Well, ...	68.1	6.1	58.50
Puttureaghat Street Well, ...	53.3	11.0	53.10
Nimtollah Street Well, ...	127.5	24.0	111.20
River water of street aqueduct,.........	19.7	2.1	1.73

And to get a full insight into the nature of such waters, a complete analysis was made of two of them, of which this is the result for 100,000 fluid grains of water.

TABLE X.

	Puttureaghat Street Well.	Nimtollah Well.
	grains.	grains.
Potash, ...	30 49	34.77
Soda, ...	31.35	35.33
Lime, ...	14.00	31.20
Magnesia, ...	8.76	22.80
Chlorine,.................................	32.30	67.81
Sulphuric acid, ...	1.84	13.20
Phosphoric acid, ...		
Silica, ...	7.00	4.80
Carbonic acid by difference, (including errors of analysis,)	23.03	47.46
	148.77	257.37
Organic matter, ...	9.23	21.23
	158	278.6
Nitric Acid, ...	none detected.	small quantity.

Phosphoric acid: very distinct indications of in both.

This was also found in smaller quantity in the other four of these waters, and in still smaller quantity in the water of the aqueduct.

The relative proportions of these constituents, so different from those of ordinary spring or even river waters, point clearly to their origin. The large quantity of alkaline salts, compared with those of Lime and Magnesia, and the large proportion of Potash and of organic matter, indicate that they are derived from the decomposition of vegetable and animal substances: the phosphoric acid and perhaps the chlorine being more particularly characteristic of their animal origin. In fact, it is the composition of sewage water, and differs from some other analyses of English town sewage* most remarkably in the large proportion of potash present, no doubt the product of the vegetable food of the mass of the population. It is indeed simply sewage water, deprived in great part of its bad smell by filtering through the earth. And the partial analyses of the other tanks and wells (except the three first tanks of the table) indicate that the waters all partake more or less of the same character, and contrast strikingly with the superior purity and different characteristics of the river water during the cold season.

The large quantity of Ammonia as exhibited by Table VIII. in the two waters fully analysed is also very striking.

Now to return to the consideration of the organic matter which has undergone comparatively little change, and for the proper examination of which we have no very ready or suitable chemical processes: the best means of judging of its nature and properties have already been discussed in my first paper. These are, chiefly, the general appearance and smell of the residue obtained by evaporating the water, the smell on burning, and the estimation of the amount of nitrogen by the Soda lime process. This last, for reasons already stated, I have not applied. But I may observe again, that these bad tank waters more resemble the river water of the rains than of the hot season, in the appearance and properties of their organic contents. No doubt this proceeds in part from the larger proportion of matter of vegetable

* Lawes and Gilbert, Journal of Chem. Soc. Ser. 2, Vol. IV. p. 118 for 1866. Way's Report on Sewage of Towns quoted in Parkes's, Manual of Practical Hygiene, 2nd edition, 1866, p. 325.

nature; non-nitrogenised matter. It appears to me, however, that there is a tendency generally to make too much of this distinction between matter of vegetable and of animal origin, it being often spoken of as if the organic matter were of little importance, if it could be shown to be vegetable matter. Now it may be admitted that most probably water tinged by peaty matter consisting of the ordinary humous class of acids and salts, may be not at all even injurious to health, and that water flowing over or percolating through the soil of mountainous districts or others bare of vegetation, where there is little herbage and much earth or rock, may be very pleasant and wholesome. But citing such cases is only evading the question. It does not follow that water draining off cultivated fields or dense jungle, or flowing between banks covered with luxuriant and rank vegetation, will be equally harmless. Putrefying animal matter is very offensive, but putrefying green vegetable matter, though not so disgusting in idea, is scarcely less offensive. Nor, be it remembered, are the poisonous properties very much dependent or connected with a disgusting taste or smell, and the most powerful poisons come from the vegetable kingdom.

In my first communication, the oxidising action of the atmospheric air dissolved in river water was brought forward as a powerful agency for purifying the water. And though Dr. Frankland's results were quoted as strikingly illustrating it in respect to the Thames waters, yet such observations are by no means new. And it must again be observed that the high temperature of the climate will materially assist this action. No doubt it assists putrefaction, fermentation also, and in some cases this may take place in a river, when its course from any cause is rendered very slow. But in the case of the Hooghly the tides cannot fail to act beneficially; twice every day damming back the water and again retreating, enabling the river to flow with increased velocity, increasing the motion amongst its waters and constantly changing the surfaces exposed to the air. This is just one of those agencies that escape general observation: it does not exhibit itself to the senses, yet it must be remembered that it is by the oxygen dissolved by water, small though that be in amount, that animal life is preserved in the waters no less than in the ordinary atmosphere.

The organic matter remaining in the mother liquors, after having as well as practicable crystallised out or otherwise removed the mineral saline constituents, is, in the case of the hot season river water, of a pale brownish yellow colour, with a comparatively faint, somewhat urinous smell; that from the tanks and river water of the rains is of a darker brown colour and a more excrementitious smell: a smell, in fact, similar to that of Guana. So far as sensible properties go, the latter is the more disagreeable, and according to the results of experiment mentioned in the first paper, probably at least equally nitrogenised. At present it would be difficult to speak more positively on the subject.

In my first paper, and more particularly in the abstract of it furnished for the proceedings of the Society, I made some remarks in connection with some of the tanks which my own observations will not bear out. This was the result of haste and inadvertence, which will now be corrected. Some of the best tanks, General's Tank more particularly, are probably equal to the river water in purity at some seasons, and superior to it at others. Tank water deteriorates during the hot season from putrefactive fermentation; the river water proper improves from oxidation, but near Calcutta deteriorates from sewerage and tidal water. Tank water improves during the rains by dilution with rain water, and the animal and vegetable life in it preserves the proper balance, removes decaying matters, and prevents putrefaction to any great extent: at least, this is the case in good tanks. General's Tank seems a well kept aquarium; it abounds in animal life: though its water has often a slightly putrid flavour, this is easily removed by exposure. But even the water of that tank is not, in my opinion, equal in freedom from organic impurity to the river water proper, taken during the dry season at ebb tide.

General Conclusions.

Before closing this communication, it may be well to make a few general remarks as to the conclusions to be drawn from the data obtained. It must have been observed that there is some uncertainty connected with the subject of the organic matter. Persevering enquiry may in time enable us to remove much of this uncertainty, but at present we can only draw conclusions from the most certain grounds we possess. Probably all will agree that it is advisable to get drinking water containing as small a quantity of organic matter as possible, and more particularly as small a proportion as possible of that which is of recent origin. If, this being kept in mind, we take up the question which seems to have been considered of greatest practical importance by the Calcutta community, namely, can the supply be safely taken from the river at Cossipore? we can scarcely answer it in the affirmative. My results, as has been pointed out, show that there is a very distinct increase in the quantity of organic matter in flood over ebb tide, even during the cold, but still more during the hot season. How far this may be due to the proximity of Calcutta, could only be ascertained from extended observations; but as the town must supply a considerable quantity of putrefying and putrefiable matter and that of recent origin, in the absence of evidence indicating the contrary, it would be desirable to avoid taking it from that locality. What is the smallest distance up the river at which this source of contamination is not appreciable, is a point that could be determined only by observations during the hot season in various circumstances and places. But it is evident enough that the further up we go, the more certain are we to avoid this source of contamination.

But though this is an important question, it is not the only one: it seems to have occupied almost exclusively the attention of that portion of the community who have taken an interest in the subject, while another, and in my opinion an equally important one, has scarcely if at all been noticed; and that is, what is to be done with the muddy water of the rainy season? If we look to the amount of putrefying matter as indicated by the permanganate test, or even as observed by the senses, the water, for the first two months at least of the rains, is worse than the flood tide water of the hot season; if we look to the two as we have them, each with its suspended mud, the rainy season water is greatly the worst. If we consider the quantity of organic matter actually dissolved in the water, probably the hot season water contains most, though this at present is not quite certain, and it is also somewhat doubtful if it be so bad in quality as in the rainy season water. Of all points in the enquiry, this is the one involving the greatest doubt and difficulty, and I should feel it quite impossible to give a decided opinion on it, without again examining the water during that season. And what makes this point of chief importance is this, that though the town contamination may be avoided by going up the river, this cannot.

That flood waters (that is, floods produced by rain fall) are most impure, as regards organic matter, is now a recognised fact in England. It is by no means a new observation. In the Report on the Metropolitan Water Supply by Messrs. Graham, Miller and Hofmann, presented to the Secretary for the Home Department in June 1851, this point is repeatedly noticed and the remedy for it discussed, though from the nature of their remarks it is evident that the amount of finely suspended mud, and the degree of its putridity, have probably been much smaller than those of the Hooghly water in the rains. It must be remembered that while in England there are numerous small floods, here we have but one large flood in the year, washing down the accumulated refuse of seven or eight months. It is true that the large quantity of rain dilutes the muddy mixture, and, so far as matter in actual solution is concerned, improves the water. Still we have it loaded with mud, part of that in a very fine state of suspension, very slow in settling, and which cannot be separated by any ordinary filtration. And as the finely suspended clay contains organic matter, putrid or putrefiable, the water must be deprived of it to be rendered fit for use.

The subject has engaged the attention of the Engineer to the Justices, and in his Report on the works for the supply of water to Calcutta, he details the plan for meeting the difficulty alluded to. He admits the difficulty, for the says, para. 28, "The muddy character of the water to be dealt with is an unusual feature in works of this description and necessitates peculiar aud special arrangements being provided." Let us see what these are.

It is to be settled in large tanks 6 or 7 feet deep for 36 hours; then the upper portion, to the depth of 4 feet, is to be drawn carefully off to the filter, after passing through which it is conveyed to covered reservoirs for storage, whence it is to be distributed as required. The filter is composed of sand and gravel, and also, according to Mr. Clark's original proposal, a layer of "Spencer's magnetic carbide." The object of this is to purify the water from organic matter, and it is also said that it removes the suspended matter.

But so far as I can gather from the Report, Mr. Clark seems to consider that the settling of the muddy water of the rains for 36 hours will put the water on an equality with that of the rest of the year as to the rapidity with which it will pass through the filter, and, I suppose, with or without the magnetic carbide, will supply it in an unobjectionable state. At least I cannot find in the Report any provision made in addition to this for the special case of the muddy waters of the rains, or a single arrangement made to provide against any difficulty in this case.

My own observations on the waters of the rainy season are not at all in favour of the success of this scheme. On the contrary, I have experienced the greatest difficulty in getting the water freed from the finely suspended matter by either subsidence or filtration. After standing to settle for several weeks, it still contained much of this finely suspended clay, from which it could not be freed by filtration in the ordinary way. It seems therefore to be impossible to avoid the conclusion that through the ordinary sand filter the water will pass little changed; or if by any modification it be made effectual, it will pass with such extreme slowness as altogether to interrupt the ordinary supply of the water. And if it pass in its muddy state into deep covered reservoirs provided for it, daily it will deposit a portion of its mud, which will be daily more or less stirred up by the new flow of water into the reservoir, a state of matters which appears to be very well adapted to maintain the water in the state in which it entered, or even to tend to make it worse. Whether the water of this season then will be in a fit state for storage, after thirty-six hours settling and the short time longer necessary for its passing though the filter and being conveyed to the reservoirs, is a question deserving of serious consideration. My own observations lead me greatly to doubt it. It would be rather a serious error, if these fears should turn out to be well founded; for not only would the water be offensive during the rainy season, but, unless the reservoirs were cleaned out, would continue to be so. And in the plan there appears no arrangement for cleaning them, and no facilities for doing so.

There are other and effectual plans for speedily separating the suspended mud from the water, and rendering it easy to be filtered perfectly transparent. These are by chemical precipitants, to some of which I have previously alluded; one well known is alum, in daily common use. These have been observed sometimes to increase the quantity of organic matter in solution, but this is probably from imperfect knowledge of the proper way to apply them, rather than essential to their operation.

This enquiry into the water of the Hooghly was commenced, as formerly stated, without any reference to the water supply of Calcutta, but simply as an investigation interesting in a scientific point of view. For even in the single point of the organic matter there is room for the expenditure of much labour and research. It is difficult and not very promising, but persevering enquiry often brings much of interest out of unpromising subjects. The high temperature of the country increases the energy of chemical action, and the comparative regularity of the seasons favours the simplicity of its operation; and thus a country like India affords a field well adapted for the study of the influence of chemical changes on the phenomena of nature. Many of these changes may not be very obvious to those unaccustomed to study them, but they are not the less real on that account, and not the less powerful in their operation on the world around us.

16*th September* 1867.

Since writing the above, the enquiry has been continued, with the view of settling one or two points left in some degree of uncertainty. These were the amount of organic matter in the river water during the hot season and during the rains. The first of these was the point on which the greatest doubt was felt by many as to the correctness of the results given in my first paper, though little shared in by myself: the second was the point on which my own opinion was most undecided. The experimental results will be given in the tables, and comments and explanations will follow.

TABLE XI.

		For 100,000 grains.	
Hot season.		Total solid contents.	Organic matter.
River water of 2[illegible]th May, 1867, Spring tide, ...	Flood,	55.60	.90
	Ebb,	16.45	.75
Ditto of 6th June, spring,	Flood,	50.75	1.70
General's Tank of 10th June,		10.74	2.40
Dalhousie Sq. Tank of 10th June,		41.35	2.58
Rainy Season.			
River Water of 13th July, purified by perchloride of iron,			1.22
Ditto by ditto in smaller proportion,			.63
Ditto settled 3 days and syphoned off, again settled 8 days,		12.07	.71
Ditto settled and sand filtered continuously with new water daily till 26th, then settled till 18th August,			1.06
River Water of 16th August,	Flood,	10.71	.74
Ditto of 24th August,	Ebb,	10 26	1.10

The experiments on the hot season waters were made to decide the question involved in the objection raised to my first results, namely, that the organic matter had been decomposed and lost by the delay (of from ten to fourteen days) in proceeding to the evaporation. In the present cases the water was evaporated on the next day after collection. The result shews only from .90 to 1.70 grains organic matter in 100,000 grains of water taken at flood tide of the highest spring tides of the season; less indeed than I had obtained in 1866. Many other experiments have shown me that there is very little change in the weight of organic matter sustained by keeping it even for several weeks, and least of all in the case of water containing so much saline matter as the river does at this season. The only thing that undergoes rapid change is the deoxidising power of the water as shewn by the permanganate test, but this does not appreciably affect the weight of the organic matter.

One thing is to be noticed in connection with these, namely, that the amount of saline contents is very decidedly smaller than it was in the corresponding season of 1866. This may possibly have arisen from the correct time of full flood not having been caught, but if so, this must have happened on both occasions: and moreover the quantity of saline matter at Ebb tide is also much smaller than in 1866. It appears to me more probable that the river water has contained less saline matter this year. It would be difficult to give an opinion as to the cause of this: besides, the observations were not sufficiently numerous to draw conclusions from with certainty.

The results of the examination of the river water of the rainy season confirm those I have already given in Table III. of the first paper and in Table V. of this. The absolute amount of organic matter is somewhat less than in the waters of the hot season, but, in proportion to the mineral constituents, very much greater. It is to be observed that the waters which were simply settled, or even sand-filtered, still contained clay: the water, clarified by a little sesqui-chloride of iron, does not give the correct amount of saline matter, therefore in the table this is omitted in these cases, but it was only by such means that the water could be got clear and free from clay, at the beginning of the rains, without delay. The two samples thus clarified were evaporated next day after collection, the others after greater delay.

The waters were also examined for ammonia by the process given in the first paper: the results are exhibited in the following table.

Table XII.

Shewing quantity of ammonia in 100,000 fl. grains water.

Hot Season.

		Grains.
River water of 13th May, Neap tide	Ebb,	.0350
	Flood,	.0240
20th May, Spring tide	Ebb,	.0090
	Flood,	.0155
6th June, Spring tide	Flood,	.0190
Average,............................		.0205

General's Tank water, ...	.0385
Dalhousie Sq. Tank water, ...	.0265

Racny Season.

River water of 10th July,..	.0240
,, ,, ,, 13th July,..	.0810
,, ,, ,, 16th August, ...	.0380
,, ,, ,, 24th August, ...	.0140
Average,......	.0392

These results exhibit great variations in the proportion of ammonia, and recent investigations throw some doubt on the trustworthiness of the method employed; besides, it is confessedly an imperfect indication of the amount of nitrogénous matter: nevertheless, so far as they go, they are confirmatory of those already given in table IV. of Part I. The waters of the rainy season yield more ammonia than do those of the hot season, and the tank waters, even the best of them, yield more than the river water. And the previous table also shews that General's Tank,—probably the best of the tanks, or at least one of the best, contains more organic matter than the river water; and the results given connected with Dalhousie Square Tank confirm the opinion expressed before, that the river water rather deteriorates by storage in tanks.

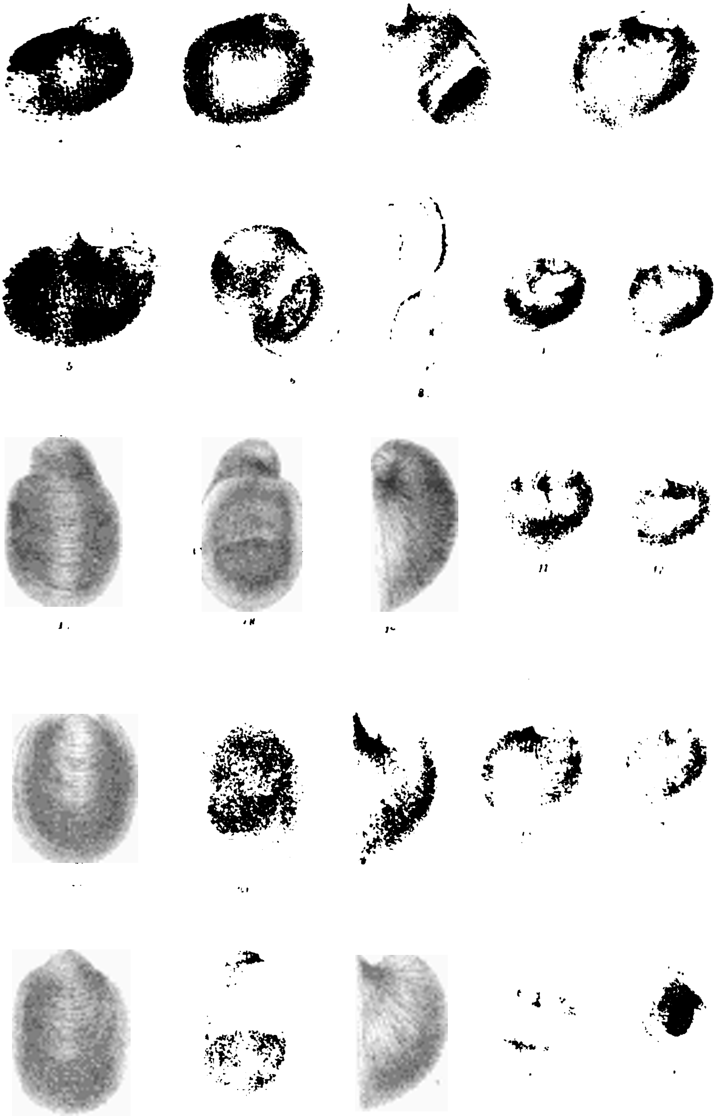
I do not mean to say that these results, as to the quantity of organic matter and the proportion of nitrogenous matter, prove with certainty that the river water is at least equal, if not superior, to even the best of the tank waters; but they are the best means of judging which chemical analysis affords of the quality of water for drinking purposes, and, in the absence of equally good evidence to the contrary, the results lead to such conclusions.

Only in one point have I to say something in modification of the results of previous examination, and that is connected with the water of the rainy season. In the previous pages I have spoken strongly of the putrid flavour of the river water of the rains, particularly of the early part of the season. This respected the year 1866. In the present year, however, I have not found this putrid flavour, or at least only to a comparatively very slight degree. At first I was inclined to attribute this difference to some local or accidental cause which had led me into a mistake as to the general character, but after further observation and consideration, I do not think that this is the explanation, but that the water is really different in this respect, this season, from what it was last. For not only has the putrid smell been absent, but the mud has been easier to separate from the water; the particles are not so fine, or at least not so glutinous, and it has not been so difficult to filter clear as it was last year at the corresponding periods; and the quantity of organic vegetable matter produced on standing in bottles has been decidedly less than it was last year. Indeed the river water of the rainy season of 1865 gave much more vegetable growth than that of either of the two succeeding years. Moreover the water of the river did not become muddy nearly so speedily after the setting in of the rains as it did last year: this was noticed particularly, as the muddy water was watched for. Neither after it had become muddy, did it exercise nearly so strong a deoxidating power on permanganate of potash as it did last year: only about one-third of the power; and this is a good indication of putridity. These facts, to which may be added the greater purity of the water of the hot season of this year, seem to indicate some general cause producing the variation. Both 1865 and 1866 were years of deficient rainfall, 62.40 and 60.32 inches; while the year preceding, 1865, was one of large rainfall, there having been 84.22 inches in 1864. This perhaps may have some connection with the points noticed. The peculiarity is worth attention in the future.

The subject of water analysis, in connection with hygiene, has lately occupied much attention in London. Dr. Frankland has expressed opinions respecting the small value of the oxidation test by permanganate, in accordance with my own and on additional grounds, and also proposed a fuller examination of the nitrogenous constituents as the most important guide. Miles Messrs. Wanklin, Chapman and Miles Smith have also proposed some new methods for determining the nitrogenous constituents. The details of these plans, however, have not yet been published, or at least have not yet come under my notice. The subject is also under experiment by myself, and will have further attention.

To sum up, it may be observed, that these extended enquiries, though leaving many points yet imperfect, still go to confirm the general conclusions arrived at in my first communication, favorable to the water of the Hooghly, compared either with the Calcutta Tank waters or the present London waters. I may repeat what I then said; " Such are the conclusions I have arrived at, some of them unexpected even to myself, and which may be disputed by others." And I may add, that they can only be properly controverted by evidence of the incorrectness of the experimental results from which these conclusions have been drawn.

Ind... ...Shells Pl. 1



All the figures nat. size

Fig. 1-12 Neritina ...guensis ... Blanf. ... 22 ... crepidularia, Less.
" 13 ... Var. ... cornucopia, Lea.
" 17-19 N... oecu...

Fig. 1. Larina Burmana, W. Bl. nat. size — Fig. 11, 12, Assiminea ...ella, W. B. enlarged 3 diam.
" 2–4. Tectura fluviatilis, W. Bl. " — " 13, 14. Irawadia ornata, W. B. "
" 5–6. Auricula nitidula, W. Bl. D° — " 15. Stenothyra ... Benson "
7–10. Amphibola Burmana, W. B. D° — 16. ... W. B. "

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Irawady Shells, Plate III.

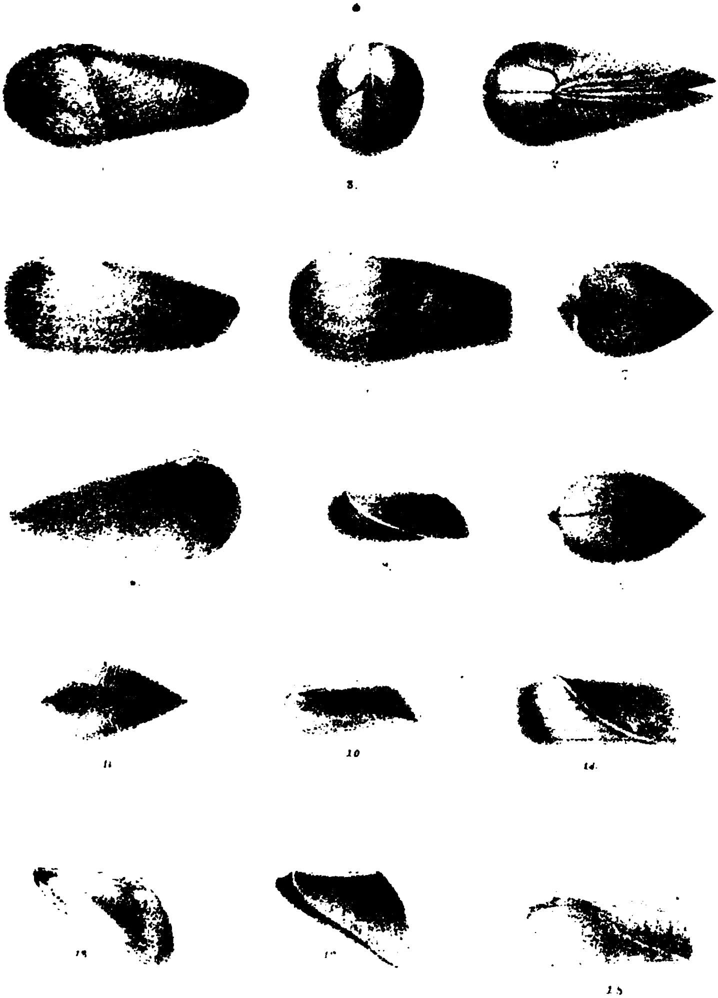
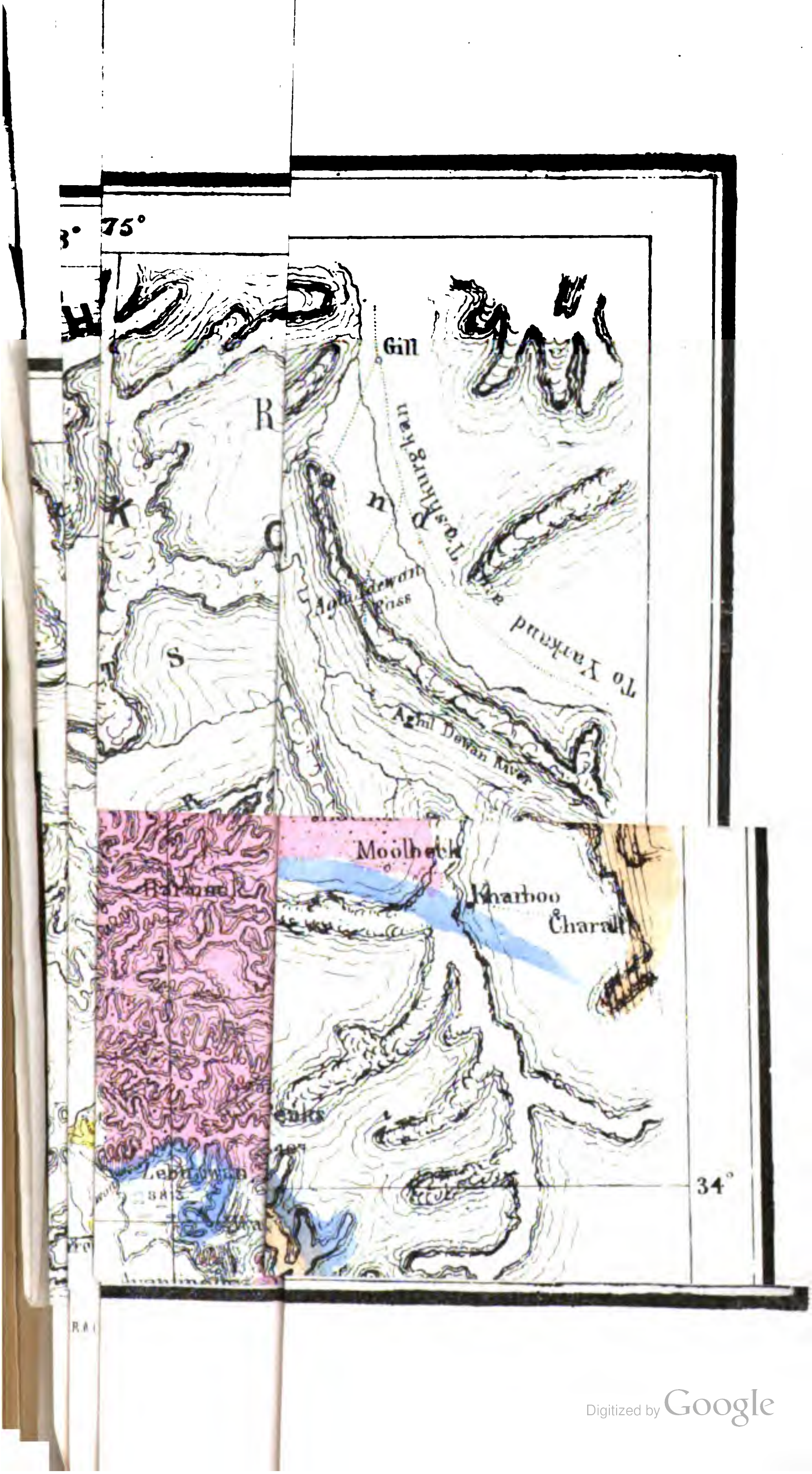


Fig. 1-3, Martesia fluminalis, W. Bl. enlarged 3 diams. Fig. 7-10. Scaphula deltae, W. Bl. enlarged 2 diams.
" 4, Sphenia perversa, W. Bl. adult, D° „ 11-13, S. pinna, Bens, D°
5, 6 D° younger, D° „ 14-15, S. celox, Bens, D°


75°
Gill
To Yarkand
Aghil Dewan River
Kharboo
34°

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PART II.—PHYSICAL SCIENCE.

No. III.—1867.

On the Reproductive Functional Relations of several Species and Varieties of Verbasca.

By John Scott, Esq.,

Curator of the Royal Botanical Gardens, Calcutta.

In this paper, I purpose giving an account of a numerous and carefully performed series of experiments on the hybrid and cross-unions of several species and varieties of Verbasca, with the view of illustrating those functional relations, or differences existing between the results of unions of distinct species on the one hand, with those of different varieties of the same species on the other. I believe, the generally accepted view of naturalists on this point is, that a certain degree of sterility always results from the union of distinct species in their first hybrid produce, and that their progeny are absolutely infertile one with another; while in the cross-unions of varieties of a species, the fertility is in no respect affected in the first cross, and the progeny are, in every case, perfectly fertile, one with another. These relative differences, then, in the products of hybridism and mongrelism are strongly maintained to be decisively demarcative of the factors, included under the terms "species" and "varieties," affording, so to speak, an unequivocal analysis, whereby nature's original and immutable units—species—may at once be discriminated from those diverged forms—varieties—to which they have given rise, and with which, from the important structural differences they frequently assume, they might be hopelessly confounded. Such, at least, is the opinion of those naturalists who regard species as the result of distinct creative acts. On the other hand, those naturalists who believe in derivative hypotheses, and look upon all existing organisms as the genealogical connections of other and earlier kinds, entertain the directly opposite view, and maintain that no such essential differences as those above stated exist between the results of hybridism and mongrelism; though they readily admit a difference in degree. This point has been ably and philosophically discussed by Mr. Darwin, who, after a careful and impartial examination of all the evidence he could collate, considers himself justified in concluding, that "first crosses between forms known to be varieties, or sufficiently alike to be considered as varieties, and their mongrel offspring, are very generally, but not, as is so often falsely stated, universally fertile.........consequently that neither fertility nor sterility afford any clear distinction between species and varieties; but that the evidence from this source graduates away, and is doubtful in the same degree, as is the evidence derived from other constitutional and structural differences."*

Though Mr. Darwin thus clearly anticipates an essential accordance between the result of hybridism and mongrelism, it is to be observed that the extreme paucity of experimental observations on the latter phenomena prevents his illustrating the subject so fully and satisfactorily as its importance demands. The want of such observations, and the importance of their bearing on that theory of the "origin of species" proposed by Mr. Darwin, has been frequently and strongly insisted on by Professor Huxley. Thus in his "Essay on Man's Place in Nature," p. 106, we find the following remarks: "Our acceptance of the Darwinian hypothesis must be provisional so long as one link in the chain of evidence is wanting, and so long as all the animals and plants certainly produced by selective breeding from a common stock are fertile, and their progeny are fertile one with another, that link will be wanting." Again in his Lectures on our knowledge of the cause of the phenomena of organic nature, Lecture VI. p. 147, after

* Darwin's "Origin of Species," 3rd Edition, pp. 271 and 300.

discussing the obligations of a hypothesis, he remarks, that "Mr. Darwin, in order to place his views beyond the reach of all possible doubt, ought to be able to demonstrate the possibility of developing from a particular stock, by selective breeding, two forms which should either be unable to cross one with another, or whose cross-bred offspring should be infertile with one another,"........"Now it is admitted on all hands that at present so far as experiments have gone, it has not been found possible to produce their complete physiological divergence by selective breeding..........If it should be proved, not only that this has not been done, but that it could not be done, I hold that Mr. Darwin's hypothesis would be utterly shattered." Professor Huxley, however, though thus strongly insisting upon the absence of facts showing that any degree of sterility has resulted from the crossing of varieties known to have originated from a common stock, states that he does not know a single fact which would justify the assertion that such sterility could not be produced by proper experiment, expressing his belief that it may and will be produced.

Considering then the as yet positively equivocal nature of the relations between the phenomena of hybridism and mongrelism, together with its important bearings on the converse theories which now divide the scientific world, I trust the reader will bear with me, while giving a somewhat detailed statement of my own experiments on the above phenomena. I venture to premise that they show pretty clearly the relative claims of the two views now held by naturalists on our acceptance, and illustrate also one or two other points of high interest in theoretical natural science. First, for the union of *V. phœniceum* vars. *roseum* and *album* and *V. nigrum*.

TABLE 1.—Results of Pure and Mixed Unions of *Verbascum phœniceum*, var. *roseum* and *album*; and *V. nigrum*.	No. of flowers fertilished.	Capsules produced.	Seeds produced.	Average of seeds per capsule.	By calculation.	
					Capsules.	Seeds.
No.						
1. *Verbascum phœniceum* by pollen of *V. phœniceum roseum*, ...	10	8	193	24	20	483
2. *V. phœniceum*, *roseum* by pollen of *V. phœniceum*, ...	12	9	306	34	20	680

Table 1, *(Contd.)*—**Results of Pure and Mixed Unions of** *Verbascum phœniceum,* **var.** *roseum* **and** *album;* **and** *V. nigrum.*	No. of flowers fertilised.	Capsules produced.	Seeds produced.	Average of seeds per capsule.	By calculation.	
					Capsules.	Seeds.
No.						
3. *V. phœniceum,* by pollen of *V. phœniceum, album,*	10	6	120	20	20	400
4. *V. phœniceum, album* by pollen of *V. phœniceum,*	16	11	287	26	20	522
5. *V. phœniceum, album* by pollen of *V. phœniceum, roseum,*	8	4	116	29	20	580
6. *V. phœniceum, roseum* by pollen of *V. phœniceum, album,*	8	0	.	...	...	...
7. *V. phœniceum,* by pollen of *V. nigrum,* ...	10	3	57	19	20	380
8. *V. phœniceum, album* by pollen of *V. nigrum,*	10	6	110	18	20	367
9. *V. phœniceum, roseum* by pollen of *V. nigrum,*	10	7	107	15	20	306
10. *V. phœniceum,* by own pollen, ...	18	0	.	...	...	...
11. *V. phœniceum, roseum* by own pollen, ...	18	0	...	...	...	...
12. *V. phœniceum, album* by own pollen, ..	18	0	...	...	...	...

The following descriptive notice of the plants in Tab. 1, will show their close morphological relations. First, *V. phœniceum ; stem* somewhat downy, simple, producing upwards a racemose panicle. *Leaves* crenate, oblong-ovate, nearly glabrous above, deep green. *Radical* subcordate, ovately-acuminate, petiolate. *Upper cauline* crenulated, semi-amplexicaul. *Bracteas* lanceolate. *Raceme* elongated. *Flowers* lax, solitary ; pedicels longer than the bracteas. *Corolla* purplish-violet, beset with violet hairs at its base. *Stamens ;* filaments of the three shorter stamens covered with long glandular purplish hairs, these of the two longer naked, except on the upper side, where there are a few similarly characterised hairs. *Anthers* of the three longer stamens nearly circular, and covered with purple and white glandulose hairs, these of the shorter stamens, reniform and nearly naked. *Pollen* copper-coloured. Second, *V. phœniceum, roseum* differs from the above only in the less elongated raceme and the rose-coloured flowers. Third, *V. phœniceum, album* is of a more robust habit than the other two.

Radical leaves ovate-lanceolate, light green. *Flowers* white and rather larger than the others, wfth a few whitish glandulose hairs near the base of petals. *Filaments* and form of *anthers* similar to these of *V. phœniceum*, but beset with white instead of purple, glandular hairs. *Pollen* similarly copper-coloured in each.

Thus, judging from the characters of these three forms alone, there can be no doubt as to their being other than conspecific. In addition to this I may add, on the authority of Mr. Stirling of Edinburgh, that they have been raised from pure seed of the *V. phœniceum*, the rose-coloured variety frequently appearing amongst the seedlings of *V. phœniceum*, the white presenting itself more rarely.

In the first part of Tab. 1, the number of flowers fertilised, and the simple results are shown, and in the right hand, for the sake of comparison, the calculated produce of the number of seeds from 20 capsules of each is given.* If we compare the results, we see that reciprocal unions may be effected becween the *V. phœniceum* and varieties, with one exception, viz., *V. phœniceum, roseum*, by pollen of *V. phœniceum, album*, in which case I have found that though the pollen tubes are abundantly developed and freely penetrate the stigmatic tissues, the capsules nevertheless drop prematurely. The goodness, however, of both the male and female elements of the above varieties is nevertheless shown by their reciprocal unions with *V. phœniceum*. The individual potency of the respective sexual elements of these varieties, in their reciprocal relations, is clearly shown; whereas by those experiments given in the three last lines of the table, in which the stigmas of each variety were covered by their own good pollen, no unions were effected, each proving utterly self-sterile!

This absolute, or conditional, sterility of the three varieties of *V. phœniceum*, when treated by their own good pollen, led me to examine

* From Mr. Darwin's suggestion in "The Origin of species" that the decreased fertility of mixed unions, as compared with that of the pure unions, might possibly be increased by the fact, that for perfectly satisfactory results, castration is necessary in the cross-unions; whereas in the latter, in pure unions, this not being necessary, we may have indiscriminate comparisons, of the two results though clearly castration may have a direct sterilising influence. In view of this prudent suggestion, I took the precaution to castrate every flower both of the pure and mixed unions, from which I intended to draw results. The sole exception to this is that given in the first line of Table 2 of *V. phœniceum* as I was unable to get any of the plants under me to produce seed by their own pollen. Whatever be the effects of castration then on the fertility of the plants so treated, in the present cases, all having undergone it, the results will be mutual.

into the apparent cause, as in certain cases we find it arising from the non-emission or non-penetration of the pollen tubes; the pollen through some mysterious cause being thus utterly impotent on its own stigma. The results of my present examination will, I trust, be found of sufficient interest to permit of my stating them here. They are as follows: first, I applied the pollen of each of the three varieties, reciprocally, to their stigmas; on dissecting these, I found them abundantly permeated by pollen tubes, many of which I distinctly traced into the ovary. Secondly, I fertilised several flowers in each variety, with its own pollen; on examining the stigmas of a few of these flowers, I found that many of the pollen grains had emitted tubes, but comparatively few had penetrated the stigmatic tissue, and of these still fewer permeated the conducting tissues of the styles. Several of the latter, however, I traced into the vascular bundles of the placenta, the pistillary cords, and in one or two instances, I believe that I detected them in the nucleus of the ovule. Nevertheless we have seen that, though these pollen tubes are developed, they most ineffectively perform their deputed function, inasmuch as not one of these matured even a single ovary! I have here to observe, however, that these pollen tubes do not seem utterly void of the fecundative influence, as many of the ovaries did undergo a certain degree of development; and on examination of these, as they dropped off, I found that the ovules also had undergone a partial and variable degree of development. In general, the fleshy albuminous envelope of the embryo was largely developed, whereas the embryo had undergone a very slight development, judging from a comparison of other good seeds of a similar stage, not at all proportionate to the size attained by the albuminous parts. In nearly all the embryos which came under my observation, the development had ceased ere they exhibited any distinct separation of parts; a few only had reached that stage in which the axial and lateral projections were visible.

We thus see, that whatever be the real cause of the inveterate self-sterility of the three varieties of the *V. phœniceum*, it does not arise, as has been shown in other cases, from the non-emission of the pollen tubes. In these, as I have elsewhere noticed it, in certain individual plants of different species of Oncidia, Maxillaria, and Passifloræ, sterility apparently results from some slight differentiation of the male element with respect to its own female element. I have also to remark, that the ultimate conditional sterility of these plants is not, relatively considered, an absolute but a graduated quantum; this is shown by the different degrees of development the embryos had undergone, thus illustrating a most interesting, though as yet imperfectly known fact, namely, that the male element, even though reaching the female element, may nevertheless fail to communicate that amount of vital stimulus necessary to the complete development of the embryo. Furthermore, I may in passing briefly refer to the perfect parallelism between these phenomena, and those occasionally observed in hybridisation, at least in the zoological kingdom, for unfortunately we are as yet nearly void of information on this point in the vegetable kingdom, hybridists having, in most instances, satisfied themselves by attending to the ultimate results, without troubling themselves to examine into the nature or degree of embryonic sterilisation. From the published papers of the Hon'ble and Rev. W. Herbert, we find, as might indeed be expected, that this point did not escape observation: thus in one case he remarks, "It has, I believe, not been duly considered, that the fecundation of the ovules is not a simple, but a complicated process. There seems to me to be three or four several processes: viz., the quickening of the capsule of the fruit, of the outer coats of the seed itself, of the internal parts or kernel, and lastly, the quickening of the embryo."........."It is further to be observed," he continues, "that there is frequently an imperfect hybrid fertilisation, which can give life, but not sustain it well. I obtained much good seed from *Hibiscus palustris* by *H. speciosus*, and sowed a little each year till it was all gone, the plants always sprouted, but I saved only one to the third leaf, and it perished then."

To recur, however, to the above parallelism, of which we have here additional and important illustrations: it has been stated by Mr. Darwin* on the authority of Mr. Hewitt, that in the hybridisation of gallinaceous birds a frequent cause of sterility in *first crosses* is the early death of the embryo. Again Mr. Salter records similar results from his experiments on the fertility *inter se* of several *hybrid Galli*,† thus concluding, "the one striking point of these experiments (which I believe has never been noticed before) is that a large proportion of

* loc. cit. p. 286.
† Nat. Hist. Rev. 1863, p. 276.

these eggs from hybrid birds breeding *inter se* have failed to produce young, not from absolute sterility, but sterility in degree, from an amount of vitalization insufficient to carry out the whole result of reproduction, in which the young individual has been completed, leaving it with vital resistance insufficient to maintain life and cope with common and customary external influences." And thus in those curious cases of sterility of structurally hermaphrodite organisms, whose sexual elements have become differentiated with respect to their mutual fertile conjunctions, so in the phenomena of sterility from hybridism, we find, as Mr. Salter well remarks, with respect to the relations of hybridism and parthenogenesis, "that the sterility is not absolute but in degree, and that the stimulus, whatever it may be, which starts the embryonic changes is feeble and imperfect rather than wholly wanting."

I have now shown that a regular more or less early embryonic abortion results from the self-fertilisation of certain individual plants of *V. phœniceum* and *vars. roseum*, and *album*; whereas by their reciprocal fertilisation, highly fertile unions may in general be effected. By again consulting Table 1, however, it will be seen that besides a reciprocal fertilisation, these three plants are also susceptible of fertilisation by pollen of other species. Thus in lines 7, 8, 9, of Table 1, the male element of *V. nigrum* is singularly enough effective in the fertilisation of each, while in a succeeding Table—4—the goodness of the male elements is also similarly shown by each effectively fertilising the female element of the *V. lychnitis, lutea.* Again, we have fuller illustrations of these curious sexual phenomena in Table 2, in which one of the above plants, *V. phœniceum*, yields a varying degree of fertility to four other distinct species; namely the *V. ferrugineum*, *Blattaria lutea* and *alba*; *Lychnitis lutea* and *ovalifolia.* These are indeed remarkable physiological revelations. How strange that an individual plant could be fertilised by the pollen of five distinct species, and yet not by its own good pollen: how singular also, as shown above, to see three hermaphrodite individuals incapable of self-fertilisation, yet having each sexual element reciprocally meeting and fertilising the opposite elements of other species. Thus, for example, the male element of *V. phœniceum* and *vars. roseum* and *album* fertilise the female element of *V. lychnitis*, while the female elements of the three former are also susceptible of fertilisation by the male element of *V. nigrum*. The full explanation of these curious and complicated sexual relations, I leave for more sagacious and ingenious investigators, and simply confine myself to remarking on the apparent support that these and more especially those other cases which I have communicated to the Linnean Society,* on the fertilisation of certain species of Passifloræ,—in which I showed that individual plants perfectly self-sterile readily effected reciprocal unions with other similarly characterised individuals of the same species—give to that view which Mr. Darwin has propounded regarding the existence of a law in nature necessitating "an occasional cross with another individual, or, that no hermaphrodite fertilises itself for a perpetuity of generations," but "that some unknown great good is derived from the union of individuals which have been kept distinct for many generations."†

In the following table, the results of the pure unions of *V. phœniceum* given on the first line are taken from capsules on a specimen in the Edinburgh University Herbarium, as I have not yet been successful in getting good capsules from any of the plants which I have had an opportunity to experiment upon by their own pollen. The other plants of *V. phœniceum* and varieties mentioned in the table are the same as those from which I had the results given in Table 1. Indeed, in one or two instances, the same experiments are re-stated, with a view to show more clearly the relative degrees of sterility resulting from the crossing of undoubted varieties of a species on the one hand, with those from the hybridisation of distinct species on the other.

TABLE 2.—Pure and Mixed Unions of *Verbascum phœniceum* and var. as ♀	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation. No. of capsules.	By calculation. No. of seeds.	The comparative fertility of the different unions.
No. 1. *Verbascum phœniceum* L. (wild plant naturally fertilised), ...	..	4	142	36	20	710	1000

* "Journal Linn. Soc." Vol. 8. p. 197. † Orchid Fertilisation, pp. 1—360.

Table 2. *Contd.*—Pure and Mixed Unions of *Verbascum phœniceum* and var. as ♀	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation.		The comparative fertility of the different unions.	
					No. of capsules.	No. of seeds.		
No.								
2. *V. phœniceum, rosea,* by pollen of *V. phœniceum* L.,	12	9	306	34	20	680	..	957.7
3. *V. phœniceum, alba,* by pollen of *V. phœniceum, rosea,*	7	5	154	31	20	616	..	867.6
4. *V. phœniceum, alba* by pollen of *V. phœniceum,* ..	16	11	287	26	20	522	..	735.2
5 *V. phœniceum,* by pollen of *V. phœniceum, rosea,* ..	10	8	193	24	20	483	..	680.3
6. *V. phœniceum* by pollen of *V. phœniceum, alba,* ...	10	6	120	20	20	400	..	563.4
7. *V. phœniceum* by pollen of *V. ferrugineum,* Andr., ..	12	7	148	21	20	423	..	595.8
8. *V. phœniceum* by pollen of *V. blattaria, lutea* L., ..	12	7	112	16	20	320	..	450.7
9. *V. phœniceum* by pollen of *V. blattaria, alba,* ..	12	4	54	13	20	270	..	380.3
10. *V. phœniceum* by pollen of *V. lychnitis lutea,* L., ...	12	8	102	13	20	255	..	359.1
11. *V. phœniceum* by pollen of *V. ovalifolium,*	12	5	43	8	20	172	..	242.2

In addition to the simple and calculated results given on Table 1, I have, in the above, given at the right hand, for the sake of comparison, the calculated product from an assumed 1,000 seeds of the pure unions relatively to those yielded by the cross and hybrid unions. By a further comparative study of these results, we find that the fertility of the pure unions of *V. phœniceum,* relatively to that of its cross-unions with the white and rose-coloured varieties, is, in the least differentiated or most highly fertile unions, viz., *V. phœniceum, rosea* by pollen of *V. phœniceum,* as 100 : 95; whereas in the least fertile unions, *V. phœniceum* by pollen of *V. phœniceum, alba,* the proportions are as 100 : 56. The average fertility of the *five* cross-unions given in the table, relatively to the pure unions given in the first line, is as 100 : 75; so that the pure unions thus exceed in fertility the cross-unions, in nearly the proportions of 4 : 3. Again by a similar comparative study of the relative fertility of the pure unions of *V. phœniceum* and the different hybrid unions given in the Table, we find that the highest degree of fertility results from the union of *V. ferrugineum* (which perhaps is correctly regarded by De Candolle and others as a mere variety of *V. phœniceum*) with *V. phœniceum*, the proportions of the pure to the hybrid unions being as 100 : 59, in favour of the former. The lowest degree of fertility results from the unions of *V. ovalifolium*, with *V. phœniceum*, the proportion of the pure to the hybrid-unions in this case being as 100 : 24.) Lastly the average fertility of the *five* hybrid unions given in the latter lines of the Table, relatively to the pure unions of *V. phœniceum*, is nearly as 100 : 40, or as 2.5 seeds of the pure unions to one of the hybrid unions. Thus, the relative differences in the degree of sterilisation resulting from the hybridisation of distinct species, and that from the cross-impregnation of varieties of a species, relatively in either case to the pure unions, is in the former as 2.5 : 1, and in the latter as 4 : 3.

TABLE 3.—Pure and Mixed Unions of *V. lychnitis*, L. var. *alba* as ♀.	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation. No. of capsules.	By calculation. No. of seeds.	The comparative fertility of the different unions.	
No. 1. *Verbascum lychnitis*, var. *alba* of gardens, by own pollen, ...	6	6	250	42	20	833	1000	
2. *V. lychnitis*, *alba*, by pollen of *V. lychnitis*, *lutea*, L.,	8	8	274	34	20	685	..	$822.\dot{3}$
3. *V. lychnitis*, *alba*, by pollen of *V. thapsus*, L. var. *alba*, of gardens, ...	10	5	98	20	20	392	..	$470.\dot{5}$
4. *V. lychnitis*, *alba*, by pollen of *V. phœniceum*, L. var. *alba* of gardens, ..	5	4	113	28	20	565	..	$678.\dot{2}$

TABLE 4.—Pure and Mixed Unions of *V. lychnitis, lutea*, L. as ♀	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation. No. of capsules.	By calculation. No. of seeds.	The comparative fertility of the different unions.	
No.								
1. *V. lychnitis, lutea*, L. by own pollen,	6	6	226	38	20	753	1000	
2. *V. lychnitis lutea* by pollen of *V. lychnitis, alba*,	8	7	249	36	20	711	..	944.2
3. *V. lychnitis, lutea* by pollen of *V. phœniceum*, L.,	5	3	75	25	20	500	..	664.0
4. *V. lychnitis, lutea* by pollen of *V. phœniceum*, L. var. *alba* of gardens,	5	3	63	21	20	420	..	557.7
5. *V. lychnitis, lutea* by pollen of *V. phœniceum*, L. var. *alba* of gardens, ..	5	2	37	18	20	370	..	491.3
6. *V. lychnitis, lutea* by pollen of *V. blattaria*, L. var. *alba* of gardens, ...	8	4	85	21	20	425	..	564.4
7. *V. lychnitis, lutea* by pollen of *V. blattaria, lutea*, L.,	8	5	97	19	20	388	..	515.2
8. *V. lychnitis, lutea* by pollen of *V. thapsus, lutea*, L., ..	10	7	123	18	20	351	..	466.1
9. *V. lychnitis, lutea* by pollen of *V. thapsus*, L. var. *alba* of gardens, ...	10	5	75	15	20	300	..	398.4
10. *V. lychnitis, lutea* by pollen of *V. nigrum*, L., ..	10	6	182	30	20	607	..	806.1
11. *V. lychnitis, lutea* by pollen of *V. virgatum*, With., ..	10	5	111	22	20	444	..	589.6
12. *V. lychnitis, lutea* by pollen of *V. thapsiforme*, Schrad, .	8	3	52	17	20	347	..	460.8

In Table 3 we have first the results of the pure unions of *V. lychnitis, alba*, and by comparing them with those resulting from fertilisation with the pollen of *V. lychnitis, lutea*, we find that the latter cross-unions undergo the proportionately decreased fertility of 100 : 82. By the hybrid-unions of *V. lychnitis, alba*, with the pollen of *V. phœniceum, alba*, a slightly higher degree of sterilisation results; the proportion in this case being as 82 : 67, relatively to 100 produced by the pure unions of *V. lychnitis, alba*. The highest degree of sterilisation in this Table results from the union of *V. lychnitis, alba*, by pollen of *V. thapsus, alba*, the proportion of the pure to the hybrid unions being here as 100 : 47.

