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The Sources of the Irawadi and the Sanpo

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while, he says, he was in the performance of his public duties. The fact is, he entrusted it to some one to take to his home, and the man stole it. He was much distressed, and expressed a hope that another chronometer exactly like it, with the same inscription engraved on it, might be sent to him, and he would gladly pay the cost of it; and then he went on to write in Hindee character the English words of the inscription, which were these :—"De President and Council of de Rael Jographical Society of London to Pundit Nain Singh for his great Jographical exploration. 25th May, 1868."

The Council was not able to comply with Nain Singh's request, but in May, 1877, the much higher honour of a Royal medal was awarded him in these terms :—"The Victoria or Patron's medal is awarded to the Pundit Nain Singh, for his great journeys and surveys in Tibet, and along the Upper Brahmaputra, during which he has determined the position of Lhasa, and added largely to our positive knowledge of the map of Asia." Colonel H. Yule, who had taken all along the greatest interest in the man and his work, received the medal at the anniversary meeting on behalf of Nain Singh, and in his reply to the eloquent words in praise of this native explorer addressed to him by the President, said : "He is not a topographical automaton, or merely one of a great multitude of native employés with an average qualification. His observations have added a larger amount of important knowledge to the map of Asia than those of any other living man, and his journals form an exceedingly interesting book of travels."

For the last few years of his life Nain Singh had retired into private life, and lived in comfortable circumstances during the hot weather in his native village of Milum, where his cousin and former companion Manee was Putwarie; and during the cold weather on a small *jaghire* or estate in the plains given to him by the Government for his services. He died at Moradabad (I believe on the 1st of February last), of cholera, contracted at the great January fair of Allahabad. He must have been about fifty-seven years old. Nain Singh was employed for many years under me, and I always had a very high opinion of him; a more truthful or reliable man could, in my opinion, not be found for the work he was called upon to do. There may be mistakes in his journals, but no wilful ones.

I don't know what family he leaves behind, but there were two boys, nephews of his, educated at the Mission School at Almorah, who became Christians some years ago, and are now studying medicine at Agra, under Dr. Valentine.

The great exploit of Nain Singh, his journey from Nepal to Lhasa and back to the Mansarowar Lake, in 1865-6, need not be further described here. A translation of his journal, with introductory remarks by Colonel (then Captain) Montgomerie, was read before this Society on the 23rd March, 1868, and published in the 38th volume of the Society's 'Journal.'

EDMUND SMYTH, Colonel.

CORRESPONDENCE.

The Sources of the Irawadi and the Sanpo.

37, EDGWARE ROAD, W.

Having had engineering charge of the districts in British Burma through which both the Irawadi and Salween rivers run, and constructed many miles of embankment along the former river, Major Sandeman's paper read at the meeting of March 13th was naturally of great interest to me. I had intended to make some remarks upon it in the discussion which followed, but the lateness of the hour prevented me; on this account I beg permission to send you the following observations, for insertion in the next number of the 'Proceedings.'