The results of my experiments on the yellow variety of *V. lychnitis* are given in Table 4. By a comparative examination of this Table, we have the following general results: first, the fertility of the pure unions of *V. lychnitis, lutea* exceeds that resulting from the cross-unions of the latter with pollen of *V. lychnitis, alba,* in the proportion of 100 : 94. The degree of sterilisation induced by these unions, though less than that resulting from the converse unions given in Table 3, is nevertheless sufficient to show a sterilising influence in the conjunctions of varieties of a species, characterised only by those, systematically considered, trifling differences in colour—the one being white, the other yellow. Secondly we have the results of unions of similarly and dissimilarly coloured forms of distinct species, with *V. lychnitis, lutea.* Thus the pollen of *V. phœniceum,* with purplish coloured flowers, applied to the stigmas of *V. lychnitis, lutea,* gives an average fertility of 66; the pollen of the white variety *V. phœniceum, alba,* gives an average of 55; while that of the rose-coloured variety is productive of the highest degree of sterilisation, giving only 49—relatively to 100, the produce of *V. lychnitis, lutea* by its own pollen. Mr. Darwin, on the authority of Gartner, states in his "Origin of Species," that similarly coloured varieties of distinct species are more fertile when crossed than are the dissimilarly coloured varieties of the same species. The particular illustration of this point will be found in a subsequent part of this paper; I will here merely state that, in the above unions, the degrees of fertility are by no means regulated by the colour affinities. Thus, we have first yellow and violet, then yellow and white, and lastly yellow and rose yielding a successively decreased fertility; whereas, judging by the colour affinities, the arrangement ought to have been, beginning with the most fertile, yellow first with white, then with rose, and lastly with violet. Secondly, with pollen of the *V. blattaria, vars. alba* and *lutea,* we see, that the *V. lychnitis, lutea* yields the higher degree of fertility with the former: *V. lychnitis, lutea,* yielding with pollen of *V. blattaria, alba,* 56, and with that of *V. blattaria, lutea,* 51, relatively to 100, the product of fertilisation with its own pollen. Thirdly, in the unions of *V. lychnitis, lutea,* by pollen of the yellow and white varieties of *V. thapsus,* we find that unions of the similarly coloured flowers are the more fertile. *V. lychnitis, lutea,* yielding with pollen of *V. thapsus, lutea,* 46, and with the pollen of *V. thapsus, alba,* 39, relatively to 100, the results of fertilisation with its own pollen. Fourthly, in accordance with recognised systematic affinities, we find the following descending scale of sterilisation resulting from the unions of *V. nigrum*, *V. virgatum* and *V. thapsiforme* with the *V. lychnitis*. Thus with the pollen of *V. nigrum*, the average fertility of *V. lychnitis*, *lutea*, is 80, with that of *V. virgatum* 58, and with that of *V. thapsiforme* 46, relatively, in each instance, to 100, the product of fertilisation by its own pollen. A similar accordance is observable between the functional and systematical relations of *V. blattaria* and *V. thapsus* with the *V. lychnitis*. In the unions, however, of *V. phœniceum* and varieties with the *V. lychnitis*, no such accordance is observable. The different unions vary greatly in the degree of fertility *inter se*, and judging indeed by the relative functional potency of the pollen of the three varieties on the stigmas of *V. lychnitis*, the different results are comparable with those from distinct species, and would cause their interpolation into systematically considered false positions, showing us that the functional and systematic affinities of the species of a genus are by no means strictly co-ordinated.

Table 5.—Pure and Mixed Unions of *Verbascum blattaria*, L. var. *alba* of gardens.	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation. No. of capsules.	By calculation. No. of seeds.	The comparative fertility of the different unions.	
No. 1. *Verbascum blattaria*, L. var. *alba* of gardens by own pollen,	8	8	438	55	20	1095	1000	
2. *V. blattaria*, *alba* by pollen of *V. blattaria*, *lutea*, L.,	6	5	217	43	20	868	...	792.6
3. *V. blattaria*, *alba* by pollen of *V. thapsus*, *lutea*, L.,	6	2	36	18	20	360	...	328.7
4. *V. blattaria*, *alba* by pollen of *V. thapsus*, L. var. *alba* of gardens,	6	4	95	24	20	475	...	433.7
5. *V. blattaria*, *alba* by pollen of *V. lychnitis*, *lutea* L.,	8	5	65	13	20	260	...	237.4
6. *V. blattaria*, *alba* by pollen of *V. lychnitis*, L. var. *alba* of gardens,	6	4	79	20	20	395	...	360.7

TABLE 6.—Pure and Mixed Unions of *V. blattaria, lutea*, L. as ♀		No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation.		The comparative fertility of the different unions.	
						No. of capsules.	No. of seeds.		
No.									
1.	*Verbascum blattaria, lutea*, L. by own pollen, ..	8	7	354	50	20	1011	1000	
2.	*V. blattaria, lutea* by pollen of *V. blattaria, alba* of gardens, .	6	3	147	49	20	980	...	969.3
3.	*V. blattaria, lutea* by pollen of *V. thapsus, lutea*, L.,	6	4	103	26	20	515	...	509.4
4.	*V. blattaria, lutea* by pollen of *V. thapsus, alba* of gardens, . ..	6	2	62	31	20	620	...	613.2
5.	*V. blattaria, lutea* by pollen of *V. lychnitis, lutea*, L.,	8	4	81	20	20	405	...	410.4
6.	*V blattaria, lutea* by pollen of *V. lychnitis, alba* of gardens, ...	8	1	23	23	20	460	...	454.8

The results of experiments on the *V. blattaria*, varieties *lutea* and *alba*. are given in the above Tables : they comprise 12 unions between the white and yellow varieties of three species. Let us briefly compare the results of their reciprocal unions. First, the fertility of *V. blattaria, alba*, when fertilised by its own pollen. undergoes the highly proportionate sterilisation of 98 : 78 when fertilised with the pollen of the yellow variety—*V. blattaria, lutea*. In the converse case, the sterilising influence of the cross relatively to the pure unions of these forms is much decreased, the pure union of *V. blattaria, lutea*, yielding more seed in the proportions of 90 : 88 than from its cross-union with the white variety—*V. blattaria, alba*. Secondly, as to the hybrid unions with the pollens of the yellow and white varieties of *V. thapsus*. In these the pollen of the white variety is the more potent. Thus *V. blattaria, alba*, fertilised by pollen of *V. thapsus, alba*, affords an average fertility of 43, whereas by that of *V. thapsus, lutea*, the produce is reduced to 32, relatively in both cases to 100, the average fertility of *V. blattaria, alba*, when fertilised by its own pollen. By the union of the yellow and white varieties of *V. thapsus* with the yellow variety of *V. blattaria*, we see that the relative differences in the potency of the two pollens on the stigmas of *V. blattaria, lutea*, are much less than those we have above noticed when *V. blattaria alba* is used as female; and also that the potency of the two pollens is greater on the stigmas of the yellow than those of the white variety of *V. blattaria lutea;* and again that the white variety of *V. thapsus* is more fertile than the yellow, in their respective unions with the *V. blattaria, alba.* Thus *V. blattaria, lutea*, by pollen of *V. thapsus, alba*, gives an average fertility of 61; by pollen of *V. thapsus, lutea*, 50, relatively to 90, the product of fertilisation by its own pollen. Lastly, we have the different unions of the two pollens of the white and yellow *V. lychnitis* on the stigmas of the yellow and white varieties of *V. blattaria.* In these unions we see first that with *V. blattaria, alba* as female, the pollen of the white variety exceeds that of the yellow in the proportion of 36 : 23; secondly, with the *V. blattaria, lutea*, as female, the pollen of the white variety is again singularly enough the more fertile, exceeding that of the yellow variety, in the proportion of 45 : 41. Thirdly, we find that here also the yellow variety of *V. blattaria* yields a higher degree of fertility,—taking the conjoint products of the two unions with the pollen respectively of *V. thapsus, lutea* and *alba*,—than the white variety of *V. blattaria* when similarly treated, the proportions being as 70 of the *V. blattaria* to 47 of the *V. blattaria, alba*, or nearly as 3 : 2.

This leads me to notice a curious fact prominently brought before us in the above Table, whatever may be its real signification, namely, that the yellow varieties of *V. lychnitis* and *blattaria*, though yielding a higher grade of fertility to the pollen of the white and yellow varieties of distinct species than do the respective white varieties of the above species when similarly fertilised, are nevertheless less productive of seed than the white, when both are fertilised with their own pollen. This will be seen by consulting the following tabular arrangement, in which I have given a reduced approximate of the relative fertility of the different unions, selecting from the hybrid unions in each instance only the most fertile.

1. *V. lychnitis, alba*, by own pollen is as 83 : 75 of *V. lychnitis, lutea*, by its own pollen.

2. *V. lychnitis, alba*, by pollen of *V. lychnitis, lutea*, is as 68 : 71 of *V. lychnitis, lutea*, by pollen of *V. lychnitis, alba.*

3. *V. lychnitis, alba,* by pollen *V. thapsus, alba,* is as 39 : 30 of *V. lychnitis, lutea,* by pollen of *V. thapsus, alba.*

4. *V. lychnitis, alba,* by pollen of *V. phœniceum, alba* as 56 : 42 of *V. lychnitis, lutea,* by pollen of *V. phœniceum, alba.*

5. *V. blattaria, alba,* by its own pollen, is as 98 : 90 of *V. blattaria, lutea* by its own pollen.

6. *V. blattaria, lutea,* by pollen of *V. blattaria, alba* is as 96 : 79 of *V. blattaria, alba,* by pollen of *V. blattaria, lutea.*

7. *V. blattaria, lutea,* by pollen of *V. thapsus, alba,* as 61 : 43 of *V. blattaria, alba,* by pollen of *V. thapsus, alba.*

8. *V. blattaria, lutea* by pollen of *V. lychnitis, alba,* as 45 : 36 of *V. blattaria, alba,* by pollen of *V. lychnitis, alba.*

We thus see, from the eight pure, cross, and hybrid unions of *V. blattaria alba* and *lutea* given in the above comparative table, that though the white variety exceeds in fertility the yellow variety, when both are fertilised by their own pollen, the yellow variety, in the mixed unions, is in every case more highly fertile than the white. In the different unions of *V. lychnitis, alba* and *lutea,* there is some little discordance, this, however, is confined to the hybrid unions which are as yet very insufficiently illustrated, as may be seen by consulting Tables 3 and 4. In the case of the pure and cross unions, we see, as in those of *V. blattaria,* that in the *pure unions* the *white* variety, and in the *cross unions* the *yellow* variety is the more fertile.

I know not whether this concordance is casual or otherwise, but I was so forcibly struck with it in the comparative study of my Tables, that I have thus ventured a special statement. I have been more especially induced to notice it also from its evidently bearing and illustrating, as I am inclined to think, that view of Mr. Darwin, (*loc. cit.*) respecting the good derived from cross fertilisation ; inasmuch as we see that the yellow and original, or normally coloured, form of the species is less fertile than the white or derivative form in the pure unions, whereas in general, in the mixed unions, the yellow variety relatively exceeds the white in the degree of fertility. Any how, the mere fact of such variations occurring, whether or not they have any bearing on other points of theoretical natural science, seems to me worth noticing, as affording an additional link to that broken chain of

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evidence which is said to disjoin the serial continuity of the phenomena of mongrelism and hybridism.

TABLE 7.—Pure and Mixed Unions of *Verbascum thapsus, lutea,* L. as ♀.	No. of flowers fertilised.	No. of capsules produced.	No. of seeds.	Average of seeds per capsule.	By calculation. No of capsules.	By calculation. No. of seeds.	The comparative fertility of the different unions.	
No. 1. *Verbascum thapsus, lutea,* L. by own pollen,	8	8	920	115	20	2300	1000	
2. *V. thapsus, lutea* by pollen of *V. thapsus* var. *alba* of gardens,	4	2	218	109	20	2180	...	947.8
3. *V. thapsus, lutea* by pollen of *V. lychnitis, lutea,* L.,	6	1	54	54	20	1080	...	465.2
4. *V. thapsus, lutea* by pollen of *V. lychnitis,* var. *alba* of gardens,	6	3	187	62	20	1246	...	541.7
5. *V. thapsus, lutea* by pollen of *V. nigrum,* L.,	10	4	275	69	20	1375	...	597.8
6. *V. thapsus, lutea* by pollen of *V. pyramidatum,* Beib.,	10	6	374	62	20	1246	...	541.7
7. *V. thapsus, lutea* by pollen of *V. thapsiforme,* Schrad,	10	8	408	51	20	1020	...	443.2
8. *V. thapsus, lutea* by pollen of *V. virgatum,* With.,	10	5	222	44	20	888	...	386.0
9. *V. thapsus, lutea* by pollen of *V. blattaria, lutea* L.,	8	3	98	33	20	653	...	283.9

In Table 7 we have several unions of the yellow variety of *V. thapsus.* If we compare these results, we see that the fertility of the *V. thapsus, lutea,* by its cross-unions with the *V. thapsus, alba,* is decreased in the proportions of 94 relatively to 100, the product of fertilisation by its own pollen. We also see a great difference in the degrees of potency of the two pollens of the white and yellow variety of *V. lychnitis* on the stigmas of the yellow variety of *V. thapsus;* the pollen of *V. lychnitis, alba,* exceeding in its fertilising influence that of *V. lychnitis, lutea,* in the proportion of 54 : 46. Judging from the results of the seven hybrid unions given in this Table, we also see how little the recognised systematic affinities of species guide us in pronouncing *a priori* as to the degree of fertility of their several unions. For example *V. thapsiforme, V. virgatum* and *V. blattaria,* though much more closely allied to the *V. thapsus* than the others given in Table, are nevertheless least effective in their conjunctive fertility with the latter species. Furthermore, we see by those unions of *V. thapsus*, *lutea*, as female, with the yellow and white varieties of *V. lychnitis*, and of *V. pyramidatum*; that though the pollen of *V. pyramidatum* is equally potent on the stigma of *V. thapsus lutea*, as is that of *V. lychnitis*, *alba*, there is nevertheless a considerable decrease in the proportionate fertility of the unions with *V. lychnitis*, *lutea*. Hence, as we have before shown it to be with the varieties of *V. phœniceum*, and judging by the physiological test, the *V. pyramidatum* would interpolate itself between these slightly different and undoubted varieties of a species.

In the foregoing Tables, then, I have given nearly all the results of my experiments in the unions of Verbasca. Before considering the nature of the evidence they afford us as to the relationship of mongrelism and hybridism, I will briefly attempt to show how far these results accord with those of Gartner, who has also largely experimented on these plants. I may premise, however, that as my experiments are much less numerous than Gartner's, comprising some 57 distinct unions, in which 527 flowers were artificially fertilised,—whereas, as will be seen beneath, Gartner subjected no less than 1085 flowers to experiment,—they would induce very different conclusions, in certain points, to those arrived at by that careful experimentalist. I readily acknowledge therefore the higher claim of the latter to a provisional acceptance, until further experiments show more conclusively their relative correctness. I have also to notice a cause of some little discordance in such a comparative examination as that which I am about to institute; namely, that I have given in every case the *average* number of seeds produced *both* by *pure* and *mixed unions*, whereas Gartner gives the *average number* of seeds in the *pure unions* only, taking in each case the *maximum* or highest number produced by a single capsule in the *mixed unions*. I was not aware of this peculiarity in Gartner's deductions when I counted the seeds in my own experiments, otherwise, I should have drawn them up for the sake of comparison on a similar basis; even though I consider it a less fair method than that which I have adopted, in all such cases as the present, in which the ovaries contain an *indefinite* number of ovules. And this the more especially if, as in my own experiments, *castration* and *artificial impregnation* be performed in both *pure* and *mixed* unions. In drawing comparisons between *uncastrated* pure unions, and *castrated* mixed unions, the *average* of the former, with the *maximum* of the latter would certainly be the fairer method, as affording a complement for the sterilising influence of castration.

For the following digest of Gartner's experiments I have to thank Mr. Darwin, who kindly sent it to me from his yet unpublished MS. illustrations of these phenomena: "To show the scale on which Gartner worked, I may state that, in the genus Verbascum, he crossed no less than 1085 flowers and counted their seed, and recorded the results. Now in two of his works he distinctly asserts that similarly coloured varieties of *V. lychnitis* and *V. blattaria* are more fertile together than when differently coloured varieties of the same species are crossed. But Gartner chiefly relied on the crosses which he made between the yellow and white varieties of these two species and nine other distinct species, and he asserts that the white-flowering species yielded more seed than did the yellow-flowered varieties when crossed with the same white varieties of these two-flowered species, and so conversely with the yellow flowering varieties with the yellow species. The general results may be seen in his Table. In one case he gives the following details; the white *Verbascum lychnitis* naturally fertilised with its own pollen had on an *average* in 12 capsules 96 good seeds : 20 flowers artificially fertilised with the pollen of its yellow variety gave as the *maximum* 89 good seeds. I should have thought that this slight difference might have been wholly due to the evil effects of castration; but Gartner shows that the white variety of *V. lychnitis*, fertilised by the pollen of the white and yellow varieties of *V. blattaria*, in both of which cases there must have been previous castration, bore seeds to the white variety in the proportion of 62, to 43 when pollen of the yellow variety was used."

First then, in regard to the greater fertility of the unions of similarily coloured varieties, relatively to that of the unions of dissimilarly coloured varieties of the *same* species. To these phenomena I will apply in the subsequent parts of this paper the following terms: "*Homochromatic*" to the unions of similarly coloured varieties, and "*hetero-*

chromatic" to those in which dissimilarly coloured varieties are united In the following table we will at once see the comparative fertility of these different unions given in the previous ones.

RELATIVE FERTILITY OF THE HOMOCHROMATIC AND HETEROCHROMATIC UNIONS.

1. *V. phœniceum* by its own pollen, . . .	1000	
2. *V. phœniceum, rosea*, by pollen of *V. phœniceum*, ...		958
3. *V. phœniceum, alba*, by pollen of *V. phœniceum, rosea*,		867
4. *V. phœniceum, alba*, by pollen of *V. phœniceum*, ...		735
5. *V. phœniceum*, by pollen of *V. phœniceum, rosea*, ...		680
6. *V. phœniceum*, by pollen of *V. phœniceum, alba*, ...		563
7. *V. lychnitis, alba*, by pollen of *V. lychnitis, lutea*, ...		822
8. *V. lychniits, lutea*, by pollen of *V. lychnitis, alba*, ...		944
9. *V. blattaria, alba*, by pollen of *V. blattaria, lutea*, ...		792
10. *V. blattaria, lutea*, by pollen of *V. blattaria, alba*, ...		969
11. *V. thapsus, lutea*, by pollen of *V. thapsus, alba*, ...		947

Here the comparative fertility is shown by calculation from the number of seeds produced by 20 assumed capsules of both unions. The various cross-unions of *V. phœniceum* and its varieties are in each case to be considered relatively to the assumed results of the pure unions of *V. phœniceum* given in Table 2, these plants experimented upon being individually self-sterile as shown in Table 1. The unions, on the other hand, of *V. lychnitis, blattaria*, and *thapsus*, with their respective varieties, are each to be considered relatively to the 1000 seeds produced by the pure union of that variety given as female. Now in all the above heterochromatic unions, as compared with the homochromatic, we have the clearest evidence of reduced fertility. Thus, taking the 10 heterochromatic unions given, and comparing them with a similiar number of homochromatic unions, we find that the average proportion in which the former exceeds the latter, is as ·05 to ·23. On again confining ourselves to those species alone which have the yellow and white varieties, and keeping the unions of white as ♀ with yellow ♂, distinct from those of yellow as ♀ with white as ♂, we find that the cross-unions with white as female are to the pure unions of the latter as ·04 to ·28; and in those cross-unions with yellow as female, the proportions are as ·23 to ·29, relatively to the pure unions of the latter. Thus, in whatever way we proceed, the general results are the same, testifying to the highly remarkable fact announced by Gärtner, that varieties of a species, characterised by no other differences than that of colour, are occasionally so differentiated functionally, that the cross-unions, as compared with the fertility of the pure unions, invariably indicate a certain degree of sterilisation!

In connection with this higher relative fertility of homochromatic to that of heterochromatic unions, as limited to the crossing of varieties of a single species, I will venture to add that this law not only holds, but, as I believe, extends to and regulates the functional relations in accordance with the relative colour affinities of the varieties crossed. Thus for the sake of illustration, we may take the three primary colours of the cyanic series, namely, blue, violet, and red. Now beginning with red, we know that greater physiological changes must take place in the minute anatomy of the petals of an originally red-coloured flower to give the impression of blue than that of violet. Hence we might suspect that a species presenting varieties characterised by such differences in colour, would likewise afford different degrees of fertility in their conjunctive functional relations, the blue and red yielding less fertile unions, than the violet and red; while the violet holding an intermediate colour position between these, might be equally as fertile in its unions with the blue as the red variety. In practical illustration of these relations, we may take the results of the various unions of *V. phœniceum* and varieties given in Table 1. Thus the *V. phœniceum* with purplish-violet flowers yields more seeds when fertilised by the pollen of the rose-coloured variety, than by that of the white variety, in the proportion of 5 to 4. Again the white variety of *V. phœniceum* fertilised by the pollen of the rose variety yields an average of 29 seeds per capsule, and by that of the purplish violet variety the average per capsule is 26, that is as 9 to 8, in favour of the unions of the rose and white varieties. We see here evident co-relations between the degrees of fertility and the colour affinities of these plants in their respective sexual unions, and I venture to look for more marked differences in these respects, had we as subjects of experiment, varieties of a species presenting three, or at least two, of the primary colours with intermediate shades irrespective of the white. The latter being rather unsatisfactory from its similar relations to the primary colours, though in such instances as the above of the purplish-violet, rose and white, in which we have secondary colours forming intermediate steps between the primary and white, by a gradual dilution of the colouring principle, we find that the white, agreeably to the above views, form less fertile conjunctions with the violet than the rose-coloured flowers. Before passing from this point of my subject, I will now only add that I have thought these indications of a tangible law, co-relating and regulating the sexual functions of varieties when crossed—dim though they as yet undoubtedly are—worth noticing, as we are as yet in utter ignorance of anything like definite or specific laws in these phenomena, the results being considered as most capricious and uncertain.

Gärtner's second proposition is, that in the hybridism of differently coloured varieties of distinct species of Verbasca, the conjunctions of the similarly coloured flowers are more fertile than these of dissimilarly coloured flowers. For example Gärtner shows* that on the calculation of *V. lychnitis*, *fl. alba*, yielding with its own pollen 1.000 seeds, it yields when fertilised with the pollen of *V. blattaria fl. alba*, 0.622 seeds, and with that of *V. blattaria*, *fl. lutea*, only 0.438, so that the similarly coloured unions of these species are more fertile than the dissimilarly coloured unions in the proportion of 3 to 2. Let us now see then in how far this law of the differences in the fertility of the homochromatic relatively to the heterochromatic unions, is borne out in the case of my own experiments as given in the preceding Tables. And here again, for the sake of clearness, and facility of reference, I will restate them in a tabular form, and show as clearly as possible the differences in the relative fertility of the homochromatic and the heterochromatic unions, in each case, by making calculations from an assumed 100 seeds produced by the more fertile of the two unions compared. The results may be conveniently arranged under three heads; thus, first, the heterochromatic unions, or those in which the unions of differently coloured flowers are the more fertile: second, the homochromatic unions, or those in which similarly colour-

* Versuche über die Bastarderzeugunj, 1849, section 216.

ed flowers are the more fertile: and lastly, the irregular unions in which no relations are observed between the degree of fertility and affinity of colours.

A. 1.—Heterochromatic union, *the* more *fertile.*

1.	*V. lychnitis, lutea,* by pollen of *V. blattaria, alba,* .	100	
2	*V. lychnitis, lutea,* by pollen of *V. blattaria, lutea,* .	„	to 91
3.	*V. blattaria, lutea,* by pollen of *V. thapsus, alba,* .	100	
4.	*V. blattaria, lutea,* by pollen of *V. thapsus, lutea,* .	„	to 83
5.	*V. blattaria, lutea,* by pollen of *V. lychnitis, alba,* .	100	
6.	*V. blattaria, lutea,* by pollen of *V. lychnitis, lutea,* .	„	to 88
7.	*V. thapsus, lutea,* by pollen of *V. lychnitis, alba,* .	100	
8.	*V. thapsus, lutea,* by pollen of *V. lychnitis, lutea,* .	„	to 87

B. 2.—Homochromatic unions, *the* more *fertile.*

1.	*V. lychnitis, lutea,* by pollen of *V. thapsus, lutea,* .	100	
2.	*V. lychnitis, lutea,* by pollen of *V. thapsus, alba,* .	„	to 85
3.	*V. blattaria, alba,* by pollen of *V. thapsus, alba,* .	100	
4.	*V. blattaria, alba,* by pollen of *V. thapsus, lutea,* .	„	to 76
5.	*V. blattaria, alba,* by pollen of *V. lychnitis, alba,* .	100	
6.	*V. blattaria, alba,* by pollen of *V. lychnitis, lutea,* .	„	to 66

C. 3.—Degree of Fertility and affinity of Colour Irregular.

1.	*V. lychnitis, lutea,* by pollen of *V. phœniceum,* .	100	
2.	*V. lychnitis, lutea,* by pollen of *V. phœniceum,* .	„	to 80
3.	*V. lychnitis, lutea,* by pollen of *V. phœniceum,* .	„	to 74

In A. and B. of the above comparative tables, I have arranged those unions in which a certain regularity is observed between the colour relationship and the degree of fertility. Now, by comparing the 14 unions therein given, we find that the heterochromatic unions are, in the greater number of cases, more fertile, viz., as 8 to 6, than the homochromatic unions, and that this higher fertility, in every case, results from those unions in which the yellow variety of the species is treated as female. Again that the average proportion of the four heterochromatic to the four converse homochromatic unions in the first of the above tables is nearly as 7 to 6 in favour of the former. In B. 2 of the tabulated results, we see in one instance the homochromatic unions with yellow as female exceed in fertility the converse heterochromatic union; but in the other cases given in lines 3 and 5, this higher fertility of the homochromatic unions is yielded by the white variety; the relative proportions of these being much more marked than in the above cases of the heterochromatic union with the yellow variety as female, viz., as 4 to 3, whereas, as we have seen, in the heterochromatic, A. 1, the proportions are as 7 to 6. In further illustrations of this point we see in B. 2 that the yellow homochromatic union of *V. lychnitis, lutea*, by pollen of *V. thapsus, lutea*, relatively to the heterochromatic unions of the former with pollen of *V. thapsus, alba*, is nearly as 5 to 4, so that we here again see (as in the heterochromatic and homochromatic unions in A 1) a more intimate approximation between the products of these two unions, than occurs in the other cognate unions of B. 2, in which the white variety is the more fertile.

These curious relations, however, as I have already shown, are partly explained by the fact,—though we can only dimly see why it should be so,—that in the pure unions of the white and yellow varieties of the above mentioned species, the white, in every case, yields more seed than the yellow; whereas in the cross-unions the yellow variety in general is the more productive. But, it may be asked, how is the greater potency of the pollen of the white variety relatively to that of the yellow variety, as shown in the above tables to be accounted for? Does it really imply that the female element of the yellow variety yet retains its normal or original potency, the male element alone having become absolutely less potent, as compared with the male element of the white variety. This hypothesis, analogically considered, does not seem to me at all improbable. I think we have clearly seen by the comparative results of the pure and mixed unions of the yellow variety with those of the white, that the pure unions of the yellow do not yield a degree of fertility at all proportionate to that of the like unions of the white variety, as judged by the relative fertility of their cross-unions; and that accordingly this would seem to be due to an acquired weakness in the generative powers of the yellow variety. In noticing this point in a former part of my paper, I treated it as if both sexual elements had undergone a similar decrease in their generative powers;

but we here see that it is more particularly, if not altogether confined to the male element. Now, as the results of hybridisation show that the pollen is more susceptible to the concomitant sterilising action of hybridism than the female element, may we not suppose that the debilitating effect of continued self-impregnation will also manifest itself more quickly in the male than in the female element, and thus afford an explanation of the decreased sexual powers of the male, as compared with the female element, in the yellow varieties of the above species of Verbasca furthermore, showing us that as it has been a slowly acquired quality, so will it be in its elimination and regainment of its pristine vigour.

The relations of the several reciprocal unions in the above tables is another point which we must briefly consider, as having most important bearings on the subject of our present enquiry. A hasty examination suffices to show that these are much complicated. Thus *V. lychinitis, lutea*, in its two unions with the white and yellow varieties of *V. blattaria*, the heterochromatic unions are the more fertile; whereas in its two unions with the white and yellow varieties of *V. thapsus*, we find it yields the more fertile by a homochromatic union. Again *V. blattaria, lutea*, in its four distinct unions with the white and yellow varieties of *V. thapsus* and *V. lychnitis*, yields the higher degree of fertility in the heterochromatic unions, while the *V. blattaria* in its similar unions with the white and yellow varieties of *V. thapsus* and *lychnitis* is, singularly enough, more highly fertile in the homochromatic than the heterochromatic unions. Lastly the *V. thapsus, lutea*, yields more seed by its heterochromatic unions with *pollen* of the *V. lychnitis, alba*, than by its homochromatic unions with the *V. lychnitis, lutea*; whereas in the converse unions we have seen that the *V. lychnitis, lutea*, is more fertile in the homochromatic unions with *V. thapsus, lutea*, than in the heterochromatic unions with *V. thapsus, alba!*

The tabulated experiments given in C. 3, afford another source of complexity to the question under examination, inasmuch as they are quite irregular in the relative degree of fertility produced by the affinity of colour. Thus by the three unions of *V. lychnitis, lutea*, with pollen of the three varieties of *V. phœniceum*, the most highly fertile is that in which *V. lychnitis, lutea*, is treated with pollen of the purplish violet, or normal form, the average in this being 25 seeds per capsule; then follows the unions with pollen of the white variety, the average of seeds being in these 21 seeds per capsule; and lastly in the unions with the variety with rose-coloured flowers, the fertility of *V. lychnitis, lutea,* is reduced to the low average of 18 seeds per capsule. Thus judging by the degrees of fertility, we clearly see that the natural functional co-relations of these plants in place of being regulated by their respective colour affinities, arrange themselves in an entirely independent and opposite scale; the extremes in the scale of colour given, viz., the purplish-violet with yellow, manifesting the nearest functional co-relation. Again as a further complication we find that the white and yellow unions,—the most closely allied of the colours mentioned,—hold a medial position between the purplish violet and rose. How obviously futile then, we may well remark, would our *á priori* conclusions have been, as to the degrees of fertility of the above unions, on a presumed coordination between colour and function in the phenomena of hybridism!

It would thus appear from the results given in the foregoing tables that in the hybridisation of varieties of distinct species characterised by differences of colour alone, no definite relations whatever can be observed between the affinities of colour, and the degrees of fertility, but that in these cases as in the reciprocal hybridisation of pure species, the relative fecundity is a most variable and unpredicable quantum. This view seems to me to be further supported by the results of my experiments on the reciprocal hybridisation of the dimorphic species of Primulæ* in which I showed that the laws of dimorphism were limited in their action to the unions of the two forms of a species; the heteromorphic and homomorphic unions of distinct species proving irregularly the more fertile. From considering the important functional co-relations of the two forms of dimorphic species, and their trifling morphological characteristics, together with the specifically limited extent of their operations, we have less reason to be surprised, if a similarly limited relationship should ultimately prove to regulate the degree of fertility of those unions of differently coloured varieties of a species as in Verbascum and analogous cases. Indeed, judging

* Linn. Soc. Jour. Vol. 8, p. 78.

from my previous remarks on the co-relations between the degree of fertility and affinity of colour in the crossing of varieties of a species, together with the results of the hybridising differently coloured varieties of distinct species, this law seems clearly indicated, that the relative degree of fertility of the cross unions between the differently coloured varieties of *certain* species is inversely proportionate to the less or more mediate colour affinities of these unions. Further that this law does not extend to, or regulate the hybrid unions of differently coloured varieties of distinct species, but is strictly limited in its operations to those unions of varieties of a single species. Such at least is the conclusion which my own experiments would induce me to hold, but seeing that they are so directly opposed to the results of Gärtner's large experience, I would rather avoid at present anything like definite or positive conclusions, until subsequent experiment affords us a crucial array of data.

In conclusion, I will now by a cursory retrospect of the above details, re-state a few of the more important points, which elucidate the mooted relations between the phenomena of the hybridisation of a species and the mongrelism of the varieties of a species. First then in *hybridism* we see on the calculation of *V. lychnitis* yielding with its own pollen 100 seeds, it yields upon fertilisation with pollen of *V. nigrum* 80 seeds, by the pollen of *V. virgatum* 58 seeds, by that of *V. phœniceum* 66 seeds and by that of *V. thapsiforme* 46 seeds. In the unions of varieties of a species, with these of other species we find differences in the sexual powers, so that the pollen of the one variety of a species is less potent than that of the other on the stigmas of the same variety of another species. Thus *V. lychnitis* fertilised by the pollen of *V. blattaria, lutea,* yields 51 seeds, by that of *V. blattaria, alba,* 56 seeds, and again by pollen of *V. thapsus, lutea, V. lychnitis* yields 46 seeds, by that of *V. thapsus, alba,* 39 seeds, relatively in each case to the 100 seeds produced by its own pollen. Again we have evidence also of reciprocal differentiation in the relative sexual powers of varieties of a species, and those of other species. Thus in the case mentioned above of *V. blattaria,* the pollen of variety *alba* is more potent on the stigma of *V. lychnitis* than that of variety *lutea,* whereas in the converse unions of these forms, we find that the pollen of *V.*

lychnitis is more potent on the stigmas of *V. blattaria, lutea,* than that on those of the variety *alba*, in the proportion of 40 to 26.

Secondly, in mongrelism, we also find variabilities in the relative sexual powers of varieties of a species, by differences in the degrees of fertility resulting from their simple and reciprocal unions. Thus on the calculation of *V. phœniceum*, yielding 100 seeds by fertilisation by its own pollen, it yields with that of the variety *rosea* 68 seeds, and by that of the variety *alba*, 56 seeds, or nearly as 5 to 3. In the reciprocal unions of these varieties, we also find variabilities in their converse sexual powers. For example, in the reciprocal unions of *V. phœniceum* and varieties, the potency of the pollen of *rosea* relatively to that of *alba* on the stigmas of the normal form is nearly as 5 to 4; whereas the pollen of the latter on the stigmas of *rosea* and *alba* is as 4 to 3. This difference in the reciprocal sexual powers of varieties when crossed is so regulated however by colour affinities, that unlike the irregular and indefinite results of the reciprocal unions of varieties of distinct species, judging by my own experience, we see that the pollen of *rosea* is more potent on the stigmas of the normal form than these of *alba* and so conversely, the pollen of the normal form is more potent on the stigmas of *rosea* than on those of *alba*. In those cases, however, in which colour differences do not come into play the pollen of one variety, relatively to that of another variety of the same species is so differentiated with respect to their reciprocal stigmatic relations that the grade of fertility of the pure unions of these varieties does not at all correspond with that of the cross unions. For example, in the pure unions of varieties *lutea* and *alba* of *V. blattaria*, the fertility of the latter exceeds that of the former in about the proportions of 12 to 11; whereas in their converse unions, *lutea* exceeds *alba* in the higher proportions of 6 to 5! Thus in the inter-crossing of varieties of a species, as in the inter-crossing of varieties of distinct species, there are converse variabilities in the reciprocal sexual powers of their respective elements.

As the facts stand then, it appears to me that in the first crosses of the varieties of certain species, as in the first hybrid crosses of distinct species, a variable degree of sterilisation results, and again, that the relative sterilising influence is as highly intensified in the crossing of undoubted varieties of certain species, as it is in the hybridising of several undoubtedly distinct species. There is also a parallelism between the results of reciprocal hybridisation of varieties of distinct species, on the one hand with those of the reciprocal inter-crossing of varieties of a single species on the other. The sole difference in the two lines at least is merely as to the degree of extension; species relative to species occupying a higher point in the divergingly extended line, than do the varieties of a species relatively to each other, and accordingly yielding in general more intensified results, harmoniously testifying to the truth of Mr. Darwin's remark that sterility is simply a superinduced quality due to incidental differences in the reproductive system....As in the varieties of a species, however, we find that the relative amount of physiological divergence,—as judged by the fertility of their reciprocal conjunctions,—is by no means regularly or definitely co-ordinated with their morphological; so in the hybridisation of the different species of a genus, the most distinct morphologically are often found to be most nearly allied in their physiological characteristics, and thus there being no necessary co-ordination of these characteristics we can readily understand how the sterility of the first crosses of varieties of a species may, and occasionally does, exceed that of well-marked and undoubtedly distinct species.

Contributions towards a history of PANOLIA ELDI; *McLelland.*

By Captain R. C. Beavan, C. M. Z. S. &c.

The published accounts of this comparatively rare species of deer are scattered through back numbers of various scientific periodicals and proceedings of Societies, some of which are out of print, and not easily procured. I have therefore brought together nearly all that has been previously written on the subject, and added much information on the manners and habits of the species procured during a recent visit to its haunts in Burmah.

PANOLIA ELDI. The Sungnái.

Nondescript Deer, McLelland, Calcutta Journ. N. H. Vol. I. p. 501, Pl. XII.

Cervus Eldi, Guthrie, (Calcutta Journ. N. H. Vol. II. p. 405, Pl. XII.

C. lyratus, Schinz. Syn. Mam. II 395.

C. dimorphe, Hodgson, Journ. As. Soc. Bengal, Vol. XII. p. 897.

C. smithi, Gray, Proc. Zool. Soc. 1837, p. 45.

Panolia acuticornis, Gray, List Mamm. B. M. 180.

Panolia platycercos, Gray. List Mamm. B. M. 181, adult; Cat. Osteol. B. M. 66.

Cervus (Rusa) frontalis, McLelland, Calcutta Journ. N. H. III. p. 401, Pl. XIII. Sundevall, Pecora, 132.

Panolia Eldi, (The Sungnái), Gray. Cat. Hodgson Coll. B. M. 34; Osteol. B. M. 66: Knowsley Menag. Cat. Mam. in Museum As. Soc. Bengal, Blyth, 1863, p. 149.

Native names, Sungnái, apud Guthrie and Blyth: Sungraëë apud Eld: Thamyn of Burmah.

Hab. Pegu, northward to the valley of Munipore: Siam: and proximate portion of the Malayan Peninsula, (Kedda) Mergui, (*Blyth.*)

The first notice we have of this deer, was published in 1841,* and entitled—'Indication of a nondescript species of Deer by John McLelland."

"Captain Guthrie of the Bengal Engineers, employed in the construction of a road from the valley of Cachar to Monypore, procured the horns of a deer whose lower, or basal antler descends in the axis of the

* Calcutta Journ. Nat. Hist. Vol. I. p. 501, Pl. XII.

beam, rather as an extension of the horn itself than as a mere shoot. The horn may be compared to the segment of a circle, the burr, or root from which both limbs extend, being placed on the outer circumference. The beam is round, and terminates by a fork, as in the Rusa deer. The lower prolongation of the horn beneath the burr may also be said to terminate in a fork, for on the left horn, about two inches below the root, there is a small snag directed forward. In illustration of this notice, a figure of the horns is given at pl. 12."

Captain Eld, one of the principal assistants to the Commissioner of Assam, who had been previously attached to the British Residency in Muneypore, having had his attention called to the notice and the figure alluded to, soon after wrote an interesting letter on the subject, which affords the first general information hitherto received relative to the habits and character of this interesting species. His description is as follows:* "I observe mention made of a new description of Deer, said to exist between Munipore and Cachar; some specimens of the horns of which were procured in the latter place by Captain Guthrie. From the drawing, it is evident to me that the Deer alluded to is of the kind originally discovered by myself in the valley of Munipore in the beginning of 1838, and several pairs of the antlers of which were given by me to Captain Guthrie in the same year. I had intended at the time to send a description of the animal to one of the Journals, but was told that a similar Deer was to be found in the north-western jungles. As this, however, does not appear to be the case, I now forward you a correct drawing of a pair of the horns in my possession, together with a short account of the animal &c. taken from notes made at the time in my sporting diary; and which you are welcome to make use of in any way you please.

"The *Sungraëë*, as it is called by the natives, or large Deer of Munipore, is only to be found in the valley of that state, but neither in Cachar, nor the Kubo valley, nor in any of the Naga hills surrounding Munipore. Its favourite haunts are the low grass and swamps round the edge of the Logta, (lake) at the western end of the valley, and the marshy ground at the foot of the hills. It is gregarious in its habits, and after the annual grass burning, I have frequently seen herds of two and three hundred. The colour of the males from the month of November, till about the end of May, is of a dark brown,

* Calcutta Journal Natural History, Vol. II. p. 415.

nearly approaching to black, and their bodies are covered down to the knee-joints with thick shaggy coats, resembling split whalebone, of four to eight inches in length.

"The hair about the neck is very thick, and just like a horse's mane, and the appearance the stag presents when roused, with his shaggy mane standing on end, coupled with the strong smell which at this season proceeds from their bodies, perceptible at 40 and 50 yards distance, is so formidable, that I have known the boldest elephant refuse to approach them. In June the stags commence shedding their horns, and the new ones have nearly attained their full size by the end of November, but are in perfection in February and March; about this time also (June) they change their coats, which lose their whalebone texture, and become of a beautiful glossy chesnut colour, and about half an inch in length. The contour of their peculiarly small heads, and the perfect symmetry of their forms, divested of their long bristly coats, are now fully developed, and at this season they are, in my opinion, the most beautiful and graceful of the Deer species. The height of the full grown stags averages about eleven and a half hands, and that of the does three or four inches less. The colour of the latter is always the same—a bright bay, but more glossy during the rains than at any other time. The principal distinction between the *Sungraëë* and others of the Deer species consists in the peculiar shape of the lower antlers, which, instead of breaking off at an angle where they are set on the head, preserve the continuity of curve downwards, and project over the eyes of the animal, which they nearly hide, their semicircular shape giving the Deer, when at gaze or in motion, the appearance of having too distinct pairs, the one inclining forwards and the other backwards. The generality of the stags have from six to ten branches or snags, but I have killed very old ones, with no less than sixteen clearly defined branches.

"It would be a great object gained, could any live specimens be procured for transmission to Europe, but it would I fear be attended with much difficulty. I have known several instances of the fawns being caught and thriving well for months, but at about a year old, they invariably pined away and died; nor have I known or heard of a single instance of one having arrived at maturity, this too in their native climate; and I therefore think the chances of one surviving a voyage home but small. I have written to a friend in the valley to send me a complete skeleton of one with the skin &c., and he has kindly promised to do so if he can succeed in procuring one; but says he can hold me out but slender hopes, as the Deer now seem to bear a charmed life, and roam about unpersecuted by anybody."

The next detailed description of this deer was given by Dr. McLelland in 1842,* and I quote his remarks nearly in full.

"Although differing considerably in the form of the horns from any of the Rusa deer, still the general form, the colour, the mane, and the Asiatic habitation of the species, seem to refer it to the Rusa group, of which it forms one of the most unique and striking examples.

"The form of the skull agrees more with that of *Cervus hippelaphus* than with that of any other species that I can refer it to, but the nasal and intermaxillary bones, as well as the muzzle generally, seem to be somewhat mere prolonged and compressed, and though the face is broad and flat between the eyes, the forehead is compressed, and the head as well as the muzzle narrow, and the profile nearly straight, but with a short prominent ridge commencing on the forehead, and extending between the horns. There are two canine teeth, not much developed, in the upper jaw of both sexes, and the suborbital sinuses are large.

"*The horns* are large and directed backwards, and obliquely outwards without ascending from the burr: they are then curved gradually upwards and outwards, and terminate in a point directed forward. A single small antler extends obliquely inward from the upper third of the horn; this antler in young individuals appears to form a fork with the summit, but in the adult it is placed about six or seven inches from the top point of the horn, and is more or less developed according to age; in the adult, and particularly in aged individuals, an imperfect nodular spine extends from the base of this antler towards the point of the horn, with several irregular blunt snags arising from it, forming an incomplete kind of crown. *The brow* antler advances directly forward from the burr, and bending upwards and onwards, terminates in a point which, if prolonged, would meet the summit of the horn, and thus complete an almost perfect circle.

* Calcutta Journ. Nat. Hist., Vol. III. p. 401, Pl. XIII. XIV.

„A single little snag sometimes shoots out promiscuously from the base of one or other horn, more frequently from that of the brow antler.

" The length of the horn following the curve is three feet, and that of the brow antler twenty inches. The circumference of the horn is five and a half inches, that of the brow antler five inches, and both together form one extended and uniform curve of four feet and seven inches; the horns spreading laterally from each other to a distance of three feet, and then approaching at their bases to an inch or an inch and a half.

" *The body* in its general symmetry is light, the limbs slender but strong, the hoofs long, black, and pointed; the head is carried erect; the tail short and conspicuous in the summer dress, but only appearing as a short tuft in the thick winter coat.

" *The coat* is thick and dense in winter, longer and coarser on the neck than on other parts, forming a thick but undefined mane of straight, harsh, and coarse hair, five or six inches long in the winter, but in summer the mane is more defined. From the withers the hair becomes shorter, diminishing towards the tail, which in summer is thinly clad, though in winter it is covered with a dense clothing of hair, in common with all the upper parts of the body. On the face, the muzzle, the limbs, and the external ears, the hair is short, close, and compact; on the lower surface of the chest it is coarse and short; it is thin, lengthy, and fine on the under-parts of the belly. The inner parts of the thighs and upper and inner parts of the forelegs are also thinly clad.

" *The colour* changes from yellowish brown in summer to a brownish grey in winter: during summer, brownish grey prevails on the face and neck, becoming yellowish brown on the upper parts of the body, the backs of the ears, and the upper and outer part of the limbs and the muzzle. The belly, the inner parts of the thighs and the forelegs, the under parts of the lower jaw, the hips, the tail, and adjoining parts of the rump, are white in summer, but the rump and upper parts of the tail partake of the colours of the upper parts of the body in winter. The lower parts of the limbs are light grey, the same also prevails irregularly round the eyes, and corners of the mouth and nose, and lengthy tufts of light grey hair cover the inner surface of the ears."

Mr. Blyth, as noticed above, considers the *Cervus dimorphe* of Hodgson to be identical with the species under notice; but that the horns of the individuals figured by the latter are abnormal, on account of their being developed in captivity. Had not Mr. Hodgson mentioned, (as quoted hereafter,) that his animal was three years old and the horns perfect, I should have been inclined to have considered it as bearing its first year's horns.

The following information was obtained during a recent visit to Burmah.

Lieut.-Colonel Blake kindly furnished me with the following account: " As regards the exact localities of the *Thamyn* I can only say where I have found them and where not. As far as I know, they do not occur to the south of Moulmein, but from within a short distance of Thabyoo point, the south-western headland of the Martaban district, to Sittang, bounded to the eastward by the forest line, they are found in large herds.

" Again, on the opposite side of the Sittang river, to the south and west of Pegu, they are also found in large numbers. How far they extend in a westerly and northerly direction, from the mouth of the Rangoon river, and in the Bassein district, I do not know, but I have heard that they are common even as high up as Munipore.

" From Pegu to the north they are found in very small parties, the ground not suiting them, until you cross the " Koon" creek or river, the separating boundary between the Martaban and Thoungoo districts, and from this to within a few miles of Thoungoo they occur in large herds.

" Sometimes the plains or open spaces between the Eng* forests will be covered with them, and three or four hundred may be seen at one time. Under these circumstances they are shy and very difficult of approach. Strange to say, that although the ground appears quite as favourable for them, I have never seen a single one to the eastward of the Sittang river north of Sittang. From the above, you will see that they are gregarious in their habits. During the night, and early morning and evening, they frequent the plains, and where the forest jungle is not distant, they retire into it during the heat of the day.

* *Dipterocarpus grandifolia,* Wallich; Wood oil Tree, Mason's Burmah, edit. 1860, p. 493.

"Their food, I imagine, consists of grass. I cannot call to mind having seen more than *one* fawn with its mother.

"The colour of the young, as well as that of the females, is what is termed light fawn colour (light rufous ?) The males are sometimes of the same, and sometimes as dark as the male of the Sambur, *Rusa hippelaphus*. I know not if any change takes place in their coats with the change of seasons."

Colonel D. Brown, Officiating Commissioner at Moulmein, has noticed them to range along both banks of the Irrawaddy, on the proper right bank up to Meanoung, and on the left bank as far as Meaday, on the British frontier, N. Lat 19° 40′ E. Long. 95° 20′ (approximately). He has also observed them as plentiful at Theeg-wen, near Bassein, a few at Padoung opposite Prome, and to be more sparsely scattered through the Therrawaddy district.

For most of the following information I am indebted to the courtesy of J. Davis, Esq., Superintendent of Police in the Martaban District, an Officer well known for his intimate acquaintance with the Burmese language ; hence his services as interpreter were invaluble when Bur-mese and Karen Shikarees had to be questioned.

Pioneered by him, early in October last, I visited the haunts of the *Thamyn* near Thatore (a town about 40 miles N. W. of Moulmein), and although, owing to the dense nature of the vegetation covering the plains at that time of year, I was only able to see a few scattered females and young of the second year, yet the insight thus afforded into their habits and economy more than repaid me for the severe attack of illness I subsequently incurred by exposure to the heat and wet.

This plain of Yengyaing was then, owing to the recent and heavy falls of rain, one large swamp. Nearly the whole of its unbroken extent, which embraces an area of 14 miles in length with an average breadth of 10, could be traversed in a small canoe, except here and there, where mud and vegetation combined obliged one to resort to a very unpleasant system of half wading in water, and half stick-ing in deep slime. A continuation of this plain, broken up by belts of jungle, extends for several hundreds of miles up the Burmese coast, and has evidently been formed by the gradual retirement of the sea, which at one time doubtless dashed its waves against the Martaban and other continuous ranges of laterite hills. It is now, at Yengyaing, some eight to ten miles distant from the hills, and seems to be still retiring, since the water along the coast of this gulf of Martaban is very shallow and studded with sandbanks. For the primary cause of this we may doubtless look to the immense amount of silt deposit brought down by the waters of the Salween, Beeling, Sittang and Rangoon rivers, all of which discharge themselves into the gulf of Martaban. As the sea retires, a belt of mangrove jungle about a mile in width appears to travel with it, thus enclosing the plain with a barrier of vegetation on one side and the mountains on the other. This strip of mangrove jungle gives cover to numberless hog-deer, tiger, leopard and pig, but is never entered by the *Thamyn*, except where somewhat open; nor on the other side do they ever attempt to penetrate into the mountains. The plain is intersected by numerous tidal creeks which in the hot weather, when deprived of water from the hills, appear to dry up to a great extent, and those still open at that time of year contain no admixture of fresh water, so that it is evident, that for two, if not three, months in the year, the *Thamyn* must be entirely deprived of fresh water, whilst during the rainy season, for six months at least, they may be said to live in water. It appears wonderful how they can manage to exist in such extremes of heat and wet. With the exception of a few stunted trees, and a fringe of hibiscus bushes along the creeks, the plain is covered with nothing but grasses and paddy, of which latter both the wild and cultivated varieties are abundant: owing, however, to the paucity of the population and the consequent demand for labour in this immediate neighbourhood, perhaps only one fourth of the whole area is under cultivation for paddy: this crop succeeds here admirably, and the grain forms one of the staple articles of export from Moulmein and other Burmese ports. The remaining three fourths are covered with the indigenous uncultivated plants which, in seasons of scarcity, are reaped and used for food. This tract of country forms a vast grazing ground both for the *Thamyn*, and for large herds of tame buffaloes which are during the rains pastured here by the Karens, but withdrawn into the heavy jungles near the hills, when, in April and May, the whole of the vegetation on the plain becomes parched up, or is devoured by jungle fires. At the time of my visit vast flocks of waders and other water-birds were arriving from the north, and the creeks were filled with pelicans of several species; whilst the mud flats absolutely swarmed with stints, sandpipers, egrets, and especially the rosy tantalus. Here and there, stalking gravely amongst the flowering paddy, might be seen pairs of the Sarus crane, *(Grus antigone)*, or a troop of adjutants, both of which breed in the neighbourhood. Occasionally the rarer Javanese adjutant was met with, and the Jabiru stork, *Mycteria australis.*

The rutting season commences in the middle of March and lasts throughout April, to the middle of May.

The female gestates nearly seven months, and brings forth her young in October and November, amongst the jungle paddy which is then flowering or in seed, and at its greatest height. The sexes begin to breed at about 18 months old and the female has only a single young one at a time, which frequently stays with its mother until the second year.* Females have only four teats. In colour they are much like the female Sambur, but perhaps a little lighter. The young are at first spotted or menilled, but this disappears with age. The females are hornless. In the second year the young males first begin to acquire horns which are perfectly developed in March, and shed in the middle of the rainy season, that is about September.† After two years they get two tines, and when about seven years old are in their prime with twelve tines (including the brow antler). The natives have a vague idea that two distinct species, the lesser and the greater *Thamyn*, are to be found in the same herds, distinguishable only by difference of size in horns, and colour; but this of course is to be accounted for by the individual distinctions common to all races of animals.

The average weight of the male is from fifty to sixty vis,‡ that of a female forty vis.

Four men can carry a male with ease, when disembowelled and quartered.§

* The mother will breed a second time in 18 months after bringing forth, so that the young of two seasons are not unfrequently seen with their parents.

† As noticed above by Blyth in Major Tickell's specimen at Moulmein.

The colour of a full grown buck is dark brown, especially about the back and neck, with underparts lighter. As far as I can ascertain there is no trace of a mane, and the texture of the coat varies considerably with the seasons; more exact information on these points is however needed.

‡ A vis is equal to 140 tolahs.

§ As noticed by Blyth, the Burmese always quarter deer with the skin on. The Karens, however, will not eat the meat, because they think it will breed cholera.

The male averages $3\frac{3}{4}$ feet in height at the shoulder. The female is a little less: the very largest males do not exceed $4\frac{1}{2}$ feet. The flesh is much liked by the Burmese, and always finds a ready sale in the neighbouring villages. It is rarely brought into Moulmein. In the country the wholesale price of a doe is Rupees 3, and that of a buck Rs. 4,* which is of course less than the usual retail bazar rate.

The flesh is said to smell a little about the end of March when the weather is very hot, but about November and December it is in good condition for the table.

Their habitat and range, according to Mr. Davis, are as follows: In the Martaban District they inhabit exclusively the open grassy plains between the sea and the mountains. In the Pegu plains they are perhaps more abundant than in any other part of Burmah; next to them the Yengyaing plain in Martaban produces most; near Rangoon they are found in the Dallah plain. About Pegu and Yengyaing they are found in herds from fifty to an hundred in the month of March, but when hunted, they congregrate much more, and as many as two hundred may then be seen together. In habits they are essentially gregarious, and associate with no other species, although hog deer abound in the grass and jungle along the edges of the plain; nor will they allow the tame buffaloes to come nearer to them than about 100 yards. In habits they are very wary and difficult of approach, especially the males; they are also very timid, and easily startled. The males, however, when wounded and brought to bay with dogs, get very savage, and charge vigorously. On being disturbed, they invariably make for the open, instead of resorting to the heavy jungles like hog deer and Sambur. In fact, the *Thamyn* is essentially a plain loving species, and although it will frequent tolerably open tree jungle, for the sake of its shade, will never venture into any composed of dense or matted underwood *i. e.*, bush jungle in contradistinction to "tree jungle." Indeed I was credibly informed of a large stag which, being driven into a corner of the plain last year, by herd boys, with pariah dogs, and finding no means of escape, took refuge in heavy jungle where its horns got entangled in a hibiscus bush, and so was actually captured alive. Its captors, however, soon put an end to its existence with a sharp dhar.

* The prices quoted are what a shikarry expects usually to realize.

When first startled, their pace is great. They commence by giving three or four large bounds like the *axis* or spotted deer, and afterwards settle down into a long trot, which they will keep up for six or seven miles on end where frequently disturbed. This is when the vegetation on the plain is comparatively short. In the rains they do not go far before they find a hiding place in the long paddy. Their powers of leaping are highly developed. On the Yengyaing plain alone there are at the present time about a thousand head, on the Thatong plain, a little further to the north west, perhaps a hundred head only, which go about in small herds of seven and eight. At Yengyaing the annual number killed amounts to about forty-five, including those bagged by Europeans, and about five natives gain their livelihood in that place, almost entirely by the sale of the flesh. They are least gregarious in the rainy weather, the females have mostly then retired in twos and threes into quiet spots, and the herds are altogether more scattered, owing to the increased density of the vegetation. They feed during both day and night, chiefly however in the early morning and evening, their food consisting principally of the jungle paddy. During the night they do a great deal of damage to the cultivated variety, treading down more than they eat. They also feed on grass, and on the leaves of two jungle trees called in Burmese the "Keay" and the "Thamey," the scientific appellations of which I am unable to resolve.* In a tamed state they will eat plantain leaves.

The call of the female, uttered when disturbed, is a short barking grunt, that of the males is louder and more prolonged. It is most frequently heard in the rutting season, during which period the males have frequent and severe battles; a pair have been known to have been captured whilst so engaged, with their antlers interlocked.

* I lately had a stag *Panolia* in confinement for many months. It was put out every day among capital pasture, but invariably abstained from eating it. I tried it with a number of trees and found that it eat quickly the leaves of *Ficus venosa, religiosa* and *indica,* and that the tender shoots and leaves of bamboos were its special favourite. It was kept close to a tank in which *convolvulus reptans* was growing luxuriantly, and it was accustomed daily betimes to stand in the water up to its middle, and feed on the leaves of this plant also. It did not appear, however, to be so fond of the water as the nearly affined *bara singha, Rucervus Duvaucellii.* A male of the latter species in my possession, in the hot season, used to spend the greater part of the day lying in the water. Its food also apparently differs from that of the *thamyn,* for it browsed on common pasture, and while in the water fed on the long straggling grass *Secrsia hexandra* (*Editor.*)

About the end of January the first jungle fire sweeps over the plain and destroys the dry herbage, leaving small patches here and there about the edges of swamps. The second burning takes place about the end of March, and leaves scarcely a blade of grass behind it; the plain is then almost entirely bare, and the deer having no cover congregate in large herds. They are then to be seen on all sides, and, the buffaloes having previously withdrawn to the tree jungle, are left alone in their glory, and, as noticed before by Colonel Blake, become at this time excessively wary. From the middle of February until the first showers fall at the end of April they apparently subsist without water, they lie in salt swamps during this period, and get the benefit of the heavy dews at night. Their only enemy appears to be man, but an epidemic occasionally breaks out amongst them and destroys large numbers. The last occurred in 1863, and some fifty or sixty head fell victims. The cause of this murrain is unknown, it is probably analagous to that which yearly in Burmah, during the rains, creates such havoc amongst domestic cattle. The Burmese readily eat the diseased flesh, and experience no bad effects from doing so. The disease attacks old and young alike, apparently causing great emaciation and loss of strength, and the animal at last dies of pure weakness. It will probably be found to be some swelling or affection of the throat and lungs, which prevents the animal from eating.

There seems to be no doubt that, in Burmah, this species is gradually decreasing, and will, at no distant date, be excessively rare. This can be accounted for by the gradual but steady increase of the population, and the greater area of country (which must naturally increase yearly) which is taken up for the cultivation of rice. Unfortunately for the *thamyn*, the whole of their favourite locale is excessively well adapted to the cultivation of rice, and there is no doubt that where the indigenous wild plant is found, there also the cultivated variety will flourish. The rice trade of Burmah is yearly increasing in extent; and a few years bid fair to see the present haunts of the *thamyn* not unlike the present state of the greater portion of the rice producing plains of lower Bengal. An intelligent Burmese shikarree, who has been a hunter from his youth upwards and is now an elderly man, tells me that in former years, before Martaban was taken by the British, the *thamyn* were much more abundant than they are now, and that the natives used to destroy them wholesale at battues: a large number of men would assemble from the surrounding villages and gradually encircle three or four moderately sized herds with long strings, upon which plantain leaves were tied so as to flutter in the wind. The circle originally formed at some distance was gradually lessened, as the deer, afraid to pass the scarecrows, got gradually driven together, until they were completely surrounded and at the mercy of the hunters. The object was to get them into a corner near the heavy jungle, into which if they attempted to run, they either became entangled or allowed their pursuers to get up quite close. My informant tells me that, in former years, he has himself seen as many as 150 to 200 killed in one battue. To such a length was this system carried, and such enormous havoc thereby created, that the Burmese Government, fearing that the species would be utterly exterminated, wisely put a stop to the practice. This shikarree informed me that five-and-twenty years ago he has seen as many as five hundred head in one herd, and his account was confirmed by others. At the present day, vast mounds of their bones, in every stage of decay, exist on the Thatong plain, the site of many a battue in former times. The value of a whole carcass then was only 4 annas or $\frac{1}{4}$ tical weight of Burmese silver, equivalent to eight or ten annas of our coinage at the present day! Several intelligent men are now living in the vicinity of Thatong and Yengyaing who formerly took part in these wholesale slaughterings, and, like many others of the present generation, are apt to look back fondly to those good old times.

These battues or *kyowine* were preceded by all sorts of ceremonies and sacrificial rites, offerings being previously made to the tutelary nâts or deities of the woods and plains, to ensure success. In addition to these battues, and the recent increase of cultivation and population, we may account for their gradual decrease by the great increase that has taken place, of late years, in the number and use of fire-arms. Nearly every Burman can shoot, and a large proportion have each their matchlock or cheap Birmingham gun. It is excessively difficult to catch a *thamyn*, even a young one, alive, owing to the open nature of the country which they frequent; and several officers in the Burmese Commission have for some time past been endeavouring, without success, to procure young individuals of both sexes for the Zoological Society of London.* Major Tickell had one alive for some time in Moulmein, but it was eventually killed by pariah dogs which got into its enclosures at night. My informant, the shikarree, tells me that he had one also tame some years since; he caught it when about three months old, fed it on milk at first, and afterwards on grass and plantain leaves, and, after a short time, it became so tame that it would follow its owner about, and never attempt to leave the dwellings of man; after an interval of two years, it got a small pair of horns shaped like those of the adult, but much smaller. Finally, like most pets, it met with an untimely end, being stolen and killed for food by rapacious Burmese officials. From this the species appear to be capable of easy domestication, although it is said by some invariably to pine away and die after capture. The horns of the species are of large size, and are kept by the natives for making handles for sickles. The small ones are of no value, and are either thrown away or cut up and used as pegs.

As to medicinal qualities, when a buffaloe is bitten by a snake, the horn of the *thamyn* ground to powder is mixed with a solution of the leaves of the "Yekazoon" (*Ipomœa. sp.* or convolvulus,) and given internally, as it is said to cure the bitten animal immediately. No other part of the beast appears to be used medicinally, and the above mentioned nostrum is of no avail for the human race.

In conclusion, there is one point to which I wish to draw especial attention, as one on which our information at present is very limited. It is not known for certain whether the *thamyn*, in its first year, has horns without the brow antler, or whether they are the same as those of adult individuals, but smaller and with fewer tynes. The *pros* and *cons* on either side of the question are I find about equal. It remains for those who have the opportunity of rearing the young animal in captivity, or of shooting a young one, to prove which is the right view of the case.

* I have since heard that Col. Phayre has one at the present time alive at Rangoon, and Mr. Grote one at Alipore, supposed to be the young of this species.
A fine full grown stag which I received for Col. Phayre is now in the Zoological Soc. Gardens, London.—*Editor.*

Zoological Notes.

By William T. Blanford, F. G. S.

Cor. Mem. Z. S. Lon.

[Received 10th June, 1867.]

The following notes refer chiefly to the distribution of various animals in India and Burma, and to the habits of a few species. There is much in them which is probably not new, more especially with regard to the habits of animals. Still the subject is so interesting, and so little studied by naturalists for want of opportunity, that I trust these few remarks may have some interest. All the facts noted are from personal observation, except where the contrary is stated.

1. *The Lion in India.* Mr. Blyth, about 2 years since, called attention to the circumstance that lions had been recently met with in parts of India in which the animal had been supposed to be extinct. Since that time, one or two other localities have been added to the list of those in which lions have been met with. A paragraph went the round of the newspapers rather more than a year ago, in 1866, to the effect that a lion had been killed near Rewah. An account of the death of this animal was given in the new Oriental Sporting Magazine; and again in "Land and Water," for December 8th, 1866, Captain Le Mesurier described the locality and gave the dimensions of the skin. The animal was killed by Messrs. Lovell and Kelsey, of the Jubbulpoor railway staff: it was a fine male *with a full mane.* The dimensions of the stretched skin were the following:

	ft.	in.
From tip of nose to end of tail,..........	9	8
Ditto to insertion of tail, ...	6	10
Ditto to hinder end of mane, ...	3	6
Across skin from fore toe to fore toe, ...	6	11

So that the animal, when alive, probably measured rather less than 9 feet from the tip of the nose to the end of the tail, measured as tigers usually are, that is, by carrying a tape from the nose over the head and along the middle of the back.

The mane is specially mentioned as very full, the longest hairs being about eleven inches in length, the colour yellow sandy, except on the crown of the head, along the crest, and across the shoulders, where a blackish shade prevailed, the hairs being white, black and yellow, in about equal proportions. The ears were black on the outside, and the tip of the tail was also black; the lower tip white. From the dark colour of a portion of the hair, there can be little doubt that this was not an aged animal, although, from the fully developed mane, it must have been mature, and not a young lion. The spot where it was killed was near the 80th milestone, on the railway from Allahabad to Jubbulpoor.

I am indebted to Mr. Grote for a note from Captain Le Mesurier confirming the above particulars, and adding the following, also mentioned in the letter published in "Land and Water."

"Some few years ago Mr. Court, who is now Commissioner of Allahabad, and a very good sportsman, disturbed two lions on the rocky plain near Sheorajpúr, twenty-five miles west of Allahabad, when he was stalking antelope."

"Two years ago (1864) Mr. Arratoon of the Police shot at and wounded a lion very near Sheorajpúr, and eventually, with native help, *stoned* him to death, as he had no spare ammunition. Some of the members of my staff saw the skin, and got the story, nearly as I relate it, from Mr. Arratoon, who still holds a police appointment somewhere in the N. W. Provinces."

The last authenticated appearances of an animal now verging on extinction in Central India are, I think, sufficiently worth preserving to demand a record. The Sheorajpúr lion is, I believe, the furthest to the eastward yet known as having been killed in the present century.

Col. Torrens also has written to Mr. Grote to say that lions still occur about Lalatpúr, between Jhansi and Saugor.

A few lions appear to be killed every year about Gwalior and Goona, but the animal is scarce, and, being eagerly sought after by some of the keenest sportsmen in India, it is rapidly becoming scarcer. In the hot weather of 1866 no less than 9 lions were shot by one party in the neighbourhood of Kota in Rajpootana. My information is derived directly from one of the sportsmen, Major Baigire. Of one of these Rajpootana lions I have seen a coloured drawing, taken immediately after death by an excellent artist. The mane was very fine and well developed, although the beast was killed in the hot weather, when the mane, like the rest of the fur, is doubtless thinner than in the winter.

From a native I learn that in a recent beat in Rajpootana (somewhere on the neighbourhood of Kota), no less than 10 lions were turned out. If this story be true, and I think I have heard of similar large gatherings amongst African lions, this animal occasionally collects in much larger numbers than tigers do. At the same time I do not place much faith in the story. The largest number of tigers of which I ever heard as being found together was six. These were full grown animals. Five I have several times heard of. In such cases all are one family, the old tiger and tigress and their full grown progeny. A tigress not unfrequently has 3 or 4 cubs (I have known the latter number of fœti to be taken from the body of a slain animal) but they rarely, I suspect, all attain to muturity.

The lion seems still to exist in 3 isolated parts of Central and Western India, omitting its occasional occurrence in Bundelkund. These are (1) from near Gwalior to Kotah. (2) Around Deesa and mount Aboo, and thence southwards nearly to Ahmedabad and (3) in part of Kattiawar, in the jungles known as the Gheer. It is possible that isolated examples may yet remain in others of its original haunts.

I may add that the opinion expressed by Mr. Blyth (Cat. Mam. in Mus. As. Soc.) of the inferiority in size of the lion to the tiger is quite borne out by all I have heard on the subject. Major Baigire, one of the best known tiger hunters of Western India, who has also killed more than one lion, told me that the muscular development of the latter animal, as displayed in the skinned carcase, is decidedly less than that of the former.

2. The hunting leopard, *Felis* (*cynalurus*) *jubatus*. Blyth, in his catalogue, gives the range of this animal in India as confined to the west and south. It is found throughout the greater portion if not the whole of the Central Provinces, though everywhere scarce, and I have seen the skin of a specimen killed near Deogurh in the Sonthal pergunnahs, and brought to that station by a shikaree. I think it will be found to exist, here and there, almost throughout the Peninsula. In Cutch it is said to be the only large feline existing, but I cannot speak positively on this subject.

3. The wild dog. *Cuon rutilans*, Pallas.

The ordinary prey of these animals, who, as is well known, hunt in packs, is the sâmbar (*Rusa Aristotelis*, Cuv.), the chital or spotted deer (*axis maculatus* Gray), and the wild pig. But they attack higher game. I have heard a perfectly authenticated account of their destroying a young gaur (*Bos gaurus*), and I myself found the fresh carcase of a full grown (tame) buffalo which had been killed by them. This was in the jungles east of Baroda. Now a buffalo is not an easy beast to kill; very few tigers will attack an adult. It struck me that the teeth of a wild dog would scarcely suffice to tear the enormously thick skin of the throat of their prey: and on examining the carcase I found scarcely the mark of a tooth on the neck and throat, although there were many about the muzzle. The animal had evidently been killed by tearing out its intestines, a portion of the pack meantime holding the animal by hanging on, in bull dog style, to his muzzle and forequarters. I suspect that they kill all large animals in the same way; a young sambur, which I saw on the Nilgiris, had apparently been killed in this manner. I have heard from natives, too, that this is their mode of attacking tigers. That they do attack and kill tigers is so universally stated in India, in every place where the wild dog is found, from the Himalayas to the extreme south, that I do not think its truth can be doubted, startling as the assertion appears. Yet, singularly enough, they never attack men: at least I never heard of their doing so. The wolf, which, although larger, is proportionately their inferior in strength and speed, and which rarely, and in India, I think, never, collects into packs as large as those of *Cuon rutilans*, not unfrequently attacks men, though I believe he rarely attacks an animal of the size of a full grown sambur.

Ruminantia.

4. The gaur and gayal. *Bos gaurus*, Smith, and *Bos pontalis*, Lambert. I had the unusual advantage last year, and at an interval of 2 months, of seeing five adult examples of both these magnificent bovine species alive. The gaur were wild in the jungles of Nimar, the gayals were the magnificent tame specimens procured by Dr. J. Anderson for the Zoological Society, and living for some time in the Botanical gardens at Calcutta. There could be little question of the purity of breed of the latter; although far more tame and gentle than most domestic cattle, their symmetry and the regularity of their colouring were those of wild animals.

There is, at the first sight, a remarkable resemblance between these two races. The massive proportions, thick horns, short legs, immense depth of body, the dorsal ridge terminating abruptly about half way down the back, the general colouring, are all characters common to both. But one or two differences are immediately perceived, and others become conspicuous on closer examination. The most remarkable of course are the comparatively straight and wide-spreading horns and the enormously developed dewlap of the gayal, as contrasted with the sharply curved horns and absence of any dewlap in the gaur, and the shorter tail of the former. But if Dr. Anderson's specimens are fair examples of the gayal, they shew that there are several minor distinctions between the two. In the gayals the head is shorter and, I think, altogether smaller than in the gaur, and the dorsal ridge is not quite so high. In the adult bull gayal in Calcutta, the skin of the back and sides is almost naked, as in the buffaloes of the plains of India; this I have never seen in the gaur. The legs below the knees too, which in the gaur are dirty white, are, in these gayals, dirty yellow. The female gayal is darker in colour than the cow gaurs which I have seen, but as the latter vary considerably in tint, the former may possibly do the same.

I have seen a good deal of the gaur in the Satpoora hills during the last few years. It there inhabits the peculiar thin jungles which cover the trap rocks of Central and Western India. These jungles, as is well known, consist of tolerably open spaces of thick grass 3 to 5 feet in height, with small scattered trees. This grass is burnt at the end of the cold weather over the greater portion of the country. In ravines and along the banks of streams the jungle is thicker, but elsewhere there are few places where the trees are an impediment to riding. The gaur feeds in these plains in the morning and evening, drinking in the evening, or at night, and retreating during the day either to a shady ravine, or, during the hot weather, at least, to the top of a high hill, the most breezy spot being apparently chosen, irrespective of shade. So far as I have observed, the gaur, like the sámbur, never remains in the vicinity of water, or drinks, during the heat of the day.*

The ferocity of the gaur has been, I think, greatly overstated. I have never heard of but one well authenticated instance of an unwounded animal attacking man, though the bulls, like those of all

* The spotted deer, on the other hand, almost invariably does so. The sámburs, I believe, only drink at night.

large bovines, are undoubtedly dangerous in the rutting season. In general, the gaur is a timid and rather stupid animal, not very sharp of sight, though, like all ruminants and, indeed, all wild mammals, gifted with strong powers of scent.

I have never seen a herd of more than 16, and ten to twelve is a more common number, the herd comprising one or two adult bulls only, the remainder being cows and calves. The bulls remain apart; either solitary, or in parties of two or three. But I have heard both from Europeans and natives of much larger gatherings having been seen. These are doubtless formed by the union of many herds, and this habit of collecting, at particular seasons, in very large numbers, appears common to most ruminants which habitually live in herds. Thus I have seen, in April, at least 150 spotted deer (*Axis maculatus*) together, and I have heard of far larger numbers collecting in the hot season, and I have recently heard of similar assemblages of the bárasingha (*Rucervus Duvaucellii*).

The cows of the gaur, as I have already mentioned, vary considerably in colour, being usually some shade of brown, approaching dun. Some, in Nimar and the Satpoora hills at all events, are of a very red tinge, in some cases approaching closely to the deep red so common in European cattle,—the colour also, I believe, of the cow Banting, *Bos sondaicus*. I am inclined to think that the colour is redder in the cold season than in the hot weather. The usual tinge in the hot season at least is a much duller brown, nearly the colour of the Nilgiri buffaloes. From what I have heard, the tint of these Nimar animals may be lighter than that of the cows in the Western Ghats and southern India, a circumstance probably connected with the much greater exposure to the sun which they must undergo in the thin trap jungles, and also partly, perhaps, accounted for by that tendency which appears to exist in most wild animals to approximate, in their colour, the general hue of their habitat. This is, of course, much lighter in a tract mainly covered by grass, which is dried and of the colour of straw for 7 months of the year, than in the depth of the evergreen forests of Malabar and the Western Ghats.

The size of the gaur, great as it is, is often, I suspect, exaggerated by unfair measurement. Instead of measuring the true height, as is done with horses, the length from the forefoot to the end of the spinal ridge is substituted. A great addition to the height is also easily made by pulling out the foreleg as the animal lies, and by measuring from the toe instead of from the heel, especially if the cord be curved a little over the side. Another plan I have lately heard of is to stretch a tape from one forefoot to the other over the back, and to take half the resulting length as the height. When it is remembered that the measurements are made by sportsmen, not by naturalists, it will easily be understood that all should be taken *cum grano* and that many may be rejected altogether. My own impression is that it is as rare to find a gaur exceeding about 17½ hands (5 ft. 10 in.) as it is to meet with a tiger above 10 feet in length. Larger animals do undoubtedly exist, but they are rare, and it is, I think, doubtful if 20 hands (6 ft. 8 in.) is ever reached. To judge from all the horns I have seen, the gaur of no part of India proper attains a larger size than in the Satpoora hills.

The gaur is called *ran pado* in Goozerat and *ran hila* by the Bheels of Kandesh, both words, like the name commonly used throughout Central and Southern India, *ran* or *jungli byns*, meaning wild buffalo, which is just as absurd, as the term *bison* applied by Anglo-Indians. I have even heard the name *arna*, which of course means the wild buffalo, applied to the gaur; and the correct name is rarely used, in Central India at least, except in the neighbourhood of districts where wild buffaloes occur.

5. The wild buffalo, *Bos* (*Bubalus*) *buffelus*.

I think Blyth is in error in restricting the range of the aboriginally wild buffalo to the Ganges valley and Assam. (Cat. Mam. As. Soc. p. 163). Wild buffaloes are completely unknown throughout Western and Southern India, but they are common on the east coast, to some distance south of Cuttack at least, and throughout the jungles of Mandla, Raipur and Sumbalpúr, extending west as far as the Wein a Gunga and Pranhita, and south to the Godavery; a few herds may occur beyond these limits, but they are very rare. My information is derived partly from my own observation, partly from various sportsmen who have seen and killed the animal in these districts; and I have myself seen the spoils. All that I have seen belong to the *B. speiroceros* race of Hodgson, with horns curving from the base. My reasons for thinking all these animals aboriginally wild, and and not feral, are—1st, the perfect symmetry and immense size of their horns. 2nd, the fact that the tract inhabited by them is contiguous to the area, Lower Bengal and Assam, inhabited by the undoubtedly wild race. 3rd, the circumstance that precisely the area mentioned comprises the range of other animals also restricted, in India proper, to Bengal and the neighbourhood; e. g. *Rucervus duvaucellii* and *Gallus ferrugineus*, concerning the distribution of which I shall have something further to say presently.

6. The four-horned antelope (*Tetracerus quadricornis.*)

This species is especially abundant in the trappean districts of Western India, it is one of the commonest wild animals in Nimar, Malwa, Khandeish, the western part of the Nerbudda valley, and throughout the Taptee valley. It is also common along the Western Ghats and in the Konkan about Bombay. It lives in jungle, and is generally to be found near water. It is comparatively a solitary animal, and I have never seen more than four together, the two parents and their young. For a long time I was inclined to look upon the animals with only the posterior pair of horns developed as a distinct race, with lighter coloured fur, and I am by no means satisfied that there is not a distinction to be drawn. The two horned specimens, in the country I have mentioned above, are quite as numerous as the four horned, and although they are fully adult, I have failed to find a trace of the cores belonging to the anterior pair of horns on the skull; a specimen with all four horns fully developed and pointed is rare, generally the anterior horns are mere knobs.

Mr. Blyth is, I think, in error in his catalogue of the Mammalia in Mus. As. Soc. p. 166, in applying the name Chikara to this animal. The Chikara or Chinkara (the latter being the correct name, but the *n* is nasal and very little sounded) is the name which I have heard universally applied to the Indian gazelle, *Antelope bennettii*, Sykes. The 4-horned antelope is called *Chousingha* in Hindee, as stated by Mr. Blyth; it is known by the Mahrattas as "*Benkara*" and by the Bheels of Guzerat as *Bokra* or *Phokra.*

7. The Indian antelope and gazelle. (*Antilope bezoartica*, Aldr and *A. Bennettii*, Sykes). Both of these animals can exist without water. The antelope abounds on the strip of sand separating the Chilka lake, which is quite salt, from the sea; and on this strip the only fresh water is obtained from one or two deep wells. The strip is about 30 miles long. I have been assured by so many people that

antelopes do drink in places, that I cannot absolutely assert that they do not, although I suspect their visits to the edges of streams and tanks are rather for the purpose of feeding on the green grass growing there than for drinking. As regards the Chinkara or Indian gazelle, I quite believe that it never drinks. I have seen it in the deserts of Sindh* in places where the only water for 20 miles around was procured from wells; and in places in Western and Central India where, in the hot weather, the only water is obtained from small pools remaining in the beds of streams, and around which the tracks of almost every animal in the forest may be seen, I never yet saw the very peculiarly formed tracks of the gazelle, although it frequently abounded in the neighbourhood. The four horned antelope, on the other hand, drinks habitually. I have seen it doing so, and its tracks are constantly to be found at water holes. The Nylgai drinks, but not, I think, habitually, except in the hot weather.

8. The Bára Singha, *Rucervus Duvaucellii.* For some remarks on the geographical distribution of this species see further on, under the jungle fowl. The localities given by Mr. Blyth† are Upper Bengal; valley of Nepal; Assam; *Nerbudda territory*; Eastern Sunderbuns. This list requires slight modification. The animal occurs, though scarce, in Beerbhoom, and I believe, here and there throughout the Chota-Nagpoor country, Sirgooja and Chutteesgurh, and it abounds in Bustar, as I have lately learned from Captain Glasfurd, the Deputy Commissioner of Sironcha. It is to be found about Umarkantak, the source of the Nerbudda, and in Mundla, but with one exception, to be presently noticed, not further to the west, and it is unknown throughout the greater portion of the Nerbudda valley. Generally the limits of its range are very nearly those which I have indicated for the wild buffalo.

PACHYDERMATA.

9. The Indian wild pigs. *Sus scropha?*

Mr. Blyth has pointed out (J. A. S. B. XXIX, 105) distinctions in the form of the skulls of wild pigs in India, but he has not referred to

* The Sindh species may be distinct.

† Catalogue of the Mammalia in the Museum of the Asiatic Society. The localities given by Mr. Blyth are in general thoroughly trustworthy, so far as my experience goes. I am therefore the more anxious to correct them where any improvement is possible, a task only practicable to those who like myself have had opportunities for extensive travelling in India.

differences in colour. Now I have seen whole herds (or sounders) of wild pigs which were brown in colour, irrespective of size or sex, and other herds in the same region, all the members of which were black. Large hogs are usually black, becoming grizzled with age, but I have seen a large solitary hog of the brown species, which had been just killed by a friend, and it was the same colour as the smaller animals. The brown race, so far as my observations extend, is never found except in bush or forest jungle, the black pigs are the common wild hog of the plains, but are also frequently met with in forest. These may be accidental varieties, but it is equally probable that the dfference in colour is connected with other distinctions. I can, however, only point out the question as one for enquiry.

Rodentia.

10. The Burmese bamboo rat, *Rhizomys castaneus*, Blyth.—In the Catalogue of mammalia in Mus. As. Soc. the locality of a specimen received from me is erroneously entered as South Arakan. The specimen was killed by me at Prome in Pegu. The distinction is important, as the fauna of S. Arakan, and of Arakan generally, is very different from that of Upper Pegu, though many species, like the present, are common to both.

Cetacea.

11. The freshwater dolphins of India and Burma (*Platanista*). It is well known that species of *Platanista*—whether the same or distinct, is less clearly ascertained, occur in the Ganges and Brahmapútra and in the Indus. It is less generally known that a species abounds in the Irrawadi. I have seen them in various parts of that river from near the mouth to nearly 100 miles above Ava, and I was told by natives that they are to be met with as far to the north as Bamo, the Burmese frontier. I was, however, never able to obtain a specimen. The species is very likely to differ from that of the Ganges.

I cannot say if these animals are found in any other Burmese rivers. They may very likely exist in the great rivers of Siam and Cambodia, and they should be looked for in the great Chinese rivers. I am pretty certain that in India they are only found in the Ganges, Brahmapútra, and Indus, and their tributaries. I can speak pretty certainly of their non-existence in the Brahmini, Mahanadi (of Cuttack), Godavery, Taptee and Nerbudda, and I never heard of their occurrence in the Krishna or Cauvery.

AVES.

12. Geographical distribution of the red and Sonnerat jungle fowls. *Gallus ferrugineus*, Gm., and *G. sonneratii*, Tem.

I regret very much having been the means of misleading Dr. Jerdon as to the distribution of the red jungle fowl. I had been told by two different observers that they had seen and shot jungle fowl exactly like the common barn door fowl in and near the Rajpihla hills, and a third had assured me that he had seen specimens of two different kinds of jungle fowl from the same neighbourhood.

I have now been through the Rajpihla hills and the western Satpooras pretty thoroughly, and I am convinced that the only jungle fowl inhabiting those ranges is *Gallus sonneratii.* This species is also found north of the Nerbudda, in the jungles east of Baroda, and around Chota Oodipoor, but how far it extends to the north and north-west I cannot say. It is not improbably to be found in the Aruvelli range and perhaps about Mount Aboo. It occurs throughout the Satpoora hills, north of Kandesh, and indeed throughout the Taptee valley. Further south I have recently shot it in the jungles just east of Chanda.

Jerdon mentions its occurrence at Pachmurri, where, however, I learn from Lieut. J. Forsyth that *G. ferrugineus* also occurs. I am indebted to Lieut. Forsyth for the following most singular fact with reference to the limits of the latter species. He tells me that it is precisely conterminous in the hills south of the Nerbudda with the Bára Singha, *Rucervus Duvaucellii*, and the Sál tree, *Shorea robusta.* The western limits of the great belt of Sál forest which covers so large a portion of Eastern India is in the Mundla district, and there bára singha and red jungle fowl also occur. The sál is not found in Western India; but there is one spot in the Deinwa valley, just under Pachmurri, where a patch of sal forest occurs, and there, and there only, the red jungle fowl and the bára singha are met with, although the nearest spot to the eastward where the three again recur is 150 miles off. Lieut. Forsyth adds that the two kinds of jungle fowl meet on the plateau at Pachmurri and he has shot both there. When in charge of the forests, he has traversed the whole of the jungle tracts south of the Nerbudda, and can speak positively as to the above very curious circumstance. It would be very interesting to ascertain whether any other animals or plants have a similar distribution. The only hypothesis which appears to account for the existence of an isolated colony of eastern forms like this is to suppose that, like a geological outlier they were formerly connected with the present main range, and that they existed throughout the intervening area in which they are now no larger found.

To the south, the range of the bára singha and red jungle fowl appears again to coincide with that of the sál tree. I have mentioned above the occurrence of the bára singha in Bustar, where Jerdon found both kinds of jungle fowl together, and where the sál tree is also met with. *Gallus ferrugineus* does appear to reach the Godavery further east, as I heard one crowing not long since in the gorge through which the river runs about 50 miles above Rajahmundry.

13. Distribution of the black and painted partridges, *Francolinus vulgaris*, Stephens, and *F. pictus* Jerd. and Selby.

Jerdon, Birds of India, pp. 559, 562, leaves the relative distribution of these two species to the west somewhat undefined. I have only seen or heard of *F. vulgaris* in Sind. *F. pictus* abounds throughout eastern Guzerat near Baroda and Surat, and I believe, extends throughout Kattiawar. It also occurs, though less commonly, in Cutch, where I have seen it.

Reptilia.

The garial (*Gavialis gangeticus.*)

This crocodile is generally supposed be confined to the Ganges and Brahmapútra with their tributaries. It is found also in one other river running into the Bay of Bengal, the Mahanadi of Cuttack. It does not, however, appear to range further south and is unknown in the Godavery. It is wanting in the Nerbudda and other rivers which fall into the sea on the west coast.* It is also unknown in Burma.

* I have been recently informed on good authority that it exists in the Indus. Editor.

Kashmir, the Western Himalaya and the Afghan Mountains, a Geological paper, by

Albert M. Verchere, Esq. M. D.
Bengal Medical Service, with a note on the fossils by
M. Edouard de Verneuil,
Membre de l'Académie des Sciences, Paris.

(Continued from page 115, of No. II. 1867.)

In April 1864, I sent a box of fossils, mostly from Kashmir, to Professor Faire, of Geneva. M. Faire kindly forwarded these to M. E. J. de Vernueil, who was good enough to examine them carefully, and to write a most interesting note, of which a translation is now given.

Some of the fossils represented in the Plates were not sent to Professor Faire, and some which were sent, are not figured here; the numbers at the head of some of the paragraphs of M. de Vernueil's note refer to the fossils represented in the Plates.

Note on the fossils forwarded by Mr. Verchere, *by* M. Edouard de Vernueil, *Member of the Academie des Sciences, &c. &c.*

The largest of the two specimens sent, of which the matrix is a dark brown limestone, belongs to the *Productus Semireticulatus,* (Martin), one of the most characteristic species of the carboniferous limestone, in Europe, in Russia and in America. This species has been brought from the south of the Oural, and Mr. Tchihatcheff has found it in Siberia in the Altai mountains.

A specimen of *Productus costatus* (Sowerby). This is a species scarcer than the preceding. The specimen from India shows well the characters of the species such as they are figured by Sowerby, whilst those from Missouri, figured by M. de Konnick, do not possess the large and thick ribs which characterise the original species. The *Productus costatus,* first found in England, does not exist in Continental Europe, except in Russia where I found it in the government of Toula. Some Russian authors mention it from the government of Tiver and of Kalonga.

Productus Humboldti (D'Orbigny). This species is very like *P. Granulosus* (Phillips) and *P. Heberti* (Vernueil, Bull. Soc. Geolog. de

France, Vol. XII. p. 1180). It is distinguished from this by its well marked sinus, and its fine and numerous spines strewed without order on the surface and not forming concentric series. The *P. Humboldti* is mentioned by Keyserling as having been found by him in the carboniferous limestone of the Soiwa, an affluent of the river Petchora on the western slope of the north of the Oural. Mr. Davidson has thought proper to make a new species which he calls *P. Purdoni* (on some Carboniferous Brachiopoda collected in India by A. Fleming and W. Purdon in 1848 and 1852, Quarterly Journal of the Geol. Soc. of London, Pl. 2 fig. 5, 1862) based on specimens similar to those under examination, and which came from Chederoo and Moosakhel (Salt Range, A. M. V.). He gives a drawing, under the name of *P. Humboldti*, of a species on which the spines are fewer and confusedly arranged in quincunces, and of which the sinus is very slight and only visible near the front of the shell. I would regard this rather as the *P. pustulosus.*

Productus Cora, (D'Orbigny). Two good specimens possessing well the characters of the species.—Discovered first in the Bolivian plateau by D'Orbigny. This species is one of the most characteristic of the carboniferous limestone in England, in Belgium, in Spain and in Russia.

At the time I found it in the last named country D'Orbigny had but just described it; I did not know his work, and, as this shell varies much, I had made two species of it under the names of *P. Tenuistriatus* and *P. Neflediwi.* It is found on both slopes of the Oural, and also in the white carboniferous limestone of the plains of Russia at Sterbitamak on the river Oka, and in the carboniferous region of Douety. Finally it is also mentioned in North America. It has therefore a great geological range.

Four specimens of *Productus.* That in the black limestone and brought from Kashmir is the *P. Flemingii* or *Longispinus* or *Lobatus* (three names of the same animal). It is one of these *Producti* largely distributed on the globe. It has been found on the Mississipi in the state of Ohio and in Kentucky. It exists in England, in Spain, and in Belgium. Messrs. Keyserling and Murchison and I have found it in the governments of Tiver, Kalonga, on the Douetz as well as on the river Belaja near the glacial sea. The specimens from the white limestone of the Kafir-Kote are a distinct variety, remarkable for a pretty considerable number of tubular spines, and by the large size of its longitudinal striæ, which are often well marked.

Four specimens of a small species which differs from the *P. Longispinus* or *lobatus* by the want of lobes and of a sinus on the middle of the greater valve. It is perhaps the *P. Aculeatus*, (Martin), but the specimens are not good enough to be determined rigorously.

Very small specimens of *Productus* which are perhaps the young of the *P. longispinus* or of *P. Boliviensis*, (D'Orbigny), of which Keyserling found a valve in the carboniferous limestone of the basin of the Petchora (government of Archangel). It is characterised by well detached ears.

Two specimens of *Athyris*, without the test and too imperfect to allow of their being determined (*Terebratula Subtilita*, Halls?)

Four specimens of a species of *Athyris* which is perhaps new. It belongs to the class of *Terebratulae* with concentric striæ and internal spires, called by D'Orbigny *Spirigera* and by M'Coy *Athyris* (a name, let us remark, which means the reverse of what exists, since, instead of being imperforate, these species have a round hole on the beak). This species from Kashmir approaches the *A. Ambigua*, (Sowerby), and the *A. Globulosa*, (Phoill.), but it is more transverse and the beak is more detached and sharper. It may be called *A. Buddhista*, as proposed by Mr. Verchere. The *A. Ambigua* is found in Russia in the carboniferous limestone, but is rare there, whilst it is common in England.

Two specimens, of which one is perhaps a variety of the *T. Subtilita*, (Hall*) or the *T. Subtilita* itself. The other appears to me to be an *Athyris Royssii*, (Vernueil), discovered by myself in the carboniferous limestone of Belgium. When this species is well preserved, the shell is seen to be covered by a pilose investment or coating, consisting of very fine spines continuing the lines of growth. The specimen I possess presents traces of this structure in the shape of a pubescence of very fine hairs.

Three specimens in a bad state of preservation, which are probably merely varieties of the *A. Roysii.*

* The *Terebratula Subtilita* is a species of Hall, found in the carboniferous of the Great Salt Lake in America. Mr. Davidson mentions it from India.

One more specimen of the same species.

Two specimens of a *Terebratula* which is probably new, but the specimens are not good enough to be determined.

Six specimens of a *Spirifer* which appears to me to be new. At first sight one would take it for the *S. Trigonalis*, (Martin), but it differs from it by the narrowness of the sinus, and by the want of folds in that part which most commonly shows some of them, more or less well marked, in the Sp. *Trigonalis*. The narrowness of the sinus reminds one of the *S. Mosquensis*, of Russia.

Spiriferina nearly allied to the S. *Octoplicata*, (Sow.), and still more to the *Sp. Cristata* of the Zechstein, two species which Mr. Davidson unites into one. This author figures the *S. Octoplicata* among the fossils of India. The specimen, which is marked No. I6, has narrower ribs and broader furrows than the specimens figured by Davidson. On another are admirably well seen the granulations peculiar to the genus *Spiriferina* of the lias, and to the Permian and Carboniferous species under notice. Pl. I. fig. 2, a, b, c, d.

Great *Cardinia*, perhaps new. Pl. VI. fig. 2.

Two specimens of *Cardinia* bearing a distant likeness to the *C. Ovalis* (Martin,) *C. Uniformis* of the Carboniferous of England and also to the *C. Listeri Unio* (Sowerby,) of the Lias.

M. de Koninck has figured a shell very similar to this under the name of *Solenopsis imbricata*, (Descrip. of new fossils from India, discovered by A. Fleming, by de Koninck, Quart. Journal of the Geol. Soc. vol. 19 Pl. IV fig. 3.) obtained from the carboniferous limestone of Varcho, (Vurcha, Salt Range, Punjab. *A. M. V.*)

Aviculo-Pecten dissimilis (*Pecten id.*, Fleming), This specimen reminds one of the *Pectea Ellipticus*, (Phillips), which is found in the Carboniferous of Russia.

Axinus, sp. nova. This shells resembles much the *Axinus obscurus*, (Sow. *Schizodus*, King,) of the magnesian limestone or Permian of England. It has also some distant likeness to the *A. Carbonarius (vernus)* Sow. Geol. Transac. vol. V. pl. 38.

Fenestella Sykesi, Koninck, Quart. Journ. vol. 19, pl. I. fig.,

Fenestella megastoma, Koninck, Quart. Journ vol. 19, pl. I.

Fenestella. Undetermined. Pl. V. fig. 1.

A very pretty species which I do not know. Perhaps the *Vincu-*

laria multangularis (Postlock). It is to be regretted that the surface is not seen and that the branches are split in two.

Lithostrotion floriforme, Flem. a common enough species in Russia in the carboniferous; found also in England.

Michelinia or Beaumontia. Ill preserved specimen.

Phyllopora cribellum, Konnick, Quart. Journ. vol. 19. pl. I fig. 2.

List of species which have been identified from the specimens sent by Mr. Verchere.

1. *Productus Semireticulatus*, Martin.
2. " *Costatus*, Sow.
3. " *Humboldtii*, D'Orbig.
4. " *Cora*, D'Orbig.
5, " *Flemingii*, Sow. = *P. Longispinus* and *P. Lobatus*, Vernueil.
6. " *Aculeatus*, Sow.
7. " *Boliviensis*, D'Orbign.
8. *Athyris ambigua ?* Sow. (perhaps *Sp. hova*).
9. " *Royssii*, Verneuil.
10. " *Terebratula Subtilita*, Hall.
11. *Spirifer Vercheri*, Verneuil (new species, nearly allied to the *S. Trigonalis*, Martin, but distinct).
12. *Spiriferina Octoplicata*, Sow.
13. *Cardinia ovalis ?* Martin.
14. *Solenopsis imbricata*, Konn.
15. *Aviculo-pecten dissimilis*, Flem.
16. *Axinus, Sp. nova* (nearly allied to *A. Obscurus* of the Gechstein)
17. *Fenestella Sykesii*, Konn.
18. " *Megastoma*, Konn.
19. *Vincularia multangularis ?* Postlock.
20. *Lithostrotion floriforme*, Flem.
21. *Phyllopora cribellum*, Konn.

Remarks.

Several notes on fossils collected in India have been published lately; the fossils were forwarded by Messrs. Fleming and W. Purdon and more recently by Captain Godwin-Austen. These publications are 1st, Davidson's Memoir "On some *Carboniferous Brachiopoda* collected in

India by A. Fleming and W. Purdon, Quart. Journal, vol. XVIII. p. 25; 2 plates. 2nd, Description of some fossils from India discovered by J. Fleming, by Dr. L. de Koninck, Quart. Journ. vol. XIX. with 8 plates on which are figured among others some very curious goniatites. 3rd, Geological notes on part of the N. W. Himalayas, by Capt. Godwin-Austen, with notes of fossils by T. Davidson, R. Etheridge and P. Woodward. It is only an abstract of the memoir, without plates. Capt. Godwin-Austen followed the Carboniferous limestone along the foot of the mountains at the north of the valley of Kashmir as far as Ishmalabad.* The carboniferous series is, according to Capt. G. Austen, as follows, from the highest to the lowest. 1st Layers with goniatites more or less analogous to the ceratites of the Musckelhalk. These layers are the highest of the carboniferous formation. 2nd. Below is found a compact limestone poor in fossils; 3rd, argillaceous series; 4th, limestone rich in fossils, *Productus*, &c. 5th quartzite.

As early as 1850, Sir Roderick Murchison had shown me some of the fossils sent by Mr. Fleming, and I had identified the *P. Cora*, *costatus*, Flemingi, the *Athyris Roysii*, *Orthis crensistria*, &c. Quart. Journ. vol. 7, p. 39. At the same epoch Dr. Falconer and Major Vicary had announced the existence of palæozoic fossils in the mountains which separate British India from Kabul, as remarked by Sir R. Murchison, Quart. Journ. vol. VII. p. 38. In 1852, Mr. A. Fleming published his observations on the Salt Range in several letters addressed to Sir R. Murchison, Quart Journ. vol. IX. p. 189.

All the fossils collected by Mr. Fleming, Mr. Purdon, Captain G. Austen and Dr. Verchere belong to the carboniferous formation. Captain Strachey alone has proved the existence of more ancient rocks (in a palæontological point of view.)† He sent to London a series of fossils collected in the mountains, from 17 to 18000 feet above the sea, which separate Thibet from the British provinces of Kumaon and Garhwal. I have identified among these fossils some *Asaphus*,

* Capt. Gordon-Austen and myself visited the localities referred to in the geological notes, during a tour we made together in the autumn of 1863. We thought at one time of writing a memoir in collaboration, but having been sent to the extremes of India, we arranged our notes separately. A. M. V.

† In the present paper are figured a few Cystoids which are in all probability *Silurian*, see Pl. VIII. fig. 61 and 62.

Lychas, *Illœnus*, *Cheirurus*, *Orthoceras*, &c. all characteristic of the Lower Silurian. In the upper part of the beds Captain Strachey found goniatites, ceratites and even ammonites, which remind one much of the Trias. So far, therefore, two of the four great divisions of the Palæzoic formation have become well known in the Himalaya, viz. the Silurian and the Carboniferous. The Devonian will be found also, for we have received from a Missionary travelling in China three species of *Brachiopoda* characteristic of the Upper Devonian rocks, among others the *Terebratula Cuboides*. These fossils have been presented this year to the Académie de Sciences de Paris. Mr. Davidson has also figured and described, as received from China, *brachiopoda* which also are characteristic of the Devonian, among other the *Spirifer*, Verneuil. The discovery and determination of the Devonian in the Himalaya requires attention and research.

I have further to remark how great is the analogy between India and Russia; I have found in this last country most of the species which Mr. Verchere has found in the Himalaya. Russia, the Oural and the Altai, are connecting links between England and India.

In terminating this note, we wish to observe that if, according to Mr. Verchere, the coal measures, (which should be superior to the carboniferous limestone), are wanting in India, this want is one more resemblance with Russia, for in all the carboniferous zone which extends from Moscow to Archangel the carboniferous limestone is never covered in by coal measures. There has been a slow upheaving motion of the ground, which has raised the strata above the sea-level, without, however, otherwise disturbing them, at the epoch when in other countries, the coal was being deposited. It is in the south of Russia only (the Douetz), and in a few localities on the western slope of the Oural, that coal measure deposits are to be found.

(Signed) Ed. de Verneuil.

Paris, 21*st Nov.*, 1864.

APPENDIX.

FOSSILS.

Silurian.

Sphæronites sp. Pl. VIII. fig 5.

Perfectly globular; covered with small rounded warts sharply defined. The whole shell, between the warts, is pierced with minute pores. No trace of plates; no mouth nor stalk-scar visible.

Found in the rocky plains at the foot of the Masha Brum, Korakoram Chain.

Sphæronites sp. Pl. VIII. fig 6.

Proposed name of a new species: *S. Ryallii, Verch.*

Globular. Large warts well set apart and not very sharply defined. The whole shell is covered with pores. No mouth. A stalk-stem very conspicuous.

From the same locality as the preceding. Name proposed in honour of Mr. Ryall, Gt. Trig. Survey, who discovered the shell.

Sphæronites sp. Pl. IX. fig. 1.

Depressed. No warts or spines; no plates or traces of plates, no stalk-scar. The whole surface pierced by minute pores.

Same locality.

Carboniferous.

Zeawan Beds.

Cephalopoda.

Nautilus Flemingianus, DeKon.

Journal, Geological Society, Vol. XIX. Part I, No. 73, p. 15. Pl. VIII. fig. 2. A fragment of this shell was found at Zeawan, Kashmir.

Nautilus Favranus, Verch., n. sp.

A very large globular Nautilus, eleven inches across the mouth. Perfectly smooth and inornate. Siphon large and central, formed by a series of dilatations, giving it a beaded appearance.

Rotta Roh in the Punjab.

Orthoceras sp.

Zowoor and Zeawan in Kashmir.

GASTEROPODA.

Macrocheilus Avellanoïdes, DeKon.

Journal, Geological Society, Vol. XIX. No. 73, p. 10. Pl. III fig. 4. Rotta Roh.

Dentalium Herculeum, DeKon.

Op. Cit. p. 8. Pl. IV. figs. 10, 11 & 12. Several specimens were found in the Rotta Roh, but none in Kashmir.

Trochus sp.

Some large specimens of Trochus, four inches across, were found at the Rotta Roh, Punjab.

LAMELLIBRANCHIATA.

Anomia Lawrenciana, DeKon.

Journal, Geological Society, Vol. XIX. p. 6. Pl. IV. figs. 7, 8 & 9. Found in the Rotta Roh, but not in Kashmir.

BRACHIOPODA.

Terebratula sacculus, Martin.

Journal, Geological Society, Vol. XXII. p. 40. Pl. II. fig. 1. Found at Zeawan Zowoor and Barus, Kashmir.

Remark. A few other species of true Terebratulæ were found in the Zeawan group of Carboniferous limestone, but I am unable to identify them at present.

Spirifer Vercheri, de Verneuil, new sp. Pl. I. figs. 1, 1*a*.

See M. de Vernueil's note.

Barus in Kashmir. It has been found in Spiti.

Spirifer striatus, Martin.

Journal, Geological Society, Vol. XVIII, No. 69, p. 28. Pl. I. figs. 9 and 10.

Several fragments were found at Zeawan and Zowoor, and complete specimens in the Rotta Roh.

Spirifer Moosakhelensis, David.

Op. Cit. p. 28. Pl. II. fig. 2.

This shell is extremely abundant at Zeawan, but was always found in fragments. It is also common at the Rotta Roh.

After comparing numerous specimens of the last two species, in various states of weathering, I must express my impression that the S. Moosakhelensis is only a variety of the S. striatus, in which the concentric laminæ (which do exist in the striatus) have become exaggerated. All stages of transition are to be observed in a moderately large series.

Spirifer Rajah, *Strachey* [*Syn. S. Keilhavii Buch ?*]

Paleont. of Niti, page 59.

Fragments found at Zeawan and Barus.

Spirifer, *spec. nor. ?* Pl. III figs. 1 & 1*a*.

Hinge-line straight and much longer than the greatest width of the shell. Umbones prominent above the hinge-line; hinge-area not seen. Six or seven irregular ribs radiate from the umbo to the margin in a wavy manner. Fine ornamental raised lines (coarser on the larger than on the smaller valve) radiate likewise in a wavy manner. Shell flat. It varies a great deal in shape and size, but is always very flat, so much so that it has somewhat the appearance of such shell as the *Strophomena grandis* of the Silurian. It may possibly be, like the precedent, a variety of the *S. Keilhavii.*

Found at Zeawan in Kashmir and at the Rotta Roh.

Spiriferina octoplicata (Sow.), var. Transversa (Verch.)

Pl. I. figs. 2, 2*a*, 2*b*, 2*c*, and 2*d*.

Specimens like *a*, are not common at all; but fragments of the shell such as are represented at *b*, are innumerable in the brown shale of Zeawan. Found also in the limestone of Kafir Kote in the Rotta Roh, but it is there rare. This shell seems to vary wonderfully, from the narrow forms figured by Davidson, (Journal Geological Society, Vol. XVIII. Pl. I. figs. 11 and 14,) to the very transverse variety represented here.

Athyris sp. (Ath. subtilita. Hall), Pl. II. figs. 1 and 1*a*.

This species varies considerably, especially as to size, but is easily recognized by the overlapping of the upper edge of the lines of growth, so that the shell looks as if made up of several layers laid one over the other, like the many capes of a coachman's cloak.

Found at Zowoor in Kashmir, in lenticular beds where it appears to be gregarious. Also in the Rotta Roh and Salt Range.

Athyris Buddhista, Verch., n. sp. Pl. II. figs. 2, 2*a*, and 2*b*.

It has flat, expanded sides on each side of a well marked sinus of the larger valve and sharp fold of the lesser. The beak terminates in a point, occasionally pierced by a small foramen but generally imperforate. The spiral oral arms appear to fill nearly the whole of the shell, leaving only a small hour-glass-shaped space in the centre.

This shell varies a good deal, some specimens being much more transverse than others, some being very flat and others less so. It was a gregarious animal found now accumulated in lenticular beds.

Zeawan and Zowoor. The name proposed is derived from the first few specimens which were found having been discovered in blocks of stone of a Buddhist ruin.

Athyris sp. probably A. Royssii, (L'Eveillé) Pl. II. fig. 3-3.

Less transverse than the preceding and ornamented with fine and closely set concentric lines of growth strongly marked. Foramen generally obliterated. Imprints showing the fringe-like expansion round the margin are very common in the brown shale of Zeawan. The shell is abundant in all the localities where the Zeawan bed has been observed in Kashmir and the Punjab.

Remark. Several other species of Athyris were discovered at Zeawan, Zowoor and Barus, some having the general facies of our figs. 2 and 3 and being probably varieties of the *A. Royssii.* Others with the umbo-marginal diameter longer than the transverse and being probably narrow varieties of the *A. subtilita.* Others again have the general facies of the *T. Digona*, and others the carinated appearance of the *Ath. Navicula* (Sow).

Retzia radialis (Phill), var. grandicosta (Davids.)

Journal, Geological Society, Vol. XVIII. p. 28. Pl. I. fig. 5.

Very frequently met with at Zeawan and Zowoor, and also in the Rotta Roh.

Streptorynchus crenistria, Phill. var. robustus.

Op. cit. p. 30. Pl. I. fig. 16.

This shell attains a very large size in Kashmir and in the Punjab, specimens five inches in tranvserse diameter not being rare. Fragments of this shell, and young shells, swarm at Zeawan and in some beds in the Rotta Roh.

Orthis resupinata, Martin.

Op. cit. page 31. Pl. I. fig. 15.

Abundant in the brown shale of Zeawan, Kashmir.

Orthis sp. Pl. III. fig. 3.

A cast of an Orthis belonging to the type of the *Orthis plicatulla*

(Hall) of the Silurian. It has six ribs, not very conspicuous, and two well-marked lines of growth; and is ornamented with fine radiating striæ. Only one specimen was found at Zeawan.

Remark. An immense number of small, or perhaps young, Orthisidæ occur in the ferruginous dark shale of Zeawan, in some places so abundantly that they cause the shale to exfoliate like a disintegrating mica-schist. The shells are, however, so thin and brittle that imprints alone can be procured.

Strophomena analoga (Phill.) ? Pl. II. fig. 4.

There is, I think, little doubt of this shell being Phillip's species. The shell is raised in irregular concentric furrows and ridges, and is ornamented by fine radiating striæ. Both valves are nearly flat; the umbones are hardly marked; the hinge is linear and nearly as long as the greatest diameter of the shell. These Indian specimens are very large, above four inches across.

Seldom found entire in Kashmir; but even pieces of it are conspicuous and easily recognized. Good specimens were obtained from the Rotta Roh in the Punjab.

Strophomena ? sp. Pl. III. fig. 2.

An internal cast only. Found at Zeàwan in Kashmir.

Productus costatus (*Sow.*)

Journal, Geological Society, Vol. XVIII. p. 31. Pl. I. figs. 20, 21.

Numerous specimens of this well known species were found at Zeawan and Zowoor in Kashmir, and in the Rotta Roh and Salt Range.