Previous to the reading of the paper, I was of opinion that the portion of the

Nu-kiang above lat. $27^{\circ} 10'$ belonged to the Irawadi river, and not to the Salween; and that the portion of the Lang-tsan-kiang above $27^{\circ} 10'$ should be ascribed as the headquarters of the Salween. My opinion was based upon the unlikelihood of a west to east bend, nearly 70 miles in length, occurring in that latitude when both the upper and lower portions of the river's course were shown as running in a straight line, nearly north and south, for hundreds of miles both above and below this unnatural bend. On looking into the original maps and into Du Halde's book on China, I found that the Jesuits had finished their map of Yünnan where the parallel of $27^{\circ} 10'$ cuts the Salween river, and that the upper portion of the Salween, and indeed the whole of Tibet, was merely a compilation from itineraries and information collected by two Lama surveyors who were sent to survey the country. The outcome of their labours, together with the surveys of the provinces of China which had been carried out by the Jesuit missionaries, were forwarded to D'Anville, with the information that the Lama survey was only approximately correct, and with the request that, from the information he had within his grasp, he would fill in and correct the survey and make a general map of the whole country. The Lama and the Jesuit surveys seem to have been connected by Père Regis's joining the fragments of the Salween together, to show simply that they were portions of the trunk of the same river; in the same way the Lang-tsan-kiang was joined with the Mekong. This piece of cobbling was faithfully copied by D'Anville on his general map, and has since been unsuspectingly followed by all succeeding cartographers; some of them have, however, artistically pared off the ugly corners of the bend and substituted for it, perhaps for the sake of symmetry, a nice-looking, easy-flowing curve, which has quite destroyed the accuracy of the course of the Salween for some distance below the point to which it was surveyed by the Jesuits. Through this error D'Anville showed the course of the Salween above lat. $27^{\circ} 10'$ as running in (Greenwich) long. $97^{\circ} 51'$, or in identically the same position and direction as the Nam Disang (Mehka or eastern branch of the Irawadi) on Lieutenant Wilcox's map. That the Nu-kiang or Lu-kiang (Salween) and the Lang-tsan-kiang enter Yünnan, and do not rise there, is clearly stated by Père Regis, who with P. P. Fridelle and Bonjour, surveyed that province. This fact, with the later information received from Mr. Cooper, who has travelled along the Mekong above lat. $27^{\circ} 10'$, and M. Desgodins who has lived on the Salween between lat. 27° and 28° , clearly uproots every idea that the Nu-kiang (Salween) above lat. $27^{\circ} 10'$ is a branch of the river Irawadi.

The Jesuit map of Yünnan seems to be reliable; the latitudes mapped by them of Yünnan, Tali, and Momein, are the same as those of Mr. Baber and Captain Gill; the latitude of Likiang is out only $0^{\circ} 13'$; and the longitudes differ only from $0^{\circ} 3'$ to $0^{\circ} 18'$. We may note here that the Salween has been depicted by the Jesuits crossing lat. $27^{\circ} 10'$ in long. $98^{\circ} 36'$; lat. $26^{\circ} 30'$ in long. $98^{\circ} 36'$; and lat. 26° in long. $98^{\circ} 29'$; or in a position slightly trending east of north.

Having thus shown that the Nu-kiang is the upper trunk stream of the Salween river, and not a branch of the Irawadi, I will proceed to discuss the question whether it is absolutely necessary that the river Irawadi should have its sources above latitude 28° . On studying Mr. R. Gordon's book on the river Irawadi, one is astonished to find that the whole of his data for the floods in the upper portion of the Irawadi is incomplete: there is no one single flood discharge of the river at Mandalay or at Bhamó, that is not based on assumptions. He assumes that the velocity of a flood at Mandalay, where the extreme rise above the dry weather level is only 26 feet, is the same as that at Saiktha, where the rise is about 40 feet. He assumes that a flood section taken by Lieutenant Heathcote, in 1854 below Mandalay, was that of an ordinary flood. In face of Dr. Bayfield's evidence that the bank of the

river at Bhamó was only from 20 to 30 feet high above the low water of the dry weather on the 10th January ; in the face of Captain Hannay's declaration that, when the river was running with an almost imperceptible current through the defile above Bhamó, on the 22nd December he found, in a place where the river was restricted to only 80 yards in breadth, the height of the flood in the rains was only 50 feet above the then level of the river ; in face of Dr. Griffiths, who had an admirable opportunity of judging, having passed through the defile when the river was rising at the rate of 16 inches an hour, declaring that 40 feet rise in the defile was equivalent to 20 feet in the open river,—Mr. Gordon accepts with unquestioning confidence the assertion of a Mr. Rose that he had measured the height of the flood rise at Bhamó above the low water of the dry weather at 60 feet. Mr. Rose may have measured the extreme depth of the river at Bhamó during a flood, but I much doubt whether his measurement was that of the height of the rise of the flood above the lowest level of the year. Mr. Gordon then, from knowing the breadth of one channel in the dry weather, assumes not only what its cross section in the rains will be, but what the area of the cross sections of two other unmeasured channels will discharge when this very doubtful flood rise of 60 feet occurs. With these assumptions, and a surmise that the flood will have the same velocity as at Saiktha, he calmly assures us that the river at Bhamó would discharge a volume of 1,200,000 cubic feet per second. What can one say to calculations based upon such suppositions ? What credit can be placed in them ? If Dr. Bayfield's, Dr. Griffiths's, and Captain Hannay's observations were correct, the flood discharge of the river at Bhamó would certainly not be more than one-third of that assumed for it by Mr. Gordon. The lowest dry weather discharge of the Irawadi above Bhamó, when restricted and passing through the Muntgoung defile, in lat. $25^{\circ} 30'$, taking the dimensions given by Mr. Strettel, when he passed through it, could not have been more than 15,000 cubic feet per second, or his boatmen could not have poled against the stream.