Productus semireticulatus (*Martin.*)

Op. Cit. p. 21.

It varies considerably, some specimens being very transverse. The Kashmir and Punjab specimens are usually very large and often deformed by pressure.

Zeawan, Zowoor, Barus. Rotta Roh, Salt Range.

Productus cora (*d'Orbigny.*)

Found abundantly every where in the Zeawan group.

Productus Humboldtii (*D'Orb.*)

Journal, Geological Society, Vol. XVIII. p. 32. Pl. II. fig. 6.

Large specimens found at Zeawan and smaller ones at Barus. Also in the Salt Range and Rotta Roh, Punjab.

Productus Purdoni (Davids).

Op. Cit. p. 31. Pl. II. fig. 5.

Zeawan in Kashmir and Rotta Roh in the Punjab. In a series of specimens of *P. Humboldtii* and *P. Purdoni*, it is quite impossible to decide where one species ends and the other begins.

Productus Flemingii (d'Orb.)

Syn. *P. longispinus (de Vern) and P. lobatus (de Vern.)*

Journal, Geological Society, Vol. XVIII. p. 31. Pl. I. fig. 19.

Davidson's figure does not show the enrolled and horn-like ears so well defined in our specimens.

M. de Vernueil regards the Rotta Roh specimens as a well defined variety ; see his note.

Found at Zeawan and Zowoor and in the Rotta Roh.

Productus Boliviensis (d'Orb.) and P. aculeatus ? (Martin).

See M. de Vernueil's Note.

Found at Zowoor and Zeawan in Kashmir.

Strophalosia ? Arachnoïdea,) Verch.) n. sp. Pl. IV. figs. 1, 1*a*, 1*b*.

The specimen of the larger valve is from the Rotta Roh and the other two from Zeawan in Kashmir ; they may be different shells. The larger valve resembles the *Productus Purdoni*, but the spines are fewer, better defined and less slanting towards the margin. The other two specimens are remarkable for the excessive length of the thread-like spines and for some complications in the hinge.

CRUSTACEA.

Eurypterus ? Limulus ? sp. Pl. V. fig. 4.

Claw of a Crustacean, belonging apparently to one or the other of the two genera above. It was found on a slab which had been worn by running water, so that a horizontal section of the claw is produced. The same slab was full of *Athyris Buddhista* (Verch.), *Productus Flemingii* (D'Orb.). *P. Aculeatus*, *Fenestella Sykesii* (deKön.) and *Vincularia Multangularis* (Patlock).

The tegument is smooth and pierced by pores, which are seen vertically sected on the margins of the claw, and appear like dots where the tegument is not worn off. The tegument forms septa in the upper mandibule, but none in the lower. The ends of the mandibules are hooked. There are no traces of teeth on the internal margin of the claw. No other part of the animal could be found.

Kashmir.

Remark. Another crustacean has been found abundantly in the Carboniferous of the Himalaya. It is a *Trilobite*, with the rings sharp and rib-like. Though common, it has not been found good enough for identification and figure.

Zeawan, Banda and Barus in Kashmir. Also Rotta Roh and Salt Range in the Punjab.

ECHINODERMATA.

Cidaris Forbesiana, (*deKön*).

Journal, Geological Society, Vol. XIX. No. 73, p. 4. Pl. IV. figs. 1 and 2.

Rotta Roh, but not in Kashmir. There are several species or varieties.

These cidarides will have, I think, to be made into a new genus when better known. They appear to have been borne on long thin branching stalks. The body has not been found yet, but I have found *hexagonal* plates with an articulation cup in the centre, spines four inches long, and stalks of considerable length.

Crinoid stems were found in enormous quantity in all the layers of the Zeawan bed. Sometimes the rock is nothing but a mass of rings pressed together. In the Rotta Roh I found a great number of an Encrinus, cup-shaped and nearly a foot in height, belonging apparently to a new genus. I cannot describe it at present. It supports a multitude of minute arms and fingers, the debris of which form a glaring-white rock, very conspicuous as one of the layers of the Zeawan bed in the Punjab.

BRYOZOA.

Tenestella Sykesii, (*deKon.*) Pl. IV. bis. figs. 1, *a. b. c. d.*

Journal I. Geological Society, Vol. XIX. p. 5. Pl. 1 fig. 1.

The colony forms a wavy leaf. The openings of the cells cover the whole surface of the longitudinal bars without assuming a linear arrangement; the transverse bars are barren of cells. The cells are arranged in bundles imbedded in sockets of the support, so that a vertical section along one of the longitudinal bars shows a succession of little cups or sockets, in each of which are collected from six to eight elongated cells, disposed fan-like. The calcareous support between the sockets is massive.

This Bryozoon is extraordinarily abundant in the Zeawan bed. The colonies are often packed one over the other like dead leaves, and I have counted seven and eight colonies in a piece of shale not an inch thick.

Fenestella Megastoma, (*deKon*). Pl. IV. bis. fig. 2, *a. b. c. d.*

Op. Cit. Vol. XIX. p. 5. Pl. II. fig. 3.

The shape of the colony was not seen. The openings of the cells cover the longitudinal bars, without assuming a linear arrangement. The bars are rounded on the cell-bearing side and are angular on the barren surface. They are hollow or tubular, and the cells are arranged over the roof of the tube, like bricks in an arch, and are not connected in bundles and contained in sockets as in the Fen. Sykesii.

Fenestella, *sp.* Pl. V. fig. 1.

Shape of colony not seen, but generally very flat and wavy. The oscules, which are small, are somewhat quadrangular. It is found mostly as an imprint. Disposition of the cells not seen.

Very abundant at Zeawan, Zowoor, Banda, in Kashmir and also in the Rotta Roh.

Vincularia Multangularis, (*Portlock*) ? Pl. IV. bis., figs. 3, *a. b. c. d.*

See M. de Vernueil's note.

The colony has a moss-like appearance. The cells are arranged all round a calcareous support, and inclined forwards.

This Bryozoon is extremely abundant in the Zeawan bed, the branches extending in all directions but never anastomosing ; their division is nearly always dichotomous. I have seen colonies cover more than a square foot of rock with their ramifications.

Disteichia ? ? (*Sharpe*). Pl. V. fig. 2.

I am unable to refer it to any genus which I know, unless to the genus *Disteichia* (Sharpe). It is found at Zeawan, but is there rare ; in the Rotta Roh it is very common. The layers of cells accumulate one over the other to a great extent, forming occasionally large masses of Coralline rock.

Acanthocladia, *sp.* Pl. V. fig. 3.

The colony has the aspect of a fern. The central stem throws out branches at regular intervals, and at a certain fixed angle, and these branches throughout younger branches. Both stem and branches support short spines like leaflets. The disposition of the cells was not seen, as only imprints of this animal were found.

Found near Banda in Kashmir.

Phyllopora ? Cribellum (deKon).

Journal, Geological Society, Vol. XIX. p. 6. Pl. I. fig. 2.

Fragments are not scarce in the Rotta Roh, but it was not found in the Kashmir beds.

Retepora Lepida, (deKon).

Op. Cit. p. 6. Pl. I. fig. 5.

Several fragments found at Zeawan and in the Rotta Roh.

Remark. A few other species, not yet satisfactorily determined, were found in this group.

ANTHOZOA.

Lithostrotion Floriforme, (Flem.).

Beautiful specimens are to be obtained near Bilote in the Rotta Roh. Not found in Kashmir.

Lithostrotion Irregulare, (Phill.) ?

A Lithostrotion which is this species, or a very near ally, is very common in the Rotta Roh. The calyces are long, rounded, irregular cylinders, more or less vermiform in appearance and varying considerably in size in various specimens, but always of nearly the same size in each individual colony.

Very small fragments only were seen in Kashmir, but in the Rotta Roh colonies of this coral attain to great size, forming masses of rock several feet across, and many tons in weight.

Alveolites Septosa, (Flem.) ?

Journal Geological Society, Vol. XIX. p. 4. Pl. II. fig. 1.

It often forms shapeless masses, the centre of which is converted into flint.

Zeawan in Kashmir and Bilote in the Rotta Roh.

Michelina, sp.

Rotta Roh. Never found in Kashmir.

Remark. The abundance of corals in the lowest beds of the Zeawan division of the Carboniferous at the Rotta Roh is sometimes astonishing. In Kashmir they are rather scarce. We have a few specimens not yet determined.

PISCES.

Saurichthys ?

Teeth of fishes, large for the genus to which they appear to belong, were found in Kashmir and in the Rotta Roh. They are conical, but compressed so that the section is an oval; they are strongly striated or rather grooved the whole length. The largest i about three quarters of an inch long.

Wean Beds.

CEPHALOPODA.

Goniatites Gangeticus, (*deKon.*)

Journal Geological Society, Vol. XIX. p. 14. Pl. V. fig. 2.

I had thought at first that this Goniatites was more like *G. Henslowii*, Sow.; but better specimens, which I have since procured, leave little doubt that the species found was DeKoninck's shell. Some of the species from the Rotta Roh are much larger than DeKoninck's figure, and some are elliptical.

Found near Banda in Kashmir and near Gung and Oomurkhel in the Rotta Roh.

Goniatites Curvicostatus, (*Verch.*), *nov. sp.* ?

The species is well characterized by curved ribs, rather coarse and irregular. The suture is like that of the *G. Gangeticus*. Only one specimen, from near Gung; not good enough to be figured.

Remark. Several indeterminable Goniatites were found near Banda, and at Barus in Kashmir.

Nautilus Clitellarius, (*Sow.*) ?

Fragments very like this species were found near Gung. Two or three other species, indeterminable, were found in the Goniatite-bed in Kashmir and at the Rotta Roh.

Orthoceras, *sp.*

A small species, about two inches long and a third of an inch thick, was found in the limestone with *Goniatites Gangeticus* near Gung.

LAMELLIBRANCHIATA.

Solenopsis Imbricata, (*deKon.*)

Journal Geological Society, Vol. XIX. p. 8, Pl. IV. fig. 3.

Found at Koonmoo and in the hills near Mutton and at the Manus Bal, in Kashmir. Also in the Rotta Roh. Good specimens were procured from blocks not in situ, near Bij-Behara in Kashmir.

Solenopsis, *sp. vel var. nov.* Pl. VI. fig. 1. Similar to the preceding but longer; the anterior end is narrower than the posterior extremity, whilst in the *S. Imbricata* both ends are nearly equal. The imbrication of the lines of growth is strongly defined.

Found with the preceding.

Cardinia, sp. (*C. Himalayana, Verch. nov. sp.*) Pl. VI. fig. 2.—(*Anthracosia, King.*) ? ?

The lines of growth are deeply impressed and imbricated, and the shell bulges a little between these lines. The hinge was not seen.

Animals gregarious; their shells occur heaped together in patches. Manus Bal, Koonmoo, Mutton?, Rotta Roh.

Cardinia, sp. (*Cardinia Ovalis, Martin,*) Pl. VI. fig. 3.—(*Anthracosia King.*) ?

A species more elongated than the preceding. Lines of growth similarly disposed. Found with the preceding.

Cucullæa, sp. Pl. VI. fig. 4.

A gregarious small shell, sometimes so abundant that it forms masses of rock by itself. Lines of growth well defined, especially near the margin. Hinge not seen. It is perhaps the young of some larger shell.

Found at Wean, Koonmoo and Ishmalabad in Kashmir and in the Rotta Roh in the Punjab.

Pecten, sp. Pl. IV. fig. 5.

Small shell, perfectly smooth with the exception of a few lines of growth. It is ornamented with *painted* dark lines, which radiate from the beak to the circumference, increasing in width as they approach the margin. The convexity is very small, and the ears small.

Only one-valve specimens were ever found, through the shell is tolerably common in the reddish limestone of Koonmoo in Kashmir.

Found also in the Rotta Roh?

Aviculo-pecten Dissmilis, (*Flem.*)

See M. de Vernueil's note.

This and the following Aviculo-pectens are apparently identical with the group of animals represented in England by the *A.-Pecten Arenaceus.* They were gregarious and all lived together, and are now found in a sandy somewhat friable limestone, in lenticular beds which are evidently the remains of sandbanks near the shore.

Our specimens of *A.-Pecten Dissimilis* are oval in shape, the umbo-marginal diameter being the longest. The shell was at first very gibbose, but after the second line of growth it is much less so. Four sunken lines of growth are well marked. Ears small and transversely striated. Shell nearly equilateral, beak prominent.

The cast shows two deep pits, corresponding on the inside of the shell to two tubercles. These pits are more than half way down the valve. The cast is covered with shallow irregular fossæ which correspond to small bosses inside the shell, and are probably due to the presence of pearly matter. There are traces of an epithelium.

Found at Koonmooh, Rotta Roh.

Aviculo-pecten, *sp.* (*A-pecten Ovatus*, *Verch.*) Pl. VI. fig. 6a, and 6b.

A small specimen, quite smooth. Outline elliptical; convexity trifling; ears meeting above the beak into a straight line.

The inside of the valve shows (*b*) two strong lateral ridges proceeding from the beak, and terminating about two-thirds down the valve in well defined tubercles. The hinge presents two short rounded ridges or teeth proceeding from the beak for about a quarter of an inch, when they also terminate in minute tubercles.

Aviculo-pecten, *sp.* (*A. pecten Ranus*, *Verch.*,) Pl. VI. fig. 7 and 7a.

Outline sub-circular; shell very flat; ears irregular. The whole valve is covered with fine radiate striæ, and with thin lines of growth. Shell thin. Internal cast not found. It is perhaps the *P. Crenisteria* (*de Koninck.*)

Aviculo-pecten Circularis, *Verch.*, Pl. VII. fig. 1a. and 1b.

Outline of shell sub-circular, rather transverse. Shell moderately convex; concentric striæ faintly seen. Lines of growth irregular and unconspicuous. The cast (*b*) presents two deep pits which are continued by a groove towards the beak, corresponding on the inside of the shell to two muscular tubercles and ridges. The ridge is much more defined posteriorly than anteriorly. Lines of growth strongly marked on the cast? No pearl fossæ. It may be a variety of *P. Ellipticus* (Phill.)??

Aviculo-pecten, *sp.* Pl. VII. fig. 2a & 2b.

Outline pyriform, umbo-marginal diameter the longest. Moderatly gibbose; beak much incurved and somewhat imbedded in the ears, which meet above it in a straight line.

The cast only was found. It shows two strongly marked lines of growth well sèt apart. No pearl-fossæ on cast.

The inside of the shell, (*b*) shows two ridges proceeding from the beak but not terminating in tubercles (at least not on one side; the other side was not seen). Two small teeth in the hinge terminate by minute tubercles. Beak grooved by a canal or foramen. Inside of ears concave.

Aviculo-pecten Testudo, Verch. Pl. VII. fig. 3 and 3a.

Shell pyriform, umbo-marginal diameter longest. Extremely gibbose. Beak pointed; ears meeting above in a straight line. A few concentric striæ. Lines of growth unconspicuous, excepting one near the margin.

Aviculo-pecten Gibbosus Verch. Pl. VII. fig. 4 and 4a.

Outline sub-circular, transverse. Shell enormously gibbose, especially as far as the second line of growth. Shell inornate. Lines of growth shallow and confused. Ears meeting in a line above the beak. Shell thick.

Remark. These Aviculo-Pectens were found in Kashmir in the Wean groups only; but in the Rotta Roh they have been found here and there mixed with shells of the Zeawan group, such as *P. Semireticulatus*, *A. Subtilita.*

Axinus, nov. spec. conf. A. Obscurus.

See M. de Vernueil's note.

Found with the Aviculo-Pectens.

BRACHIOPODA.

Spiriferina Stracheyii, (Salter.)

Paleontology of Niti, page 72, Pl. IX. fig. 13.

This shell is not rare in the Wean group near Koonmooo; in some beds it swarms in company with a small Terebratula. We have two varieties, one like Mr. Salter's figure and another higher and narrower Some specimens show plainly to the naked eye the punctate structure of the shell.

POST-SCRIPTUM. *Productus Lævis*, (David.) T. Geol. Soc. Vol. XXII. p. 44, Pl. XI. fig. 16, and *Spirifera Barusiensis*, (David), Op. Cit. p. 42, Pl. XI. fig. 7.

Both these shells are found in the Wean limestone near Koonmoo, and at the Rottah Roh in the flaggy limestone with *Goniatites Gangeticus.* I have not found them in the Zeawan group, except at the Rotta Roh in the mixed beds.

Trias (Middle and Upper.)

Kothair Beds.

In the text I considered provisionally the Kothair group as either the uppermost layer of the Carboniferous, or else Permian or Triasic. I had no fossils then to decide the point. During the time which has elapsed between my first sending in this paper and its publication I have found, in breaking up some rocks from the Kothair bed in Kashmir, a Globosus with Ceratite-like sutures; and I have discovered in the Rottah Roh, in beds corresponding to the Kashmir bed, a few shells which do not leave a doubt of this group being Triasic.

Cephalopoda.

Ammonites, sp. conf. A. Gaytani (Klip.)

Paleont. of Niti, p. 65, Pl. TII. fig. 4.

Our specimen is a little more than half an inch across, and very globose. It shows well two or three of the sutures which are identical with Mr. Salter's figure.

From the Upper Bed, near Banda in Kashmir.

Ceratites Semi-partitus (Gaillardot.)

A very good and nearly complete specimen was found in the Rotta Roh, in a pale limestone which forms a high cliff above the much disturbed Carboniferous. The shell is slightly elliptical. The suture is exactly like that represented in Pictet's Traite de Paléontologie. It has some resemblance to M. de Konninck's *Ceratites Lyellianus* or more still to his *C. Lawrencianus*, but the suture differs. Cliffs above Kotela and Oomurkhel, Rotta Roh.

Remark. I have but little doubt that several of the Ceratites described by Mr. de Koninck (from Dr. A. Fleming's collection), as obtained from Carboniferous beds with Spirifers and Producti, had their situs in those cliffs or similar ones, and had dropped and become mixed with the much broken up and fragmentary rocks of the Zeawan and Wean groups below.

Ceratites Nodosus (Sow.) ?

On a slab of reddish calcareous sandstone from the Alged Wan, Rotta Roh, a shell, which has all the characters of this species, is to be seen in company with the Posidonomya to be hereafter described, with fragments of bone and what appears to be a tooth of Lepidotus (?)

GASTEROPODA.

Natica, sp.

Like *N. Subglobulosa* (Kl.) Pal. Niti, p. 68, Pl. VIII. fig. 12.

Only sections and outlines were seen on the weathered surface of rocks. Very abundant in the upper beds at Banda and at Kothair in Kashmir.

Macrocheilus, sp.

Sections and outlines of a shell of this genus are very abundant at Sono Murg and Kothair.

Nerinæa, sp.?

Small shells with a raised spot in the centre of each half-whorl.

Pyramidella or *Loxonema?*

Several specimens of this fine Pyramidella were seen on the weathered surface of the sandy limestone of the patch of Kothair rock near Koonmoo.

LAMELLIBRANCHIATA.

Posidonia conf. P. Minuta.

Minute shells of this genus, with well-marked concentric striæ, were found in the sandstone containing the *C. Nodosus.* Algerd Wan, Rotta Roh.

Outlines of small bivalves are very abundant on the weathered surface of the rocks at Sono Murg and Kothair, but the shells cannot be extracted.

ECHINODERMATA.

Pentacrinites, sp.? Pl. VIII. fig. 1.

Starry rings of Encrinite stems are very abundant in most of the arenaceous limestone of the Wean groups, and also in the rocks of the Kothair groups at Sono Murg and Kothair in Kashmir.

ANTHOZOA.

Cyathophyllum, sp.

Abundant on the weathered surface of Kothair-rocks.

Cyathophyllum, sp.

Same remark as above.

Cyathophyllun, sp.

Generally found as figured at (*a*). Found as represented at (*b*) near Martand, Kashmir.

Remark. Several small species of corals were seen in the Kothair limestone in Kashmir, but in a very bad state of preservation.

LIAS (LOWER.)

CEPHALOPODA.

Ammonites Tubar (*Strachey.*)

Pl. Niti, p. 32, Pl 20 fig. 2 a—c and Pl. 21 figs. 1 a—c.

Three good specimens of this shell showing well all the characters and the suture, as represented by Mr. Blanford.

From a muddy and sandy brown bed, very sparingly calcareous, in the Chichali pass near Kalabagh, Punjab.

Ammonites, sp.

Pal. Niti, Pl. 19 fig. 3 a, 6 and c.

The figure in the Palæontology of Niti is exactly like our shell; it is not described in the text and not named. It resembles a little the *A. Striatulus* (Sow.).—Found in the same bed as the preceding.

Belemnites, sp.

A coarse species when full-grown, with a well marked front sulcus, and often a back one also. The section is oval.

From the same bed as above in Chichali and from some brown sandstones under the Oolite at the foot of Sheikh Bodeen near Tora Obo.

POST-SCRIPTUM. I find this species described and figured by Mr. Stoliczka, (Sections across Himal., Mem. Geol. Surv. of India, Vol. V. Part 1, fig. 78, Pl. VIII. fig. 1-4,) under the name of *B. Bisulcatus* (Stol.) from the lower Lias of Spiti.

LAMELLIBRANCHIATA.

Gryphœa Arcuata (Lam.)

Some specimens, from the Chichali pass and the same bed as the Ammonites, belong certainly to this well-known species.

Astarte, sp.

A very circular Astarte from the same bed, Chichali.

OOLITE (OXFORDIAN).

CEPHALOPODA.

Ammonites Biplex, Sow.

Journal Asiat. Soc. No. 2, 1863, p. 129, Pl. II., fig. 5 and Pl. III. figs. 4 and 5.

Ammonites Strigilis, Blanford.

Op. Cit. p. 126, Pl. III figs. 1 and 1*a*.

Five fragments showing well the single ribs bending forwards.

Ammonites Triplicatus, Sow.

Pal. of Niti, p. 80, Pl. 13 fig. 1.

Ammonites Scriptus (Strachey).

Pal. of Niti, p. 81, Pl. 16, fig. 2.

Ammonites Guttatus (Strach.)

Op. Cit. p. 79, Pl. 18, fig. 2.

Ammonites Wallachii, (Gray.)

Op. Cit. p. 84, Pl. 15, fig. 1 and Pl. 19, figs. 1 and 2.

All these Ammonites are from the Inferior limestone bed of Shaikh Bodeen in the Punjab.

Belemnites Sulcatus, Miller.

Journal Asiat. Soc. p. 125, Pl. 1, fig. 1.

Very abundant in the Ammonite bed at Shaikh Bodeen. Rarer in the beds above.

Belemnites Canaliculatus, Sch.

This is perhaps a variety or a younger shell of the above. Found in the same beds.

Remark. One or two more species of Belemnities were found with the preceding at Shaikh Bodeen.

GASTEROPODA.

Acteonina, sp.

In all beds, Shaikh Bodeen.

Turbo, sp. and Scoliostoma, sp.

Both in Ammonite-bed, Shaikh Bodeen.

Natica, sp.

Same locality.

LAMELLIBRANCHIATA.

Pecten Arcuatus, Sow. ?

Not unlike *P. Comatus*, Munster, (Pal. Niti, Pl. 22, fig. 9). It is more strongly ribbed than Salter's figure of the *P. Comatus* and it is flatter, thus answering perfectly the description of the *P. Arcuatus.*

Ammonite-bed, Shaikh Bodeen.

Hinnites Tubulipora, Verch., n. sp.

Like *Spondylus Tuberculosus*, Goldf., but the ribs of our species are much coarser, fewer, and more foliated and the tubular spines are larger, more in number, and rather lamellar.

It is not rare in the Ammonite-bed, Shaikh Bodeen.

Homomya (Pholadomya) sp.

We have three species of *Pholadomya* without rays from Shaikh Bodeen.

Pholadomya (Ph. Semireticulata, Verch. nov. sp.) Pl. IX. fig. 2.

This pretty shell is mostly found as a cast. It is not rare in the Oxfordian bed and extends to the Corallian above.

Pholadomya (Ph. Quinque-costata, Verch., nov. sp.) Pl. IX. figs. 3 and 3a.

Ammonite bed, Shaikh Bodeen.

Plagiostoma sp. conf. P. Consobrina (D'Orb.)

Ammonite-bed, Shaikh Bodeen.

Ostræa Gregarea, (Sow.)

Several specimens found near the Ammonite-bed, Shaikh Bodeen.

Ostræa Marshii, (Sow.) ?

Same bed as above.

Ostræa Flabelloides, (Desh.) ?

Fragments similar to Pal. of Niti, Pl. 22, fig. 1, found in the Ammonite-bed, Shaikh Bodeen.

Ostræa conf. O. Deltoidea, (Sow.) ?

The only difference between our specimens and the figures of this species is that our *Ostræa* have the muscular impression very strongly marked, forming a regular pit with a ridge round it.—From the same bed as the above.

Ostræa like O. Nana, (Sow.)

In nearly all the beds, Shaikh Bodeen.

Ostrea sp.

A large flat circular oyster, very common in some of the lowest oolitic beds at Shaikh Bodeen.

BRACHIOPODA.

Terebratula Globata, Sow., Pl. IX. fig. 4.

Extremely abundant in the Ammonite-bed and in all the beds near it, at Shaikh Bodeen. It varies considerably.

POST-SCRIPTUM. The *T. Gregaria*, Suess, (Memoirs of Geol. Surv. of India, Vol. V. Part I. page 68, and *T. Tibetensis*, David, (Journ. Geol. Soc. Vol. XXII. p. 37, Pl. I. fig. 11—14, appear to be the same species.

Terebratula Bodeenensis, Verch., nov. sp. or *var.;* Pl. IX. figs. 6 and 6a.

It is very perfectly oval and varies but little in shape. It has, in most specimens, neither sinus or folds, and the line of junction of the valves forms a nearly perfect curve in front. In a few specimens there is a very trifling undulation of this line. The absence of sinus and fold distinguishes from the *T. Globata ;* it is also a smaller shell, but yet may be only a variety of it. Found with the above.

Terebratula Carinata, Lam.

Pal. of Niti, p. 99, Pl. 21. fig 5.

Our specimens are much more like the *T. Carinata* than the figure in Pal. of Niti. It varies considerably, but the shallow sinus is always well marked. Our specimens are larger than the Niti ones.

Shaikh Bodeen, with the other *Terebratulæ.*

Terebratula Numismalis, Lam.

Op. Cit. p. 99, Pl. 21, fig. 4.

Several specimens showing well the depressed aspect of the front of the greater valve, and the well-marked concentric lines of growth.

Ammonite-bed, Shaikh Bodeen.

Remark. Two or three specimens not yet identified were found in the same beds, together with a *Waldheimia* rather globular and of the type of *W. Impressa,* Bach, of the Oxford clay.

Rhynchonella, sp. (*R. Concinna, Sow.* ?) Pl. IX. figs. 5, 5a. and 5b. See also Pal. of Niti, Pl. 21, fig. 8.

It has generally, but not always, the sinus better marked than in the Niti figure. Very common at Shaikh Bodeen in nearly all the beds.

Remark. Six other species of *Rhynchonella* have been found at Shaikh Bodeen, but are not yet satisfactorily determined.

Bryozoa.

Eschara Asiatica, Verch. n. sp. ?

A fenestella-like Eschara, appearing in large flat and undulated plates on the surface of the rocks. In the Ammonite-bed, Shaikh Bodeen.

Among the corals, a *Fungia* somewhat like the *Fungia Coronula,* Goldf., but too much worn to be identified, and a *Meandrina* like *M. vel Comoseris Vermicularis* (Edw and Haime), were found in the Ammonite bed at Shaikh Bodeen.

Oolite (Corallian.)

Cephalopoda.

Belemnites Canaliculatus, (Sch.)

Upper Bed, Shaikh Bodeen and Mari-on-Indus, Salt Range.

Gasteropoda.

Nerinæa conf. N. Goodhallii., (*Fitton.*)

Fragments and sections of this shell are very common in the upper beds at Shaikh Bodeen. The section of the whorls is precisely similar to the figure in Lyell's Elements, p. 304.

Lamellibranchiata.

Astarte Scalaria, (Roemer.) ? ? *vel A. Lamellosa*, (Roem.)——

An Astarte with lamellous concentric lines, referred to the species above from description only, as I have never seen a specimen or a figure of these species.

Upper beds, Shaikh Bodeen.

Anthozoa.

Thamnastræa sp.

Upper bed, Shaikh Bodeen and near Palusseen, Wuziristan.

Thamnastræa sp.

A minute species found with the preceding at Shaikh Bodeen.

Tsastræa sp.

Much like the *T. Oblongata* (Edw. and Haime.)

Upper beds, Shaikh Bodeen.

Tsastræa sp.

Another species from Mari-on-the-Indus.

Thecosmilia Annularis (Edw. and Haime.)

Upper bed, Shaikh Bodeen and Mari-on-Indus.

Meandrina sp.

Mari-on-Indus.

Eunomia sp.

Mari-on-Indus.

Rhizangia sp.

Mari-on-Indus.

Areacis sp.

Wuziristan.

Lobocœnia sp.

A very pretty, spreading specimen from Wuziristan.

Turbinolia sp. ?

From Palussen, Wuziristan.

ROCK SPECIMENS.

Pl. X. figs. 1 and 1a.

Amygdaloidal greenstone with gas-vents branching through the mass. Abundant in the Zebanwan in Kashmir. Found also amongst the rolled stones of the torrents which drain the Afghan mountains.

Pl. X. figs. 2 and 2a.

Trachyte with starry crystals of dull white albite for which I have proposed the name of *Soolimanite.* From the Tukht-i-Sulaiman in Kashmir.

EXPLANATION OF PLATES.

Pl. I.

Spirifer Vercheri, (de Verneuil), n. s. Natural size.

Spiriferina Octoplicata (Sow.) Var. *Transversa*, (Verch.), natural size.

Pl. II.

Athyris sp. (*A. Subtilita*, Hall,)—natural size.

Athyris Buddhista, (Verch.), nov. sp.—natural size.

Athyris, probably *A. Royssii*, (L'Eveillé)—natural size.

Strophomena Analoga, (Phill.) ?—half natural size.

Pl. III.

Spirifer sp. ? (Var. of *S. Keilhavii*, (Buch.) ?—natural size.

Strophomena sp. ?—natural size.

Orthis sp.—natural size.

Pl. IV.

Strophalosia ? Arachnoidea, (Verch.), n. sp.—natural size.

Fenestella Sykesii (DeKon).

Fenestella Megastoma (DeKon).

Vincularia Multangulari, (Portlock).

Pl. V.

Fenestella sp.—natural size.

Disteichia ? ? sp.—natural size.

Acanthocladia sp.—natural size.

Eurypterus vel Limulus ? sp.—natural size.

Pl. VI.

Solenopsis sp.—natural size.

Cardinia Himalayana, (Verch.), n. sp —natural size.

Cardinia Ovalis, Martin), ?—natural size.

Cucullæa ? sp.— natural size.

Pecten sp.—natural size.

Aviculo-pecten sp. (*A. pecten Ovatus* Verch.)—natural size.

Aviculo-pecten sp. (*A pecten Planus*, Verch.)—natural size.

Pl. VII.

Aviculo-pecten Circularis, (Verch.)—natural size.

Aviculo-pecten sp.—natural size.

Aviculo-pecten Testudo, (Verch.)—natural size.

Aviculo-pecten Gibbosus, (Verch.)—natural size.

Pl. VIII.

Pentacrinite ? sp.—natural size.

Cyathophyllum sp.—natural size.

Cyathophyllum sp.—natural size.

Cyathophyllum sp.—natural size.

Sphæronites sp.—natural size.

Sphæronites Ryallii, (Verch.). nov. sp.—natural size.

Pl. IX.

Sphæronites sp.—natural size.

Pholadomya Sesquireticulata, (Verch.), nov. sp.—natural size.

Pholadomya Quinque-costata (Verch.), nov. sp. natural size.

Terebratula Globata, (Sow.)—natural size.

Rhynchonella Concinna, (Sow.) ?—natural size.

Terebratula Bodeenensis, (Verch.), sp. vel var. nov.—natural size.

Amygdaloid with gas-vents—natural size.

Soolimanite.

Irawady Shells, Plate III.

Fig: 1-3, Martesia fluminalis, W. Bl. enlarged 3 diams. Fig. 7-10, Scaphula deltæ, W. Bl. enlarged 2 diams.
" 4, Sphenia perversa, W. Bl. adult, D° " 11-13, S. pinna, Bens, D°
" 5, 6, D° younger, D° " 14-15, S. celox, Bens, D°

Irawady Shells, Plate II.

Pl. XIII

Fig: 1, Larina Burmana, W. Bl. nat. size.
" 2–4, Tectura fluviatilis, W. Bl. D°
" 5–6, Auricula nitidula, W. Bl. D°
7–10, Amphibola Burmana, W. Bl. D°

Fig: 11, 12, Assiminia rubella, W. Bl. enlarged 3 diams
" 13, 14, Irawadia ornata, W. Bl. D°
" 15, Stenothyra monilifera, Bens, D°
" 16, Plecotrema Cumingiana, W. Bl. D°

Irawady Shells, Plate 1.

All the figures natural size

Fig 1-12 Neritina Peguensis W Blanf

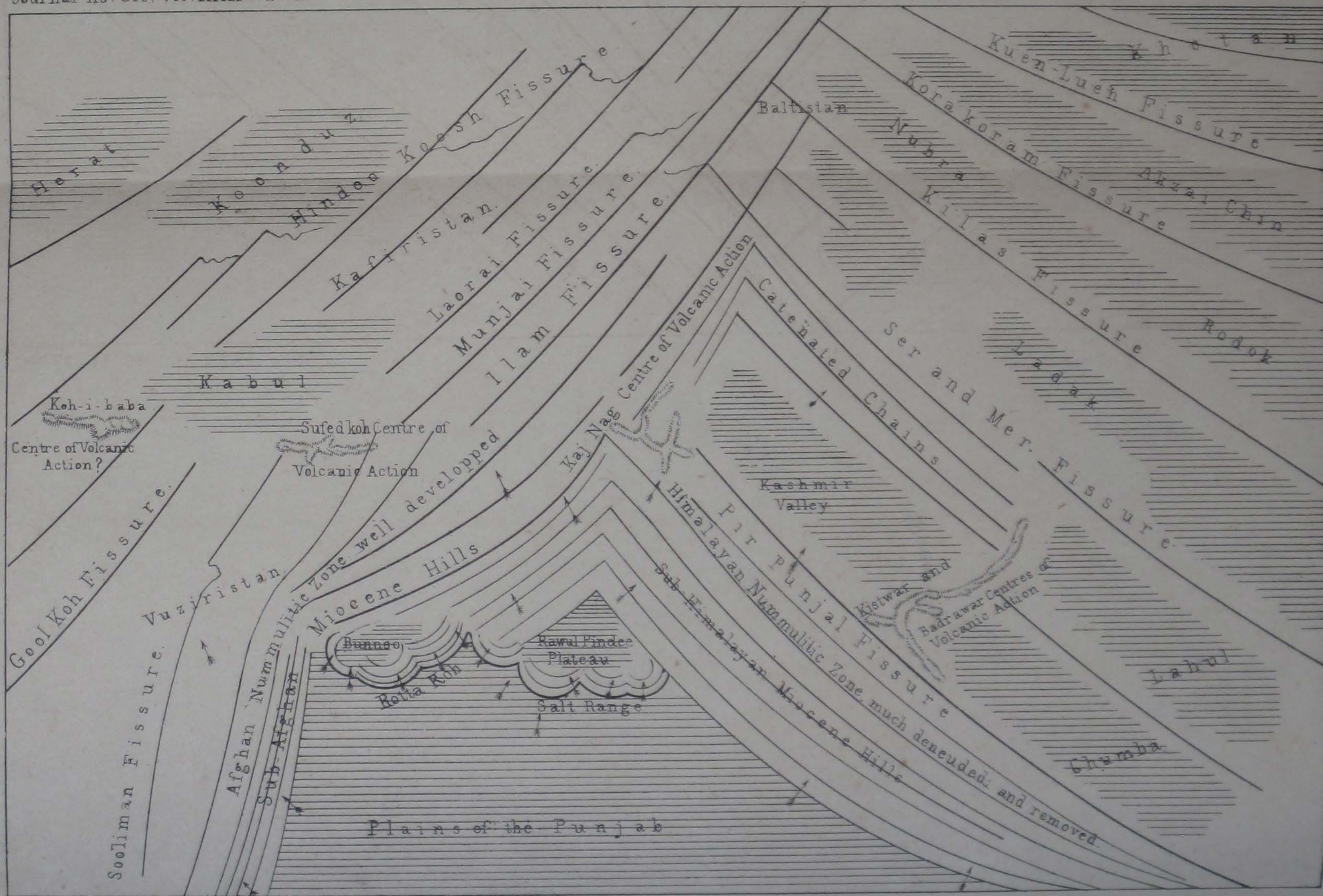
„ 13-16 D^o. D^o.

„ 17-19 N. (Dostia) depressa, Bens.

Fig 20 22 . N. (Dostia) crepidularia, Less.

Var. „ 23 25 N (Dostia) cornucopia, Bens.

Plate XI



On stone by Hemanauth Dass.
LITH: AT THE SURVEYOR GENERAL'S OFFICE CALCUTTA JANY 1867.

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2.a.

1.a.

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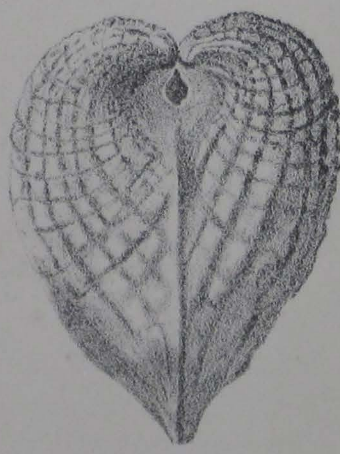

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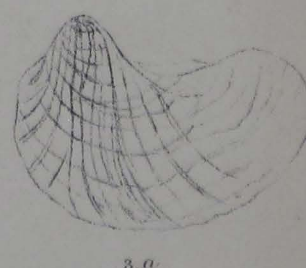

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5.a.

5.b.

6

6.a

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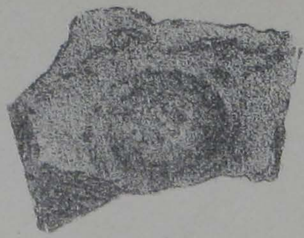

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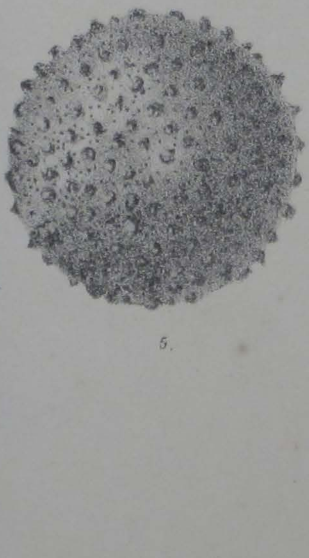

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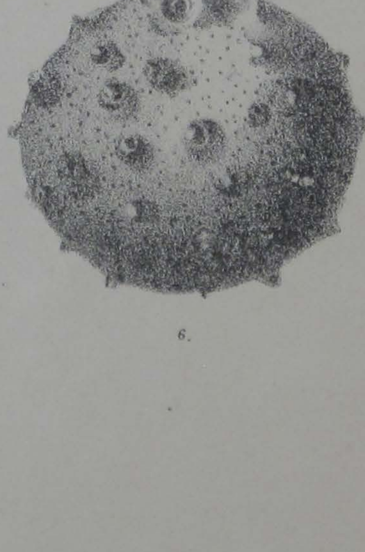

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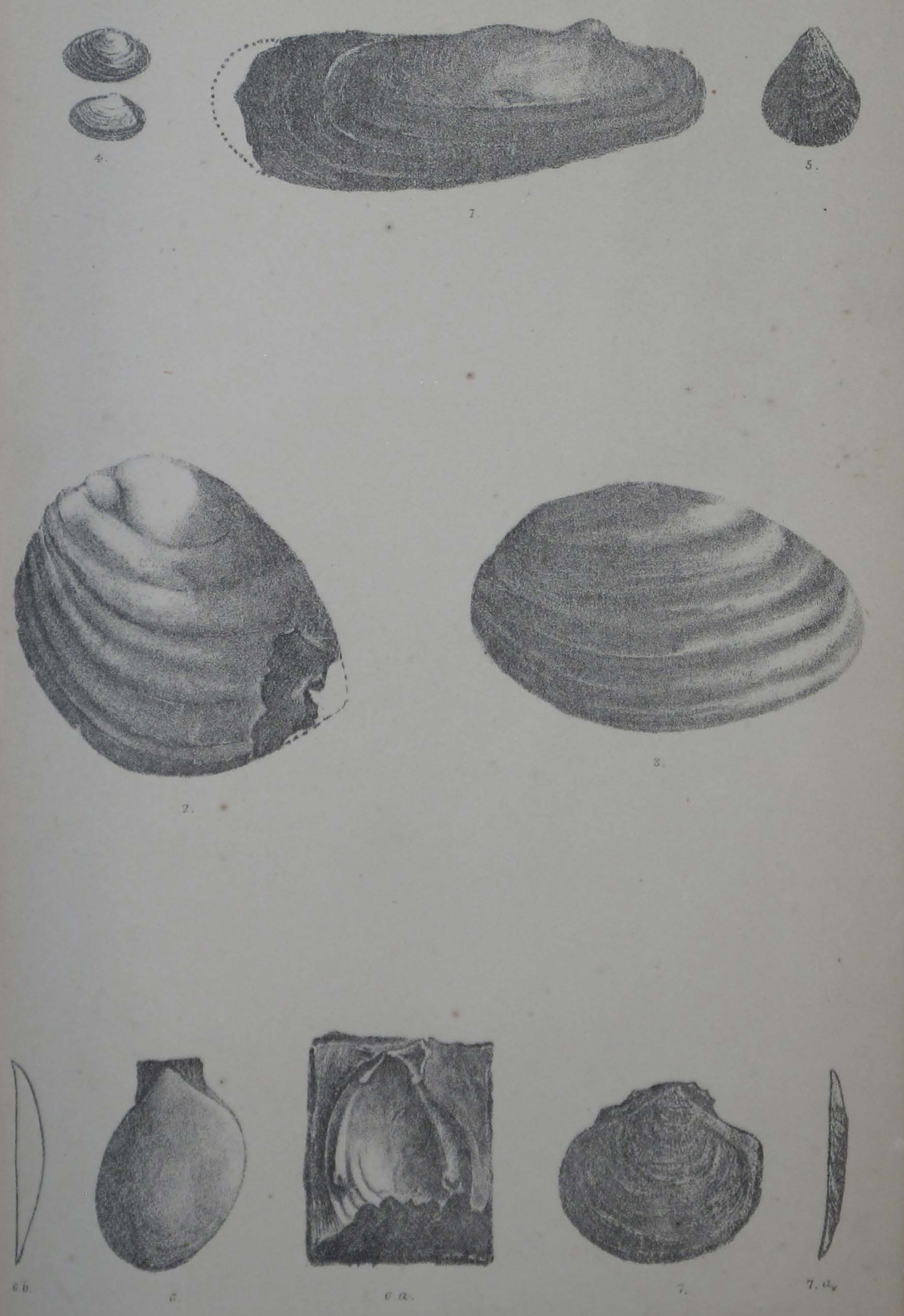
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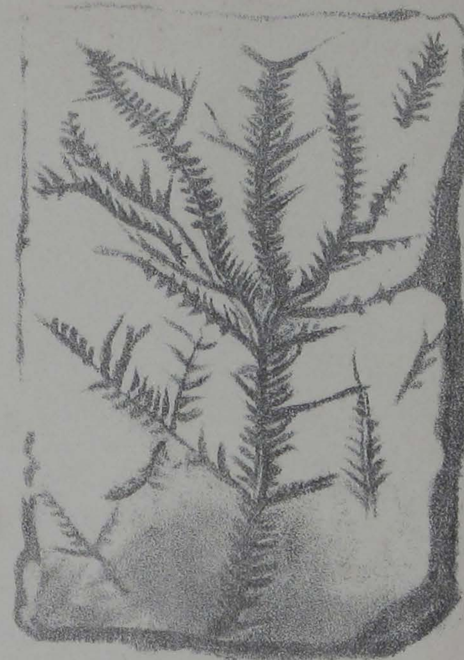

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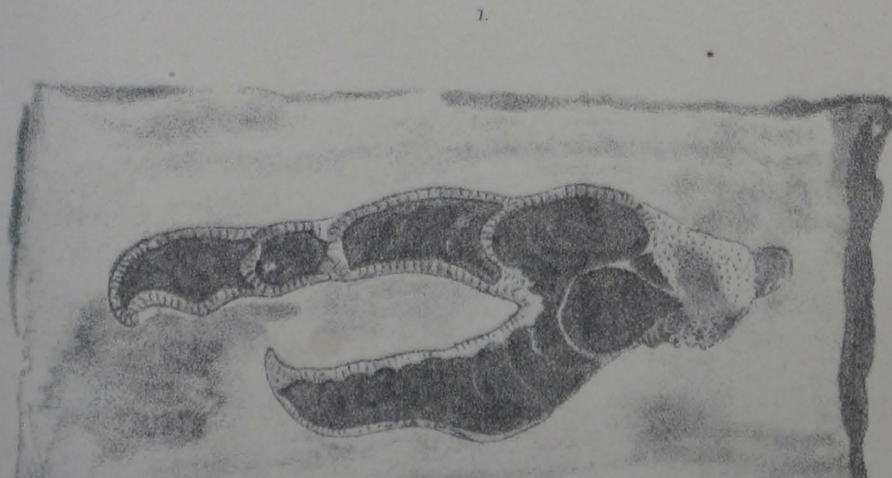

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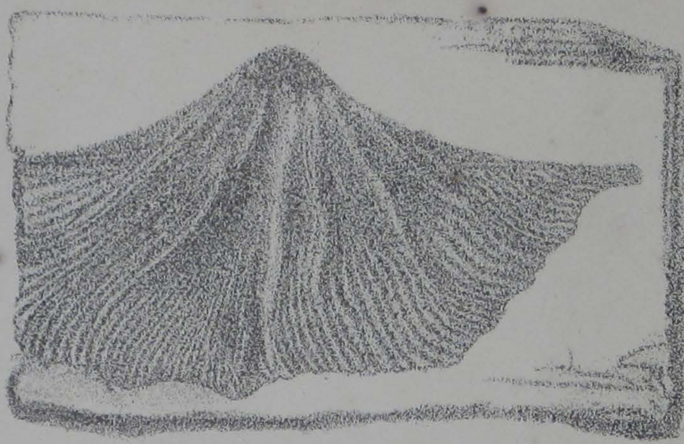
1. a.

1. b.



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1.

1. a

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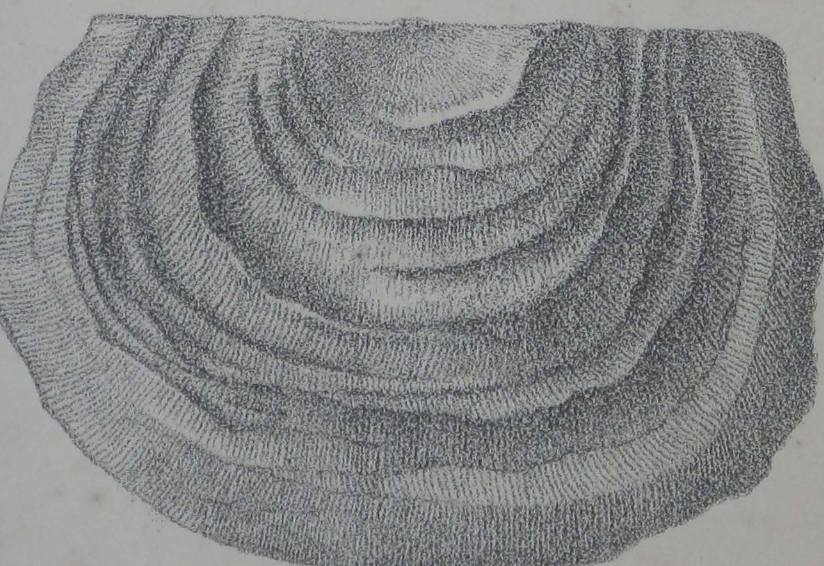
3. a



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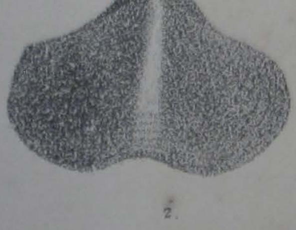

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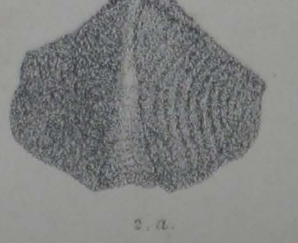

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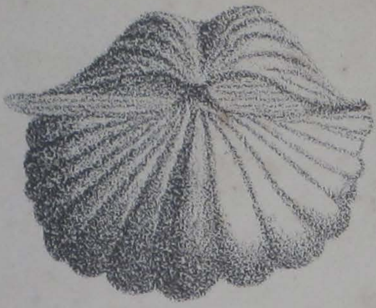

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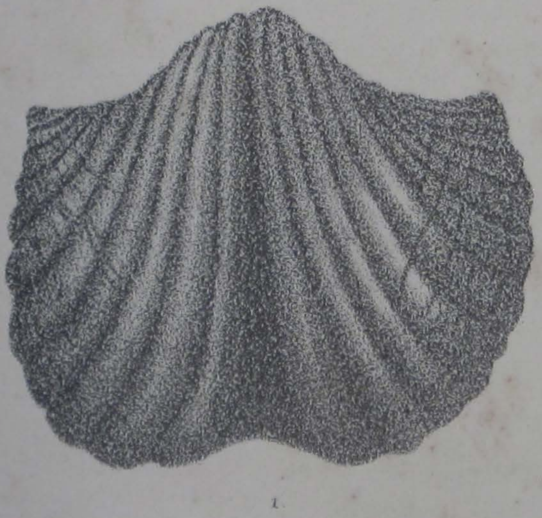

1.

2. a.

2.

2. c.

2. d.

2. b.

INDEX TO PART II.

ERRATA in Dr. Verchere's Paper on the Geology of Kashmir and the Western Himalayas.

(Only those errors which change the meaning of a sentence, or render the name of a locality or fossil impossible to recognize, have been noticed here.)

PART II. 1866.

Page	*Line*	*For*	*Read*
92	9	fossil	theories.
100	8	quartz like rock crystals	quartz and rock crystals.
101	1	map	mass.
103	20	(Sect G).	The section is not given.
103	last	intricated	imbricated.
120	2	*Insert after* igneous rocks	and sedimentary rocks.
133	10	sp. nora	sp. nova.
162	12	Pl. VIII.	Pl. VI.
169	23	Fig. 3.	Fig. 2.
174	2	very similar to	viz. the.
185	33 & 37	Arkbal	Archibal.
186,1,9,12&c.		Arkbal	Archibal.

PART II. 1867.

Page	*Line*	*For*	*Read*
10	3	Aksai chain	Aksai chin.
10	31	Crossing	Cropping.
11	last	See Pl. IX.	Plate not given.
12	11	Boliricutes	Boliviensis.
17	4	a Neimas	a Nérinees.
17	4	Zena	Jura.
19	23	dirty	cherty.
21	20	The	No
21	22	...	*omit* round.
23	11	salpetre, of soda,	sulphate of soda.
23	14	Russian	Prussian.
23	29	disposition	deposition.
23	31	Charpentin	Charpentier.
24	note	Sketches	Selections.
24	25	elastic	volcanic.
29	7	Tummoo	Jummoo.
33	17	of	to.
45	29	vales	oases.
9	9	Verziristan	Waziristan.

Page	*Line*	*For*	*Read*
91	26	the other N. W.—S. E.	the other N. E.—S. W.
93	5	lignite	sienite.
93	25	N. W.—N. W.	N. W.—N. E.
95	10	long	large.
101	34	anticlinal dip, which	anticlinal dips which
105	25	salt	silt.
106	29	cows, of	bones of
114	1	Munee Range	Murree Range.
114	3	averted	arrested.
114	18	(not vertical)	(now vertical).
201	2	Faire	Favre.
203	15	...	add Pl. II. fig. 2, 2a & 2b.
203	25	...	add Pl. II. fig. 1 & 1a.
203	29	...	add Pl. II. fig. 3 & 3a.
204	43	...	add Pl I. fig. 1, 13 & 16.
204	20	...	add Pl. VI. fig. 3.
205	17	(sp. hova)	(sp. nova).
206	last	Pl. VIII. fig. 62 & 63	Pl. VIII. fig. 5 & 6 & Pl. IX. fig. 1
207	13	Verneuil	*Verneuilli.*
214	28	*Tenestella*	*Fenestella.*
214	28	...	Omit Pl. IV. bis fig. 1, *a, b, c, d,*
215	5	...	Omit Pl. IV. bis fig. 2, *a, b, c, d,*
215	19	...	Omit Pl. IV. bis fig. 3, *a, b, c, d,*
219	19	*Aviculo Pect Ranus*	*Aviculo Pecten Planus.*
219	27	*b*	(1a).
220	1	*b*	(2a).
222	30	...	add Pl. VIII. fig. 2.
222	32	...	add Pl. VIII. fig. 3.
222	34	...	add Pl. VIII. fig. 4, & 4a.
227	21,22,24	*Tsastræa*	*Isastræa.*
228	30,31,32	...	*Omit* Fenestella Sykesii.
		...	„ Fenestella megastoma.
		...	„ Vincularia Multangularis
229	28	...	*add* Pl. X.

ABSTRACT STATEMENT

OF

RECEIPTS AND DISBURSEMENTS

OF THE

ASIATIC SOCIETY,

FOR

THE YEAR 1866.

STATEMENT

Abstract of the Cash Account

RECEIPTS.

		1866.	1865.
Admission Fees.			
Received from New Members, Rs.	1,280 0 0		
		1,280 0 0	928 0 0
Contributions.			
Received from Members, ...	8,676 0 0		
		8,676 0 0	9,445 0 0
Journal.			
Sale proceeds of, and Subscription to the Journal of the Asiatic Society, ...	1,285 10 0		
Refund of Postage Stamps, ...	31 10 0		
Ditto of Packing Charges, ...	3 7 0		
Ditto of the amount from the Baptist Mission Press, overpaid in Bill No. 13438, being the cost of 6 Copies of Journal No IV. 1864, ...	6 6 0		
		1,327 1 0	758 1 0
Library.			
Sale proceeds of Books, ...	586 0 9		
Refund of Freight, ...	12 2 0		
Ditto of the amount paid for a of copy Owen's Comparative Anatomy, Vol. I., ...	12 0 0		
		610 2 9	193 15 0
Museum.			
Received from the General Treasury at 500 Rs. per month, from December, 1865 to April, 1866,	2,500 0 0		
Savings of salary, ...	41 0 3		
Refund in part of the Contingent Expenses, ...	2 6 0		
Ditto of the amount paid from the Contingent Account in March and April to Harry, Taxidermist,	40 0 0		
Ditto in part of the amount paid to Dr. J. Anderson for Medicine by Messrs. Bathgate and Co.'s bill on the 22nd May, 1866, ...	5 13 0		
		2,589 3 3	6,037 13
Secretary's Office.			
Refund of Postage Stamps, ...	17 10 0		
Ditto of Packing Charges, ...	0 7 0		
Savings,...	4 0 0		
Discount on Postage Stamps, ...	0 7 0		
Refund of Freight, ...	0 5 0		
		22 13 0	34 7 0
General Establishment, ...		17 1 0	1 14 9
Carried over, Rs.		14,522 5 0	

No. 1.

of the Asiatic Society for 1866.

DISBURSEMENTS.

		1866.	1865.
Journal.			
Freight, ... Rs.	113 11 0		
Printing Charges, ...	1,729 9 0		
Commission on Sale of Books, ...	16 2 1		
Purchase of Postage Stamps, ...	194 10 0		
Packing Charges, ...	28 4 0		
Lithographing and Engraving Charges, &c., ...	705 4 3		
Purchase of a copy of Journal Supplementary Number, Vol. 15,	1 0 0		
Petty Charges, ...	11 7 6		
		2,799 15 10	3,272 4 3
Library.			
Salary of the Librarian, ...	840 0 0		
Establishment, ...	84 0 0		
Salary for preparing a revised Catalogue, ...	500 0 0		
Purchase of Books, ...	375 3 3		
Ditto of a Standford Library Map of Asia on roller, ...	35 0 0		
Ditto of Album of Photographs of Sháhaná, ...	125 15 6		
Mounting 4 Sheets of german Map of Asia on roller, ...	5 0 0		
Purchase of a set of Photographs of Cashmire, ...	42 0 0		
Ditto of a set of ditto, ...	140 0 0		
Ditto of 27 Photograph Views, ...	69 0 0		
Book-Binding, ...	263 14 0		
Landing Charges, ...	14 10 6		
Commission on Sale of Books, ...	40 13 2		
A Blank Book, ...	5 0 0		
Freight, ...	3 4 0		
Salary of Office Punkha-man, ...	40 0 0		
Ditto for preparing List of the Duplicate Books, ...	40 0 0		
Ditto of ticca Duftory, ...	12 4 3		
6 Dusters for cleaning books, ...	1 12 0		
Prepairing two Teak wood Book cases, ...	682 8 0		
Purchase of Custom Stamps, ...	3 0 0		
Petty Charges, ...	23 4 3		
Subscription to the Indian Medical Gazette, ...	15 0 0		
			2,576 9 6
	3,361 8 11		
Purchase of Books through Messrs. Williams and Norgate, London,	1,889 1 10		
		5,250 10 9	
Carried over, Rs.		8,050 10 7	

RECEIPTS.

	Brought over, Rs.	14,522 5 0	
VESTED FUND.			
Sale proceeds of Government Securities, ...	7,500 0 0		
Interest on ditto, ...	255 0 6		
Premium on ditto, ...	387 8 0		
		8,142 8 6	337 8 0
COIN FUND.			
Sale proceeds Silver Coins, ...	5 0 0		
		5 0 0	236 15 6
BABU POORNO CHUNDER BYSACK.			
Refund in part of the amount advanced for Contingent Expenses, ...	1,648 8 6		
		1,648 8 6	762 15 3
MESSRS. WILLIAMS AND NORGATE.			
Sale proceeds of Books on their account, ...	4 4 0		
		4 4 0	
MAJOR-GENL. CUNNINGHAM.			
Refund of Packing Charges, ...	0 6 6		
		0 6 6	
J. H. BATTEN, ESQ.			
Refund of the amount advanced,	2 9 0		
		2 9 0	
HARRY, TAXIDERMIST.			
Refund of the amount advanced,	103 0 0		
		103 0 0	
CAPTAIN M. W. CARR.			
Received from him in Deposit, ...	3 12 0		
		3 12 0	
MAJOR A. S. ALLAN.			
Received from him in Deposit, ...	7 4 0		
		7 4 0	
JAMES BEAMES, ESQ.			
Received from him in Deposit, ...	0 12 0		
		0 12 0	
CAPTAIN C. MACGREGOR.			
Refund of Banghy Expenses and Postage Stamps for sending Library Books, ...	5 3 0		
		5 3 0	
REV. H. A. JÆSCHKE.			
Sale proceeds of a Copy of Tibetan Grammar on his account, ...	1 0 0		
		1 0 0	
GOVERNMENT NORTH WESTERN PROVINCES.			
Refund of freight for sending Journal and Proceedings for 1865, ...	16 5 0		
		16 5 0	
CAPTAIN H. H. G. AUSTEN.			
Refund of the amount paid for sending Library Books, ...	15 10 0		
		15 10 0	
	Carried over, Rs.	24,478 7 6	

DISBURSEMENTS.

Brought over, Rs.				8,050	10	7			
Museum.									
Salary of the Sub-Curator, ...	500	0	0						
Establishment, ...	320	10	6						
Extra Taxidermist's Salary and Contingent Pay, ...	1,742	13	11						
Contingent Expenses, ...	2,596	7	7						
Advertising Charges, ...	3	12	0						
Paid Messrs. Higgs and Haldar, for white Satin Painting, to Museum Coses, ...	478	14	9						
Ditto ditto for Stands, Railing and Painting, ...	363	14	6						
Ditto ditto for making an animal stand, and taking up and re-setting in brick, &c. &c., ...	78	0	0						
Ditto ditto for Asphalting two rooms and renewing glasses to the Almirah and Sash door, &c., .	159	10	0						
Printing 500 Copies of Circular, .	15	0	0						
Engraving 3 sets of Figures on Brass with Handle for branding the specimens of the Museum,	13	8	0						
				6,272	11	3	6,468	3	6
Secretary's.									
General Establishment, ...	403	8	0						
Secretary's Office Establishment,	1,068	0	0						
Purchase of Postage Stamps, ...	128	7	0						
Stationery, ...	139	5	6						
Purchase of Blank Books, ...	7	4	0						
Insufficient Postage, ...	6	3	3						
Printing Charges, ...	12	0	0						
Repairing a Tin Almirah, ...	8	0	0						
Petty Charges, ...	11	6	6						
				1,784	2	3	2,349	13	3
Vested Fund.									
Purchase of 5½ per cent. Government Securities, ...	3,000	0	0						
Interest on ditto, ...	13	12	0						
Premium on ditto, ...	232	8	0						
Commission on ditto, ...	22	8	0						
Brokerage on ditto, ...	9	6	0						
Commission to the Bank of Bengal for drawing Interest on the Government Securities, ...	0	7	10						
Fee for renewing Government Securities, ...	6	0	0						
				3,284	9	10	0	13	6
Coin Fund.									
Purchase of Coins, ...	340	0	3						
Ditto of a fire-proof Treasure Chest with Cooly-hire, ...	133	0	0						
Prepairing an under Case of ditto with ditto, ...	30	0	0						
Cocoanut Oil for cleaning Coins, .	0	3	0						
				503	3	3	386	11	9
Carried over, Rs.				19,895	5	2			

RECEIPTS,

	Brought over, Rs.	24,478 7 6	
MOTHOOR MOHUN KUR. Refund of the amount paid him as advance for preparing two book cases, ...	200 0 0		
		200 0 0	
E. T. ATKINSON, ESQ. Refund of Banghy Expenses and Postage Stamps for sending Library Books, ...	8 0 0		
		8 0 0	3 8 0

Carried over, Rs. 24,686 7 6

DISBURSEMENTS.

	Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
Brought over, Rs.				19,895	5	2			
Building.									
Assessment, ...	480	0	0						
Ditto for Lighting, ...	96	0	0						
Repairing, ...	1,858	15	0						
An Iron shed erected in the compound of the Society, ...	200	0	0						
				2,634	15	0	2,340	7	6
Miscellaneous.									
Salary of the Mally,... ...	57	0	0						
Advertising Charges, ...	6	0	0						
Meeting Charges, ...	179	8	6						
Purchase of Receipt Stamps, ...	12	0	0						
Paid 25 per cent. increase of Salaries for 6 months, ...	55	14	0						
Ditto W. H. Johnson, Esq., for a Tea pot Khokan, ...	8	0	0						
Fee to the Bank of Bengal for Stamping cheques, ...	3	2	0						
Petty Charges, ...	41	1	3						
				362	4	9	265	12	3
Museum Transfer Account.									
Printing 25 Copies of Act of the British Parliament, ...	20	0	0						
				20	0	0	58	0	0
Ethnology Committee.									
Paid Banghy Expenses for sending a parcel of Official Papers, .	0	12	0						
Copying Report forwarded by the Government of Bengal on various Human Races, ...	10	0	0						
A Blank Book for Proceeding, ...	2	8	0						
				13	4	0			
Babu Poorno Chunder Bysack.									
Paid advance on the Contingent Expenses for the Museum, ...	1,445	0	0						
				1,445	0	0	1,045	0	0
James Beames, Esq.									
Paid Postage Stamps for sending Library Books, ...	4	1	0						
				4	1	0			
Captain Macgregor.									
Paid Banghy Expenses and Postage Stamps for sending Library Books,...	5	3	0						
				5	3	0			
Government North Western Provinces.									
Paid Railway Freight for sending Journal and Proceedings, ...	14	8	0						
				14	8	0	16	5	0
Captain H. H. G. Austen.									
Paid Banghy Expenses for sending Library Books, ...	12	0	0						
				12	0	0	3	4	0
Messrs. Williams and Norgate.									
Paid freight for Sending their Books,	8	0	0						
				8	0	0	385	12	0
Carried over, Rs.				24,414	8	11			

RECEIPTS.

Brought over, Rs. 24,686 7 6

Carried over, Rs. 24,686 7 6

LIST OF MEMBERS

OF THE

ASIATIC SOCIETY OF BENGAL,

ON THE 31ST DECEMBER, 1866.

LIST OF ORDINARY MEMBERS.

The * distinguishes Non-Subscribing and the † Non-Resident Members.

Date of Election.		
1847 June 2.	†Abbott, Brigdr.-Genl. J., Royal Artillery.	Dinapore
1860 Dec. 5.	Abdool Luteef, Khan Bahadur, Maulavi.	Calcutta
1865 June 7.	Agabeg, J. Esq.	Calcutta
1860 July 4.	†Ahmad Khan, Saiëd, Bahadur.	Allyghur
1862 April 2.	†Aitchison, C. U. Esq., C. S.	Lahore
1862 April 4.	†Aitchison, J. E. T. Esq., M. D.	Umritsar
1859 Feb. 2.	*Alabaster, C. Esq.	China
1866 Jan. 0.	†Allan, Major A. S.	Allahabad
1852 July 7.	*Allen, C. Esq., B. C. S.	Europe
1864 May 4.	†Alexander, N. S. Esq., C. S.	Purneah
1860 Oct. 3.	Amir Ali Khan, Múnshí.	Calcutta
1861 May 1.	Anderson, Dr. T., F. L. S.	Calcutta
1865 Jan. 11.	Anderson, Dr. J., F. L. S.	Calcutta
1843 Sept. 4.	*Anderson, Lieut.-Col. W., Bengal Artillery.	Europe
1866 July 4.	†Anderson, A. Esq.	Fyzabad
1864 Dec. 7.	Anderson, W. Esq.	Calcutta
1860 Nov. 7.	†Anley, W. A. D., Esq.	Sarun
1861 Sept. 4.	Asghur Ali Khan Bahadur, Nawab.	Calcutta
1861 July 3.	*Asphar, J. J. T. H. Esq.	Europe
1864 Dec. 7.	†Atkinson, E. F. T. Esq.	Jaunpore
1855 July 4.	Atkinson, W. S. Esq., M. A., F. L. S.	Calcutta
1861 Feb. 6.	†Austen, Capt. H. H. G., H. M.'s 24th Foot, Surv. Genl.'s Dept.	Dehra Dhoon
1826 Sept. 6.	Avdall, J. Esq.	Calcutta
1835 Oct. 7.	*Baker, Col. W. E., Bengal Engineers.	Europe
1865 Nov. 1.	Ball, V. Esq. Geol. Survey.	Calcutta

Date of Election.		
1866 Sept. 5.	Ballard, Lieut.-Col. H., C. B.	Calcutta
1860 Nov. 7.	Banerjea, Rev. K. M.	Calcutta
1864 May 4.	Barry, Dr. J. B.	Calcutta
1866 Jan. 17.	Barton, Rev. J.	Calcutta
1862 Aug. 6.	†Basevi, Capt. J. P., Royal Engineers.	Dehra Dhoon
1860 July 4.	*Batten, G. H. M. Esq., B. C. S.	Europe
1838 Jan. 3.	*Batten, J. H. Esq., B. C. S.	Europe
1859 May 4.	Bayley, E. C. Esq., B. C. S.	Calcutta
1861 Feb. 6.	Bayley, S. C. Esq., B. C. S.	Calcutta
1849 June 6.	Beadon, Hon'ble Sir Cecil, B. C. S.	Calcutta
1864 Sept. 7.	†Beames, J. Esq., B. C. S.	Motehary Chumparun
1841 April 7.	Beaufort, F. L. Esq., B. C. S.	Calcutta
1861 Sept. 4.	*Beavan, Lieut. R. C., late 62nd B. N. I.	Europe
1847 Aug. 4.	Beckwith, J. Esq.,	Allipore
1830 Sept. 1.	*Benson, Lieut.-Col. R.	Europe
1862 Dec. 3.	†Bernard, C. E. Esq., B. C. S.	Nagpore
1862 Aug. 6.	Beverley, H. Esq., C. S.	Calcutta
1862 June 4.	†Bhau Daji, Dr.	Bombay
1862 July 2.	Bhola Nath Mullick, Bábu.	Calcutta
1864 Nov. 2.	Bhoodeb Mookerjee, Bábu.	Chinsurah
1840 July 15.	*Birch, Major-General Sir R. J. H., K. C. B.	Europe
1864 May 4.	Bird, Dr. R., Civil Surgeon.	Howrah
1846 Mar. 4.	*Blagrave, Major T. C., 26th Regt., B. N. I.	Europe
1859 Sept. 7.	Blane, Lieut.-Col. S. J.	Calcutta
1857 Mar. 4.	Blanford, H. F. Esq., A. R. S. M., F. G. S.	Calcutta
1859 Aug. 3.	†Blanford, W. T. Esq., A. R. S. M., F. G. S. Geol. Surv.	Bombay
1864 April 6.	Blochmann, H. Esq., M. A.	Calcutta
1857 Aug. 2.	*Bogle, Lieut.-Col. Sir A., Kt.	Europe
1859 Aug. 3.	Bolie Chand Singh, Bábu.	Calcutta
1866 June 6.	Bourke, W. M. Esq.	Calcutta
1859 Oct. 12.	*Bowring, L. B. Esq., B. C. S.	Europe
1854 Nov. 1.	*Boycott, Dr. T., B. M. S.	Europe
1865 May 3.	†Bradford, C. W. V. Esq.	Hooghly
1860 Mar. 7.	*Brandis, Dr. D.	Europe
1860 Oct. 3.	Brandreth, Hon'ble J E. L.	Calcutta
1864 Dec. 7.	Branson, J. H. A. Esq.	Calcutta
1862 Jan. 15.	*Briggs, Major D.	Europe
1866 April 4.	†Broderick, H. C. Esq., M. D.	Augur W. Mulwa Central India Horse
1847 June 2.	*Brodie, Capt. T., 5th Regt., B. N. I.	Europe

Date of Election.		
1866 Jan. 17.	†Brown, Lieut.-Col. D.	Amherst
1860 Nov. 7.	†Browne, Capt. Horace A.	Rangoon
1866 Feb. 7.	Browne, Rev. J. Cave	Calcutta
1866 June 6.	†Brownfield, C. Esq.	Gowhatty
1866 June 6.	Buckle, Dr. H. B., C. B.	Calcutta
1863 Aug. 5.	Bunkim Chunder Chatterjee, B. A. Bábu.	Barripore
1856 Sept. 3.	Busheerooddin, Sultan Mohammad.	Chinsurah
1860 June 6.	†Campbell, C. J. Esq., C. E.	Delhi
1859 Sept. 7.	*Campbell, Dr. A.	Europe
1863 June 3.	Campbell, Hon'ble G.	Calcutta
1860 Jan. 3.	†Carnac, J. H. Rivett, Esq., B. C. S.	Nagpore
1865 Nov. 1.	†Carnegy, P. Esq.	Fyzabad
1860 Oct. 3.	†Christian, J. Esq.	Monghyr
1863 Aug. 5.	†Chunder Nath Roy, Cowar.	Natore
1863 April 1.	Cleghorn, Dr. H.	Calcutta
1863 June 3.	†Clementson, E. W. Esq.	Moulmein
1864 May 4.	†Cline, G. W. Esq. L.LD. F. G. S.	Nagpore
1861 Sept. 4.	†Cockburn, J. F. Esq., C. E.	Kurhurbari Colliery
1862 April 2.	Colles, J. A. P. Esq., M. D.	Calcutta
1851 Mar. 5.	*Colvin, J. H. B. Esq., B. C. S.	Europe
1860 Dec. 5.	†Cooper, F. H. Esq., B. C. S.	Lahore
1857 Mar. 4.	*Cowell, E. B. Esq., M. A.	Europe
1866 May 2.	*Cox, W. H. Esq.	Europe
1866 Jan. 17.	Crawford, J. A. Esq., C. S.	Calcutta
1861 July 3.	*Crockett, Oliver, R. Esq.	China
1866 Feb. 7.	†Daly, N. Esq.	Myanoung Burma
1862 April 2.	*Dalrymple, F. A. E. Esq., C. S.	Europe
1847 June 2.	†Dalton, Lieut.-Col. E. T., 9th Regt. B. N. I.	Chota Nagpore
1861 Mar. 6.	†Davey, N. T. Esq., Revenue Survey.	Dacca
1865 May 3.	Davies, C. Esq.	Rotasghur
1861 Nov. 6.	†Davies, R. H. Esq., B. C. S.	Oudh
1864 July 6.	†Debendra Mullick, Bábu.	Calcutta
1856 June 4.	†DeBourbel, Major R., Bengal Engrs.	Assam
1861 June 5.	*Denison, His Excellency Sir W. K. C. B.	Europe
1863 Feb. 4.	†Deo Narain Singh, Hon'ble Rajah.	Benares
1863 June 3.	†Depree, Capt. G. C., Royal Artillery.	Chota Nagpore
1861 Mar. 6.	*Devereux, Hon'ble H. B., B. C. S.	Europe
1862 May 7.	†Dhunpati Sinha Dooghur, Roy Bahadur.	Azimgunge

Date of Election.		
1853 Sept. 7.	Dickens, Lieut.-Col. C. H.	Calcutta
1860 Nov. 7.	Digumber Mitra, Bábu.	Calcutta
1859 Sept. 7.	*Douglas, Lieut.-Col. C.	Europe
1854 July 5.	†Drummond, Hon'ble E., B. C. S.	Allahabad
1864 Dec. 7.	*Dunlop, H. G. Esq.	Europe
1860 Jan. 4.	†Duka, Dr. T.	Simla
1861 May 1.	*Earle, Capt. E. L., Bengal Artillery.	Europe
1857 May 6.	*Eatwell, Dr. W. C. B.	Europe
1840 Oct. 7.	*Edgeworth, M. P. Esq., B. C. S.	Europe
1863 May 6.	†Edgar, J. W. Esq., B. C. S.	Cachar
1865 Feb. 1.	†Egerton, P. H. Esq., B. C. S.	Umritsar
1846 Jan. 7.	*Elliott, Walter, Esq., M. C. S.	Europe
1859 Nov. 2.	†Elliott, C. A. Esq., B. C. S.	Futtehghur
1863 April 1.	†Ellis, Hon'ble R. S., C. S., C. B.	Madras
1856 Mar. 5.	*Ellis, Lieut.-Col. R. R. W., 23rd Regt. B. N. I.	Europe
1854 Nov. 1.	†Elphinstone, Capt M. W. 4th Regt. B. N. I.	Lahore
1861 Jan. 9.	†Erskine, Hon'ble C. J., Bombay C. S.	Bombay
1856 Aug. 6.	*Erskine, Major W. C. B.	Europe
1863 Oct. 7.	Ewart, Dr. J.	Calcutta
1862 Aug. 6.	*Eyre, Col. Vincent, C. B.	Europe
1865 June 7.	Fawcus, Dr. J.	Calcutta
1851 May 7.	Fayrer, Dr. J., B. M. S.	Calcutta
1863 Jan. 15.	†Fedden, Francis, Esq., Geol. Survey.	Calcutta
1865 Aug. 2.	Fenn, S. Esq.	Calcutta
1859 Oct. 12.	†Fisher, A. Esq.	China
1860 Mar. 7.	*Fitzwilliam, Hon'ble W. S.	Europe
1865 April 5.	*Fleming, Dr. J. M. 29th P. N. I.	Europe
1861 Feb. 6.	†Forrest, R. Esq., Civil Engineer.	Etwah
1863 Dec. 2.	†Forsyth, Lieut. J.	Nagpore
1863 June 3.	†Forsyth, T. D. Esq., C. B.	Lahore
1860 Mar. 7.	†Frere, His Excellency Sir H. Bartle, K. C. B., B. C. S.	Bombay
1861 Sept. 4.	†Fuller, Capt. A. R.	Lahore
1859 Oct. 12.	†Furlong, Major J. G. R.	Agra
1859 Dec. 7.	Futteh Ali, Maulavi.	Calcutta
1849 Sept. 5.	†Fytche, Lieut.-Col. A. 70th Regt. B. N. I.	Rangoon
1866 Jan. 17.	G. M. Tagore, Esq.	Calcutta
1864 Aug. 11.	†Garrett, C. B. Esq., C. S.	Chaprah
1859 Aug. 3.	Gastrell, Lieut.-Col. J. E., 13th Regt. N. I., Rev. Survey.	Calcutta

Date of Election.		
1859 Sept. 7.	*Geoghegan, J. Esq., B. C. S.	Europe
1865 June 7.	†Giles, A. H. Esq.	Dinajpore
1842 Sept. 2.	*Gladstone, W. Esq.	Europe
1859 Sept. 7.	*Goodeve, E. Esq., M. D.	Europe
1862 July 2.	Gordon, J. D. Esq., C. S.	Calcutta
1864 Dec. 5.	†Gooroochurn Dáss Bábu.	Jungipore
1862 Feb. 5.	†Gourdoss Bysack, Bábu.	Jahanabad
1863 Nov. 4.	†Gowan, Major J G.	Sirhind Division, Umbala
1859 Dec. 7.	*Grant, Sir J. P., K. C. B.	Europe
1860 Jan. 4.	Grant, T. R. Esq.	Calcutta
1860 July 4.	Grey, Hon'ble W., B. C. S.	Calcutta
1866 June 6.	†Gribble, T. W. Esq., B. C. S.	Sasseeram
1861 Sept. 4.	†Griffin, L. Esq., B. C. S.	Lahore
1860 Nov. 7.	†Griffith, R. T. H. Esq.	Benares
1849 Aug. 1.	Grote, A. Esq., B. C S., F. L. S.	Calcutta
1861 Feb. 6.	†Growse, F. S. Esq., B. C. S.	Mynpoorie
1862 Feb. 5.	*Guthrie, Col. C. S., Bengal Engrs.	Europe
1847 June 2.	*Hall, F. E. Esq., M. A., D. C. L.	Europe
1866 Jan. 17.	†Hamilton, Capt. T. C.	Moulmein
1863 June 3.	*Hamilton, Col. G. W.	Europe
1855 Mar. 7.	†Hamilton, R. Esq.	Bombay
1828 Nov. 12.	*Hamilton, Sir R. N. E., Bárt., B. C. S.	Europe
1847 May 5.	*Hannyngton, Col. J. C., 63rd Regt. N. I.	Europe
1859 Oct. 12.	*Hardie, Dr. G. K.	Europe
1866 Nov. 7.	Harendra Krishna Kumar.	Calcutta
1863 Mar. 4.	Hári Dáss Dutt, Bábu.	Calcutta
1862 Oct. 8.	*Harington, Hon'ble H. B.	Europe
1860 Oct. 3.	†Harris, E. B. Esq., C. S.	E I. Railway Rohnee W. Deoghur
1861 Feb. 6.	†Harrison, A. S. Esq., B. A.	Behar.
1864 Nov. 2.	Hatton, C. W, Esq.	Calcutta
1859 Oct. 12.	†Haughton, Lieut.-Col. J. C., C. S. I.	Julpigorie
1848 May 3.	*Hearsay, Maj.-Gl. Sir J. B, K. C. B.	Europe
1862 Aug. 6.	†Heeley, W. L. Esq., C. S.	Berhampore
1866 April 4.	Henry, N. A. Esq.	Calcutta
1859 Aug. 3.	Henessey, J. B. N. Esq.	Calcutta
1853 July 6.	†Herschel, W. J. Esq., B. C. S.	Midnapore
1854 Mar. 1.	*Hichens, Lieut. W., Bengal Engrs.	Europe
1866 Jan. 17.	Hicks, J. G. Esq.	Calcutta
1860 May 2.	Hobhouse, C. P. Hon'ble B. C. S.	Calcutta
1859 Sept. 7.	†Hopkinson, H. Lieut.-Col. H.	Assam
1863 July 1.	†Horne, C. Esq., C. S.	Mynpoorie

Date of Election.		
1860 Mar. 7.	Hovenden, Major J. J., Bengal Engrs.	Calcutta
1863 Jan. 15.	†Howell, M. S. Esq., C. S.	Shajehanpore
1866 Jan. 17.	†Hughes, Lieut. W. G.	Martaban
1866 Feb. 7.	Hoyle, G. W. Esq.	Calcutta
1866 Mar. 7.	†Irvine, W. Esq., C. S.	Muzafernagar
1860 Jan. 4.	†Innes, Major J. J. M.	Lahore
1862 Oct. 8.	†Irwin, Valentine, Esq., C. S.	Narail, Jessore
1853 Dec. 7.	†Ishureeprasád Sinha, Bahadur, Rajah.	Benares
1864 Sept. 7.	*Jackson, Hon'ble E.	Europe
1861 Jan. 9.	Jackson, Hon'ble L. S., B. C. S.	Calcutta
1841 April 7.	*Jackson, W. B. Esq., B. C. S.	Europe
1851 April 2.	Jadava Krishna Singha, Bábu.	Calcutta
1861 Dec. 4.	James, Major H. R., C. B.	Calcutta
1864 Sept. 7.	*Jardine, R. Esq., C. S.	Europe
1845 Dec. 3.	†Jerdon, Dr. T. C., M. M. S.	Mussoorie
1866 Feb. 7.	†Johnson, W H. Esq.	Dehra
1847 June 2.	Johnstone, J. Esq.	Europe
1862 Mar. 5.	*Johnstone, Capt. J., Assistant Commissioner.	Europe
1859 Sept. 7.	*Jones, R. Esq.	Europe
1865 June 7.	†Joykissen Dáss Bahadur, Rajah.	Allyghur
1866 Mar. 7.	Kadar Nath Mookerjee.	Bhowanipore
1858 Feb. 3.	Kaliprosonno Singha, Bábu.	Calcutta
1863 July 1.	*Kane, H. S. Esq., M. D.	Europe
1850 April 3.	*Kay, Rev. W., D. D.	Europe
1861 Dec. 15.	†Kempson, M. Esq., M. A.	Bareilly
1862 Jan. 15.	†King, W. Esq., Jr., Geol. Survey.	Madras
1839 Mar. 6.	*Laidlay, J. W. Esq.	Europe
1861 Mar. 6.	*Laing, Hon'ble S.	Europe
1863 Sept. 2.	Lane, T. B. Esq., B. C. S.	Calcutta
1851 Dec. 3.	†Layard, Major F. P.	Bhagulpore
1864 Feb. 3.	†Leeds, H. Esq., Conservator of Forests.	Burmah
1852 April 7.	Lees, Major W. N., LL. D.	Calcutta
1859 Dec. 7.	Leonard, H. Esq., C. E.	Calcutta
1865 June 7.	†Lewin, Capt. T. H.	Chittagong
1856 Feb. 6.	*Liebig, Dr. G. Von., B. M. S.	Europe
1860 Jan. 4.	Lindsay, E. J. Esq.	Calcutta
1861 Nov. 6.	†Lloyd, Capt. M.	Tôunghoo
1862 Dec. 3.	Lobb, S. Esq., M. A.	Calcutta
1835 Oct. 7.	Loch, Hon'ble G., B. C. S.	Calcutta
1864 Nov. 2.	Locke, H H. Esq.	Calcutta
1866 May 2.	†Lovett, Lieut. B..	Punjab
1828 July 2.	*Low, Major-General Sir J., K. C. B.	Europe

Date of Election.		
1866 Jan. 17.	†Low, James, Esq., G. T. S.	Debra Dhoon
1861 April 3.	*Lumsden, Major P. S.	Europe
1854 Nov. 1.	*Lushington, F. A. Esq., B. C. S.	Europe
1866 Mar. 7.	†Macdonall, A. P. Esq.	Monghyr
1866 June 6.	†Macdonald, Capt. J. Staff Corps.	Chandu Division, Nagpore
1848 April 5.	†Maclagan, Lieut.-Col. R., F. R. S. E.	Lahore
1866 Jan. 17.	†Macgregor, Lieut. C.	Buxa
1865 Nov. 1.	Mackenzie, A. Esq., C. S.	Calcutta
1863 Jan. 15.	Maine, Hon'ble H. S.	Calcutta
1860 Jan. 4.	Mair, D. K. Esq., M. A.	Calcutta
1865 Mar. 1.	Malleson, Major G. B.	Calcutta
1862 Sept. 3.	Mallet, F. R. Esq.	Calcutta
1860 July 4.	†Man, E. G. Esq.	Burdwan
1852 Nov. 3.	Manickjee Rustomjee, Esq.	Calcutta
1861 June 5.	†Mán Sinha Bahadur, Mahárajah.	Oudh
1864 Aug. 11.	*Marks, Rev. J. Ebenezer.	Europe
1850 Jan. 2.	*Marshman, J. C. Esq.	Europe
1866 July 4.	Mathews, J. H. Esq.	Calcutta
1863 Oct. 7.	†Martin, T. Esq., C. E.	Gowhatty
1863 Nov. 4.	*McClelland, Dr. J.	Europe
1837 Oct. 4.	†McLeod, Hon'ble D. F., C. B., B. C. S.	Lahore
1860 Mar. 7.	†Medlicott, H. B. Esq., F. G. S.	Gwalior
1861 Feb. 6.	†Melville, Capt. A. B., late 67th N. I. Surv. Genl.'s Dept.	Gwalior
1855 Nov. 7.	*Middleton, J. Esq.	Europe
1850 April 3.	*Mills, A. J. M. Esq., B. C. S.	Europe
1847 April 7.	*Money, D. J. Esq., B. C. S.	Europe
1856 Feb. 6.	Money, J. W. B. Esq.	Calcutta
1865 July 5.	†Morland, Major J.	Umballa
1854 Dec. 6.	†Morris, G. G. Esq., B. C. S.	Jessore
1864 June 1.	†Moula Bukhsh, Khan Bahadur, Maulvi	Patna
1837 July 5.	*Muir, J. Esq.	Europe
1854 Oct. 11.	Muir, Hon'ble W., B. C. S.	Calcutta
1859 Aug. 3.	†Murray, Lieut. W. G., 68th N. I.	Mussoorie
1862 July 2.	†Napier, His Excellency Major-Genl. Sir R., K. C. B.	Bombay
1860 Nov. 7.	*Newmarch, Major C. D.	Europe
1865 Feb. 1.	†Newul Kishwar, Moonshee.	Lucknow
1852 Sept. 1.	*Nicholls, Capt. W. T., 24th Regiment, M. N. I.	Europe
1863 Sept. 2.	Norman, Major F. B.	Calcutta
1863 Jan. 15.	Norman, Hon'ble J. P.	Calcutta

Date of Election.		
1860 June 4.	†Oldham, C. Esq., Geological Survey.	Madras
1851 June 4.	Oldham, T. Esq., LL. D., F. R. S.	Calcutta
1864 Dec. 7.	Onslow, D. B. Esq.	Barrackpore
1866 July 4.	Ormsby, M. H. Esq.	Calcutta
1837 June 7.	*O'Shaughnessy, Sir W. B.	Europe
1847 Feb. 10.	*Ousely, Major W. R.	Europe
1864 Mar. 2.	Palmer, Dr. W. J.	Calcutta
1862 May 7.	Partridge, S. B. Esq., M. D.	Calcutta
1860 Feb. 1.	†Pearse, Major G. G.	Madras
1864 Mar. 2.	†Pellew, F. H. Esq., C. S.	Burrisal
1865 Sept. 6.	†Peppe, J. H. Esq.	Gya
1835 July 1	†Phayre, Lt.-Col. A P., C B.	Rangoon
1864 Nov. 2.	Phear, Hon'ble J. B.	Calcutta
1862 Oct. 8.	†Poolin Behary Sen, Bábu.	Berhampore
1839 Mar. 6.	Pratt, Ven'ble Archdeacon J. H., M. A.	Calcutta
1860 Jan. 4.	Preonath Sett, Bábu.	Calcutta
1825 Mar. 9.	*Prinsep, C. R. Esq.	Europe
1837 Feb. 1.	Prosonno Coomar Tagore, Bábu.	Calcutta
1864 Feb. 3.	†Pullan, Lieut. A., G. T. Survey.	Dehra Dhoon
1862 April 2.	Raban, Lieut.-Col. H.	Calcutta
1853 April 6.	Radha Nath Sikdar, Bábu.	Calcutta
1849 Sept. 5.	Rajendra Dutt, Bábu.	Calcutta
1856 Mar. 5.	Rajendalála Mitra, Bábu.	Calcutta
1864 May 4.	Ramánath Bose, Bábu.	Calcutta
1837 Feb. 1.	Ramánath Tagore, Bábu.	Calcutta
1865 July 5.	†Ramsden, Lieut. W. C.	Cawnpore
1866 Jan. 17.	Rattray, A. Esq.	Hidgelee Kantee
1860 Mar. 7.	†Reid, H. S. Esq.	Oudh
1864 Dec. 7.	†Richardson, R. J. Esq., C. S.	Gya
1857 June 7.	Riddell, Hon'ble H. B., B. C. S.	Calcutta
1857 Aug. 6.	†Roberts, Hon'ble A. A., B. C. S.	Panjab
1863 April 1.	†Robertson, C. Esq., C. S.	Nyne Tal
1864 Dec. 7.	†Robertson, E. S. Esq.	Azimghur
1863 May 6.	†Robertson, H. D. Esq., C. S.	Saharunpore
1865 Feb. 1.	Robinson, S. H. Esq.	Calcutta
1847 Dec. 1.	*Rogers, Capt. T. E.	Europe
1866 Dec. 5.	Ross, J. M. Esq.	Calcutta
1859 Sept. 7.	Russell, A. E. Esq., B. C. S.	Hoogly
1865 June 7.	†Sárodáprosád Mookerjee, Bábu.	Baraset
1859 Feb. 2.	Satischunder Roy Mahárajah.	Krishnagur
1856 Aug. 6.	Satyasharana Ghosal, Rajah.	Bhookylas, Calcutta
1861 Dec. 4.	†Saunders, C. B. Esq., B. C. S.	Mysore

Date of Election.		
1864 June 1.	*Saunders, J. O'B. Esq.	Europe
1854 Dec. 6.	†Saxton, Lt.-Col. G. H., F. G. S., 38th M. N. I.	Ganjám
1854 May 2.	Schiller, F. Esq.	Calcutta
1860 Feb. 1.	*Scott, Col. E. W. S.	Europe
1859 Aug. 3.	†Scott, W. H. Esq.	Dhera Dhoon
1866 Jan. 17.	*Seaton, Lieut. G.	Europe
1863 Sept. 3.	Sama Churn Sirkar, Bábu.	Calcutta
1860 July 4.	†Shelverton, G. Esq.	Dhera Dhoon
1866 Sept. 5.	Sherer, Capt. F. S.	Gowhatty
1845 Jan. 14.	*Sherwill, Lt.-Col. W. S., 66th Regiment B. N. I., F. G. S., F. R. G. S.	Europe
1863 April 1.	Showers, Major C. L.	Calcutta
1864 Feb. 3.	Shumbhoonath Pundit, Hon'ble.	Calcutta
1866 June 6.	Sime, J. Esq., B. A.	Calcutta
1864 Sept. 7.	†Sladen, Capt. E. B.	Mandalay
1866 June 6.	†Smart, R. B. Esq.	Assam
1865 July 5.	Smith, D. Boyes, Esq., M. D.	Calcutta
1856 Feb. 6.	*Smith, Col. J. F.	Europe
1866 May 2.	†Soorut Nauth Mullick, Baboo.	Howrah
1854 Sept. 6.	Spankie, R. Esq., B. C. S.	Agra
1864 Mar. 2.	†Spearman, Lieut. H. R.	Yangzaleen British Burmah
1860 May 2.	†Staunton, Major F. S., Beng. Engs.	Darjiling
1843 Sept. 4	*Stephen, Major J. G., 8th N. I.	Europe
1863 Jan. 15.	Sterndale, R. A. Esq.	Calcutta
1863 May 6.	†Stevens, W. H. Esq.	Futtyghur
1863 Sept. 2.	Stewart, R. D. Esq.	Calcutta
1864 April 6.	†Stewart, J. L. Esq. M. D.	Lahore
1861 Sept. 4.	Stokes, Whitley, Esq.	Calcutta
1863 Nov. 4.	Stoliczka, Dr. F.	Calcutta
1843 May 3.	†Strachey, Lt.-Col. R., F. R. S. F. L. S., F. G. S.	Bombay
1859 Mar. 2.	†Stubbs, Capt. F. W., Beng. Artillery.	Govinghur Umritsur
1861 Oct. 2.	†Sudderuddin, Moonshi.	Pundooah
1858 July 7.	†Sutherland, H. C. Esq., B. C. S.	Backergunje
1864 Aug. 11.	Swinhoe, W. Esq.	Calcutta
1865 Sept. 6.	Tawney, C. H. Esq.	Calcutta
186b April 5.	†Taylor, R. Esq.	Madras
1860 May 2.	†Temple, R. Esq., B. C. S.	Nagpore
1859 Mar. 2.	†Theobald, W. Esq., Jr., Geological Survey.	Thayet Myo

Date of Election.		
1860 June 6.	Thompson, J. G. Esq.	Calcutta
1863 Mar. 4.	†Thompson, Major G. H., Bengal Staff Corps.	Hazareebaug
1855 June 6.	*Thompson, Dr. T., M. D., F. R. S., F. L. S., F. R. G. S.	Europe
1853 Nov. 21.	†Thornhill, C. B. Esq., B. C. S.	Allahabad
1863 June 4	†Thornton, T. H. Esq.	Murree,Punjab
1847 June 2.	Thuillier, Lt.-Col. H. L., F. R. G. S., Bengal Artillery.	Calcutta
1863 May 6.	Thuillier, Lt. H. R.	Calcutta
1862 July 2.	*Thurlow, Hon'ble T. J. H.	Europe
1865 July 5.	†Tolbort, T. W. H. Esq., C. S.	Panjab
1865 July 5.	Tonnerre, Dr. C. F.	Calcutta
1862 Feb. 5.	†Torrens, Col. H. D.	Saugor
1861 June 5.	†Tremlett, J. D. Esq., C. S.	Goorranualla, Lahore
1863 Mar. 4.	*Trevelyan, Right Hon'ble Sir C., K. C. B.	Europe
1841 Feb. 3.	Trevor, Hon'ble C. B., B. C. S.	Calcutta
1863 Feb. 4.	*Trevor, E. T. Esq., B. C. S.	Europe
1864 Mar. 2.	*Trevor, Lt. E. A. Royal Eng.	Europe
1464 July 6.	†Trotter, Lieut. H. Bengal Eng.	Meerut
1864 Sept. 4.	Tween, A. Esq., Geological Survey.	Calcutta
1863 May 6.	†Tyler, Dr. J.	Etah
1860 May 2.	†Vanrenen, Capt. A. D., late 71st B. N. I.	Lahore
1864 Feb. 3.	†Verchere, A. M., Esq., M. D.	Kohat
1864 April 6.	†Vijayaráma Gajapati Raj Munnia Sultan Bahadur, Maharajah Mirza.	Vizianagaram
1865 Nov. 1.	Waldie, D. Esq.	Calcutta
1861 May 1.	†Walker, Lt.-Col. J. T., Bom. Engrs.	Dehra Dhoon
1863 Dec. 2.	†Walker, A. G. Esq.	Shahapur, Panjab
1863 May 6.	*Wall, P. W. Esq., C. S.	Europe
1863 Oct. 7.	Waller, Dr. W. K.	Calcutta
1863 Dec. 2.	Walters, Rev. M. D. C.	Calcutta
1862 Jan. 15.	†Ward, G. E. Esq., B. C. S.	Dehra Dhoon
1852 July 7.	*Ward, J. J. Esq., B. C. S.	Europe
1859 July 6.	*Warrand, R H. M. Esq., B. C. S.	Europe
1865 May 3.	Waterhouse, Lieut. J., Royal Artillery.	Calcutta
1854 July 5.	*Watson, J. Esq., B. C. S.	Europe
1847 Nov. 8.	*Waugh, Major-General Sir A. S., C. B., F. R. S., F. R. G. S.	Europe
1862 Oct. 8.	Wheeler, J. T. Esq.	Calcutta

Date of Election.		
1864 Mar. 2.	Wilkinson, C. J. Esq.	Calcutta
1861 Sept. 4.	†Williams, Dr. C., H. M.'s 68th Regt.	Rangoon
1859 Sept. 7.	†Wilson, W. L. Esq.	Beerbhoom
1859 Aug. 3.	†Wilmot, C. W. Esq.	Deoghur
1865 Feb. 1.	†Wilmot, E. Esq.	Delhi
1866 Mar. 7.	†Wise, Dr. J. F. N.	Dacca
1861 May 7.	Woodrow, H. Esq., M. A.	Calcutta
1859 Mar. 2.	*Wortley, Major A. H. P.	Europe
1862 Aug. 6.	Wylie, J. W. Esq., Bambay C. S.	Calcutta
1855 April 4.	*Young, Lt.-Col. C. B.	Europe
1856 July 2.	*Yule, Lt.-Col. H.	Europe

LIST OF HONORARY MEMBERS.

Date of Election.		
1825 Mar. 9.	M. Garcin de Tassy, Membre de l' Inst.	Paris
1826 „ 1.	Sir John Phillippart.	London
1829 July 1.	Count De Noe.	Paris
1831 Sept. 7.	Prof. Francis Bopp, Memb. de l' Académie.	Berlin
1831 „ 7.	Prof. C. Lassen.	Bonn
1834 Nov. 5.	Sir J. F. W. Herschel, F. R. S.	London
1834 „ 5.	Col. W. H. Sykes, F. R. S.	London
1835 May 6.	Prof. Lea.	Philadelphia
1840 Mar. 4.	M. Reinaud, Memb. de l' Instit., Prof. de l' Arabe.	Paris
1842 Feb. 4.	Dr. Ewald.	Göttingen
1842 „ 4.	Right Hon'ble Sir Edward Ryan, Kt.	London
1843 Mar. 30.	Prof. Jules Mohl, Memb. de l' Instit.	Paris
1847 May 5.	His Highness Hekekyan Bey.	Egypt
1847 Sept. 1.	Col. W. Munro.	London
1847 Nov. 3.	His Highness the Nawab Nazim of Bengal.	Moorshedabad
1848 Feb. 2.	Dr. J. D. Hooker, R. N., F. R. S.	London
1848 Mar. 8.	Prof. Henry Princeton.	United States
1853 April 6.	Major-Gen. Sir H. C. Rawlinson, K. C. B., F. R. S., D. C. L.	London
1854 Aug. 2.	Col. Sir Proby T. Cautley, K. C. B., F. R. S.	London
1855 Mar. 7.	Rájá Rádhákánta Deva, Báhádur.	Brindabun
1858 July 6.	B. H. Hodgson, Esq.	Europe
1859 Mar. 2.	Hon'ble Sir J. W. Colvile, Kt.	Europe
1860 „ 7.	Prof. Max Müller.	Oxford
1860 Nov. 7.	Mons. Stanislas Julien.	Paris
1860 „ 7.	Col. Sir George Everest, Kt., F. R. S.	London
1860 „ 7.	Dr. Robert Wight.	London
1860 „ 7.	Edward Thomas, Esquire.	London
1860 „ 7.	Dr. Aloys Sprenger.	Germany
1860 „ 7.	Dr. Albrecht Weber.	Berlin
1865 Sept. 6.	Edward Blyth, Esquire.	Europe

LIST OF CORRESPONDING MEMBERS.

1844 Oct. 2.	MacGowan, Dr. J.	Europe
1856 June 4.	Kremer, Mons. A. Von.	Alexandria
1856 „ 4.	Porter, Rev. J.	Damascus
1856 „ 4.	von Schlagintweit, Herr H.	Berlin
1856 „ 4.	Smith, Dr. E.	Beyrout
1856 „ 4.	Tailor, J., Esquire.	Bussorah
1856 „ 4.	Wilson, Dr.	Bombay
1857 Mar. 4.	Neitner, J., Esquire.	Ceylon

Date of Election.		
1858 „ 3.	von Schlagintweit, Herr H. R.	Berlin
1859 Nov. 2.	Frederick, Dr. H.	Batavia
1859 May 4.	Bleeker, Dr. H.	Batavia
1860 Feb. 1.	Baker, Rev. H.	E. Malabar
1860 „ 1.	Swinhoe, R., Esq., H. M.'s Consulate.	Amoy
1860 April 4.	Haug, Dr. M.	Poonah
1861 July 3.	Gosche, Dr. R.	Berlin
1862 Mar. 5.	Murray, A., Esquire.	London
1863 Jan. 15.	Goldstücker, Dr. T.	London
1863 July 4.	Barnes, R. H. Esquire.	Ceylon
1866 May 7.	Von. Schlagintweit, Prof. E.	Prussia
1866 „ 7.	Sherring, Rev. M. A.	Europe

LIST OF ASSOCIATE MEMBERS.

1835 Oct. 7.	Stephenson, J., Esquire.	Europe
1838 Feb. 7.	Keramut Ali, Saiëd.	Hooghly
1843 Dec. 6.	Long, Rev. J.	Calcutta
1865 May 3.	Dall, Rev. C. H. A.	Calcutta

ELECTIONS IN 1866.

Corresponding Members.

Schlagintweit, Prof. E. Von.	Russia
Sherring, Rev. M. A.	Europe

Ordinary Members.

Major A. S. Allan.	Allahabad
Rev. J. Barton.	Calcutta
Lieut.-Col. D. Brown.	Amherst
J. A. Crawford, Esq., C. S.	Calcutta
*G. M. Tagore, Esq.	Calcutta
Capt T. C. Hamilton.	Moulmein
J. G. Hicks, Esq.	Calcutta
Lieut. W.G. Hughes.	Martaban
James Low, Esq.	Dehra Dhoon.
A. Rattray, Esq.	Hedgellee Kantai
A. Mackenzie, Esq., C. S.	Calcutta
Lieut. G. Seaton.	Tenasserim
N. Daly, Esq.	Myanoung Burma
*Rev. J. Cave Browne.	Calcutta
G. W. Hoyle, Esq.	Calcutta
W. H. Johnson, Esq.	Dehra
Baboo Kadar Nath Mookerjee.	Calcutta
Dr. J. F. N. Wise.	Dacca
W. Irvine, Esq., C. S.	Mozufurnugger
A. P. Macdenall, Esq., C. S.	Calcutta
N. A. Henry, Esq.	Calcutta
H. C. Broderick, Esq., M. D.	Augur West Malwa Cent. Malwa Horse
W. H. Cox, Esq.,	Krishnagur
Lieut. B. Lovelt.	Kohat, Punjab
Baboo Soorut Nath Mullick.	Howrah
W. M. Bourke, Esq.	Calcutta
C. Brounfield, Esq.	Gowhatty
Dr. H. B. Buckle, C. B.	Calcutta
T. W. Gribble, Esq., B. C. S.	Sassereem
Capt. J. Macdonald.	Chanda Division, Nagpore
J. Sime, Esq., B. A.	Calcutta
R. B. Smart, Esq.	Dacca
A. Anderson, Esq.	Fyzabad
J. H. Mathews, Esq.	Calcutta
M. H. Ormsby, Esq.	Calcutta
Capt. F. S. Sherer.	Gowhatty
Lieut.-Col. H. Ballard, C. B.	Calcutta
Kumar Harendra Krishna Bahadoor.	Calcutta
J. M. Ross, Esq.	Calcutta

* Re-elected.

LOSS OF MEMBERS DURING THE YEAR 1866.

By Retirement.

Ordinary Members.

R. B. Chapman, Esq.	Calcutta
Hon'ble A. Eden.	Calcutta
H. Duhan, Esq.	Dehra Dhoon
Baboo Kasinauth Chowdry.	Calcutta
R. L. Martin, Esq.	Dacca
C. C. Stevens, Esq.	Barasat.
Dr. A. C. Macrae.	Calcutta
Lieut.-Col. D. G. Robinson.	Calcutta
J. C. Wilson, Esq.	Fyzabad
Capt. G. M. Bowie.	Bhugulpore
Baboo Jadoo Nath Mookerjee.	Rajshaye
J. Strachey, Esq., C. S.	Oudh
J. M. Scott, Esq.	Calcutta
J. C. Sarkies, Esq.	Calcutta
Baboo Kaliprasunno Dutt.	Calcutta
Raja Apurva Krishna Bahadoor.	Calcutta
S. Jennings, Esq.	Calcutta
W. T. Dodsworth, Esq.	Dehra Dhoon
A. Money, Esq.	Bhugulpore

By Death.