The area of the Irawadi basin between Bhamó and lat. 98° is about 30,000 square miles. Taking the flood discharge of the river at Bhamó as about 400,000 cubic feet per second, the discharge per square mile would be about $13\frac{1}{2}$ cubic feet per second, or about one-fourth of the discharge per mile from the country into the Dibong branch of the Brahmaputra, which lies in the same latitude, actually nudging against it, or only separated by an arm of hills, which, running from north to south, do not intercept the drift of the south-west monsoon rains. This 30,000 square miles of area, in which the sources of the Irawadi most likely take their rise, is a district bounded on three sides by high and snow-capped ranges, which precipitate the moisture of the heavy rain-bearing clouds drifting up the valley of the river, and might reasonably be supposed to supply even the quantity of outflow that Mr. Gordon assumes to pass through the channel of the Irawadi at Bhamó ; if this was the case, it would still be supplying one-fifth per square mile less than is actually discharged from the area drained by the Dibong. It is impossible for me to comprehend how Mr. Gordon can assume that his river, with its dry weather flow, in lat. $25^{\circ} 30'$, of 15,000 cubic feet per second, must receive the Sanpo, and thus have a course of over 1400 miles in length above that place ; and I think that his opinion may be dismissed without further consideration.

I will now consider the theory of the Sanpo being the upper course of the Dihong river. The arguments on this side have been most ably stated by Colonel Yule in his 'Introductory Essay' prefacing Captain Gill's 'River of Golden Sand.' On looking at the Government of India map, issued in 1881, we notice that the drainage area of a large portion of hills, which have not been surveyed, lying between 92° and 95° long., has been divided by the cartographer into compartments

which are at present only the fruits of surmise; if these are expunged, we have an area of 7500 square miles lying behind a snow-capped range of mountains, with peaks ranging from 14,316 to 21,552 feet above mean sea-level, which must exclude from this area all of the low-lying, heavy, rain-bearing clouds brought up by the south-west monsoon. The drainage from this area probably could not exceed, even when the snow is melting, 10 cubic feet per second for each square mile of area, and the total discharge would not be more than 75,000 cubic feet per second.

The whole of the drainage basin of the Dibong is exposed to the full drift of the south-west monsoon, and the rainfall is therefore very heavy; the discharge of the river per second as given by Lieutenant Harman is 144,000 cubic feet. The area of the basin being 2800 square miles, the discharge is at the rate of a little over 51 cubic feet for each square mile of area.

The Subansiri river has a watershed to the south of the snowy range of 6500 square miles, the flood discharge of the river is only 240,000 cubic feet per second; supposing that none of the drainage from behind the snowy range enters the Subansiri, the discharge per square mile from the area in front of the range alone would be about 37 cubic feet per second, or 14 cubic feet less than the discharge from the basin of the Dibong. The reason of this lesser discharge is evident, for the watershed of the Subansiri is more or less protected on its south and west sides from the drift of the south-west monsoon by the sheltering hills.

If the Sanpo passes close to the Jungla peak, on its supposititious course towards the Irawadi, and threw out no branch to the southwards, the watershed allowed to the Dihong would be 4500 square miles; calculating the discharge of this at 37 cubic feet per mile per second, the basin of the Dihong being protected like that of the Subansiri, the discharge would be only 166,500 cubic feet per second; adding to this the 75,000 cubic feet draining from behind the snowy range, the gross discharge would be, at the time of extreme high flood, only 241,500 cubic feet per second; but the discharge of this river has been proved to be 423,000 cubic feet per second; it may therefore be fairly asked, where does the unaccounted for 188,500 cubic feet of flood water come from? Only one answer can reasonably be given to this,—from the Sanpo, the great river of Tibet.