Dr. E. Roer.	Brunswick, Germany
J. G. Medlicott, Esq.	Midnapore
Raja Pratab Chunder Sing.	Pakpara
Calcutta, Right Rev. Lord Bishop of,	Calcutta
J. Obbard, Esq.	Europe.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Latitude 22° 23′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18-11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.789	29.866	29.740	0.126	81.4	93.6	72.8	20.8
2	.821	.898	.748	.150	82.3	92.8	74.5	18.3
3	.821	.927	.745	.182	81.4	91.7	72.4	19.3
4	.756	.818	.678	.140	81.8	93.6	72.0	21.6
5	.786	.865	.732	.133	82.4	94.8	72.4	22.4
6	.816	.892	.757	.135	81.8	94.0	71.4	22.6
7	.792	.860	.724	.136	82.6	94.0	75.4	18.6
8	.793	.876	.719	.157	83.4	95.2	72.5	22.7
9	.800	.872	.732	.140	83.8	95.0	75.4	19.6
10	.784	.859	.719	.140	83.4	94.4	76.7	17.7
11	.858	.937	.775	.162	83.6	92.4	76.8	15.6
12	.977	30.060	.900	.160	83.4	92.4	77.4	15.0
13	.967	.056	.872	.184	83.3	92.2	77.8	14.4
14	.845	29.945	.764	.181	86.4	96.4	77.9	18.5
15	.828	.924	.761	.163	84.3	94.0	76.6	17.4
16	.871	.952	.812	.140	84.5	94.0	79.0	15.0
17	.885	.970	.822	.148	84.0	94.4	77.0	17.4
18	.820	.899	.750	.149	83.4	92.9	77.0	15.9
19	.798	.869	.729	.140	84.5	95.0	77.6	17.4
20	.842	.921	.779	.142	84.3	94.0	76.6	17.4
21	.798	.878	.703	.175	85.5	96.5	76.8	19.7
22	.717	.803	.619	,184	86.7	98.6	77.8	20.8
23	.715	.790	.663	.127	86.4	98.4	77.8	20.6
24	.751	.838	.684	.154	84.9	95.3	77.6	17.7
25	.748	.827	.678	.149	86.4	96.2	81.0	15.2
26	.700	.769	.626	.143	87.4	97.4	80.7	16.7
27	.730	.811	.668	.143	86.1	95.1	79.5	15.6
28	.812	.914	.743	.171	84.9	93.2	76.0	17.2
29	.859	.960	.771	.189	81.9	91.6	73.8	17.8
30	.855	.927	.775	.152	81.0	91.0	72.4	18.6
31	.806	.887	.739	.148	83.7	93.0	77.0	16.0

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March* 1866.**

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	72.9	8.5	66.9	14.5	0.657	7.06	4.21	0.63
2	72.8	9.5	66.1	16.2	.640	6-87	.71	.59
3	70.3	11.1	62.5	18.9	.568	.11	5.16	.54
4	69.4	12.4	60.7	21.1	.536	5.75	.65	.50
5	70.2	12.2	61.7	20.7	.554	.93	.68	.51
6	69.4	12.4	60.7	21.1	.536	.75	.65	.50
7	76.9	5.7	72.9	9.7	.797	8.56	3.12	.73
8	74.5	8.9	68.3	15.1	.688	7.37	4.59	.62
9	77.2	6.6	72.6	11.2	.790	8.47	3.63	.70
10	77.3	6.1	73.0	10.4	.801	.58	.38	.72
11	72.8	10.8	65.2	18.4	.621	6.66	5.37	.55
12	75.3	8.1	69.6	13.8	.717	7.68	4.28	.64
13	76.7	6.6	72.1	11.2	.778	8.34	3.59	.70
14	77.1	9.3	70.6	15.8	.741	7.89	5.17	.60
15	75.0	9.3	68.5	15.8	.692	.41	4.87	.60
16	73.5	11.0	65.8	18.7	.634	6.77	5.58	.55
17	74.2	9.8	67.3	16.7	.666	7.12	.05	.59
18	74.8	8.6	68.8	14.6	.699	.48	4.48	.63
19	75.6	8.9	69.4	15.1	.713	.62	.73	.62
20	73.6	10.7	66.1	18.2	.640	6.84	5.44	.56
21	75.4	10.1	68.3	17.2	.688	7.34	.38	.58
22	76.3	10.4	70.1	16.6	.729	.76	.42	.59
23	75.6	10.8	68.0	18.4	.681	.26	.80	.56
24	78.6	6.3	74.2	10.7	.832	8.89	3.60	.71
25	79.6	6.8	74.8	11.6	.849	9.04	4.02	.69
26	80.8	6.6	76.8	10.6	.905	.61	3.84	.71
27	76.3	9.8	69.4	16.7	.713	7.59	5.36	.59
28	79.1	5.8	75.0	9.9	.854	9.12	3.37	.73
29	75.1	6.8	70.3	11.6	.734	7.89	.55	.69
30	75.1	5.9	71.0	10.0	.751	8.09	.05	.73
31	77.3	6.4	72.8	10.9	.795	.52	.55	.71

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.821	30.007	29.706	0.301	79.1	82.8	72.5	10.3
1	.807	.001	.696	.305	78.6	82.0	72.4	9.6
2	.794	29.985	.682	.303	78.1	81.6	72.8	8.8
3	.784	.978	.671	.307	77.5	81.5	72.8	8.7
4	.781	.982	.668	.314	77.2	81.6	72.8	8.8
5	.796	.995	.687	.308	76.8	81.4	71.6	9.8
6	.815	30.009	.707	.302	76.4	81.1	71.5	9.6
7	.839	.025	.730	.295	76.7	81.4	71.4	10.0
8	.869	.043	.748	.295	78.8	82.8	73.8	9.0
9	.885	.055	.761	.294	81.9	86.6	76.6	10.0
10	.889	.060	.751	.309	85.1	89.8	80.0	9.8
11	.878	.056	.769	.287	87.9	92.4	83.8	8.6
Noon.	.851	.031	.740	.291	90.3	94.6	87.6	7.0
1	.818	.003	.711	.292	92.0	96.0	89.2	6.8
2	.784	29.976	.666	.310	93.4	97.4	91.0	6.4
3	.761	.957	.642	.315	94.1	98.4	90.6	7.8
4	.748	.933	.625	.308	94.0	98.6	89.8	8.8
5	.745	.939	.619	.320	92.5	97.4	87.6	9.8
6	.752	.950	.624	.326	88.9	93.6	84.6	9.0
7	.769	.964	.633	.331	86.0	90.6	82.6	8.0
8	.793	.990	.666	.324	84.0	87.0	81.6	5.4
9	.819	30.009	.693	.316	82.1	84.8	73.8	11.0
10	.830	.021	.707	.314	80.9	83.8	76.2	7.6
11	.831	.019	.706	.303	79.8	83.0	74.2	8.8

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Midnight.	75.8	3.3	73.5	5.6	0.814	8.79	1.74	0.84
1	75.6	3.0	73.5	5·1	.814	.81	.57	.85
2	75.4	2.7	73.5	4.6	.814	.81	.41	.86
3	75.0	2.5	73.2	4.3	.806	.75	.29	.87
4	74.7	2.5	72.9	4.3	.797	.66	.29	.87
5	74.5	2.3	72.9	3.9	.797	.66	.17	.88
6	74.2	2.2	72.7	3.7	.792	.61	.11	.89
7	74.6	2.1	73.1	3.6	.803	.72	.08	.89
8	75.2	3.6	72.7	6.1	.792	.58	.86	.82
9	75.8	6.1	71.5	10.4	.763	.21	3.23	.72
10	75.7	9.4	69.1	16.0	,706	7.53	5.04	.60
11	75.0	12.9	67.3	20.6	.666	.06	6.58	.52
Noon.	74.9	15.4	65.7	24.6	.632	6.68	7.95	.46
1	74.6	17.4	64.2	27.8	.601	.32	9.04	.41
2	74.5	18.9	63.2	30.2	.582	.11	.88	.38
3	74.3	19.8	62.4	31.7	.567	5.93	10.39	.36
4	74.9	19.1	63.4	30.6	.586	6.13	.14	.38
5	75.1	17.4	64.7	27.8	.611	.43	9.16	.41
6	75.1	13.8	66.8	22.1	.655	.94	7.10	.49
7	75.5	10.5	68.1	17.9	.684	7.28	5.63	.56
8	75.1	8.9	68.9	15.1	.701	.51	4.66	.62
9	75.3	6.8	70.5	11.6	.739	.93	3.58	.69
10	75.8	5.1	72.2	8.7	.781	8.40	2.70	.76
11	75.9	3.9	73.2	6.6	.806	.70	2.05	.81

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	General Aspect of the Sky.
	o	Inches		
1	146.0	...	N. W. & W. & S.	Clear.
2	142.0	...	W.	Clear.
3	142.8	...	W. & S. W.	Clear.
4	141.6	...	W. & S. W & S.	Clear.
5	148.5	...	W. & S.	Clear.
6	142.0	...	W.	Clear.
7	141.5	...	S. & S. W.	Clear. Scuds from S. between 4 &7 A. M.
8	142.4	...	S. & W.	Clear to 4 A. M., scatd. ⌣i to 9 A. M., clear afterwards.
9	136.4	...	S. W.	Clear, slightly foggy from 4 to 6 A. M.
10	137.2	...	S. & N.	Clear, slightly foggy from 3 to 8 A. M.
11	140.0	...	N. & W.	Clear, slightly foggy at 4 A. M.
12	142.0	...	S. & N.	Clear.
13	137.0	...	S. & S. W.	Clear to 2 A. M., overcast to 6 A. M., clear afterwards.
14	140.0	...	S. & W.	Clear, slightly foggy at 1 A. M.
15	141.0	...	S. & W.	Clear, slightly foggy from 3 to 5 A. M.
16	150.0	...	S. W. & W.	Scatd. clouds to 8 A. M., clear afterwards.
17	137.0	...	S. & N.	Clear to 7 A. M. \i to 7 P. M., clear afterwards.
18	134.7	...	S. &. S. W.	\i to 8 P. M., clear afterwards.
19	142.0	...	W. & S. & S. W.	\i to 8 A. M., clear afterwards.
20	149.0	...	S.W.&W.&N.W.	Clear, foggy from 4 to 7 A. M.
21	142.0	...	W. & S. W. & S.	Clear to 1 P. M., scatd. \i to 6 P. M., clear afterwards.
22	142.0	...	S. W. & W. & S.	Clear.
23	146.0	...	S. & W.	Clear.
24	140.5	...	S.	Clear.
25	141.0	...	S. & S. W.	Scatd. ⌒i to 9 A. M., clear afterwards.
26	146.0	...	S.	Clouds of different kinds.
27	142.5	...	S.	Clear.
28	137.0	...	S.	Clear to 6 A. M., scatd. ⌒i to 5 P. M., overcast afterwards. Thin rain Lightning. and Thunder at 10 & 11 P. M.
29	132.0	...	S.	Overcast to 6 A. M., scatd. ⌒i to 8 P. M. over cast afterwards Thin rain at 11 P. M.

\i Cirri, —i Strati, ⌒i Cumuli, \‒i Cirro-strati, ⌒ i Cumulo strati, ⌒‒i Nimbi, \⌒i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	General Aspect of the Sky.
30	135.0	...	S.	⌒i to 10 A. M. ⌒i to 4 P. M., clear afterwards.
31	137.0	...	E. & S. & S. W.	Clear to 4 A. M. ⌒i to 1 P. M. Scatd. \i afterwads.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month,...	29.811
Max. height of the Barometer occurred at 10 A. M. on the 12th, ...	30.060
Min. height of the Barometer occurred at 5 P. M. on the 22nd, ...	29.619
Extreme range of the Barometer during the month, ...	0.441
Mean of the daily Max. Pressures, ...	29.893
Ditto ditto Min. ditto	29.740
Mean daily range of the Barometer during the month, ...	0.153

	o
Mean Dry Bulb Thermometer for the month, ...	83.9
Max. Temperature occurred at 4 P. M. on the 22nd, ...	98.6
Min. Temperature occurred at 7 A. M. on the 6th, ...	71.4
Extreme range of the Temperature during the month, ...	27.2
Mean of the daily Max. Temperature	94.3
Ditto ditto Min. ditto, ...	76.1
Mean daily range of the Temperature during the month,... ...	18.2

Mean Wet Bulb Thermometer for the month, ...	75.1
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	8.8
Computed Mean Dew-point for the month, ...	68.9
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	15.0
	Inches.
Mean Elastic force of Vapour for the month, ...	0.701

	Troy grains.
Mean Weight of Vapour for the month	7.51
Additional Weight of Vapour required for complete saturation, ...	4.62
Mean degree of humidity for the month, complete saturation being unity	0.62

	Inches.
Drizzled 2 days,—Max. fall of rain during 24 hours	Nil
Total amount of rain during the month, ...	Nil
Prevailing direction of the Wind, ...	S. & W. & S. W.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of March 1866.

Monthly Results.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

Hour.	N.	Rain on.	N. E.	Rain on.	E.	Rain on.	S. E.	Rain on.	S.	Rain on.	S. W.	Rain on.	W.	Rain on.	N. W.	Rain on.	Calm.	Rain on.	Missed.
								No. of days											
Midnight.					1		2		18		7		3						
1					1		2		18		8		2						
2					1				20		8		2						
3							1		17		8		4						1
4							1		15		9		5						1
5							1		13		10		6						1
6	1		1						14		9		5						1
7	1				1				12		11		5						1
8	3								11		11		6						
9	1								9		9		10		2				
10	2								5		10		10		4				
11	5		1				1		3		6		9		6				
Noon.	5		2		1		1		5		4		7		6				
1	2		2		2				3		6		11		5				
2	2		1		2		1		3		3		15		4				
3	4				2		1		2		6		15		1				
4	3				2		1		6		3		15		1				
5	3		1		1		1		8		2		14		1				
6	2		1		2				9		2		13		2				
7	2		1		2				14		1		9		2				
8	2				1				17		1		9		1				
9	1				1				21		3		4		1				
10	1						1		21		5	1	3						
11							1		19		6		4	2	1				

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18-11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.842	29.976	29.781	0.195	82.5	89.9	76.9	13.0
2	.844	.915	.796	.119	82.6	91.8	76.4	15.4
3	.853	.955	.801	.154	77.4	83.4	73.6	9.8
4	.811	.882	.753	.129	78.6	89.0	71.4	17.6
5	.806	.879	.725	.154	82.1	93.0	72.8	20.2
6	.738	.834	.620	.214	83.9	95.0	78.2	16.8
7	.695	.772	.617	.155	85.6	96.8	77.2	19.6
8	.688	.760	.621	.139	86.6	97.6	78.0	19.6
9	.707	.794	.629	.165	88.2	98.8	81.0	17.8
10	.655	.730	.562	.168	89.3	102.6	81.8	20.8
11	.615	.685	.545	.140	89.1	102.3	78.8	23.5
12	.642	.709	.576	.133	88.1	100.2	77.4	22.8
13	.730	.810	.671	.139	87.7	100.2	77.0	23.2
14	.716	.799	.634	.165	88.5	101.8	79.2	22.6
15	.674	.747	.581	.166	88.8	102.6	80.6	22.0
16	.676	.736	.630	.106	86.3	93.8	80.7	13.1
17	.700	.766	.642	.124	85.3	90.8	81.4	9.4
18	.723	.796	.618	.178	85.1	92.1	80.8	11.3
19	.734	.812	.679	.133	86.4	95.6	81.2	14.4
20	.803	.894	.732	.162	86.8	94.0	81.4	12.6
21	.914	30.062	.806	.256	82.4	91.4	69.6	21.8
22	.983	.074	.899	.175	75.5	84.4	68.4	16.0
23	.951	.039	.845	.194	79.3	88.2	73.0	15.2
24	.902	29.973	.804	.169	82.5	91.2	75.0	16.2
25	.835	.917	.721	.196	83.6	94.2	75.7	18.5
26	.766	.853	.660	.193	85.7	96.4	77.4	19.0
27	.796	.858	.731	.127	86.1	94.4	77.8	16.6
28	.853	.995	.788	.207	80.3	89.8	72.2	17.6
29	.874	.959	.792	.167	78.2	87.0	73.0	14.0
30	.839	.900	.751	.149	81.0	90.6	72.0	18.6

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—(*Continued.*)

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	75.1	7.4	69.9	12.6	0.725	7.77	3.87	0.67
2	75.1	7.5	69.8	12.8	.722	.74	.94	.66
3	71.1	6.3	66.7	10.7	.653	.07	2.94	.71
4	69.9	8.7	63.8	14.8	.593	6.41	3.97	.62
5	73.2	8.9	67.0	15.1	.659	7.08	4.43	.62
6	77.3	6.6	72.7	11.2	.792	8.49	3.64	.70
7	75.2	10.4	67.9	17.7	.679	7.24	5.52	.57
8	79.2	7.4	74.8	11.8	.849	9.04	4.10	.69
9	81.2	7.0	77.0	11.2	.910	.67	.09	.70
10	80.4	8.9	75.1	14.2	.857	.08	5.13	.64
11	76.7	12.4	69.3	19.8	.711	7.52	6.60	.53
12	75.3	12.8	67.6	20.5	.672	.13	.59	.52
13	77.6	10.1	71.5	16.2	.763	8.11	5.45	.60
14	78.2	10.3	72.0	16.5	.776	.21	.67	.59
15	79.8	9.0	74.4	14.4	.838	.89	.11	.64
16	80.7	5.6	76.8	9.5	.905	9.63	3.39	.74
17	79.7	5.6	75.8	9.5	.876	.35	.29	.74
18	79.7	5.4	75.9	9.2	.879	.40	.17	.75
19	80.1	6.3	75.7	10.7	.873	.30	.76	.71
20	80.4	6.4	76.6	10.2	.899	.57	.64	.72
21	76.2	6.2	71.9	10.5	.773	8.29	.32	.71
22	70.7	4.8	67.3	8.2	.666	7.25	2.21	.77
23	74.6	4.7	71.3	8.0	.758	8.20	.39	.77
24	76.1	6.4	71.6	10.9	.766	.22	3.42	.71
25	78.0	5.6	74.1	9.5	.830	.89	.14	.74
26	78.7	7.0	73.8	11.9	.822	.76	4.04	.68
27	80.6	5.5	76.7	9.4	.902	9.62	3.33	.74
28	76.3	4.0	73.5	6.8	.814	8.78	2.13	.81
29	74.0	4.2	71.1	7.1	.753	.16	.09	.80
30	74.1	6.9	69.3	11.7	.711	7.64	3.50	.69

All the Hygrometrical elements are computed by the Greenwich Constants.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April* 1866.**

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.783	30.042	29.623	0.419	79.5	83.4	68.8	14.6
1	.771	29.963	.608	.355	79.0	83.0	68.4	14.6
2	.761	.982	.593	.389	78.8	82.6	68.8	13.8
3	.752	.959	.580	.379	78.5	82.2	68.4	13.8
4	.755	.960	.587	.373	78.2	82.0	69.0	13.0
5	.770	.982	.600	.382	78.0	82.2	69.0	13.2
6	.790	30.005	.620	.385	77.8	82.2	68.6	13.6
7	.811	.038	.640	.398	78.8	83.4	70.4	13.0
8	.833	.068	.665	.403	81.2	85.8	70.7	15.1
9	.849	.074	.684	.390	84.3	88.8	73.3	15.5
10	.851	.070	.685	.385	86.9	92.2	75.0	17.2
11	.841	.014	.683	.331	89.1	95.6	76.3	19.3
Noon.	.822	.007	.662	.345	90.6	98.9	77.6	21.3
1	.791	29.971	.627	.344	91.9	100.2	78.0	22.2
2	.757	.947	.585	.362	92.7	101.8	82.0	19.8
3	.729	.918	.565	.353	93.0	102.3	82.8	19.5
4	.709	.899	.555	.344	92.4	102.6	81.0	21.6
5	.705	.905	.545	.360	90.6	100.8	79.0	21.8
6	.727	.917	.557	.360	87.7	96.4	77.2	19.2
7	.741	.948	.577	.371	84.7	91.6	72.8	18.8
8	.768	.963	.605	.358	82.6	89.8	73.6	16.2
9	.783	.989	.632	.357	81.6	87.0	73.4	13.6
10	.796	30.016	.641	.375	80.6	85.0	72.2	12.8
11	.795	.062	.639	.423	80.0	84.4	73.3	11.1

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	76.1	3.4	73.7	5.8	0.819	8.85	1.81	0.83
1	76.0	3.0	73.9	5·1	.824	.92	.58	.85
2	76.1	2.7	74.2	4.6	.832	9.00	.44	.86
3	76.1	2.4	74.4	4.1	.838	.08	.27	.88
4	76.0	2.2	74.5	3.7	.840	.11	.14	.89
5	75.8	2.2	74.3	3.7	.835	.05	.14	.89
6	75.8	2.0	74.4	3.4	.838	.10	.03	.90
7	76.3	2.5	74.5	4.3	.840	.11	.33	.87
8	77.2	4.0	74.4	6.8	.838	.02	2.19	.81
9	77.8	6.5	73.2	11.1	.806	8.63	3.65	.70
10	78.1	8.8	72.8	14.1	.795	.47	4.78	.64
11	78.1	11.0	71.5	17.6	,763	.08	6.04	.57
Noon.	77.7	12.9	70.0	20.6	.727	7.66	7.10	.52
1	77.9	14.0	69.5	22.4	.715	.53	.79	.49
2	77.7	15.0	68.7	24.0	.697	.32	8.36	.47
3	77.6	15.4	68.4	24.6	.690	.25	.56	.46
4	77.4	15.0	68.4	24.0	.690	.25	.29	.47
5	77.3	13.3	69.3	21.3	.711	.50	7.26	.51
6	77.5	10.2	71.4	16.3	.761	8.08	5.48	.60
7	76.9	7.8	71.4	13.3	.761	.13	4.29	.66
8	76.7	5.9	72.6	10.0	.790	.49	3.19	.73
9	76.5	5.1	72.9	8.7	.797	.57	2.77	.76
10	76.3	4.3	73.3	7.3	.809	.72	.29	.79
11	76.1	3.9	73.4	6.6	.811	.75	3.06	.81

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General Aspect of the Sky.
	o	Inches		lb	
1	132.0	...	W. S. W. & E.S.E.	2.75	Overcast to Noon, \i to 5 P. M., clear afterwards.
2	141.0	...	S. S. E. & W. S. W.	1.25	⌣i to 7 A. M., scatd. ⌒i to 4 P. M., overcast to 8 P. M. \i afterwards.
3	121.5	...	N. & N. N. W.	2.25	\i to 3 P. M., overcast afterwards. Thin rain between 6 & 7 A. M. & at 8 & 10 P. M.
4	128.0	...	W. S. W.	0.25	\i to 5 A. M., ⌒i to Noon, clear afterwards.
5	135.0	...	W. S. W. &. S. S.W	...	Clear to 11 A. M., scatd. ⌒i to 5 P. M., clear afterwards.
6	132.0	...	S. S. W. & S. W.	2.25	Clear to 7 A. M., scatd. ⌒i to 7 P. M. clear afterwards, lightning to the S. E. at 10 & 11 P. M.
7	141.0	...	S. W. & W. N. W.	0.50	Clear scuds, from S. W. from 4 to 7 A. M, Foggy at 6 A. M.
8	145.6	...	S. & W. S. W.	0.25	Clear to 10 A. M. Scatd. ⌒i to 5 P. M., clear afterwards.
9	140.0	...	S. by E. & S.	...	Scuds from S. to N. to 9 A. M. clear afterwards.
10	143.0	...	S. & S. S. W.	...	Scuds from S. W. to N. E. to 8 A. M. clear afterwards.
11	144.6	...	S. & N. W.	...	Clear.
12	140.5	...	S. & variable	0.50	Clear. Foggy at 6 & 7 A. M.
13	145.5	...	S. & variable	0.50	Clear. Foggy from 5 to 7 A. M.
14	140.5	...	S. & W.	0.75	Clear.
15	148.4	...	S. S. W. & S. by E.	...	Clear to 3 A. M. Scatd. clouds to 8 A. M., clear afterwards.
16	132.4	...	S. & S, S. W. (high)	2.00	Clear to 9 A. M. Scuds from S. to N. to 3 P. M. clear afterwards.
17	122.0	...	S. (high)	4.50	Clear to 4 A. M. Scuds from S. to N. to 3 P. M. Overcast to 7 P. M. clear afterwards, lightning to the S. at 7 & 8 A. M., thin rain between 4 & 5 A. M.
18	128.7	...	S. S. W. & S.	3.25	Clouds of different kinds.
19	130.2	...	S.&S.S.W.&S.by W.	2.00	Clouds of different kinds to 6 P. M., clear afterwards. Lightning to the S. E. at 4 A. M.
20	138.0	...	S. & S. S. W.	1.80	Clouds of different kinds. Lightning to the E.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General Aspect of the Sky.
	o	Inches		lb	
21	......	* 0.51 (21 & 22)	S. & S. S. E.	10.50	Overcast Lightning Thunder & rain at 10 & 11 P. M. Hails at 10 P. M.
22	123.2	...	S. E. & variable	2.00	Overcast to Noon \i & _i afterwards, Lightning & Thunder at Midnight light rain at Midnight, 1 & from 4 to 6 A. M.
23	128.0	0.14	S. W. & N. N. W.	2.80	\⌒i & ⌒i to 6 P. M. clear afterwards. Lightning to S. at 9 P. M. Rain at 4 & 5 P. M.
24	135.8	...	E. S. E. & variable.	1.00	Overcast to 3 A. M. clear to 9 A. M. Scatd. ⌒i to 6 P. M. clear afterwards, Lightning to S. W at 1 A. M.
25	132.0	...	E. & S. S. W.	1.00	Clear to 6 A. M. Scatd. ⌒i to 4 P. M. clear afterwards.
26	128.5	...	S. S. W. & S.	1.25	Clear to 1 P. M. ⌒i afterwards Lightning to the W. & S. at 7 & 8 P. M. Thunder at 7 P. M. Light rain between 7 & 8 P. M.
27	131.6	...	S. S. E. & S.	1.00	⌒i to A. M. Scuds from S. to 10 A. M. \⌒i to 4 P. M. clear afterwards.
28	......	1.16	S. E. & E.	2.75	Clear to 7 A. M. Scuds from S. to 10 A. M. Overcast afterwards Lightning to the E. from 6 to 9 P. M. Thunder at 5 & 6 P. M. rain at Noon, 5, 6 & 8 P. M.
29	128.0	...	W. & variable.	2.00	Scatd. ⌒i to 5 A. M. _i & ⌒i to 1 P. M. overcast afterwards Lightning to the E. at 8 & 9 P. M. Thin rain at 6 P. M.
30	131.0	...	S. W. & N. N. E.	5.00	Scatd. \i & _i to 1 P. M. Scatd ⌒i to 5 P. M. overcast afterwards Lightning to the S. W. at 9 P. M. Thin rain at 10 & 11 P. M.

\i Cirri, —i Strati, ⌒i Cumuli, _i Cirro-strati, ⌒_i Cumulo strati, \⌒_i Nimbi, \⌒i Cirro cumuli.

* Fell from 10 P. M. of the 21st to 6 A. M. of the 22nd.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month,...	29.779
Max. height of the Barometer occurred at 9 A. M. on the 22nd, ...	30.074
Min. height of the Barometer occurred at 5 P. M. on the 11th, ...	29.545
Extreme range of the Barometer during the month, ...	0.529
Mean of the daily Max. Pressures, ...	29.863
Ditto ditto Min. ditto	29.700
Mean daily range of the Barometer during the month, ...	0.163

	°
Mean Dry Bulb Thermometer for the month, ...	84.1
Max. Temperature occurred at 4 P. M. on the 10th & 15th	102.6
Min. Temperature occurred at 1 & 3 A. M. on the 22nd	68.4
Extreme range of the Temperature during the month, ...	34.2
Mean of the daily Max. Temperature	94.0
Ditto ditto Min. ditto, ...	76.7
Mean daily range of the Temperature during the month,... ...	17.3

Mean Wet Bulb Thermometer for the month, ...	76.9
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	7.2
Computed Mean Dew-point for the month, ...	71.9
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	12.2
	Inches.
Mean Elastic force of Vapour for the month, ...	0.773

	Troy grains.
Mean Weight of Vapour for the month	8.28
Additional Weight of Vapour required for complete saturation, ...	3.93
Mean degree of humidity for the month, complete saturation being unity	0.68

	Inches.
Rained 9 days,—Max. fall of rain during 24 hours	1.16
Total amount of rain during the month, ...	1.81
Total amount of rain indicated by the Gauge attached to the anemometer during the month.	1.37
Prevailing direction of the Wind, ...	S. & S. S. W. & W. S. W.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of April* 1866.**

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.
Mid night							2	1	1		1							
1							1				1		1	1			1	
2	2										1						1	
3	2										1		2					
4	2				1						1						2	
5	1				1		1						1				1	
6	1				1								1				2	
7	1				2								1				1	
8	1				1		1						1				1	
9					1		2		1								1	
10					1								1		1		1	
11			1														2	
Noon.	1						1	1										
1							1		1									
2													2				1	
3							1		1				1					
4									1									
5													1	1			1	
6	2	1					1										1	
7							1						2				1	
8	2	1			1	1	1		1								1	
9					1				2				1				1	
10	1	1					1						1	1				
11	2	1					1											

Hour.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.
Mid night	3		2		3		6		2		4		3		2			
1	3		2		1		7		2		5		3		2			
2	3		2		1		6		3		6		1		3			
3	1		3		3		4		2		7		1		4			
4	2	1	3		3		4		2		4		1		4			
5			4	1	3		7				5		1		3			
6			4		3		6				5		1		3			
7	1				3		6		1		5		4		3			
8			2				5		2		5		4		5			
9							6		3		5		5		5			
10					1		7		2		3		6		4			
11	1		1		1		7				2		6		4			
Noon.	2		2		1		5				6		5		4			
1	2						6				2		9		5			
2	2		1				5				2		3		7			
3	1		1				6		2		4				5		1	
4	2						6		1		5		5	1	1		1	
5							6	1	2		6		5		2			
6			2		1		5		2		6		3		2			
7			3		1		9		2		4		1		1			
8	2		1				10	1	2		5		1		1			
9			2				12		1		3		4		1			
10	1		2		1		12				3		4		2			
11	2		3		2		8		1		4		4	1	2			

Hour.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night									1			
1					1							
2												
3												
4					1							
5					1				1			
6			1	1	1		1					
7	1								1	1		
8							1		1			
9									1			
10							1		2			
11	1				1		2				1	
Noon.							2		1			
1	2				1				1			
2	4		1		1		1					
3	4		2		1							
4	4				1		2				1	
5	2				1		1		2		1	1
6					1		1		3	1		
7					1		1		3			
8					1				1			
9	1								1			
10	1	1							1			
11									1			

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18-11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.827	29.900	29.736	0.164	81.4	91.0	72.4	18.6
2	.838	.890	.807	.083	78.8	87.4	73.6	13.8
3	.769	.855	.686	.169	78.9	88.9	71.7	17.2
4	.705	.758	.628	.130	79.5	89.8	74.6	15.2
5	.659	.726	.569	.157	82.2	91.2	72.7	18.5
6	.579	.630	.482	.148	84.2	93.2	76.6	16.6
7	.563	.607	.514	.093	84.4	93.0	76.0	17.0
8	.583	.634	.542	.092	87.2	94.9	82.0	12.9
9	.611	.701	.552	.149	88.3	98.6	82.4	16.2
10	.674	.733	.606	.127	88.8	99.2	81.8	17.4
11	.672	.739	.564	.175	86.9	97.8	78.4	19.4
12	.622	.675	.543	.132	87.7	96.7	80.8	15.9
13	.643	.694	.588	.106	88.5	96.6	82.0	14.6
14	.681	.740	.612	.128	87.4	96.4	76.0	20.4
15	.680	.751	.595	.156	84.8	95.0	76.4	18.6
16	.652	.693	.561	.132	85.8	96.3	74.2	22.1
17	.666	.735	.600	.135	85.9	94.3	78.2	16.1
18	.665	.720	.586	.134	87.0	95.8	77.0	18.8
19	.661	.720	.604	.116	87.9	97.3	79.2	18.1
20	.681	.740	.624	.116	89.3	97.8	83.0	14.8
21	.670	.734	.576	.158	89.3	97.2	83.8	13.4
22	.621	.672	.532	.140	89.2	95.8	83.8	12.0
23	.577	.642	.495	.147	89.3	96.4	83.8	12.6
24	.599	.647	.497	.150	88.3	96.8	80.4	16.4
25	.595	.657	.523	.134	90.0	97.8	84.0	13.8
26	.614	.680	.553	.127	90.7	102.6	83.0	19.6
27	.585	.660	.505	.155	92.0	105.8	83.0	22.8
28	.553	.617	.479	.138	91.2	101.0	84.4	16.6
29	.547	.623	.476	.147	90.3	98.2	84.6	13.6
30	.610	.677	.542	.135	90.2	98.4	83.0	15.4
31	.633	.690	.537	.153	90.6	98.0	85.0	13.0

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	72.7	8.7	66.6	14.8	0.651	6.99	4.28	0.62
2	74.4	4.4	71.3	7.5	.758	8.20	2.24	.79
3	72.6	6.3	68.2	10.7	.686	7.41	3.06	.71
4	74.1	5.4	70.3	9.2	.734	.93	2.73	.74
5	76.2	6.0	72.0	10.2	.776	8.33	3.21	.72
6	79.3	4.9	75.9	8.3	.879	9.42	2.82	.77
7	80.7	3.7	78.1	6.3	.943	10.10	.21	.82
8	82.4	4.8	79.5	7.7	.986	.49	.88	.79
9	82.0	6.3	78.2	10.1	.946	.05	3.75	.73
10	81.7	7.1	77.4	11.4	.922	9.79	4.21	.70
11	80.2	6.7	76.2	10.7	.887	.45	3.80	.71
12	81.5	6.2	77.8	9.9	.934	.93	.63	.73
13	81.7	6.8	77.6	10.9	.928	.85	4.03	.71
14	79.6	7.8	74.9	12.5	.851	.04	.41	.67
15	78.5	6.3	74.1	10.7	.830	8.87	3.59	.71
16	80.5	5.3	76.8	9.0	.905	9.65	.18	.75
17	80.9	5.0	77.4	8.5	.922	.83	.04	.76
18	81.5	5.5	78.2	8.8	.946	10.07	.22	.76
19	82.3	5.6	78.9	9.0	.967	.28	.36	.75
20	83.3	6.0	79.7	9.6	.992	.51	.70	.74
21	82.7	6.6	78.7	10.6	.961	.18	4.03	.72
22	83.1	6.1	79.4	9.8	.983	.41	3.75	.74
23	83.2	6.1	79.5	9.8	.986	.45	.76	.74
24	80.4	7.9	75.7	12.6	.873	9.26	4.54	.67
25	83.2	6.8	79.1	10.9	.973	10.30	.20	.71
26	83.6	7.1	79.3	11.4	.979	.36	.44	.70
27	83.8	8.2	78.9	13.1	.967	.20	5.16	.66
28	85.0	6.2	81.3	9.9	1.043	11.02	4.00	.73
29	84.2	6.1	80.5	9.8	.017	10.76	3.87	.74
30	82.7	7.5	78.2	12.0	0.946	.00	4.59	.69
31	83.3	7.3	78.9	11.7	.967	.22	.54	.69

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month. Max.	Min.	Diff.	Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month. Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.660	29.868	29.545	0.323	82.2	86.8	73.2	13.6
1	.650	.858	.534	.324	81.9	86.2	73.2	13.0
2	.639	.839	.525	.314	81.7	85.6	72.9	12.7
3	.630	.826	.511	.315	81.4	85.8	72.6	13.2
4	.635	.823	.531	.292	81.1	85.8	72.2	13.6
5	.646	.830	.540	.290	81.0	85.6	71.7	13.9
6	.660	.846	.571	.275	81.1	86.6	72.0	14.6
7	.677	.868	.573	.295	82.5	88.2	73.4	14.8
8	.693	.895	.582	.313	85.2	89.8	77.0	12.8
9	.700	.900	.582	.318	88.1	93.6	80.7	12.9
10	.701	.896	.582	.314	90.5	96.5	83.6	12.9
11	.690	.874	.568	.306	92.6	97.4	85.2	12.2
Noon.	.673	.851	.548	.303	94.1	101.4	85.6	15.8
1	.650	.827	.535	.292	95.1	103.0	86.8	16.2
2	.626	.820	.521	.299	95.3	104.4	74.3	30.1
3	.604	.818	.512	.306	95.4	105.8	76.7	29.1
4	.585	.811	.481	.330	94.3	105.0	75.6	29.4
5	.576	.812	.476	.336	92.7	101.5	75.7	25.8
6	.589	.813	.488	.325	89.8	96.5	74.8	21.7
7	.613	.822	.496	.326	86.8	91.6	74.2	17.4
8	.635	.838	.516	.322	84.6	90.0	74.2	15.8
9	.653	.843	.549	.294	83.7	88.2	73.6	14.6
10	.661	.842	.561	.281	83.3	88.0	74.2	13.8
11	.663	.856	.573	.283	82.7	87.6	73.8	13.8

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	78.6	3.6	76.1	6.1	0.885	9.51	2.03	0.82
1	78.7	3.2	76.5	5·4	.896	.65	1.79	.84
2	78.7	3.0	76.6	5.1	.899	.67	.70	.85
3	78.7	2.7	76.8	4.6	.905	.73	.54	.86
4	78.7	2.4	77.0	4.1	.910	.81	.36	.88
5	78.7	2.3	77.1	3.9	.913	.84	.30	.88
6	79.0	2.1	77.5	3.6	.925	.96	.21	.89
7	79.9	2.6	78.1	4.4	.943	10.14	.50	.87
8	81.0	4.2	78.1	7.1	.943	.08	2.53	.80
9	81.8	6.3	78.0	10.1	.940	9.99	3.73	.73
10	82.3	8.2	77.4	13.1	.922	.75	4.97	.66
11	83.0	9.6	77.2	15.4	.916	.65	5.98	.62
Noon.	83.2	10.9	76.7	17.4	.902	.47	6.85	.58
1	83.6	11.5	76.7	18.4	.902	.45	7.34	.56
2	83.2	12.1	75.9	19.4	.879	.21	.68	.55
3	83.1	12.3	75.7	19.7	.875	.13	.81	.54
4	82.9	11.4	76.1	18.2	.885	.28	.13	.57
5	82.5	10.2	76.4	16.3	.893	.41	6.27	.60
6	81.8	8.0	77.0	12.8	.910	.63	4.79	.67
7	80.5	6.3	76.7	10.1	.902	.60	3.61	.73
8	79.4	5.2	75.8	8.8	.876	.37	.02	.76
9	79.1	4.6	75.9	7.8	.879	.42	2.65	.78
10	78.9	4.4	75.8	7.5	.876	.39	.54	.79
11	78.8	3.9	76.1	6.6	.885	.50	.22	.81

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General Aspect of the Sky.
	o	Inches		lb	
1	130.5	...	S. & variable.	3.50	Overcast to 2 A. M., scatd. \i to 3 P. M., scatd. \i & ⌣i afterwards. Thin rain at Midnight.
2	126.0	...	S. by W. & N. E.	3.00	Scatd. \i to 6 A. M. \⌒i to Noon \⌒i & \⌣i afterwards. Lightning to S. E. at 1 P. M. Thunder at 2 P. M. Thin rain at 2 & 8 P. M.
3	126.0	...	N. W. & S. by E.	1.75	\⌒i to 5 A. M. scatd. \i to 11 A. M. \⌒i & ⌒i afterwards. Lightning to W. at 8 & 9 P. M.
4	129.6	0.88	S. by E. & E.	2.20	\⌒i to 3 A. M. Scatd. ⌒i to 1 P. M. \⌣i afterwards. Thunder at 3 & 4 P. M. Lightning at 4 & 8 P. M. Hail at 4 P. M. Rain from 3 to 5 P. M.
5	130.2	...	E. & S.	0.50	Scatd. ⌒i to 7 P. M., clear afterwards.
6	127.0	0.31	S. S. E. & S.	2.70	Clear to 1 A. M. Scuds from S. to 11 A. M., scatd. ⌒i to 3 P. M. Overcast afterwards. Thunder at 7 & 8 P. M. Lightning from 7 to 11 P. M. Rain from 6 to 8 P. M.
7	129.0	...	S. & S. S. E. & E.	1.00	Scatd. ⌒i to 4 P. M., clear afterwards.
8	135.0	...	S. by E. & S.	1.00	Clear to 4 A. M. Scuds from S to A.M., scatd. ⌒i to 4 P. M., clear afterwards.
9	135.0	...	S. & variable	1.50	Clear to 3 A. M. Scuds from S. to 10 A. M., clear afterwards.
10	140.0	...	S.	0.50	Clear to 2 P. M. Scatd. ⌒i to 7 P. M., clear afterwards. Lightning to N. at 8 P. M.
11	137.0	0.12	S. & variable.	3.60	Clear to 5 A. M. Scatd. ⌒i to 8 P. M., clear afterwards. Lightning to N. E. at 7 & 8 P. M. Rain at 7 P. M.
12	136.0	...	S.	0.60	Clear.
13	128.2	...	S. & S. S. E.	0.50	Scatd. ⌒i to 6 A. M. Scuds from S. to 10 A. M. Scatd. ⌒i afterwards. Lightning to N. W. at 8, 9 & 11 P. M.
14	130.0	0.55	S. E. & S. by E.	19.50	Clear to 6 A. M. ⌒i to 7 P. M. Overcast afterwards. Lightning from 7 to 11 P. M. Thunder from 8 to 10 P. M. Rain at 8 P. M.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
15	129.2	...	Variable.	2-00	Overcast to 4 A.M. Clear to Noon. Scatd ⌒i to 6 P. M. Scatd \i afterwards.
16	134.9	0.58	S. & S. by E.	12.00	Scatd. \i to 5 A. M., scatd. ⌒i to 6 P. M. Overcast aferwards. Lightning from 7 to 10 P. M. Thunder at 7 & 8 P. M. Rain between 6 & 7 P. M.
17	130.2	...	S. by E. & S. by W.	0.25	Clear to 7 A. M., scatd. ⌒i to 6 P. M., clear afterwards.
18	128.0	0.12	S. & S. S. W.	3.00	Clear to 6 A. M., scatd ⌒i to 6 P. M. Overcast afterwards. Rain between 7 & 8 P. M.
19	132.0	...	S. S.W. & S.W. & S.	0.70	Clear to 11 A. M., scatd ⌒i to 2 P. M., clear afterwards.
20	130.0	...	S. S. W. & S.	0.50	Clear.
21	130.2	...	S. & S. S. W.	0.30	Scatd. \i to 4 A. M., clear afterwards.
22	134.0	...	S. & S. S. W.	0.70	Clear.
23	129.0	...	S. & S. S. W.	3.50	Clear to 5 A. M., scuds from S. to 11 A. M., clear afterwards. Shock of an earthquake, felt at 3-41 from N. W. to S. E., the shock, or shocks, lasted several minutes and there was apparently a cross wave from N. to S.
24	132.0	...	S. & S. S. E.	1.25	Scatd. ⌒i to 11 A. M., clear afterwards. Lighting to N. W. at 8 & 9 P. M.
25	130.0	...	S. & S. S. W.	1.00	Clear.
26	141.6	...	S. & S. S. W.	1.00	Clear.
27	143.0	...	S. & S. W.	0.60	Clear.
28	132.0	...	S.	0.25	Clear to 3 A. M., scuds from S. to 7 A. M., clear to 6 P. M.,, scuds from S. afterwards.
29	128.0	...	S. & S. S. W.	1.50	Scuds from S. to 9 A. M. Clouds of different kinds afterwards.
30	133.0	...	S. & S. S. W.	1.30	Clear to 4 A. M., scatd. ⌒i to 6 P. M. Overcast afterwards. Lightning to N. W. at 8 & 9 P. M. Thin rain between 1 & 9 P. M.
31	130.0	...	S. & S. S. W.	0.80	Scatd. ⌒i.

\i Cirri, —i Strati, ⌒i Cumuli, \—i Cirro-strati, ⌒—i Cumulo strati, \⌒—i Nimbi, \⌒i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month,...	29.646
Max. height of the Barometer occurred at 9 A. M. on the 1st, ...	29.900
Min. height of the Barometer occurred at 5 P. M. on the 29th, ...	29.476
Extreme range of the Barometer during the month, ...	0.424
Mean of the daily Max. Pressures, ...	29.708
Ditto ditto Min. ditto	29.571
Mean daily range of the Barometer during the month, ...	0.137

	o
Mean Dry Bulb Thermometer for the month, ...	87.0
Max. Temperature occurred at 3 P. M. on the 27th	105.8
Min. Temperature occurred at 5 A. M. on the 3rd	71.7
Extreme range of the Temperature during the month, ...	34.1
Mean of the daily Max. Temperature	96.1
Ditto ditto Min. ditto, ...	79.6
Mean daily range of the Temperature during the month,... ...	16.5

Mean Wet Bulb Thermometer for the month, ...	80.7
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	6.3
Computed Mean Dew-point for the month, ...	76.9
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	10.1
	Inches.
Mean Elastic force of Vapour for the month, ...	0.908

	Troy grains.
Mean Weight of Vapour for the month	9.66
Additional Weight of Vapour required for complete saturation, ...	3.63
Mean degree of humidity for the month, complete saturation being unity	0.73

	Inches.
Rained 9 days,—Max. fall of rain during 24 hours	0.88
Total amount of rain during the month, ...	2.56
Total amount of rain indicated by the Gauge attached to the anemometer during the month.	1.85
Prevailing direction of the Wind, ...	S. & S. S. W. & S. S. E.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of May 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
																					No. of days																											
Mid night							1										1				5		5		12		2		3		1	1																
1													1						2		2		6		14		1		2								1											
2													1						1		1		4		14		1		6														1					
3													1								3		5		13		1		3		1												2					
4													2								2		5		12		2		3		1												1		1			
5							1						1				1				2		4		11		2		4		1						1						1				1	
6	1												1						2		2		4		10		3		4		1												1				1	
7	1						1						2		1				2		2		2		9		3		1		5																1	
8	1				1		1										1		2		4				8				6		6																	
9	1		1		1		1												1		2				8		3		5		4		2				1											
10			1								1		2								3		1		10				9		3						1											
11													1		1				1		1				11		2		9		2		1				1											
Noon.																	1		3		4		3		3		5		7		4						1											
1													1						1		5		3		5		3		7		3		1		1								1					
2									1		1						1		3	1	3		1		10				5		6																	
3													1		1		1		3	1	1		1		13		3		5										1						1			
4	2	1											1						4		2		3		8		6		4										1									
5																	1		2		3		3		15	1	1		5																1			
6					1		1	1	1				1						1		3		5		9		4		4																			
7					1		1	1	1	1							1		1	1	5		3		14		2				1																	
8													2								4	1	6		12	1	1		3														1	1	1	1		
9							1										1		2		2		5		15		1		1										1				1	1				
10													2				2		1		2		6		12		3		1										1									
11																			3		4		9		9		3		2																			

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18-11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.610	29.662	29.548	0.114	89.9	99.2	83.0	16.2
2	.629	.682	.557	.125	87.4	98.0	79.6	18.4
3	.625	.678	.555	.123	87.8	98.4	79.2	19.2
4	.593	.647	.480	.167	88.9	98.2	81.4	16.8
5	.571	·628	.499	.129	90.2	98.4	83.4	15.0
6	.509	.557	.404	.153	90.4	98.6	84.0	14.6
7	.494	.551	.431	.120	91.1	99.8	84.2	15.6
8	.551	.612	.479	.133	91.4	101.6	83.6	18.0
9	.570	.622	.497	.125	90.5	97.8	82.0	15.8
10	.546	.621	.447	.174	89.5	98.6	76.2	22.4
11	.503	.573	.423	.150	88.3	96.8	80.2	16.6
12	.499	.550	.425	.125	89.1	95.6	85.4	10.2
13	.532	.604	.462	.142	89.4	98.4	83.0	15.4
14	.538	.596	.450	.146	89.9	98.2	84.6	13.6
15	.492	.544	.440	.104	83.4	86.5	80.8	5.7
16	.494	.533	.443	.090	83.3	87.3	79.6	7.7
17	.515	.571	.451	.120	82.2	85.0	79.6	5.4
18	.531	.575	.476	.099	82.9	87.2	78.4	8.8
19	.503	.563	.436	.127	82.7	86.8	80.0	6.8
20	.425	.485	.350	.135	84.3	89.0	81.8	7.2
21	.375	.416	.319	.097	80.9	82.4	79.0	3.4
22	.429	.519	.365	.154	82.1	89.2	79.0	10.2
23	.502	.557	.446	.111	83.3	90.8	79.4	11.4
24	.483	.545	.408	.137	82.9	87.8	79.6	8.2
25	.441	.489	.380	.109	85.7	91.2	81.8	9.4
26	.431	.477	.376	.101	85.3	89.5	81.2	8.3
27	.465	.520	.415	.105	83.3	85.1	80.6	4.5
28	.514	.579	.452	.127	84.1	88.6	82.0	6.6
29	.573	.637	.503	.134	87.2	93.4	83.4	10.0
30	.607	.667	.560	.107	83.9	87.4	81.8	5.6

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June* 1866.**

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	82.2	7.7	77.6	12.3	0.928	9.83	4.63	0.68
2	80.7	6.7	76.7	10.7	.902	.58	3.87	.71
3	81.0	6.8	76.9	10.9	.908	.64	4.04	.71
4	82.7	6.2	79.0	9.9	.970	10.29	3.75	.73
5	83.7	6.5	79.8	10.4	.995	.54	4.05	.72
6	83.1	7.3	78.7	11.7	.961	.16	.51	.69
7	84.1	7.0	79.9	11.2	.998	.54	.43	.70
8	83.6	7.8	78.9	12.5	.967	.20	.90	.68
9	82.8	7.7	78.2	12.3	.946	.00	.72	.68
10	82.4	7.1	78.1	11.4	.943	.00	.29	.70
11	81.6	6.7	77.6	10.7	.928	9.85	3.95	.71
12	83.2	5.9	79.7	9.4	.992	10.53	.79	.75
13	83.0	6.4	79.2	10.2	.976	.35	.90	.73
14	82.3	7.6	77.7	12.2	.931	9.86	4.60	.68
15	80.6	2.8	78.6	4.8	.958	10.28	1.68	.86
16	80.1	3.2	77.9	5.4	.937	.06	.87	.84
17	79.7	2.5	77.9	4.3	.937	.08	.46	.87
18	79.5	3.4	77.1	5.8	.913	9.80	.99	.83
19	80.5	2.2	79.0	3.7	.970	10.42	.30	.89
20	80.6	3.7	78.0	6.3	.940	.07	2.21	.82
21	78.8	2.1	77.3	3.6	.919	9.90	1.20	.89
22	79.9	2.2	78.4	3.7	.952	10.23	.28	.89
23	80.4	2.9	78.4	4.9	.952	.21	.72	.86
24	79.9	3.0	77.8	5.1	.934	.03	.76	.85
25	80.3	5.4	76.5	9.2	.896	9.57	3.23	.75
26	80.4	4.9	77.0	8.3	.910	.73	2.91	.77
27	81.2	2.1	79.7	3.6	.992	10.63	1.30	.89
28	81.7	2.4	80.0	4.1	1.001	.72	.49	.88
29	81.0	6.2	77.3	9.9	0.919	9.78	3.59	.73
30	79.8	4.1	76.9	7.0	.908	.72	2.41	.80

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.532	29.646	29.407	0.239	83.4	87.2	79.2	8.0
1	.518	.630	.397	.233	83.2	87.0	79.2	7.8
2	.507	.621	.383	.238	83.0	87.0	79.2	7.8
3	.500	.633	.367	.266	82.8	86.8	78.8	8.0
4	.497	.641	.365	.276	82.7	86.8	78.4	8.4
5	.507	.644	.365	.279	82.7	86.4	78.8	7.6
6	.524	.651	.379	.272	82.7	86.6	79.0	7.6
7	.539	.664	.397	.267	83.7	88.0	80.0	8.0
8	.553	.678	.397	.281	85.2	90.8	80.6	10.2
9	.561	.676	.396	.280	86.9	95.0	81.0	14.0
10	.561	.682	.394	.288	88.5	97.2	80.4	16.8
11	.552	.676	.379	.297	89.8	98.6	80.6	18.0
Noon.	.539	.651	.362	.289	90.9	100.6	81.3	19.3
1	.520	.632	.352	.280	91.6	101.6	82.4	19.2
2	.499	.618	.339	.279	91.9	101.2	81.6	19.6
3	.481	.579	.329	.250	91.9	101.0	80.8	20.2
4	.463	.565	.319	.246	91.0	100.2	80.4	19.8
5	.459	.652	.323	.329	90.0	98.2	81.0	17.2
6	.475	.578	.343	.235	88.2	95.2	81.4	13.8
7	.500	.601	.362	.239	85.9	92.7	76.2	16.5
8	.520	.614	.382	.232	85.1	90.8	79.4	11.4
9	.538	.656	.401	.255	84.4	89.8	79.0	10.8
10	.549	.651	.411	.240	83.9	88.4	79.2	9.2
11	.547	.656	.416	.240	83.5	87.8	79.4	8.4

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Midnight.	80.3	3.1	78.1	5.3	0.943	10.12	1.84	0.85
1	80.3	2.9	78.3	4·9	.949	.18	.71	.86
2	80.5	2.5	78.7	4.3	.961	.33	.49	.87
3	80.5	2.3	78.9	3.9	.967	.39	.36	.88
4	80.5	2.2	79.0	3.7	.970	.42	.30	.89
5	80.6	2.1	79.1	3.6	.973	.45	.27	.89
6	80.6	2.1	79.1	3.6	.973	.45	.27	.89
7	81.1	2.6	79.3	4.4	.979	.51	.56	.87
8	81.4	3.8	78.7	6.5	.961	.26	2.35	.81
9	81.8	5.1	78.7	8.2	.961	.24	3.01	.77
10	82.0	6.5	78.1	10.4	.943	.02	.86	.72
11	82.3	7.5	77.8	12.0	.934	9.89	4.53	.69
Noon.	82.8	8.1	77.9	13.0	.937	.90	.99	.67
1	82.9	8.7	77.7	13.9	.931	.82	5.37	.65
2	83.1	8.8	77.8	14.1	.934	.85	.47	.64
3	82.9	9.0	77.5	14.4	.925	.76	.56	.64
4	82.9	8.1	78.0	13.0	.940	.93	.00	.67
5	82.5	7.5	78.0	12.0	.940	.95	4.55	.69
6	82.2	6.0	78.6	9.6	.958	10.17	3.59	.74
7	80.9	5.0	77.4	8.5	.922	9.83	.04	.76
8	80.4	4.7	77.1	8.0	.913	.76	2.81	.78
9	80.0	4.4	76.9	7.5	.908	.70	.61	.79
10	80.1	3.8	77.4	6.5	.922	.87	.26	.81
11	80.2	3.3	77.9	5.6	.937	10.04	1.96	.84

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	136.0	...	S. & S. S. E.	0.80	Clear to 5 A. M. Scatd. \i to 9 A. M. Scatd. \⌣i to 4 P. M. Clear afterwards.
2	132.0	0.32	S. S. E. & S.	2.00	Clear to 5 A. M. Scatd ⌒i to 4 P. M. Overcast afterwards. Thunder & Lightning at 6, 7 & 9 P. M. Rain from 5 to 9 P. M.
3	137.0	...	S. & S. E.	1.25	Overcast to 5 A. M. \i to 6 P. M. Clear afterwards.
4	135.0	...	S. by E. & S.	5.00	\i to 10 A. M. clear to 3 P. M. Overcast afterwards. Lightning to the E. at 9 P. M.
5	130.0	...	S. & S. S. W.	1.25	Scatd. \i to 11 A. M. Scatd. ⌒i to 5 P. M. Overcast afterwards. Lightning to the N at 7 & 8 P. M.
6	...	...	S. S. W. & S.	4.25	Clouds of various kinds. Thin rain at 9. P. M.
7	130.0	...	S. S. E. & S.	2.00	Clear to 3 A. M. Scatd. \i to 5 P. M. \⌣i & \⌣i afterwdrds.
8	132.0	...	S. by E. & variable	3.00	\⌣i to 6 A. M. Thin clouds to 10 A. M. Clear to 5 P. M. Overcast afterwards. Lightning to N. E. at 8 & 9 P. M. Thunder at 8 P. M. Light rain at 10 & 11 P. M.
9	135.0	0.15	S. W. & S.	3.00	Overcast to 3 A. M. Scatd. ⌒i & \⌣i to 5 P. M. Overcast afterwards. Lightning at 8 & 10 P. M. Thunder at 10 P. M. Rain at 9 P. M.
10	128.0	0.24	S. & S. S. E.	23.00	Overcast to 4 A. M. Scatd. ⌒i & \⌣i to 5 P. M. Overcast afterwards. Rain from 7 to 9 P. M.
11	126.0	...	E. & S. S. E.	0.25	Scatd. \i to ⌣i to 10 A. M. ⌒i to 7 P. M. Overcast afterwards. Lightning to the N. at 8 P. M.
12	128.0	...	E. S. E. & variable.	0.30	Overcast to 8 A. M. \⌣i to 7 P. M. Clear afterwards. Thunder at 3 P. M. Thin rain from 7 to 9 A. M. & at 3 P. M.
13	136.0	...	E. N. E. & S. & E.	0.50	Clear to 4 A. M. \i to 8 A. M. Scatd. ⌒i afterwards. Lightning to the N. E. at 9 & 10 P. M.
14	131.0	...	E. S. E. & S. E.	0.50	Overcast to 3 A. M. Scatd. ⌒i to 7 P. M. Clear afterwards. Lightning to the N. at 1 A. M.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
15	...	0.38	E. S. E. & E.	0.80	Clear to 4 A. M. \⌒i to 11 A. M. Overcast afterwards. Thunder at 1 P. M. Rain at 6 & 9 A. M. & from 1 to 5 P. M.
16	...	0.18	S. E. & E. by S.	0.80	Clear to 3 A. M. Overcast afterwards. Thunder at 7 A. M. Rain at 5, 6 & 7 A. M. & at 2 P. M.
17	...	0.53	S E & S S E & S by E	0.90	Overcast. Light rain from 2 to 9 A. M. & at 1 and 2 P. M. Lightning at 2, 3, & 4 A. M. Thunder at 2 & 11 A. M.
18	...	...	S.S.E.&S.S.W.&W.	0.50	\i & \⌒i to 7 P. M. Overcast afterwards. Light rain at 11 A. M.
19	...	0.23	W. & S. W.	0.40	Overcast. Light rain after intervals.
20	...	*	W. S. W.	0.40	Overcast. Thin rain at 3 A. M. & from 7 to 11 P. M.
21	...	0.96	W. by S. & W. N. W.	0.60	Overcast. Light rain after intervals.
22	...	0.58	W. N. W. & S.	0.80	Overcast to 5 A. M. \⌒i & ⌒i to 1 P. M. Overcast to 7 P. M. Clear afterwards. Rain at 3, 4 & 7 P. M.
23	121.0	2.41	S. S. W. & W.	0.80	⌒i to 3 A. M. Overcast to 11 A. M. ⌒i to 4 P. M. Overcast afterwards. Rain at 5 & from 8 to 11 P. M. Thunder & Lightning at 8 & 9 P. M.
24	...	0.28	W. by S. & W.S.W.	0.80	Overcast nearly the whole day. Light rain from 6 to 11 A. M.
25	117.0	...	W. S. W. & W. by S.	0.40	Clear to 5 A. M. \i to 9 A. M. ⌒i to 3 P. M. Overcast afterwards. Slight rain between 2 & 3 P. M.
26	117.8	...	S. W. & W. N. W.	0.40	⌒i & \⌒i to 6 P. M. Overcast afterwards. Slight rain at 3, 10, & 11 P. M.
27	...	0.64	W. S.W. & N.N.W.	1.25	Overcast rain at 1, 4, 5 & from 7 to 9 A. M. & at 8 P. M.
28	...	...	W. S. W. & S. W.	0.50	Overcast. Slight rain at 6, 10 & 11 A. M.
29	126.0	...	W. by S. & N. N. W.	0.50	\⌒i to 3 A. M. Overcast to 7 A. M. \⌒i & ⌒i to 5 P. M. Overcast afterwards.
30	...	0.12	W. by N. & variable	0.50	Overcast to Noon. \⌒i, to 5 P. M. Thin clouds afterwards. Rain at 6 & 7 A. M.

\i Cirri, —i Strati, ⌒i Cumuli, _i Cirro-strati, ⌢i Cumulo strati, \⌢i Nimbi, \⌒i Cirro cumuli.

*Fell from 7 P. M. of the 20th to 10 P. M. of the 21st.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month,...	29.518
Max. height of the Barometer occurred at 10 A. M. on the 2nd, ...	29.682
Min. height of the Barometer occurred at 4 P. M. on the 21st, ...	29.319
Extreme range of the Barometer during the month, ...	0.363
Mean of the daily Max. Pressures, ...	29.575
Ditto ditto Min. ditto	29.449
Mean daily range of the Barometer during the month, ...	0.126

	o
Mean Dry Bulb Thermometer for the month, ...	86.4
Max. Temperature occurred at 1 P. M. on the 8th	101.6
Min. Temperature occurred at 7 P. M. on the 10th	76.2
Extreme range of the Temperature during the month, ...	25.4
Mean of the daily Max. Temperature	92.8
Ditto ditto Min. ditto, ...	81.3
Mean daily range of the Temperature during the month,... ...	11.5

Mean Wet Bulb Thermometer for the month, ...	81.4
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	5.0
Computed Mean Dew-point for the month, ...	77.9
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	8.5
	Inches.
Mean Elastic force of Vapour for the month, ...	0.937

	Troy grains.
Mean Weight of Vapour for the month	9.98
Additional Weight of Vapour required for complete saturation, ...	3.08
Mean degree of humidity for the month, complete saturation being unity	0.76

	Inches.
Rained 21 days,—Max. fall of rain during 24 hours	2.41
Total amount of rain during the month, ...	7.02
Total amount of rain indicated by the Gauge attached to the anemometer during the month.	6.25
Prevailing direction of the Wind, ... S. S. E. & S. & W. S. W.	

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of June 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.
Mid night																	5		2		3		3	
1							1										4		3		1		4	
2							1				1		2		2				1		3		3	1
3							1				1		3		1				1		4	1	2	
4									2				2		1				2	1	3		3	
5									3				2		1	1			3	1	2		3	
6	1	1					1		2				1				2	2	4	1	3		2	
7			1	1			1		2	1			1				1		3	1	4	1	5	
8	3	1					1										3	1	5		3		1	
9	1		1								1						1		4	2	4		1	
10					1	1	1										2		2		7		1	
11													2				3	1	1		2		1	
Noon.							1										2		3		2			
1									1				1				2	1	1		2		2	1
2									2						1	1			2		2	1	2	1
3									1								2	2	4		3		2	1
4					1		1												4	1	5		2	1
5					2				1								1	1	1		4		5	
6															1		1		2		4		5	
7					1								2				1		2		4		1	
8					1	1	1						1		1		2		1		2		4	1
9							1	1	1						1		3		2		2		3	1
10	1				1				1						1		4		2		4	1	4	
11	1																4		3		5		2	

Hour.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night	2				4		2		3		2	1	1				2		1					
1	4				2		2		4	1	2		1				1		1					
2	3				2		2		5		2		1				2							
3	3				3		2		4	1	3	1	1				1							
4	2				3		2		3		3		1	1	1	1	1		1					
5	2				2		2		3		2	1	2		1	1	1		1					
6	2				1		2		3	1	1		2		1		1		1	1				
7					1		2		1		2	1	2		2	2	1		1					
8	4				1		2		1		1	1	5	2										
9	4		1		2	1	1		2		2	2	2				1		2	2				
10	1				3		1		2	1	4	1			1				1		3			
11	1		2	1	5		2		3	1	1						4	1			2		1	
Noon.	5		2		3		1		4		2						2		1		2			
1	3		1		4		3				4		1				3		2					
2	5				6				3		1		1		2		1		2					
3	3		1		3				2		1		5	1			2	1	1					
4	3		1		2		2		2		3				1		2				1			
5	2				3		1		3		2		1				3	2					1	1
6	4	1			2		3	1	2		8	1			2		1							
7	6	1	1				3	1	5	1	1				1		1		1	1				
8	4		1				2		6	2	1				1		2	1						
9	2	1	2				3	2	3	1	1		2		2		1	1			1	1		
10			1				4	1	2		1	1	1		1	1	1	1			1	1		
11	1		2				3	1	4	1	1	1	1				2	1	1	1				

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.602	29.642	29.551	0.091	77.7	81.0	75.6	5.4
2	.597	.646	.537	.109	76.2	77.8	75.2	2.6
3	.569	.613	.517	.096	79.1	85.6	74.4	11.2
4	.538	.576	.476	.100	81.2	85.4	78.0	7.4
5	.529	.580	.484	.096	81.3	86.6	77.4	9.2
6	.604	.665	.564	.101	81.6	87.6	78.4	9.2
7	.635	.698	.570	.128	83.2	89.0	79.8	9.2
8	.572	.634	.482	.152	85.1	93.0	80.0	13.0
9	.520	.575	.433	.142	85.8	93.2	80.6	12.6
10	.494	.547	.436	.111	86.2	91.6	83.2	8.4
11	.505	.558	.441	.117	85.1	90.5	81.0	9.5
12	.555	.616	.506	.110	84.5	90.0	81.0	9.0
13	.646	.697	.593	.104	84.6	89.8	81.2	8.6
14	.660	.714	.602	.112	85.0	90.4	80.2	10.2
15	.575	.651	.489	.162	83.4	86.0	81.2	4.8
16	.521	.560	.469	.091	84.2	86.7	82.0	4.7
17	.555	.597	.522	.075	83.2	91.0	78.6	12.4
18	.563	.600	.516	.084	82.9	86.2	80.4	5.8
19	.580	.631	.509	.122	83.3	88.6	79.0	9.6
20	.604	.654	.547	.107	82.3	86.0	80.2	5.8
21	.615	.662	.555	.107	82.7	86.8	79.2	7.6
22	.587	.634	.534	.100	83.4	87.0	79.8	7.2
23	.614	.664	.545	.119	84.5	89.4	80.0	9.4
24	.638	.681	.584	.097	84.6	87.8	81.8	6.0
25	.634	.670	.573	.097	84.0	90.4	81.6	8.8
26	.597	.645	.517	.128	82.2	85.0	81.2	3.8
27	.597	.639	.533	.106	83.7	88.6	79.2	9.4
28	.611	.668	.555	.113	83.2	87.5	80.4	7.1
29	.631	.691	.560	.131	84.3	90.2	79.8	10.4
30	.629	.673	.573	.100	84.8	90.8	80.3	10.5
31	.631	.668	.575	.093	83.0	87.8	80.6	7.2

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	75.3	2.4	73.6	4.1	0.817	8.86	1.24	0.88
2	75.0	1.2	74.2	2.0	.832	9.05	0.61	.94
3	77.0	2.1	75.5	3.6	.868	.38	1.15	.89
4	78.9	2.3	77.3	3.9	.919	.90	.31	.88
5	78.1	3.2	75.9	5.4	.879	.47	.77	.84
6	79.3	2.3	77.7	3.9	.931	10.02	.32	.88
7	80.4	2.8	78.4	4.8	.952	.21	.68	.86
8	81.0	4.1	78.1	7.0	.943	.08	2.49	.80
9	81.6	4.2	78.7	7.1	.961	.26	.57	.80
10	82.1	4.1	79.2	7.0	.976	.41	.58	.80
11	80.8	4.3	77.8	7.3	.934	9.99	.58	.80
12	80.1	4.4	77.0	7.5	.910	.73	.62	.79
13	80.6	4.0	77.8	6.8	.934	.99	.40	.81
14	80.7	4.3	77.7	7.3	.931	.96	.57	.80
15	81.2	2.2	79.7	3.7	.992	10.63	1.33	.89
16	81.4	2.8	79.4	4.8	.983	.51	.73	.86
17	80.4	2.8	78.4	4.8	.952	.21	.68	.86
18	80.1	2.8	78.1	4.8	.943	.12	.67	.86
19	80.8	2.5	79.0	4.3	.970	.42	.51	.87
20	80.6	1.7	79.4	2.9	.983	.56	.02	.91
21	80.4	2.3	78.8	3.9	.964	.36	.36	.88
22	80.2	3.2	78.0	5.4	.940	.09	.87	.84
23	81.4	3.1	79.2	5.3	.976	.45	.90	.85
24	81.5	3.1	79.3	5.3	.979	.48	.91	.85
25	81.1	2.9	79.1	4.9	.973	.42	.75	.86
26	80.3	1.9	79.0	3.2	.970	.44	.10	.91
27	80.3	3.4	77.9	5.8	.937	.04	2.03	.83
28	80.0	3.2	77.8	5.4	.934	.03	1.86	.84
29	80.7	3.6	78.2	6.1	.946	.13	2.15	.83
30	80.5	4.3	77.5	7.3	.925	9.90	.56	.80
31	79.9	3.1	77.7	5.3	.931	10.00	1.82	.85

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.605	29.674	29.515	0.159	81.2	84.5	76.0	8.5
1	.593	.663	.491	.172	81.0	83.8	75.8	8.0
2	.583	.656	.466	.190	80.7	83.5	75.4	8.1
3	.573	.650	.456	.194	80.4	83.3	74.8	8.5
4	.570	.659	.476	.183	80.2	83.2	74.6	8.6
5	.577	.664	.480	.184	80.4	83.4	74.4	9.0
6	.591	.680	.493	.187	80.6	83.4	74.5	8.9
7	.606	.700	.504	.196	81.2	84.0	74.6	9.4
8	.618	.705	.516	.189	82.5	85.3	75.8	9.5
9	.626	.712	.530	.182	84.1	87.4	76.6	10.8
10	.629	.714	.535	.179	84.9	88.8	77.0	11.8
11	.620	.702	.529	.173	85.7	90.2	76.8	13.4
Noon.	.608	.686	.509	.177	86.1	91.2	77.2	14.0
1	.591	.675	.491	.184	86.5	92.2	76.4	15.8
2	.569	.657	.460	.197	86.3	93.0	76.6	16.4
3	.548	.632	.433	.199	85.9	93.2	75.2	18.0
4	.536	.616	.439	.177	85.6	91.0	75.6	15.4
5	.534	.608	.443	.165	85.3	89.6	75.5	14.1
6	.542	.616	.456	.160	84.5	88.0	75.5	12.5
7	.560	.637	.480	.157	83.3	86.0	75.4	10.6
8	.581	.660	.505	.155	82.7	85.2	75.6	9.6
9	.602	.684	.527	.157	82.3	84.7	75.6	9.1
10	.616	.697	.540	.157	81.8	85.2	75.6	9.6
11	.616	.689	.542	.147	81.4	85.0	75.6	9.4

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	79.4	1.8	78.1	3.1	0.943	10.16	1.05	0.91
1	79.3	1.7	78.1	2·9	.943	.16	0.98	.91
2	79.1	1.6	78.0	2.7	.940	.13	.91	.92
3	79.1	1.3	78.2	2.2	.946	.21	.73	.93
4	78.9	1.3	78.0	2.2	.940	.15	.73	.93
5	79.0	1.4	78.0	2.4	.940	.15	.79	.93
6	79.2	1.4	78.2	2.4	.946	.21	.80	.93
7	79.5	1.7	78.3	2.9	.949	.22	.99	.91
8	80.2	2.3	78.6	3.9	.958	.30	1.34	.89
9	80.7	3.4	78.3	5.8	.949	.16	2.05	.83
10	80.8	4.1	77.9	7.0	.937	.02	.47	.80
11	81.2	4.5	78.0	7.7	.940	.03	.77	.78
Noon.	81.2	4.9	77.8	8.3	.934	9.97	.98	.77
1	81.2	5.3	78.0	8.5	.940	10.01	3.09	.76
2	81.1	5.2	77.5	8.8	.925	9.86	.16	.76
3	81.1	4.8	77.7	8.2	.931	.94	2.93	.77
4	80.8	4.8	77.4	8.2	.922	.85	.91	.77
5	80.8	4.5	77.6	7.7	.928	.91	.73	.78
6	80.3	4.2	77.4	7.1	.922	.87	.48	.80
7	79.8	3.5	77.3	6.0	.919	.86	.07	.83
8	79.8	2.9	77.8	4.9	.934	10.03	1.69	.86
9	79.7	2.6	77.9	4.4	.937	.08	.50	.87
10	79.6	2.2	78.1	3.7	.943	.14	.26	.89
11	79.6	1.8	78.3	3.1	.949	.22	.05	.91

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1		0.80	W. & S. W.	4.20	Overcast. Rain day & night.
2		*4.20	S. W. & W. N. W.	2.60	Overcast. Rain day & night.
3		†1.32	W. S. W. & S. S. E.	2.25	Overcast to 11 A. M. Scatd. \⌒i & \i afterwards. Rain from 5 to 10 A. M.
4			S. E. & E. S. E.	2.00	Scatd. \i to 4 A. M. Overcast to 5 P. M. clear afterwards. Light rain at 6 & 10 A. M. & at 1 & 3 P. M.
5	118.4	0.13	S. S. E. & S. by E.	1.50	Overcast to 8 A. M. ⌒i afterwards. Light rain at 2, 7 & 10 A. M. and at 4 & 10 P. M.
6	...	0.87	S. by E. & S. by W.	1.00	Overcast to 2 P. M. Scatd. ⌒i to 6 P. M. clear afterwards. Rain at 2, 5, 8 & 11 A. M. & at 2 & 5 P. M.
7	...	0.61	S.S.E.&S.& S.byW.	0.25	Clear to 4 A. M. ⌒i to 7 P. M. clear afterwards. Rain between 10 & 11 A. M. & at 2 P. M.
8	119.0	...	S. by W. & S.	0.30	Overcast to 5 A. M. \⌒i to 11 A. M. ⌒i afterwards. Light rain at 4 A. M.
9	134.0	...	S. S. W. & S.	0.50	\⌒i to 4 P. M. overcast afterwards Thunder at 6 P. M. Lightning to the N. W. at 8 P. M.
10	125.4		S. S. E. & S. E.	0.50	Scatd. ⌒i to 7 P. M. clear afterwards.
11	128.0	0.10	S. E. & E. by S.	1.20	Clear to 3 A. M. Scatd. ⌒i to 8 P. M. clear afterwards. Rain between 10 & 11 A. M. & between 2 & 3 P. M.
12	112.0	0.09	S. E. & E. S. E.	2.10	Clear to 3 A. M. \⌒i to 11 A. M. Scatd. ⌒i & ⌣i to 5 P. M. \i afterwards. Rain at 5 A. M. & between 9 & 10 A. M.
13	129.8	...	S. E. & S. S. E.	0.70	Scatd. ⌒i & \⌒i to 7 P. M. clear afterwards. Light rain at 6½ & 11½ A. M.
14	121.0	...	S. & S. S. E.	0.50	Clear to 4 A. M. Scatd. ⌒i & \⌒i to 7 P. M. clear afterwards. Light rain at 6 P. M.
15		0.16	S. by E. & S.	0.50	Scatd \i to 4 A. M. \⌒i & ⌒i to 8 P. M. clear afterwards. Light rain from 9 to 11 A. M.

*Fell from 1 P. M. of the 1st to 4 P. M. of the 2nd.
† Do. 5 P. M. of the 2nd. to 10 A. M. of the 3rd.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July* 1866.**

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
16	...	0.18	S.	1.00	\⌒—i to 3 A. M. \⌒i to 10 A. M. overcast to 7 P. M. clear afterwards. Rain from 9 A. M. to Noon.
17	118.0	0.78	S. S. W. & S. by W	4.30	Clear to 3 A. M. \⌒i to 2 P. M. overcast afterwards. Rain from 3 to 5 P. M.
18	...	...	S. W.	1.00	Overcast, slight rain at 6½, 7½ & 10 A. M.
19	...	0.88	S. & S. W. & W.	1.00	Overcast nearly the whole day. Rain from 2 to 6 A. M. & at 8 A. M.
20	...	0.85	S. by E. & S. & S. S. E.	0.20	Overcast to 4 P. M. ⌒i afterwards. Rain at 10 & 11, A. M. & at 1, 3, 4 & 7 P. M.
21	...	...	S. & S. S. E.	0.50	\⌒—i & \⌒i nearly the whole day. Slight rain at 7 A. M. & at 3 P. M.
22	...	0.18	S. & S. S. E.	0.50	\⌒i & ⌒i. Rain at 6 & 10½ A. M. & between Noon & 1 P. M.
23	113.7	...	S. & S. S. W.	0.50	⌒i & \⌒i.
24	...	...	S. S. W. & S.	0.50	Scatd. \—i to 5 A. M. overcast afterwards.
25	...	0.50	S. by W. & S.	0.60	Overcast nearly the whole day. Rain at 3, 10 & 11 A. M. & from 2 to 4 P. M.
26	...	1.94	S. & S. S. E.	0.40	Overcast nearly the whole day, Rain at 6 & from 8 to 11½ A. M.
27	120.0	...	S. by W. & E. S. E.	0.40	Scatd. \⌒i to 10 A. M. ⌒i to 5 P. M. Scatd. \—i & \i afterwards.
28	114.0	...	S. S. E. & S.	0.70	⌒i to 4 P. M. Scatd. \i & \—i afterwards. Light rain at 5 & 7 A. M. & at 3 P. M.
29	134.0	...	S. E. & S. S. E.	0.70	Scatd. ⌒i to 4 P. M. Scatd. \i afterwards. Rain between midnight & 1 A. M. & at 4 P. M.
30	127.0	0.10	E. S. E. & S. E.	0.40	Scatd. \i to 8 A. M. ⌒i to 4 P. M. Scatd. \i afterwards. Rain at 11 A. M. & at 1 P. M.
31	...	...	E. N. E. & N. E.	0.25	Clear to 5 A. M. \i & \⌒i to 10 A. M. Overcast afterwards. Thunder at 2 P. M. Light rain from 1 to 3 P. M.

\i Cirri, —i Strati, ⌒i Cumuli, \—i Cirro-strati, ⌒—i Cumulo strati, \⌒—i Nimbi, \⌒i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

Monthly Results.

	Inches.
Mean height of the Barometer for the month,...	29.587
Max. height of the Barometer occurred at 10 A. M. on the 14th, ...	29.714
Min. height of the Barometer occurred at 3 P. M. on the 9th, ...	29.433
Extreme range of the Barometer during the month, ...	0.281
Mean of the daily Max. Pressures, ...	29.637
Ditto ditto Min. ditto	29.527
Mean daily range of the Barometer during the month, ...	0.110

	o
Mean Dry Bulb Thermometer for the month, ...	83.1
Max. Temperature occurred at 3 P. M. on the 9th	93.2
Min. Temperature occurred at 5 A. M. on the 3rd	74.4
Extreme range of the Temperature during the month, ...	18.8
Mean of the daily Max. Temperature	88.0
Ditto ditto Min. ditto, ...	79.7
Mean daily range of the Temperature during the month,... ...	8.3

Mean Wet Bulb Thermometer for the month, ...	80.1
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	3.0
Computed Mean Dew-point for the month, ...	78.0
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	5.1
	Inches.
Mean Elastic force of Vapour for the month, ...	0.940

	Troy grain.
Mean Weight of Vapour for the month	10.09
Additional Weight of Vapour required for complete saturation, ...	1.77
Mean degree of humidity for the month, complete saturation being unity	0.85

	Inches.
Rained 26 days,—Max. fall of rain during 24 hours	3.43
Total amount of rain during the month, ...	13.42
Total amount of rain indicated by the Gauge attached to the anemometer during the month.	12.06
Prevailing direction of the Wind, ... S. & S. S. E. & S. E.	

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of July 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Midnight	1	1															4		4		5		4		6		3		1				2								1	1						
1	1	1													1		2		6	1	5		3		7		2				2		1								1	1						
2	1	1											1		1		2		3		7	1	3	1	6		3				2	1	1								1	1						
3	1	1													2		1		6		5		3		4		3		2	1	2	1	1								1	1						
4											1				4	1	2		4		4		3		5	1	4	1	1		1		1								1	1						
5									1				1		2	1	2	1	3		6		1		7	2	4		1		1		1	1											1	1		
6							1						1	1	1		3		5	1	3	1	2		5	1	5	1	2	1	1		1	1											1	1		
7							1								1		3		4	2	5	2	1		3		6	2	2		2	1	1	1			1	1			1							
8							1										5		4		3		1	1	6	1	1		3		5	3					1	1	1	1								
9							1										2		7		1		1		6	1			4		6	3			2	1	1	1										
10							1								1	1	2		5		2	2	1		5	2	1		3	2	5	2	3	2	2	1												
11									1						1				6	1	3	1	3	1	4	2	2	1	2	1	5	2	3	1									1	1				
Noon.											1		1				1		4	1	2		4		7	1			3		2	1	3				2	1			1	1						
1									1	1					1	1	4	1	4				5	1	2	1	3		5		3	1	1						1				1	1				
2											1	1			1		3		3		3	1	2		6				6	2	3	1	1				1	1			1							
3									1	1							1		7	2	1		5	1	9	1			3	1	2	1			1	1					1							
4													1		1		1	1	6	1	2		3	1	7		1		4	1	3	1							1	1			1	1				
5													1				1		4		7		4	2	4		1		5		2	1	1	1	1	1												
6													1				1		4		6		5		4		2	1	2		3	1	1				1	1					1					
7									1						1				3		5	1	6		7				4		3	1					1	1										
8									1						1		1		2		9		1		7		2		5		1	1					1	1										
9									1						1		1		3		7		2		8		3		2		2	1					1	1										
10									1						1		4		1		6	1	2		9		3		1				2	1			1	1										
11									1								2		5		6		2		8		8		1				2	1							1	1						

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August* 1866.**

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.586	29.625	29.520	0.105	83.2	89.6	80.4	9.2
2	.614	.695	.544	.151	80.7	83.2	78.2	5.0
3	.730	.809	.683	.126	80.4	83.6	79.2	4.4
4	.739	.777	.677	.100	80.0	82.7	79.0	3.7
5	.680	.742	.616	.126	81.5	84.8	79.4	5.4
6	.540	.655	.442	.213	82.2	86.0	79.8	6.2
7	.390	.449	.332	.117	81.2	85.4	79.2	6.2
8	.414	.499	.369	.130	80.9	85.2	78.2	7.0
9	.544	.630	.475	.155	83.6	89.7	78.8	10.9
10	.593	.631	.524	.107	84.3	90.8	80.7	10.1
11	.557	.613	.474	.139	84.6	89.2	81.8	7.4
12	.501	.551	.426	.125	83.6	89.4	80.4	9.0
13	.542	.595	.489	.106	83.0	87.6	79.8	7.8
14	.597	.639	.541	.098	83.3	87.4	80.0	7.4
15	.617	.651	.560	.091	83.4	89.6	80.2	9.4
16	.589	.631	.531	.100	82.4	86.0	78.8	7.2
17	.563	.623	.484	.139	83.5	87.8	80.2	7.6
18	.525	.572	.452	.120	82.6	86.7	80.5	6.2
19	.505	.547	.442	.105	83.8	88.3	80.2	8.1
20	.509	.561	.465	.096	83.2	85.6	81.5	4.1
21	.548	.607	.495	.112	82.0	85.2	79.6	5.6
22	.578	.634	.515	.119	83.7	89.4	79.4	10.0
23	.562	.615	.475	.140	84.6	90.4	80.4	10.0
24	.558	.613	.485	.128	85.0	90.8	81.4	9.4
25	.585	.645	.515	.130	84.3	89.8	81.8	8.0
26	.606	.657	.547	.110	83.6	88.4	80.6	7.8
27	.607	.649	.550	.099	82.3	88.4	80.3	8.1
28	.582	.636	.511	.125	82.0	86.0	77.4	8.6
29	.670	.739	.615	.124	81.9	85.8	78.6	7.2
30	.754	.822	.691	.131	84.1	90.0	79.0	11.0
31	.723	.787	.639	.148	86.2	91.8	81.4	10.4

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	79.8	3.4	77.4	5.8	0.922	9.89	2.00	0.83
2	79.1	1.6	78.0	2.7	.940	10.13	0.91	.92
3	79.0	1.4	78.0	2.4	.940	.15	.79	.93
4	78.5	1.5	77.4	2.6	.922	9.95	.86	.92
5	79.8	1.7	78.6	2.9	.958	10.32	.99	.91
6	80.0	2.2	78.5	3.7	.955	.27	1.27	.89
7	79.2	2.0	77.8	3.4	.934	.07	.14	.90
8	79.0	1.9	77.7	3.2	.931	.04	.06	.91
9	80.1	3.5	77.6	6.0	.928	9.95	2.08	.83
10	80.9	3.4	78.5	5.8	.955	10.23	.05	.83
11	81.3	3.3	79.0	5.6	.970	.37	.02	.84
12	80.0	3.6	77.5	6.1	.925	9.92	.11	.83
13	79.9	3.1	77.7	5.3	.931	10.00	1.82	.85
14	80.3	3.0	78.2	5.1	.946	.15	.78	.85
15	80.4	3.0	78.3	5.1	.949	.18	.78	.85
16	79.8	2.6	78.0	4.4	.940	.11	.50	.87
17	80.3	3.2	78.1	5.4	.943	.12	.88	.84
18	79.7	2.9	77.7	4.9	.931	.00	.68	.86
19	81.0	2.8	79.0	4.8	.970	.40	.70	.86
20	81.5	1.7	80.3	2.9	1.011	.84	.05	.91
21	80.2	1.8	78.9	3.1	0.967	.41	.06	.91
22	80.8	2.9	78.8	4.9	.964	.34	.73	.86
23	81.2	3.4	78.8	5.8	.964	.31	2.08	.83
24	81.3	3.7	78.7	6.3	.961	.29	.24	.82
25	80.7	3.6	78.2	6.1	.946	.13	.15	.83
26	80.4	3.2	78.2	5.4	.946	.15	1.88	.84
27	79.9	2.4	78.2	4.1	.946	.17	.41	.88
28	79.4	2.6	77.6	4.4	.928	9.99	.48	.87
29	79.8	2.1	78.3	3.6	.949	10.20	.24	.89
30	80.6	3.5	78.1	6.0	.943	.10	2.11	.83
31	82.1	4.1	79.2	7.0	.976	.41	.58	.80

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.601	29.760	29.399	0.361	81.3	83.7	79.0	4.7
1	.589	.751	.389	.362	80.9	83.8	79.2	4.6
2	.580	.744	.379	.365	80.7	83.0	79.2	3.8
3	.570	.738	.372	.366	80.5	82.6	78.9	3.7
4	.566	.741	.368	.373	80.2	82.2	78.2	4.0
5	.574	.750	.378	.372	80.1	81.8	77.4	4.4
6	.588	.771	.378	.393	80.3	82.4	77.8	4.6
7	.603	.801	.393	.408	81.0	83.2	78.8	4.4
8	.616	.809	.411	.398	82.0	84.8	79.0	5.8
9	.626	.816	.424	.392	83.6	87.0	79.6	7.4
10	.629	.822	.432	.390	84.7	88.4	79.2	9.2
11	.618	.812	.408	.404	86.1	89.6	80.5	9.1
Noon.	.603	.796	.384	.412	85.7	90.4	81.4	9.0
1	.583	.766	.378	.388	86.1	91.0	81.2	9.8
2	.560	.733	.353	.380	85.8	91.2	79.2	12.0
3	.540	.713	.339	.374	85.8	90.8	79.4	11.4
4	.525	.694	.332	.362	85.7	91.0	79.6	11.4
5	.527	.693	.343	.350	85.0	91.8	80.0	11.8
6	.540	.713	.355	.358	83.8	89.7	79.6	10.1
7	.558	.723	.367	.356	83.1	87.7	79.2	8.5
8	.583	.748	.388	.360	82.6	86.4	79.6	6.8
9	.604	.758	.400	.358	82.2	85.6	79.6	6.0
10	.617	.809	.411	.398	81.9	84.8	79.6	5.2
11	.613	.767	.415	.352	81.6	84.4	79.2	5.2

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	79.7	1.6	78.6	2.7	0.958	10.32	0.92	0.92
1	79.5	1.4	78.5	2.4	.955	.31	.79	.93
2	79.4	1.3	78.5	2.2	.955	.31	.73	.93
3	79.2	1.3	78.3	2.2	.949	.24	.74	.93
4	79.0	1.2	78.2	2.0	.946	.21	.67	.94
5	78.9	1.2	78.1	2.0	.943	.18	.66	.94
6	79.0	1.3	78.1	2.2	.943	.18	.73	.93
7	79.5	1.5	78.4	2.6	.952	.25	.89	.92
8	80.0	2.0	78.6	3.4	.958	.32	1.15	.90
9	80.5	3.1	78.3	5.3	.949	.18	.85	.85
10	80.8	3.9	78.1	6.6	.943	.08	2.34	.81
11	81.5	4.6	78.3	7.8	.949	.12	.83	.78
Noon.	81.3	4.4	78.2	7.5	.946	.09	.71	.79
1	81.6	4.5	78.4	7.7	.952	.15	.80	.78
2	81.2	4.6	78.0	7.8	.940	.03	.80	.78
3	81.2	4.6	78.0	7.8	.940	.03	.80	.78
4	81.2	4.5	78.0	7.7	.940	.03	.77	.78
5	80.7	4.3	77.7	7.3	.931	9.96	.57	.80
6	80.4	3.4	78.0	5.8	.940	10.07	.03	.83
7	80.2	2.9	78.2	4.9	.946	.15	1.71	.86
8	80.1	2.5	78.3	4.3	.949	.20	.48	.87
9	79.9	2.3	78.3	3.9	.949	.20	.34	.88
10	80.0	1.9	78.7	3.2	.961	.35	.09	.91
11	79.9	1.7	78.7	2.9	.961	.35	0.99	.91

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	126.0	0.34	E. N. E. & E.	0.50	\⌒i nearly the whole day. Rain between 11 & Noon & between 5 & 6 P. M.
2	...	0.43	E. S. E. & E.	0.80	Overcast. Rain constantly.
3	...	0.67	E. S. E. &S. by E.	0.75	Overcast. Rain at 2, 5, 7, 9, & 10 A. M. & from 1 to 3 P. M. Thunder at 8 A. M.
4	...	1.56	S. S. E. & S. by E.	0.75	Overcast. Rain from 4 A. M. to 5 P. M. Thunder & Lightning at 4 A. M.
5	...	0.21	W.N.W. & S. S. E.	0.40	Clear to 2 A. M. Overcast to 10 A. M. \⌒i to 8 P. M. Overcast afterwards. Rain at 10 A. M. at 2 & 3 P.M. Thunder at 2 & 3 P. M. Lightning at 9 P. M.
6	...	0.44	N. N. E.	0.50	Overcast to 11 A. M. \⌒i to 8 P. M. Overcast afterwards. Rain at 8 & 11 A. M. & at 2, 6 & 9 P. M. Lightning at midnight.
7	...	0.58	N. N. E. & E. S.E.	2.12	Overcast. Rain constantly.
8	...	0.18	E. S. E. & S. S. E.		Overcast to 3 P. M. ⌒i to 6 P. M., clear afterwards. Rain from midnight to 4 A. M. at 8 A. M. & at 3 P. M.
9	130.0	0.12	S. S. E. & S. E.		Scatd. ⌒i to 5 P. M. clear afterwards. Rain at 4, 6 & 11 A. M. & between 4 & 5 P. M.
10	125.0	...	S.S.E.&S.E.&SSW.		Clear to 7 A. M. Scatd. ⌒i to 8 P. M. clear afterwards. Light rain at 5 P. M.
11	126.0	...	S. S. W. & variable & S. by E.		Clear to 2 A. M. \⌒i to 7 P. M. clear afterwards. Light rain between Noon & 1 P. M. & at 6 P. M.
12	124.0	0.25	S. E. & E.		Clear to 4 A. M. Scuds from E to 11 A. M. Scatd. ⌒i to 8 P. M. clear afterwards. Rain at 7, 11 & Noon.
13	130.0	0.17	S. S. E. & E. by S.		Scatd. \⌒i & _i to 6 A. M. clouds of different kinds afterwards. Rain at 9 & between 11 & Noon & between 10 & 11 P.M.
14	...	...	S. E. & S. by E.		Overcast to 10 A. M. \⌒i & ⌒i to 6 P. M. clear afterwards. Slight rain at 3 & 4 A. M.
15	131.0	0.14	S. S. E. & S. E.		Clear to 3 A. M. \⌒i afterwards. Rain between 5 & 6 A.M. & at 2 P.M.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	✦ General aspect of the Sky.
	o	Inches		lb	
16	...	...	S. S. W.	...	Overcast to 3 P. M. \⌒i to 7 P. M. \i afterwards. Light rain at 2 & 9½ A. M. & at 1¾ P. M.
17	...	...	S. S. W. & S. S. E.	...	\⌒i nearly the whole day.
18	...	1.36	S. S. W. & S. W.	Instruments out of order	_i to 3 A. M. \⌒i to 10 A. M. Overcast afterwards, Rain at 11 A. M. 12½ P. M. & from 5 to 11 P. M.
19	...	...	S. S. W. & variable		Overcast nearly the whole day. Lightning & Thunder at midnight. Slight rain from midnight to 2 A. M. & at 6 P. M.
20	...	0.44	W. & variable		Overcast to 4 P. M. ⌒i & \⌒i afterwards. Rain at 2 & 3 A. M. & at Noon.
21	...	0.63	S. &. S. by W.		Overcast nearly the whole day. Rain from midnight to 2 & at 5 & from 7 to 9 A. M.
22	...	...	S. by E. &. S. S. E.		Scatd. \i to 8 A. M. ⌒i to 1 P. M. Overcast to 6 P. M. Thin clouds afterwards.
23	133.0	...	S. S. E. & S. by E.		\⌒i to 9 A. M. ⌢i afterwards.
24	...		E. &. E. S. E.		\⌒i & ⌒i nearly the whole day. Light, rain at 3 P. M.
25	...	0.12	E· N. E. & E. S. E.		⌒i & \⌒i nearly the whole day. Rain at 3 & 4 P. M.
26	...	0.10	S. E. & E. N. E.		Scatd. clouds to 7 A. M. ⌒i to Noon. Overcast at 5 P. M. Scatd. clouds afterwards, Rain at 1 & 4½ P. M.
27	...	0.30	E. & S. S. E.		Scatd. clouds to 11 A. M. Overcast to 3 P. M. Thin clouds afterwards, Rain at 11½ A. M.
28	...	0.30	S. E. & S. S. E.		Overcast to 6 A. M. \⌒i & Scuds from E to 11 A. M. Thin clouds to 4 P. M. Scatd. ⌒i afterwards. Rain from 2 to 5 A. M. at 10 A. M. Noon 3½ P. M. & at 10½ P. M.
29	...	3.14	S. by W. & variable.		Overcast to 1 P. M. ⌒i to 6 P. M. clear afterwards, rain from 3 to 5 A. M. at 8 A. M. & at 3½ P. M.
30	133.0	...	S. & S. S. W.		⌒i to 7 P. M. clear afterwards. Light rain at Noon.
31	134.6	...	S. S. W. & S. by W.		Clear to 2 A. M. Scatd. ⌒i to 6 P. M. clear afterwards.

\i Cirri, —i Strati, ⌒i Cumuli, _i Cirro-strati, ⌢i Cumulo strati, \⌢i Nimbi, \⌒i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month,...	29.584
Max. height of the Barometer occurred at 10 A. M. on the 30th, ...	29.822
Min. height of the Barometer occurred at 4 P. M. on the 7th, ...	29.332
Extreme range of the Barometer during the month, ...	0.490
Mean of the daily Max. Pressures, ...	29.642
Ditto ditto Min. ditto	29.519
Mean daily range of the Barometer during the month, ...	0.123

	o
Mean Dry Bulb Thermometer for the month, ...	82.9
Max. Temperature occurred at 5 P. M. on the 31st, ...	91.8
Min. Temperature occurred at 5 A. M. on the 28th, ...	77.4
Extreme range of the Temperature during the month, ...	14.4
Mean of the daily Max. Temperature	87.6
Ditto ditto Min. ditto, ...	79.9
Mean daily range of the Temperature during the month,... ...	7.7

Mean Wet Bulb Thermometer for the month, ...	80.2
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer,	2.7
Computed Mean Dew-point for the month, ...	78.3
Mean Dry Bulb Thermometer above computed mean Dew-point. ...	4.6
	Inches.
Mean Elastic force of Vapour for the month, ...	0.949

	Troy grain.
Mean Weight of Vapour for the month	10.18
Additional Weight of Vapour required for complete saturation, ...	1.61
Mean degree of humidity for the month, complete saturation being unity	0.86

	Inches.
Rained 27 days,—Max. fall of rain during 24 hours	3.14
Total amount of rain during the month, ...	11.48
Total amount of rain indicated by the Gauge attached to the anemometer during the month.	10.67
Prevailing direction of the Wind, ...	S. S. E. E. S. E. & S. by E.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of August 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.
Mid night							1	1	1				2	1	1		5		2		5	
1	1						1		1		1		4	1	1		4	1	1		5	
2					2				2				4		2	1	2	2	2	1	5	
3					2				2				4	1	3		3	3	3	1	5	
4					2	1	1		3		1		4	2	1		4	3			6	2
5					2	1	1		3		1		4	1	1		4	2	2	1	4	
6					1		3	1	2				3		1		4	1	1		4	
7					1		1	1	3	1			2		2		6	1	1		3	
8					1	1	1	1	3				2		2	1	6	1	2		5	1
9					1		1	1	2				4				3		5	1	3	
10			1		1		1		2		1		1				4	1	5	2	5	
11							3	2	3		1	1	2				3		7		2	2
Noon.			1						5		1	1	2	1	1		2		5	3	2	1
1	1								3	1	1		2	1	1		3	1	6	1	3	
2			1	1			1		2				2	1	1		4	1	3		4	1
3					1				2				1				3	1	5	1	6	4
4							1		1				3	1	2	1	2	1	5	1	4	
5					1				1						2		4		1		6	1
6					1	1							1		3	2	2	1	2		4	
7					1								2		1		2		2		4	
8					1												4		3		5	
9					1	1							1				4	2	2		6	
10					1				1								3	1	4		5	
11					1										1		5	2	3	2	6	

Hour.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night	6	1	1		2		3												1							
1	4		1		1		4	1	1																	
2	4		1		2	2	3		1	1																
3	1		1		1		4								1	1										
4	1		3				4								1											
5	2	1	1				5	1							1											
6	2	1	3	1	1		4	1			1				1											
7	1		4	1	1		3	1	1		1				1											
8			1		3	1	1		1		1				2											
9	2	1	4	2	1				2		1				1										1	
10			3				2		4	2					1											
11	2		2		2		1				2	1			1											
Noon.	5	2			2		3		1		1															
1	2	1	2		2		2		2	1	1															
2	3		3	1	1		3	1	2				1	1												
3	4		1		3		2		2								1	1								
4	2	1	2		1		5		1								1	1	1							
5	3	1	4	1	3	1	3		1		1	1							1							
6	6		5	1			5	1	1										1							
7	7		3		5	1	3												1							
8	7		4		2		4												1							
9	6		2		2		5						1	1					1							
10	7		1		2		5						1	1					1							
11	5		1		2		5						1	1					1							

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.669	29.730	29.582	0.148	87.0	93.2	82.2	11.0
2	.646	.715	.576	.139	86.8	93.0	82.2	10.8
3	.598	.669	.517	.152	86.5	92.0	82.0	10.0
4	.570	.627	.494	.133	83.1	87.2	80.0	7.2
5	.612	·683	.550	.133	83.3	89.4	79.9	9.5
6	.666	.726	.615	.111	83.9	88.4	80.6	7.8
7	.667	.726	.584	.142	85.7	90.2	81.6	8.6
8	.571	.652	.473	.179	83.5	89.0	79.6	9.4
9	.498	.555	.444	.111	80.8	82.8	79.0	3.8
10	.548	.607	.504	.103	83.3	87.3	80.2	7.1
11	.626	.687	.569	.118	83.2	87.0	80.6	6.4
12	.615	.672	.534	.138	84.2	90.1	80.5	9.6
13	.638	.691	.586	.105	84.9	91.8	81.8	10.0
14	.642	.694	.575	.119	84.8	88.0	81.8	6.2
15	.579	.618	.515	.103	85.8	91.6	81.8	9.8
16	.579	.622	.511	.111	84.5	92.8	80.2	12.6
17	.599	.645	.523	.122	82.9	86.2	80.2	6.0
18	.643	.724	.576	.148	82.9	86.8	79.8	7.0
19	.730	.786	.674	.112	83.2	89.0	80.6	8.4
20	.741	.797	.681	.116	82.5	87.6	80.4	7.2
21	.712	.762	.645	.117	82.6	87.5	79.0	8.5
22	.763	.812	.713	.099	84.1	89.8	79.6	10.2
23	.802	.855	.746	.109	85.1	90.8	80.2	10.6
24	.773	.834	.698	.136	84.1	89.0	79.0	10.0
25	.729	.776	.657	.119	82.2	84.0	79.2	4.8
26	.731	.782	.652	.130	83.9	90.0	78.0	12.0
27	.767	.842	.688	.154	85.4	91.2	80.8	10.4
28	.752	.811	.676	.135	86.2	91.4	82.2	9.2
29	.751	.803	.676	.127	86.5	93.2	81.4	11.8
30	.760	.831	.677	.154	86.5	93.6	81.8	11.8

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	82.9	4.1	80.4	6.6	1.014	10.79	2.50	0.81
2	82.7	4.1	80.2	6.6	.008	.73	.48	.81
3	82.5	4.0	80.1	6.4	.005	.71	.39	.82
4	80.6	2.5	78.8	4.3	0.964	.36	1.50	.87
5	80.5	2.8	78.5	4.8	.955	.25	.68	.86
6	81.4	2.5	79.6	4.3	.989	.60	.53	.87
7	82.4	3.3	80.1	5.6	1.005	.71	2.09	.84
8	80.6	2.9	78.6	4.9	0.958	.28	1.72	.86
9	79.3	1.5	78.2	2.6	.946	.19	0.88	.92
10	80.7	2.6	78.9	4.4	.967	.39	1.54	.87
11	79.1	4.1	76.2	7.0	.887	9.52	2.37	.80
12	80.8	3.4	78.4	5.8	.952	10.19	.05	.83
13	81.5	3.4	79.1	5.8	.973	.40	.09	.83
14	82.1	2.7	80.2	4.6	1.008	.77	1.69	.86
15	82.1	3.7	79.5	6.3	0.986	.53	2.30	.82
16	81.4	3.1	79.2	5.3	.976	.45	1.90	.85
17	81.0	1.9	79.7	3.2	.992	.66	.13	.90
18	80.5	2.4	78.8	4.1	.964	.36	.43	.88
19	80.7	2.5	78.9	4.3	.967	.39	.50	.87
20	80.2	2.3	78.6	3.9	.958	.30	.34	.89
21	79.4	3.2	77.2	5.4	.916	9.85	.83	.84
22	80.4	3.7	77.8	6.3	.934	10.01	2.20	.82
23	81.5	3.6	79.0	6.1	.970	.37	.20	.83
24	79.7	4.4	76.6	7.5	.899	9.61	.60	.79
25	79.4	2.8	77.4	4.8	.922	.91	1.63	.86
26	79.3	4.6	76.1	7.8	.885	.48	2.65	.78
27	80.8	4.6	77.6	7.8	.928	.91	.77	.78
28	81.9	4.3	78.9	7.3	.967	10.32	.67	.79
29	81.5	5.0	78.5	8.0	.955	.18	.92	.78
30	81.8	4.7	79.0	7.5	.970	.33	.77	.79

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month. Max.	Min.	Diff.	Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month. Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.681	29.807	29.537	0.270	82.2	84.6	79.0	5.6
1	.672	.805	.519	.286	82.0	84.2	79.2	5.0
2	.663	.800	.503	.297	81.7	83.8	78.8	5.0
3	.655	.791	.488	.303	81.4	83.2	78.4	4.8
4	.648	.781	.469	.312	81.2	83.0	78.2	4.8
5	.656	.798	.464	.334	81.1	82.8	78.0	4.8
6	.671	.811	.479	.332	81.0	83.0	78.2	4.8
7	.687	.824	.499	.325	82.0	84.8	79.6	5.2
8	.705	.846	.506	.340	83.8	87.0	81.3	5.7
9	.716	.851	.519	.332	85.3	88.2	81.8	6.4
10	.718	.855	.523	.332	86.3	90.2	82.2	8.0
11	.708	.846	.516	.330	87.2	91.0	82.2	8.8
Noon.	.688	.836	.502	.334	87.8	91.2	80.4	10.8
1	.661	.808	.481	.327	88.2	92.8	81.2	11.6
2	.633	.782	.461	.321	88.1	92.8	80.0	12.8
3	.611	.769	.444	.325	88.2	93.6	80.7	12.9
4	.603	.758	.448	.310	87.7	93.0	81.4	11.6
5	.604	.746	.456	.290	86.8	92.6	80.2	12.4
6	.622	.760	.480	.280	85.2	90.7	80.5	10.2
7	.642	.774	.490	.284	84.4	89.0	80.5	8.5
8	.666	.786	.519	.267	83.6	88.4	80.4	8.0
9	.686	.801	.551	.250	83.0	85.8	80.0	5.8
10	.695	.812	.555	.257	82.7	85.6	79.6	6.0
11	.690	.809	.550	.259	82.4	85.0	79.2	5.8

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	80.4	1.8	79.1	3.1	0.973	10.47	1.07	0.91
1	80.2	1.8	78.9	3.1	.967	.41	.06	.91
2	80.2	1.5	79.1	2.6	.973	.47	0.90	.92
3	80.0	1.4	79.0	2.4	.970	.46	.81	.93
4	79.8	1.4	78.8	2.4	.964	.40	.81	.93
5	79.8	1.3	78.9	2.2	.967	.43	.74	.93
6	79.8	1.2	79.0	2.0	.970	.46	.68	.94
7	80.4	1.6	79.3	2.7	.979	.53	.94	.92
8	81.0	2.8	79.0	4.8	.970	.40	1.70	.86
9	81.5	3.8	78.8	6.5	.974	.29	2.35	.81
10	81.6	4.7	78.3	8.0	.949	.12	.90	.78
11	81.8	5.4	78.6	8.6	.958	.19	3.18	.76
Noon.	82.0	5.8	78.5	9.3	.955	.16	.44	.75
1	82.3	5.9	78.8	9.4	.964	.25	.51	.75
2	81.9	6.2	78.2	9.9	.946	.07	.65	.73
3	82.2	6.0	78.6	9.6	.958	.17	.59	.74
4	81.9	5.8	78.4	9.3	.952	.12	.44	.75
5	81.4	5.4	78.2	8.6	.946	.07	.14	.76
6	81.2	4.0	78.4	6.8	.952	.17	2.44	.81
7	81.2	3.2	79.0	5.4	.970	.40	1.91	.85
8	80.9	2.7	79.0	4.6	.970	.40	.63	.87
9	80.5	2.5	78.7	4.3	.961	.33	.49	.87
10	80.5	2.2	79.0	3.7	.970	.42	.30	.89
11	80.5	1.9	79.2	3.2	.976	.50	.11	.90

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	139.0	...	S. by W. & S.		Clear to 7 A. M. Scatd. ⌒i to 1 P. M. \i & ⁻i afterwards. Lightning to E at 7 & 11 P.M.
2	141.0	3.08	S. & S. W.		Scatd. \i to 6 A. M. Scatd. ⌒i to 6 P. M. Overcast afterwards. Thunder at 9 & 10 P. M. Lightning at 9, 10 & 11 P. M. Rain from 7 to 11 P. M.
3	130.6	...	W. S. W. & N. W.		\i & ⁻i. Lightning at 10 P. M. Light rain at midnight & 8 A. M.
4	...	0.42	S. S. W. & S. W.		Overcast nearly the whole day. Thunder & Lightning from midnight to 3 A. M. Rain at 1, 2 & 4 & from 8 to 10 A. M.
5	128.0	0.20	Variable.		\i to Noon. ⌒i to 6 P. M. Overcast afterwards. Rain at 7 A. M. & at 3 & 8 P. M.
6	...	...	E. S. E. & variable		Clear to 3 A. M. ⌒i to 8 P. M. Clear afterwards. Slight rain at 9 A. M. & 5 P. M.
7	129.2	...	S. & S. W.		Clear to 5 A. M. \i to 3 P. M. ⌒i afterwards. Lightning to N W from 8 to 11 P. M.
8	...	0.73	Variable.		⌒i to 4 P. M. Overcast afterwards. Thunder at 11 P. M. Lightning from 9 to 11 P. M Rain at 1, 2 & 11 A. M. & at 5 & 11 P. M.
9	...	3.84	Variable.		Overcast. Rain constantly from midnight to 4 P. M.
10	...	...	S. S. E. & E. S. E.		Scatd. \i to 6 A. M. Scatd. ⌒i to 1 P. M. Overcast to 8 P. M. Clear afterwards.
11	140.2	...	S.S.E,S., & S. by E.		⌒i nearly the whole day. Slight rain at 11 P. M.
12	149.2	0.18	S. S. E. & S. by E.		Scatd. ⌒i to 6 P. M. Clear afterwards. Rain at midnight, 1 & 6 A. M. & between 3 & 4 P. M.
13	142.7	...	S. S. E. & S. E.		Clear to 5 A. M. Scatd. ⌒i to 7 P. M. Clear afterwards.
14	133.8	0.27	S. S. E. & S.		Clear to 4 A. M. Scatd. ⌒i to 6 P. M. Scatd. \i to 9 P.M. Clear afterwards. Rain at Noon & 1½ P. M.
15	143.2	...	S. S. W. & S.		Clear to 7 A. M. ⌒i afterwards. Light rain at 8 P. M.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of September 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 5 feet above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
16	148.2	2.52	S. & variable.	...	Clear to 5 A. M. Scatd. ⌒i to 1 P. M. Overcast afterwards. Thunder at 4, 6 & 7 P. M. Lightning at 7 P. M. Rain at 3, 4, 7 & 8 P. M.
17	...	0.39	N. E. & N. N. E.	...	Overcast nearly the whole day. Rain from 11½ A. M. to 2 P.M. & at 5 P. M.
18	...	1.29	E. N. E. & S. E.		Clear to 3 A. M. Scatd. \i to 7 A. M. ⌒i afterwards. Rain from 9½ A. M. to 12½ A. M.
19	142.4	0.78	E. S. E. & variable		Clear to 5 A. M. ⌒i to 11 A. M. Overcast afterwards. Lightning & Thunder at 5 P. M. Rain at 7 A.M. Noon, 1 & from 5 to 7 P. M.
20	143.7	1.00	S. S. E. & S. E.		⌒i & \⌒i. Rain at 1 & 3 P. M.
21	136.2	0.09	S. S. E.		Clouds of different kinds. Rain at 12½ & at 5½ P. M.
22	147.8	...	S. E. &. S. by E.		Clear to 4 A. M. ⌒i to 6 P. M. Clear afterwards.
23	140.2	...	S. by E. & S. S. W.		Clear to 7 A. M. ⌒i to 4 P. M. _i afterwards.
24	140.0	...	N. W. & W.		_i to 9 A. M. Clouds of different kinds afterwards. Light rain at 7 P. M.
25	...	0.03*	W. & variable.		Scatd. \i to 2 A. M. Overcast to 4 P. M. Scatd. _i afterwards Slight rain at 4 & 5 A. M.
26	140.2	0.14	E. S. E. & S. E.		Scatd. \i to 5 A. M. Scatd. ⌒i to 1 P. M. Scatd. \⌒i afterwards. Rain at 8 & 9 P. M.
27	846.2	0.84	S. by E., S.S.E.&S.		Clear to 7 A. M. Scatd. _i to 10 A. M. Scatd. ⌒i to 5 P. M. \⌒i afterwards. Thunder at 6 P.M Rain at 6 & 7 P. M.
28	147.4	0.05	S. & S. E.		Clear to 7 A. M. Scatd. ⌒i to 6 P. M. Clear afterwards. Light rain at 5 P. M.
29	138.2	0.12	S. & variable.		Scatd. \i to 7 A. M. Scatd. ⌒i to 6 P. M. Overcast afterwards. Lightning & Thunder from 7 to 9 P.M. Rain between 8 & 9 PM
30	145.2	...	S. S. W. & variable		Clear to 8 A. M. Scatd. ⌒i afterwards.