It is much to be regretted that Major Sandeman has based his survey of the country lying between Bhamó and $26^{\circ} 8'$ lat. upon the position of Bhamó as given by Captain Bowers, viz. $96^{\circ} 54'$ E. Had he adopted Mr. Ney Elias's observation, which I believe to be the most reliable, the Nam-kioo river, if produced, would not only run in the same direction, but actually coincide with the Maleeka branch of the Irawadi river, and both the appearance and the accuracy of the map would be much improved. If Major Sandeman will shift his survey this $0^{\circ} 14'$ to the east, so as to make it agree with Mr. Ney Elias's observations, he will find his position for that wonderful Noungsa lake, which even that sharp-sighted native of Kacho could not see across, traverses the course of the Salween river. He may then, if he will study Mr. Baber's remarks upon the native ideas of distance (by which it appears that one English mile equals two Chinese li along roads in a flat country and from five to fifteen where they pass over hills), find it rather puzzling to accurately determine the position of his Burmese Nyanza.

Major Sandeman's deductions from Alaga's observations appear to me not always warranted. He presents us with the information that the Maleeka, owing to the melting of the snow, was in flood from the 24th January to the 18th February, and that this flood caused a rise (vide his Report) at Saiktha from the 19th February to the 3rd March, when it ceased; but that the Mehka does not rise until April, and that both of these rivers take their rise in the same snowy range. Does Major Sandeman really infer that the snow at the sources melts during a fortnight of the coldest part of the

year, whilst at the sources of the neighbouring stream it is allowed to follow the ordinary course of nature and commence to melt, as we are told by many observing travellers it does in that latitude, towards the end of April? It appears, from Dr. Bayfield's journal, that heavy rains are not unusual, in the district west of the Maleeka, both in January and February,—the phenomenon of a January thaw was therefore not required in order to account for the flood noticed in the Maleeka.

Major Sandeman draws another conclusion which I think is not quite exact. He states that the rainfall, in the district he is considering, must be heavy because of the quantity of hungry or rather thirsty leeches in the hills. When surveying for a road near Promé, where the rainfall is only from 50 to 60 inches, I found it nearly impossible to take a line of levels, owing to the number of leeches attacking the staff-bearers.

The next time an explorer is sent to collect information as to the courses and sources of rivers, it might be as well to instruct him in the very simple method of measuring streams, without having to wade through them; he might be asked to use this knowledge, and bring back, as well, some facts as to the heights of the banks of the rivers above the water-level; the depths and the velocities of the streams would likewise be useful, the velocity can very easily be taken if the man has a companion. Such observations, with a few inquiries as to whether the streams flood their banks in the rains, would enable us to set the subject under discussion finally at rest. As it is there can be no doubt that Mr. Gordon will write another book, giving us we will hope more facts and less assumptions than before, and do his best to upset Major Sandeman's conclusions.

HOLT S. HALLETT, M.I.C.E., F.R.G.S.

Lake Shirwa or Kilwa, the source of the Lujende River.

H.M. CONSULATE, MOZAMBIQUE, February 11th, 1882.

Let me say one word on the interesting point that has arisen, regarding the upland lake which is the ultimate source of the Liendi or Lujende river.

I first heard of the Lake Kilwa being the source of this river about twelve months ago. The similarity between the names Shiwa and Kilwa at once struck me, as well as their stated proximity to each other, and I steadily kept in mind the possibility of their being one and the same during my further inquiries, and whilst on my late journey into the interior. The possibility, however, did not seem to strengthen as I progressed in both, and though I frequently asked the question "Is not Kilwa lake sometimes called Shirwa?" I never got an affirmative answer. In the January number of the 'Proceedings' just received, I notice that Mr. Johnson throws out a suggestion that the lake he saw was Shirwa, and that he mentions the existence of a place near to it called "Chilwa." The transition is an easy one between "Kilwa," "Chilwa," and "Shirwa," and I confess Mr. Johnson's guess seems strengthened by it. It appeared to me too bold a suggestion to hazard upon a mere similarity of names, and a proximity to each other, and though I am far from being convinced yet, I think there is a strong probability that the two reported lakes will be found to be one and the same. It has raised an interesting question for solution. If it is not settled before, I hope to be able to do this on my journey to Blantyre (on the highlands near Shirwa) and Lake Nyassa in the course of the present year. Within the next week or ten days I am leaving Mozambique on a coasting journey southwards, and I hope to visit the Quizungo, Tejungo, Licungo and other rivers, and gain some personal knowledge of them.

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