\i Cirri, —i Strati, ⌒i Cumuli, _i Cirro-strati, ⌒_i Cumulo strati, \⌒_i Nimbi, \⌒i Cirro cumuli.

* Rain Gauge 1 Foot 2 Inches above ground.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of Septemper 1866.

MONTHLY RESULTS.

	Inches.
Mean height of the Barometer for the month...	29.666
Max. height of the Barometer occurred at 10 A. M. on the 23rd ...	29.855
Min. height of the Barometer occurred at 3 P. M. on the 9th ...	29.444
Extreme range of the Barometer during the month	0.411
Mean of the daily Max. Pressures	29.724
Ditto ditto Min. ditto	29.597
Mean daily range of the Barometer during the month	0.127

	o
Mean Dry Bulb Thermometer for the month	83.4
Max. Temperature occurred at 3 P. M. on the 30th	93.6
Min. Temperature occurred at 5 A. M. on the 26th	78.0
Extreme range of the Temperature during the month	15.6
Mean of the daily Max. Temperature	89.5
Ditto ditto Min. ditto, ...	80.5
Mean daily range of the Temperature during the month... ...	9.0

Mean Wet Bulb Thermometer for the month	81.0
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer	3.3
Computed Mean Dew-point for the month	78.7
Mean Dry Bulb Thermometer above computed mean Dew-point ...	5.6
	Inches.
Mean Elastic force of Vapour for the month	0.961

	Troy grain.
Mean Weight of Vapour for the month	10.29
Additional Weight of Vapour required for complete saturation ...	1.99
Mean degree of humidity for the month, complete saturation being unity	0.84

	Inches.
Rained 23 days,—Max. fall of rain during 24 hours	3.84
Total amount of rain during the month	15.97
Total amount of rain indicated by the Gauge attached to the anemometer during the month	15.07
Prevailing direction of the Wind	S. S. E. & S.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of Sept. 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night											1				1		4		2		4		6	1	4		2		2				1	1			1		1	1			1					
1									1						1		4		3		5	1	3		4		1		3				1				1		1	1	1	1			1	1		
2	1	1					1		1				1				4		2		5	1	4		4		1		3				1				1						1	1				
3					2				2								3		2		5		2		5		1		4				1				1						1					
4					2				3						1		3		1		5		2		5		1		3	1			1				1	1			1				1	1		
5					2				3				1				3		3		2		2		5		2		3				1				1	1					1		1			
6					1		1		3								5				3	1	1		6		1		4		1		1				1						1		1			
7	1	1			1				2				1				4	1	2		3		2		5		2		4	1			1				1						1					
8	1		1	1			1		1		1		1				4		4		4		1		4				2	1	3										1	1			1			
9			1				1		2				2				2	1	8		2		1		3		1		2	1	2		1										2					
10									3				2	1	2				6		6		1		2				3	1	2		1										1		1			
11							1						3	2	1		3		6	1	4		2		2		1		2		2		1								1		1					
Noon.							2		2	1	1	1	1	1	1		1		6	1	3	1	3	1	2						2		2								2		2					
1	1						1	1	1		2	1	1		2		2	1	5	2	4	1	2		3				1		1				1						1				1			
2					2	1	2		1				1				1		3	1	5		2		2				2		2				1				2		2	1			2			
3					2		1												1		6		5	1	3				1		4		3	1					1		2	1			1			
4					1		1								1						5	1	2		4		1		5	1	5								2				1		2	1		
5			1	1	1	1	1		1	1							1		3		4		2		3		2		1		5	1			1	1			1		1		1		1			
6	1						2		1										2		6	2	1		6		2		1		2		1				2	1	2		1		1					
7	1						2	1					1						4	1	6	1	2		6	1	2		2		1				1	1			1				1					
8			1				1		1				1	1			1		4	2	5	1	4		5		1		4		1	1													1			
9			1						2		1		1	1			2		1		4	1	5		4		2		6	1											1							
10			1						1				1				3				8	1	4		5		2		3								2											
11			1						2								2		1		6	1	5		7	1	1		3								2	1										

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.759	29.808	29.689	0.119	85.2	91.2	82.0	9.2
2	.795	.857	.745	.112	84.3	92.2	81.4	10.8
3	.853	.915	.791	.124	85.6	90.4	81.0	9.4
4	.849	.913	.785	.128	84.0	90.6	80.0	10.6
5	.815	.864	.733	.131	84.4	91.2	80.4	10.8
6	.821	.884	.759	.125	83.7	88.0	81.0	7.0
7	.819	.882	.748	.134	84.1	89.8	79.6	10.2
8	.847	.901	.780	.121	82.7	87.4	79.4	8.0
9	.841	.903	.782	.121	81.5	89.2	77.8	11.4
10	.779	.854	.705	.149	80.2	85.4	77.0	8.4
11	.799	.875	.743	.132	82.5	88.6	78.0	10.6
12	.876	.938	.832	.106	83.1	89.8	78.0	11.8
13	.877	.953	.808	.145	84.1	89.9	79.2	10.7
14	.855	.923	.797	.126	85.0	90.5	81.0	9.5
15	.839	.902	.773	.129	84.4	90.2	80.7	9.5
16	.869	.928	.816	.112	81.9	88.4	78.8	9.6
17	.905	.951	.857	.094	83.2	90.0	78.0	12.0
18	.936	.998	.880	.118	82.4	88.0	77.4	10.6
19	.909	.981	.841	.140	82.6	88.8	77.0	11.8
20	.869	.965	.787	.178	83.7	90.2	77.6	12.6
21	.820	.875	.751	.124	81.5	85.6	77.7	7.9
22	.778	.836	.706	.130	80.5	84.2	78.0	6.2
23	.749	.810	.668	.142	80.2	87.0	75.8	11.2
24	.638	.715	.566	.149	75.9	77.5	74.0	3.5
25	.628	.802	.514	.288	79.2	82.7	76.5	6.2
26	.850	.915	.778	.137	75.8	79.4	71.9	7.5
27	.924	.982	.848	.134	78.2	83.4	73.6	9.8
28	.950	30.004	.900	.104	78.9	86.0	73.6	12.4
29	.922	29.994	.879	.115	79.6	85.6	74.0	11.6
30	.904	.966	.849	.117	79.3	85.4	74.8	10.6
31	.895	.954	.843	.111	79.6	84.6	75.4	9.2

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	81.4	3.8	78.7	6.5	0.961	10.26	2.35	0.81
2	80.7	3.6	78.2	6.1	.946	.13	.15	.83
3	81.1	4.5	77.9	7.7	.937	.00	.76	.78
4	80.7	3.3	78.4	5.6	.952	.19	1.98	.84
5	80.6	3.8	77.9	6.5	.937	.02	2.29	.81
6	80.7	3.0	78.6	5.1	.958	.28	1.79	.85
7	79.8	4.3	76.8	7.3	.905	9.69	2.52	.79
8	79.5	3.2	77.3	5.4	.919	.88	1.84	.84
9	78.5	3.0	76.4	5.1	.893	.62	.69	.85
10	77.8	2.4	76.1	4.1	.885	.55	.33	.88
11	79.5	3.0	77.4	5.1	.922	.91	.73	.85
12	79.2	3.9	76.5	6.6	.896	.61	2.25	.81
13	79.6	4.5	76.4	7.7	.893	.56	.65	.78
14	80.0	5.0	76.5	8.5	.896	.57	.96	.76
15	79.4	5.0	75.9	8.5	.879	.40	.91	.76
16	77.9	4.0	75.1	6.8	.857	.21	.23	.81
17	77.0	6.2	72.7	10.5	.792	8.49	3.40	.71
18	75.7	6.7	71.0	11.4	.751	.07	.54	.70
19	76.1	6.5	71.5	11.1	.763	.20	.48	.70
20	77.6	6.1	73.3	10.4	.809	.66	.41	.72
21	78.2	3.3	75.9	5.6	.879	9.46	1.85	.84
22	77.6	2.9	75.6	4.9	.871	.39	.59	.86
23	77.2	3.0	75.1	5.1	.857	.25	.63	.85
24	74.3	1.6	73.2	2.7	.806	8.77	0.80	.92
25	75.8	3.4	73.4	5.8	.811	.76	1.80	.83
26	72.6	3.2	70.4	5.4	.736	.02	.52	.84
27	74.2	4.0	71.4	6.8	.761	.23	2.02	.80
28	73.7	5.2	70.1	8.8	.729	7.89	.58	.75
29	74.3	5.3	70.6	9.0	.741	8.00	.69	.75
30	74.4	4.9	71.0	8.3	.751	.12	.47	.77
31	73.2	6.4	68.7	10.9	.697	7.52	3.17	.70

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.842	29.953	29.560	0.393	79.8	84.4	75.2	9.2
1	.834	.949	.534	.415	79.5	84.2	74.6	9.6
2	.826	.946	.522	.424	79.2	83.8	74.0	9.8
3	.819	.939	.421	.408	78.9	84.0	73.0	11.0
4	.817	.936	.514	.422	78.7	83.8	72.7	11.1
5	.830	.954	.523	.431	78.5	83.6	72.4	11.2
6	.846	.970	.533	.437	78.3	83.0	71.9	11.1
7	.861	.987	.562	.425	79.1	83.8	72.6	11.2
8	.881	30.001	.596	.405	80.9	86.8	73.8	13.0
9	.891	.004	.627	.377	82.7	87.8	74.6	13.2
10	.895	.004	.648	.356	84.0	90.4	76.0	14.4
11	.880	29.998	.645	.353	85.1	91.0	75.8	15.2
Noon.	.856	.965	.631	.334	85.6	91.2	76.2	15.0
1	.825	.937	.621	.316	86.3	91.4	76.8	14.6
2	.800	.921	.606	.315	86.8	92.2	75.8	16.4
3	.785	.911	.577	.334	86.4	91.2	74.8	16.4
4	.787	.904	.577	.327	84.7	90.4	74.9	15.5
5	.791	.913	.573	.340	84.2	90.4	75.1	15.3
6	.804	.923	.571	.352	82.5	88.0	75.1	12.9
7	.821	.935	.566	.369	81.7	86.6	76.8	9.8
8	.842	.945	.590	.355	81.1	86.0	76.2	9.8
9	.856	.954	.597	.357	80.6	85.3	75.4	9.9
10	.862	.961	.588	.373	80.2	85.2	75.0	10.2
11	.855	.958	.576	.382	79.8	85.0	74.7	10.3

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Midnight.	77.7	2.1	76.2	3.6	0.887	9.58	1.17	0.89
1	77.5	2.0	76.1	3.4	.885	.57	.09	.90
2	77.3	1.9	76.0	3.2	.882	.54	.02	.90
3	77.1	1.8	75.8	3.1	.876	.48	0.99	.91
4	76.9	1.8	75.6	3.1	.871	.42	.99	.91
5	76.8	1.7	75.6	2.9	.871	.42	.93	.91
6	76.7	1.6	75.6	2.7	.871	.42	.86	.92
7	77.0	2.1	75.5	3.6	.868	.38	1.15	.89
8	77.2	3.7	74.6	6.3	.843	.09	2.01	.82
9	77.9	4.8	74.5	8.2	.840	.03	.69	.77
10	78.2	5.8	74.1	9.9	.830	8.89	3.28	.73
11	78.4	6.7	73.7	11.4	.819	.76	.81	.70
Noon.	78.4	7.2	73.4	12.2	.811	.66	4.10	.68
1	78.5	7.8	73.0	13.3	.801	.53	.49	.66
2	78.5	8.3	73.5	13.3	.814	.67	.54	.66
3	78.3	8.1	72.6	13.8	.790	.42	.64	.65
4	77.6	7.1	72.6	12.1	.790	.45	3.97	.68
5	77.7	6.5	73.1	11.1	.803	.60	.64	.70
6	77.8	4.7	74.5	8.0	.840	9.03	2.61	.78
7	77.9	3.8	75.2	6.5	.860	.24	.13	.81
8	77.9	3.2	75.7	5.4	.873	.41	1.76	.84
9	78.0	2.6	76.2	4.4	.887	.58	.43	.87
10	77.8	2.4	76.1	4.1	.885	.55	.33	.88
11	77.5	2.3	75.9	3.9	.879	.49	.26	.88

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	148.4	0.06	S. by W.		Scatd. ⌒i to 2 P. M. Overcast to 6 P.M. Clear afterwards. Rain at Noon & 6 P. M. Thunder from 1 to 5 P. M. Lightning at 4 P. M.
2	148.0	0.45	S. & variable		Clear to 5 A. M. Scatd. ⌒i to 6 P. M. Clear afterwards. Rain from 3 to 5 P. M.
3	143.7	...	W. by N. & variable		Clear to 7 A. M. Scatd. ⌒i to 5 P. M. Clear afterwards.
4	127.2	1.14	W. by N. & S. S. E.		Clear to 7 A. M. ⌒i & \i to 2 P. M. Overcast afterwards. Rain from 4 to 6 P. M.
5	154.2	...	S. S. E. & S. W.		Clear to 5 A. M. Scatd. ⌒i to 7 P. M. Clear afterwards.
6	...	...	S. & variable.		Clear to 5 A. M. Scatd. ⌒i to Noon. \i & _i afterwards.
7	149.2	...	S. & S. S. E.		Scatd. ⌒i to 6 P. M. _i afterwards. Light rain between Noon & 1 P. M.
8	120·1	...	S. & variable.		Clear to 7 A. M. Scatd. ⌒i to 7 P. M. Clear afterwards. Light rain at 4 P. M.
9	126.2	1.23	E. by N. & E. S. E.		Scatd. _i to 3 A. M. Scatd. \i to 9 A. M. Scatd. ⌒i to 3 P.M. Overcast to 7 P. M. Clear afterwards. Rain from 3 to 7 P. M.
10	115.2	1.39	N. N. E. & N. E.		Clear to 5 A. M. Overcast to 6 P. M. _i afterwards. Rain between 3 & 4 P. M.
11	...	...	N. N. E. & E.		Overcast to 3 A. M. ⌒i to 6 P. M. Clear afterwards.
12	144.0	...	N. E.		Clear to 6 A. M. Scatd. ⌒i to 6 P. M. Clear afterwards.
13	143.0	...	N. E. & N. N. W.		Clear to 7 A. M. Scatd. ⌒i to 4 P. M. Scatd. _i afterwards.
14	143.5	...	W. N. W. & N. W.		Scatd. ⌒i to 5 P. M. Clear afterwards.
15	126.0	...	S. E. & E. S. E.		Clouds of different kinds till 10 A. M. Scatd. ⌒i to 9 P. M. Clear afterwards.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
16	145.2	...	S. by E. & N. W.	...	Clear to 5 A. M. Scatd. \⌒i to 9 A. M. ⌒i to 3 P. M. Scatd. \⌒i afterwards.
17	144.6	...	E. N. E. & S. by E.		Clear nearly the whole day. Foggy from 9 to 11 P. M.
18	140.2	...	N. E. & N. by E.		Clear to 11 A. M. \⌒i to 3 P. M. Clear to 8 P. M. Scatd. _i afterwards. Foggy at 11 P. M.
19	144.8	...	N. by E. &. N. E.		Clear to 10 A. M. Scatd. ⌒i to 4 P. M. Clear afterwards.
20	142.2	...	NE.&ENE.&NNE.		Clear to 5 A. M. \⌒i & ⌢i afterwards.
21	...	0.77	S. & N. E.& S. S. E.		Overcast to 11 A. M. Scatd. ⌒i to 6 P. M. Thin clouds afterwards.
22	...	0.15	N.NE.&SSE&ESE.		Thin clouds to 3 A. M. Overcast to 10 A. M. \⌒i afterwards. Rain from 5 to 8 A. M.
23	146.8	0.57	N. N. E. & N. E.		Overcast & \⌒i. Rain from 7 to 9 A. M. & between 3 & 4 P. M.
24	...	2.00	E. N. E.		Overcast. Low scuds from E from Noon to 6 P. M. Rain nearly the whole day.
25	...	0.08	W. S. W. & S. W.		\⌒i & ⌒i Low scuds from S from 7 A. M. to 2 P. M. Light rain at midnight, 4 & 5 A. M. & at 8 P. M.
26	115.0	...	N. N. W. & N. W.		Clouds of different kinds to 6 P. M. Clear afterwards.
27	130.0	...	N. N. W.		Scatd. \i to Noon. Scatd. \⌒i to 5 P. M. Clear afterwards.
28	...	...	N. N. W. & N. W.		Clear to 10 A. M. Scatd. \⌒i to 7 P. M. Clear afterwards. Foggy at midnight.
29	146.5	...	N. N. W.		Clear to 9 A. M. Scatd. ⌒i to 4 P. M. Clear afterwards.
30	147.0	...	N. N. W.		Clear to 7 A. M. Scatd. ⌒i to 4 P. M. _i & \⌒i afterwards.
31	146.0	...	N.W.&N.byW.&N.		\⌒i & ⌒i to 5 P. M. Clear afterwards.

\i Cirri, —i Strati, ⌒i Cumuli, _i Cirro-strati, ⌢i Cumulo strati, \⌢i Nimbi, \⌒i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of October 1866.

Monthly Results.

	Inches.
Mean height of the Barometer for the month...	29.838
Max. height of the Barometer occurred at 9 & 10 A. M. on the 28th...	30.004
Min. height of the Barometer occurred at 4 A. M. on the 25th ...	29.514
Extreme range of the Barometer during the month	0.490
Mean of the daily Max. Pressures	29.905
Ditto ditto Min. ditto	29.773
Mean daily range of the Barometer during the month	0.132

	o
Mean Dry Bulb Thermometer for the month	81.9
Max. Temperature occurred at 2 P. M. on the 2nd	92.2
Min. Temperature occurred at 6 A. M. on the 26th	71.9
Extreme range of the Temperature during the month	20.3
Mean of the daily Max. Temperature	87.5
Ditto ditto Min. ditto, ...	77.8
Mean daily range of the Temperature during the month... ...	9.7

Mean Wet Bulb Thermometer for the month	77.7
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer	4.2
Computed Mean Dew-point for the month	74.8
Mean Dry Bulb Thermometer above computed mean Dew-point ...	7.1
	Inches.
Mean Elastic force of Vapour for the month	0.849

	Troy grain.
Mean Weight of Vapour for the month	9.13
Additional Weight of Vapour required for complete saturation ...	2.31
Mean degree of humidity for the month, complete saturation being unity	0.80

	Inches.
Rained 12 days,—Max. fall of rain during 24 hours	2.00
Total amount of rain during the month	7.83
Total amount of rain indicated by the Gauge attached to the anemometer during the month	7.25
Prevailing direction of the Wind	N. N. W. & N. E.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of Oct. 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No.of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night			1		2		2		2				2						4	1	2		1		5		1												1		1		2		3		1	
1			1		2		2		2		1		1						1		4		2		5		1												1		1		2		3		1	
2			1		2		1		4		2								1		2		2		5		1				1								1		1		2		3		1	
3	1		1		1		2		4		1								2		2		3		3		1												1		1		2		4		1	
4	2		1		3		3		2		2		1						1		1		3	1	3		1												1		1		1		4			
5			1		4	1	3		2	1	2		1						1		1		2		4	1	1												1		1		1		3		2	
6	1		2		1		4		2	1	2		1						1		2				4	1	2				1		1						1		1		1		3		1	
7	4						6	1	5	2	1						1		1		1				2		1		1		1								1		1		1		1		3	
8	6				2		4		3	2	2		1		1	1			3								2				1		1						1		1		1		1		1	
9	2		1		1		5		2		3	1	2	1	1	1			1		2						1		1		1		1						1				1		3		1	
10	1				2		5		3		1		2		1		1		4						1						2	1	1										2		5			
11					4		7	1					2	1	1				3		2										2		1										4		4		1	
Noon.			2		3		5		1				4	2	1				1		1		1						1		1								2				4		3		1	
1	1		3		3		3		4				2				1		2	1											1				1				2				4		4	1		
2	2				4		4		4	1	1						3				2										1		1						2				6				1	
3	1		2		1		3		4								3	1	3		2	1							1		2		1						1		1		4		2			
4	2		1		1		2		3	2					2	1	3	1	2	2	2		2		1								1		1	1			1						6			
5	1		1	1	3		2		4				1				2		2	2	1		1		2								2						1				3		5			
6			1		2		4		5								1	1			3	1	1		2				1				1						1				2		6			
7			1		4		3		2	1			1				1	1			2		1		3		2						1						1				2		6			
8			1		3		3		3	1									1		4		1		2		2						1	1					1				2		6			
9			1		3		2		4				1				2	1			3		1		2						1		1		1				1				1		6			
10			1		3		3		3		1						2	1			2		1		4								1		1				1				1		6			
11			1		2		3		2				1				2		3	1	2		1		4														1		1		2		5			

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November* 1866.**

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	29.907	29.963	29.861	0.102	80.0	86.0	74.2	11.8
2	.954	30.013	.911	.102	79.9	85.4	74.8	10.6
3	.989	.059	.943	.116	81.7	88.6	75.9	12.7
4	30.002	.074	.945	.129	82.1	87.8	77.0	10.8
5	29.972	·045	.921	.124	79.9	84.0	76.5	7.5
6	.946	.001	.888	.113	79.5	85.0	75.6	9.4
7	.936	.009	.872	.137	78.9	84.9	73.4	11.5
8	.910	29.979	.847	.132	78.6	86.6	72.0	14.6
9	.900	.961	.846	.115	78.3	85.8	72.0	13.8
10	.859	.915	.786	.129	76.7	84.0	70.0	14.0
11	.885	.944	.829	.115	75.7	83.6	68.0	15.6
12	.983	30.047	.925	.122	76.6	83.6	70.8	12.8
13	30.021	.096	.965	.131	77.2	84.8	70.8	14.0
14	.011	.074	.953	.121	77.4	85.2	71.2	14.0
15	.051	.124	30.003	.121	77.1	84.8	70.4	14.4
16	.082	.143	.037	.106	77.0	84.1	71.0	13.1
17	.097	.163	.029	.134	76.2	83.9	70.2	13.7
18	.063	.142	29.991	.151	76.0	83.6	70.0	13.6
19	.050	.121	30.007	.114	76.0	83.4	70.0	13.4
20	.032	.106	29.971	.135	75.5	82.6	69.2	13.4
21	.026	.094	.959	.135	75.4	82.6	69.8	12.8
22	.021	.083	.964	.119	74.1	81.8	67.2	14.6
23	.000	.058	.939	.119	73.1	81.0	66.7	14.3
24	29.990	.064	.931	.133	71.4	80.1	64.8	15.3
25	.985	.059	.919	.140	71.3	79.6	64.0	15.6
26	.936	29.999	.876	.123	70.4	79.0	62.8	16.2
27	.945	.991	.890	.101	70.1	78.0	62.0	16.0
28	30.000	30.060	.955	.105	72.0	80.0	64.4	15.6
29	.029	.095	.983	.112	71.8	80.4	64.2	16.2
30	.038	.107	.974	.133	71.7	81.0	65.0	16.0

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	73.3	6.7	68.6	11.4	0.695	7.50	3.31	0.69
2	73.8	6.1	69.5	10.4	.715	.72	.06	.72
3	76.4	5.3	72.7	9.0	.792	8.52	2.85	.75
4	76.2	5.9	72.1	10.0	.778	.36	3.15	.73
5	74.0	5.9	69.9	10.0	.725	7.82	2.96	.73
6	73.3	6.2	69.0	10.5	.704	.59	3.07	.71
7	72.2	6.7	67.5	11.4	.670	.26	.21	.69
8	72.4	6.2	68.1	10.5	.684	.38	.00	.71
9	71.8	6.5	67.2	11.1	.664	.19	.09	.70
10	68.1	8.6	62.1	14.6	.561	6.08	.72	.62
11	67.8	7.9	62.3	13.4	.565	.15	.36	.65
12	69.6	7.0	64.7	11.9	.611	.64	.13	.68
13	70.2	7.0	65.3	11.9	.623	.76	.19	.68
14	70.6	6.8	65.8	11.6	.634	.87	.14	.69
15	70.5	6.6	65.9	11.2	.636	.90	.02	.70
16	70.5	6.5	65.9	11.1	.636	.90	2.99	.70
17	68.9	7.3	63.8	12.4	.593	.45	3.21	.67
18	69.6	6.4	65.1	10.9	.619	.74	2.86	.70
19	70.2	5.8	66.1	9.9	.640	.96	.64	.73
20	69.4	6.1	65.1	10.4	.619	.75	.71	.71
21	68.8	6.6	64.2	11.2	.601	.54	.89	.69
22	67.1	7.0	62.2	11.9	.563	.14	.93	.68
23	66.2	6.9	60.7	12.4	.536	5.86	.93	.67
24	94.3	7.1	58.6	12.8	.499	.47	.88	.66
25	64.8	6.5	59.6	11.7	.516	.66	.67	.68
26	63.4	7.0	57.8	12.6	.486	.34	.76	.66
27	64.2	5.9	59.5	10.6	.515	.65	.38	.70
28	65.9	6.1	61.0	11.0	.541	.93	.57	.70
29	65.7	6.1	60.8	11.0	.537	.89	.56	.70
30	65.4	6.3	60.4	11.3	.530	.82	.61	.69

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	29.990	30.104	29.861	0.243	73.2	80.8	67.4	13.4
1	.984	.102	.852	.250	72.6	80.2	66.6	13.6
2	.977	.100	.845	.255	72.0	79.4	65.6	13.8
3	.971	.100	.833	.267	71.6	79.0	64.8	14.2
4	.969	.105	.829	.276	71.0	78.0	64.0	14.0
5	.978	.111	.850	.261	70.4	77.4	64.0	13.4
6	.994	.122	.872	.250	69.9	77.0	63.2	13.8
7	30.016	.144	.894	.250	70.3	77.4	62.0	15.4
8	.037	.154	.902	.252	73.0	79.8	64.4	15.4
9	.052	.163	.910	.253	75.6	81.8	67.0	14.8
10	.050	.157	.915	.242	78.7	85.2	69.9	15.3
11	.028	.132	.893	.239	80.7	87.0	73.2	13.8
Noon.	.002	.105	.860	.245	82.0	87.4	75.0	12.4
1	29.971	.072	.825	.247	82.6	87.8	76.7	11.1
2	.949	.049	.801	.248	83.1	87.4	77.4	10.0
3	.936	.037	.786	.251	83.0	88.6	78.0	10.6
4	.932	.043	.789	.254	81.5	87.0	76.4	10.6
5	.941	.059	.798	.261	80.3	85.8	75.8	10.0
6	.953	.072	.805	.267	78.2	84.2	73.3	10.9
7	.971	.087	.840	.247	76.8	83.0	71.6	11.4
8	.989	.095	.853	.242	75.9	82.3	69.6	12.7
9	30.001	.112	.866	.246	75.1	81.6	69.4	12.2
10	.007	.111	.867	.244	74.3	81.2	68.6	12.6
11	.002	.108	.868	.240	73.6	80.8	68.2	12.6

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	69.1	4.1	65.8	7.4	0.634	6.94	1.88	0.79
1	68.6	4.0	65.4	7.2	.626	.85	.81	.79
2	68.2	3.8	65.2	6.8	.621	.81	.69	.80
3	67.7	3.9	64.6	7.0	.609	.69	.71	.80
4	67.3	3.7	64.3	6.7	.603	.63	.62	.80
5	66.9	3.5	64.1	6.3	.599	.59	.51	.81
6	66.6	3.3	64.0	5.9	.597	.57	.41	.82
7	66.8	3.5	64.0	6.3	.597	.57	.51	.81
8	68.1	4.9	64.2	8.8	.601	.57	2.19	.75
9	69.4	6.2	65.1	10.5	.619	.74	.74	.71
10	70.7	8.0	65.1	13.6	.619	.70	3.71	.64
11	71.3	9.4	64.7	16.0	.611	.58	4.46	.60
Noon.	71.3	10.7	63.8	18.2	.593	.37	5.10	.56
1	71.0	11.6	62.9	19.7	.576	.17	.51	.53
2	71.0	12.1	62.5	20.6	.568	.08	.78	.51
3	70.9	12.1	62.4	20.6	.567	.06	.76	.51
4	70.4	11.1	62.6	18.9	.570	.13	.18	.54
5	70.7	9.6	64.0	16.3	.597	.44	4.47	.59
6	71.2	7.0	66.3	11.9	.644	.98	3.27	.68
7	70.9	5.9	66.8	10.0	.655	7.11	2.72	.72
8	70.5	5.4	66.7	9.2	.653	.10	.33	.74
9	70.0	5.1	66.4	8.7	.646	.04	.30	.75
10	69.7	4.6	66.5	7.8	.648	.07	.05	.78
11	69.3	4.3	66.3	7.3	.644	.05	1.88	.79

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	150.8	...	N. by W. & N. W.		\i to 5 A. M. _i to 1 P. M. ⌒i & \i to 5 P. M., clear afterwards.
2	145.0	...	N.&N.E.&N.by W.		Clear to 3 A. M. \i to 5 P. M., clear afterwards.
3	145.0	...	N. & N. N. W.		Clear to 5 P. M. \i to 10 A. M. \i & ⌒i to 7 P. M., clear afterwards.
4	147.0	...	N. N. W.		Clear to 7 A. M. \i to 6 P. M. ⌒i afterwards.
5	141.0	...	N.&N.N.W.&N.W.		⌒i to 7 A. M. \i to 3 P. M. Overcast afterwards, Thin Rain at 5, 6 & 11 P. M.
6	145.5	...	N. by W.		Overcast to 6 A. M., \i to 2 P. M., clear afterwards, Slight Rain at 4 A. M.
7	145.0	...	N. by W. & N.		Clear to 9 A. M. Scatd. \i to 1 P. M., clear afterwards.
8	146·0	...	N. N. W. & N.		Clear
9	148.0	...	N. N. E. & N.		Clear to 7 A. M. Scatd. \i to 6 P. M., clear afterwards.
10	143.0	...	N. N. W.		Clear.
11	138.0	...	N. W. & .N N. W.		Clear.
12	140.0	...	N. W. & W.		\i to 8 A. M. clear to 11 A. M. ⌒i to 5 P. M. \i afterwards.
13	140.0	...	W.		Clear to 10 A. M. Scatd. \i to 7 P. M., clear afterwards.
14	142.8	...	W. & N. & N. by W.		Clear, slightly foggy at 10 P. M.
15	147.0	...	N. by E. & N. W.		Clear to 10 A. M. Scatd. ⌒i to 4 P. M. Scatd. \i afterwards.
16	149.0	...	N.&N.N.W.&NNE.		Clear to 4 A. M. Scattered _i to 7 A. M. Scatd. ⌒i & \i afterwards.
17	138.0	...	NW&NbyE&EN.E.		Clear to 9 A. M. Scatd. _i to 6 P. M. Scatd. \i afterwards. Slightly foggy at 7 & 8 P. M.
18	148.0	...	N.		Clear to 11 A. M. Scattered ⌒i afterwards.
19	144.4	...	N. E.		Scatd. ⌒i & \i to 2 P. M., clear afterwards.
20	148.0	...	N. N. W.&N.by W.		Clear to 10 A. M. Scatd. ⌒i to 3 P. M. \i afterwards.
21	145.5	...	N. N. E. & N. N W.		Clear to 10 A. M Scatd. ⌒i to 4 P. M., clear afterwards.
22	141.4	...	N. W. & N.		Clear to Noon. Scatd. \i afterwards. Slightly Foggy from 8 to 11 P. M.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November* 1866.**

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
23	142.0	...	N. N. E. & N. by W.	...	Clouds of different kinds to 5 P. M., clear afterwards, Foggy at 11 P. M.
24	140.2	...	N.		Scatd. ⎯i to 9 A. M., ⟍i afterwards. Foggy at 8 P. M.
25	137.0	...	N. by W. & N. W.		Clear to 10 A. M. Scatd. ⌒i to 6 P. M., clear afterwards.
26	139.8	...	N. W. & N. N. W.		Clear to 11 A. M. Scatd. ⌒-i to 3 P. M., clear afterwards.
27	133.0	...	N. N. W. & N. W.		Chiefly clear.
28	145.0	...	N. by W. & N. by E.	.	Clear to 11 A. M. Scatd. ⌒-i to 5 P. M., clear afterwards.
29	140.0	...	N. by E. & N. W.		Clear.
30	142.0	...	N.W.&N.by E.		Clear.

⟍i Cirri, —i Strati, ⌒i Cumuli, ⎯i Cirro-strati, ⌒-i Cumulo strati, ⌢⌣i Nimbi, ⟍⌒i Cirro cumuli.

***Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of November* 1866.**

Monthly Results.

	Inches.
Mean height of the Barometer for the month...	29.988
Max. height of the Barometer occurred at 9 A.M. on the 17th ...	30.163
Min. height of the Barometer occurred at 3 P. M. on the 10th ...	29.786
Extreme range of the Barometer during the month	0.377
Mean of the daily Max. Pressures	30.053
Ditto ditto Min. ditto	29.930
Mean daily range of the Barometer during the month	0.123

	o
Mean Dry Bulb Thermometer for the month	76.1
Max. Temperature occurred at 3 P. M. on the 3rd	88.6
Min. Temperature occurred at 7 A. M. on the 27th	62.0
Extreme range of the Temperature during the month	26.6
Mean of the daily Max. Temperature	83.4
Ditto ditto Min. ditto, ...	69.8
Mean daily range of the Temperature during the month... ...	13.6

Mean Wet Bulb Thermometer for the month	69.5
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer	6.6
Computed Mean Dew-point for the month	64.9
Mean Dry Bulb Thermometer above computed mean Dew-point ...	11.2
	Inches.
Mean Elastic force of Vapour for the month	0.615

	Troy grain.
Mean Weight of Vapour for the month	6.70
Additional Weight of Vapour required for complete saturation ...	2.93
Mean degree of humidity for the month, complete saturation being unity	0.70

	Inches.
Drizzled 2 days,—Max. fall of rain during 24 hours	Nil
Total amount of rain during the month	Nil
Total amount of rain indicated by the Gauge attached to the anemometer during the month	Nil
Prevailing direction of the Wind	N. W. N. N. W. & N.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of Nov. 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.
Mid night	3		2		1		2								1	
1	6		2		1		2		1							
2	6		3		3				1							
3	6		4		3				1							
4	9		5		3				1							
5	7		5		3		1									
6	8		5		4											
7	7		5		3											
8	8		6		4				1							
9	7		4		7		2		2							
10	4		2		9		2		3		1					
11	5		3		5		4				1					
Noon.	6		3		4		2		1							
1	8		2		2		1									
2	8		3		5		2									
3	7		5		1											
4	8		1		1		1									
5	3		1		2		1									
6	2		2				1									
7	2		2				1									
8	2		2				1									
9	2		2		1											
10	2		2		1											
11	2		2		1				1							

Hour.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.
Mid night	1		1													
1	1		1													
2			1													
3																
4																
5																
6																
7																
8																
9																
10																
11																
Noon.	1															
1	1															
2																
3																
4																
5																
6																
7																
8																
9	1															
10	1															
11	1															

Hour.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night	1				2						4		7		4	
1	1				2						1		6		5	
2	1				2						2		5		5	
3					2						3		4		6	
4					2						2	1	3		4	
5					1		1				3		2		6	
6					1		1				3		4		4	
7					1						2		6		6	
8					1						3		6		1	
9					1						1		4		2	
10					1						2		6			
11					1						7		3		1	
Noon.					1				1		6		3		2	
1					1				1		7		6		1	
2					1				1		6		3			
3					1				1		5		9		1	
4					1		1				7		5		5	
5					2						4		10		7	
6					2						5		10	1	8	
7					2						7		9		6	
8					2						8		8		6	
9					2						10		8		3	
10					2						10		7		4	
11					2						10	1	6		4	

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Latitude 22° 33′ 1″ North. Longitude 88° 20′ 34″ East.

Height of the Cistern of the Standard Barometer above the sea level, 18.11 feet.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Date.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer during the day.			Mean Dry Bulb Thermometer.	Range of the Temperature during the day.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
1	30.023	30.072	29.962	0.110	71.7	82.0	64.0	18.0
2	.017	.088	.935	.153	71.8	80.6	64.6	16.0
3	.014	.100	.947	.153	69.8	80.6	61.4	19.2
4	.011	.065	.941	.124	68.4	78.0	60.2	17.8
5	29.985	.062	.911	.151	68.2	78.0	60.0	18.0
6	.961	.044	.904	.140	67.0	76.6	60.6	16.0
7	30.006	.071	.944	.127	65.9	77.0	57.6	19.4
8	.071	.159	30.000	.159	65.8	76.0	57.0	19.0
9	.071	.131	.029	.102	65.4	76.0	56.8	19.2
10	.104	.173	.054	.119	67.1	76.4	59.0	17.4
11	.130	.185	.085	.100	67.9	78.0	60.0	18.0
12	.113	.195	.045	.150	67.0	76.8	59.0	17.8
13	.025	.096	29.955	.141	67.5	77.0	59.6	17.4
14	.014	.078	.959	.119	68.0	77.2	60.6	16.6
15	.065	.122	30.022	.100	67.2	77.2	58.7	18.5
16	.136	.208	.087	.121	67.9	77.5	59.8	17.7
17	.145	.222	.076	.146	66.7	76.6	58.8	17.8
18	.144	.217	.088	.129	68.0	77.2	61.0	16.2
19	.171	.256	.119	.137	67.5	77.3	58.4	18.9
20	.195	.273	.121	.152	66.9	76.6	58.6	18.0
21	.164	.226	.108	.118	67.1	76.0	58.8	17.2
22	.164	.232	.117	.115	67.1	76.0	58.8	17.2
23	.158	.231	.097	.134	66.5	76.0	58.2	17.8
24	.170	.254	.124	.130	66.0	75.6	58.0	17.6
25	.163	.249	.096	.153	65.3	74.2	57.4	16.8
26	.119	.186	.050	.136	65.4	75.8	56.6	19.2
27	.075	.138	.012	.126	65.4	75.4	56.0	19.4
28	.088	.159	.035	.124	65.1	75.4	56.4	19.0
29	.023	.113	29.952	.161	64.8	75.8	56.8	19.0
30	29.960	.033	.890	.143	65.4	77.4	55.6	21.8
31	.979	.049	.934	.115	67.1	77.0	58.0	19.0

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived, from the hourly observations, made during the day.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Daily Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Date.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
1	65.6	6.1	60.7	11.0	0.536	5.87	2.56	0.70
2	64.4	7.4	58.5	13.3	.498	.45	3.00	.65
3	63.2	6.6	57.9	11.9	.488	.36	2.59	.67
4	60.6	7.8	54.4	14.0	.434	4.78	.84	.63
5	61.6	6.6	56.3	11.9	.462	5.10	.48	.67
6	59.8	7.2	54.0	13.0	.428	4.73	.57	.65
7	59.3	6.6	54.0	11.9	.428	.74	.32	.67
8	58.8	7.0	53.2	12.6	.416	.62	.42	.66
9	59.4	6.0	54.6	10.8	.437	.85	.10	.70
10	61.3	5.8	56.7	10.4	.469	5.18	.14	.71
11	62.7	5.2	58.5	9.4	.498	.50	.01	.73
12	61.9	5.1	57.8	9.2	.486	.38	1.92	.74
13	61.5	6.0	56.7	10.8	.469	.17	2.25	.70
14	61.5	6.5	56.3	11.7	.462	.10	.43	.68
15	61.0	6.2	56.0	11.2	.458	.07	.28	.69
16	61.6	6.3	56.6	11.3	.467	.16	.35	.69
17	60.7	6.0	55.9	10.8	.456	.05	.18	.70
18	61.5	6.5	56.3	11.7	.462	.10	.43	.68
19	60.9	6.6	55.6	11.9	.452	.00	.42	.67
20	60.1	6.8	54.7	12.2	.438	4.85	.43	.67
21	60.6	6.5	55.4	11.7	.449	.96	.36	.68
22	60.8	6.3	55.8	11.3	.455	5.04	.28	.69
23	59.9	6.6	54.6	11.9	.437	4.84	.35	.67
24	58.9	7.1	53.2	12.8	.416	.62	.46	.65
25	58.3	7.0	52.7	12.6	.409	.55	.38	.66
26	58.1	7.3	52.3	13.1	.404	.49	.46	.65
27	58.9	6.5	53.7	11.7	.423	.70	.25	.68
28	59.3	5.8	54.7	10.4	.438	.87	.02	.71
29	59.6	5.2	55.4	9.4	.449	.99	1.84	.73
30	59.9	5.5	55.5	9.9	.450	5.00	.95	.72
31	61.6	5.5	57.2	9.9	.476	.26	2.06	.72

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.

Hour.	Mean Height of the Barometer at 32° Faht.	Range of the Barometer for each hour during the month.			Mean Dry Bulb Thermometer.	Range of the Temperature for each hour during the month.		
		Max.	Min.	Diff.		Max.	Min.	Diff.
	Inches.	Inches.	Inches.	Inches.	o	o	o	o
Mid-night.	30.082	30.205	29.958	0.247	63.2	68.6	58.6	10.0
1	.076	.195	.952	.243	62.6	68.4	58.4	10.0
2	.069	.188	.946	.242	61.9	68.0	58.2	9.8
3	.063	.186	.943	.243	61.2	67.4	58.0	9.4
4	.060	.182	.940	.242	60.6	67.0	57.4	9.6
5	.070	.196	.949	.247	60.0	66.3	56.7	9.6
6	.085	.212	.968	.244	59.2	65.0	56.4	8.6
7	.103	.231	.982	.249	59.0	64.6	55.6	9.0
8	.126	.253	.993	.260	62.2	66.5	57.6	8.9
9	.148	.266	30.033	.233	65.9	69.8	62.6	7.2
10	.150	.273	.031	.242	69.6	73.2	65.0	8.2
11	.131	.259	.008	.251	72.6	76.4	69.2	7.2
Noon.	.097	.231	29.973	.258	74.7	79.0	71.0	8.0
1	.064	.186	.930	.256	75.8	80.0	73.2	6.8
2	.040	.157	.908	.249	76.8	81.2	74.2	7.0
3	.026	.135	.891	.244	76.8	82.0	74.1	7.9
4	.021	.124	.890	.234	75.2	80.2	72.9	7.3
5	.030	.129	.904	.225	73.3	77.6	71.3	6.3
6	.044	.142	.914	.228	70.3	74.7	68.5	6.2
7	.060	.162	.932	.230	68.3	73.0	66.0	7.0
8	.076	.174	.949	.225	66.9	72.0	64.2	7.8
9	.091	.194	.967	.227	65.8	70.7	62.6	8.1
10	.101	.221	.969	.252	64.9	69.8	59.9	9.9
11	.093	.212	.961	.251	64.1	69.2	59.0	10.2

The Mean Height of the Barometer, as likewise the Dry and Wet Bulb Thermometer Means are derived from the observations made at the several hours during the month.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Hourly Means, &c. of the Observations and of the Hygrometrical elements dependent thereon.—*(Continued.)*

Hour.	Mean Wet Bulb Thermometer.	Dry Bulb above Wet.	Computed Dew Point.	Dry Bulb above Dew Point.	Mean Elastic force of Vapour.	Mean Weight of Vapour in a Cubic foot of air.	Additional Weight of Vapour required for complete saturation.	Mean degree of Humidity, complete saturation being unity.
	o	o	o	o	Inches.	T. gr.	T. gr.	
Mid-night.	59.6	3.6	56.4	6.8	0.464	5.17	1.32	0.80
1	59.1	3.5	55.9	6.7	.456	.09	.28	.80
2	58.6	3.3	55.6	6.3	.452	.06	.17	.81
3	58.1	3.1	55.3	5.9	.447	.01	.09	.82
4	57.6	3.0	54.9	5.7	.441	4.94	.04	.83
5	57.1	2.9	54.5	5.5	.435	.88	0.99	.83
6	56.7	2.5	54.4	4.8	.434	.87	.86	.85
7	56.4	2.6	54.1	4.9	.429	.83	.86	.85
8	57.9	4.3	54.0	8.2	.482	.78	1.51	.76
9	59.9	6.0	55.1	10.8	.444	.93	2.13	.70
10	61.7	7.9	55.4	14.2	.449	.94	.96	.63
11	62.8	9.8	55.0	17.6	.442	.84	3.82	.56
Noon.	63.3	11.4	55.3	19.4	.447	.88	4.35	.53
1	63.4	12.4	54.7	21.1	.438	.76	.78	.50
2	63.8	13.0	54.7	22.1	.438	.75	5.08	.48
3	63.7	13.1	54.5	22.3	.435	.72	.11	.48
4	63.2	12.0	54.8	20.4	.440	.78	4.59	.51
5	63.8	9.5	56.2	17.1	.461	5.03	3.81	.57
6	63.6	6.7	58.2	12.1	.493	.42	2.66	.67
7	62.9	5.4	58.6	9.7	.499	.51	.09	.73
8	62.1	4.8	58.3	8.6	.494	.46	1.82	.75
9	61.6	4.2	58.2	7.6	.493	.46	.58	.78
10	61.0	3.9	57.9	7.0	.488	.41	.44	.79
11	60.3	3.8	56.9	7.2	.472	.25	.42	.79

All the Hygrometrical elements are computed by the Greenwich Constants.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
1	141.0	...	N. by W.&N. N. W.		Clear to 4 P. M. Scatd. \i to 8 P. M., clear afterwards.
2	141.2	...	N. & N. by W.		Clear to 7 A. M. \i & _i to 3 P. M., clear afterwards.
3	143.4	...	N. & N. by E.		Clear to 11 A. M._i to 3 P. M., clear afterwards.
4	138.4	...	W.N.W.&N.N.W.		Clear. Slightly foggy at 9 & 10 P. M.
5	138.0	...	W. by N. & N. W.		Clear.
6	138.8	...	W. & W. N. W.		Clear
7	139.0	...	N. W. & N. N. W.		Clear. Foggy from 7 to 11 P. M.
8	138·0	...	N. N. E. & N. N. W.		Clear.
9	135.0	...	N. W.		Clear.
10	134.2	...	N. W. & W. & N.		Clear.
11	136.0	...	N. & .N N. W.		Clear. Slightly foggy at 7 P. M.
12	138.0	...	N. & N. W.		Clear. Slightly foggy at 10 & 11 P. M.
13	137.0	...	W.N.W.&W.S.W.		Clear. Foggy at 6 & 7 A. M. & from 7 to 11 P. M.
14	140.0	...	W.S. W.& variable.		Clear.
15	131.2	...	N. by E. & W. by N.		Clear. Slightly foggy from 7 to 10 P. M.
16	138.0	...	N. & variable.		Chiefly clear. Foggy from 7 to 10 P. M.
17	135.5	...	N. by E & N. W.		Clear. Foggy at 6 A. M. & from 7 to 11 P. M.
18	134.0	...	N. & N. N. E.		Clear to 5 A. M. \i to 1 P. M., clear afterwards. Foggy from Midnight to 4 A. M. & at 9 & 10 P. M.
19	139.0	...	N. by W. & N.		Clear.
20	136.0	...	N. by W.&N.N. W.		Clear.
21	133.0	...	N. N. W. & N W.		Clear.
22	135.0	...	N.byW.&N&NNW.		Clear to 9 A. M. Scatd. \i to 6 P. M., clear afterwards.
23	136.0	...	N. by W.		Clear to 6 A. M. Scatd. \i to 6 P.M., clear afterwards. Foggy at 8 & 9 P. M.
24	136.8	...	N. W.		Clear.
25	133.0	...	N. N. W. &N. by W.		Clear.
26	137.6	...	N.		Clear.
27	136.0	...	N. by W.		Clear. Slightly foggy from 8 to 11 P. M.
28	135.2	...	N. by W. &N. N. W. & N. W.		Clear. Foggy from Midnight to 2 A. M. & from 7 to 11 P. M.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Solar Radiation, Weather, &c.

Date.	Max. Solar radiation.	Rain Guage 1 ft. 2 in. above Ground.	Prevailing direction of the Wind.	Max. Pressure of Wind.	General aspect of the Sky.
	o	Inches		lb	
29	133.0	...	N.W.&N.N.W.&N.	...	Clear. Foggy from Midnight to 4 A. M. & from 8 to 11 P. M.
30	138.2	...	W.N.W.&SSW.&S.		Clear. Slightly foggy from Midnight to 6 A. M. & at 8 & 9 P. M.
31	138.0	...	S.		Chiefly clear.

\i Cirri, —i Strati, ⌒i Cumuli, ⌣i Cirro-strati, ~i Cumulo strati, ~i Nimbi, ~i Cirro cumuli.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of December 1866.

Monthly Results.

	Inches.
Mean height of the Barometer for the month...	30.079
Max. height of the Barometer occurred at 10 A.M. on the 20th ...	30.273
Min. height of the Barometer occurred at 4 P. M. on the 30th ...	29.890
Extreme range of the Barometer during the month	0.383
Mean of the daily Max. Pressures	30.151
Ditto ditto Min. ditto	30.019
Mean daily range of the Barometer during the month	0.132

	o
Mean Dry Bulb Thermometer for the month	67.1
Max. Temperature occurred at 3 P. M. on the 1st	82.0
Min. Temperature occurred at 7 A. M. on the 30th	55.6
Extreme range of the Temperature during the month	26.4
Mean of the daily Max. Temperature...	77.0
Ditto ditto Min. ditto, ...	58.9
Mean daily range of the Temperature during the month... ...	18.1

Mean Wet Bulb Thermometer for the month	60.7
Mean Dry Bulb Thermometer above Mean Wet Bulb Thermometer	6.4
Computed Mean Dew-point for the month	55.6
Mean Dry Bulb Thermometer above computed mean Dew-point ...	11.5
	Inches.
Mean Elastic force of Vapour for the month	0.452

	Troy grain.
Mean Weight of Vapour for the month	5.00
Additional Weight of Vapour required for complete saturation ...	2.32
Mean degree of humidity for the month, complete saturation being unity	0.68

	Inches.
Rained No. days,—Max. fall of rain during 24 hours	Nil
Total amount of rain during the month	Nil
Total amount of rain indicated by the Gauge attached to the anemometer during the month	Nil
Prevailing direction of the Wind... ...	N. & N. N. W. & N. W.

Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor General's Office, Calcutta, in the month of Dec. 1866.

MONTHLY RESULTS.

Tables shewing the number of days on which at a given hour any particular wind blew, together with the number of days on which at the same hour, when any particular wind was blowing, it rained.

No. of days

Hour.	N.	Rain on.	N. by E.	Rain on.	N. N. E.	Rain on.	N. E.	Rain on.	E. N. E.	Rain on.	E. by N.	Rain on.	E.	Rain on.	E. by S.	Rain on.
Mid night	5		2													
1	6		2										1			
2	6		2				1						1			
3	5		3		2		1						1			
4	7		3		2		1				1					
5	6		3		2											
6	7		3		2											
7	5		1		4		1						1			
8	4				3		2				1					
9	4				3		2		2							
10	6		1		4		1		1				2			
11	7		1				3						1			
Noon.	8		4		3		2		1							
1	8		4				1									
2	5		1													
3	9				1		1									
4	8		2		1											
5	8		1		1											
6	6		1		1											
7	5		1													
8	6															
9	5															
10	5															
11	4															

Hour.	E. S. E.	Rain on.	S. E.	Rain on.	S. S. E.	Rain on.	S. by E.	Rain on.	S.	Rain on.	S. by W.	Rain on.	S. S. W.	Rain on.	S. W.	Rain on.
Mid night									1							
1									1							
2									1							
3									1							
4									1							
5									1							
6					1				1							
7					1				1							
8	1				1				1							
9	1								1							
10									1				1			
11	1								1		1					
Noon.							1								1	
1					2										1	
2			1													
3									1				1		1	
4			1						1		1					
5									1				1			
6									1				1			
7									1				1			
8									2							
9									2							
10									2							
11									2							

Hour.	W. S. W.	Rain on.	W. by S.	Rain on.	W.	Rain on.	W. by N.	Rain on.	W. N. W.	Rain on.	N. W.	Rain on.	N. N. W.	Rain on.	N. by W.	Rain on.
Mid night			1		2				1		6		7		5	
1			1		2				1		4		3		9	
2			1		2				1		4		3		8	
3	1		1		1		1		1		2		4		6	
4	1				1		1		1		1		3		7	
5	1				1		1		1		2		4		8	
6	1				2		1		1		1		3		8	
7	1				2		1				3		6		4	
8	1				2		1				3		6		5	
9	1				1		1				5		4		6	
10	1						1		1		4		7			
11	1								2		4		7		2	
Noon.	1										7		2		1	
1							1		3		8		2		1	
2	1						1		6		7		5		4	
3							1		6		5		4		1	
4	1						1		3		8		4			
5	1						1		3		8		3		3	
6	1						1		3		6		6		3	
7	1						1		3		9		4		3	
8	1						1		3		8		5		3	
9	1						1		3		9		5		3	
10	1		1						4		7		5		4	
11	1		1		1				4		5		6		5	