

from 200 to 1400 fathoms; between Java and Port Darwin, in North-West Australia, from 500 to 1630; and between Hongkong and Manilla, depths reaching to 2350 fathoms.

The Indiarrubber, Gutta-percha, and Telegraph Works Company, through their engineer, Mr. R. K. Gray, has also contributed a valuable series of deep-sea soundings in the Bay of Biscay. The painstaking accuracy bestowed on this series has added to the delineation of the 100-fathoms edge of the bank of soundings extending from the French shores on the 46th parallel of latitude.

Acknowledgments are also due to Sir James Anderson, the managing director of the Eastern Telegraph Company, for contributions in the same field.

The Hydrographic Department during the past year has issued 205 Notices to Mariners; an increase, indicative of much activity in the interests of commerce over the globe. Thirty-two Hydrographic Notices have also been published, in 323 octavo pages.

In addition to the usual Tide Tables and Light Lists—gradually expanding from the activity just referred to—the following revised editions of Sailing Directions have been published:—

Bristol Channel.

China Sea Directory, vol. ii.—This embraces the navigation of the China Sea between Singapore and Hongkong.

Africa Pilot, Part I.—This volume includes the West Coast of Africa to the River Cameroons; with the Azores, Madeira, Canary, and Cape Verde Islands.

Africa Pilot, Part III.—This volume includes the South and East coasts of Africa from the Cape of Good Hope to Cape Guardafui, together with the islands in the Mozambique Channel.

Australia Directory, vol. ii.—Comprises the East Coast, Coral Sea and Torres Strait, South-Eastern Coasts of New Guinea, and Louisiade Archipelago.

There are also preparing for early publication; 'Mediterranean Pilot,' vol. iii.; 'The West Coast of Hindostan Pilot'; and 'The Norway Pilot,' Part II.

Since the statement of last year, sixty-two new plates of charts and plans have been published; many of these represent original work, and all may be considered of immediate interest to seamen. 2040 chart plates have received corrections and additions, some of these in extended and important details; notices of these latter are now advertised as in the case of newly published charts. 192,060 charts have been printed, during the financial year, for Her Majesty's Service and for the use of the general public.

Indian Surveys for the year 1878-1879.

THE principal triangulation of all India has now so nearly approached completion—on the lines originally laid out by Colonel Everest,—that only one party was employed on it during the official year 1878-79. This party, under Lieut.-Colonel Branfill, was engaged in completing the Madras Coast Series, a chain of triangles running from Madras to Cape Comorin, and designed to supplement the somewhat restricted and insufficient operations of Colonel Lambton in the early part of the century, and to supply a means of connection between the Surveys of India and Ceylon. Of secondary triangulation some important pieces of work were carried out during the year under review. The Eastern Frontier Series, having been carried along the Tenasserim portion of the peninsula, had arrived at a point not much more than 130 miles distant in a direct line from Bangkok, the capital of Siam. On the other hand, owing to the extraordinary length of the Malay Peninsula, the distance by sea between the two points is fully 2000 miles. It was thus considered

desirable in the interests of exact geography that the two localities should be directly connected and a check supplied on the maritime surveys executed along the coasts. With the co-operation of the Siam Government the line of triangles was successfully laid by Captain Hill up to within 25 miles of Bangkok, though the intricate and unfavourable conformation of the ground in the narrow tract on the British side of the frontier line, coupled with exceptionally heavy rains, occasioned unusual difficulties to the surveyors. During the current season (1879-80), the operations were to consist of the completion of the branch series to Bangkok, and the extension of the principal series to the southernmost point of Tenasserim. Here the Indian triangulation will be brought to an appropriate termination, and a base of verification measured with the Colby apparatus of compensation bars and microscopes. A branch series of secondary triangulation, extended from a side of the Great Indus Series and commenced in the previous season, was continued by Mr. Price across the flat woodless waste of desert between Jacobabad and the Bolan Pass, and thence up through Quetta to the boundary of Pishin in Southern Afghanistan. In the southern part of British Burma the triangulation was carried down to Cape Negrais, its southern extremity, whence the position of the Alguada Lighthouse was determined, and for a short distance along the coast in the Rangoon District. The beacons to be erected on the site of the Krishna Lighthouse (which so mysteriously disappeared in 1878) will be determined by a traverse survey.

Turning to the topographical operations carried on in British territory, we observe that the Gwalior and Central India Survey party, under Captain Strahan, were chiefly engaged on surveys of the Luni River, which discharges into the Runn of Cutch, and of the city of Oodepur. Another party operated in various tracts in the Khandesh districts, and some of the native states in the vicinity of the Tapti, while to the north a party under Major Wilmer completed a good out-turn of work in Gwalior, Indore, and other adjacent independent native states.

In the east of India, the party engaged hitherto on the survey of the Khasia and Garo Hills, south of the Brahmaputra River, was transferred to the southern portions of Cachar and Sylhet, where Major Badgley conducted a survey, partly revenue and partly topographical, of tracts which included various tea grants and estates. Of these no proper survey had previously existed, and the want thereof was supposed to be costing Government heavily in fraudulent zemindari claims. Of the various tribes encountered in the course of his operations, Major Badgley reports that both the Tipperahs and Manipuris are pleasant people; the former being excellent hands at jungle-cutting (an important qualification from a surveyor's point of view) and bringing down a hill-side of bamboo like corn before a reaper. The Sylhetias, on the other hand, are strong, cowardly, and morose, and quite uncompromising in their hatred of Europeans, whom they molest in every possible way.

In Rajputana a very large expanse of country still awaits survey, though this is being gradually diminished by the considerable areas mapped year after year. The year under review formed no exception to this rule, and under Lieut.-Colonel Depree a large out-turn of triangulation and detail survey was completed in Bikanir, Jodhpur, and Shaikhawati. The cessation of famine works in Mysore operated beneficially on the topographical survey of that province, in enabling surveyors who had been temporarily detached for famine duties to be retransferred to their legitimate work. Triangulation was carried on along the boundary between Mysore and South Canara, and the detail survey of this long debated frontier line will be continued till finished. In Guzerat the survey operations are of threefold nature, viz. a topographical survey, the same with certain additions required for revenue purposes, and a special forest survey on a larger scale (4 inches to the mile) of the Danga. This latter tract so far as surveyed consists of one mass of hills of bold and complicated

features and wild aspect, densely covered with forest trees which make the progress of the survey very tedious. The forests also lie in a notoriously unhealthy tract of country which it is not safe to enter till March, when three-fourths of the season is over. It will be readily understood therefore that this survey is one of unavoidably slow progression.

Revenue surveys on the two-inch scale have been conducted in the Saharanpur and Muzaffarnagar districts of the North-West Provinces, together with larger scale surveys of some of the riparian villages in the Umballa district, for the purpose of determining alluvial and diluvial disputes. The topographical operations in the Peninsula of Kattywar lay chiefly in the Hallar and South Prants of the province and embraced part of the inhospitable and difficult tract called the Gir, a well-known refuge for outlaws and marauders. This survey had not been conducted the previous season, owing to the scarcity of water in that locality; the next year (1878-9) the rainfall was ample, but was succeeded by so unhealthy a season that the people of the surrounding districts died in thousands. Notwithstanding this serious drawback the survey was successfully completed in about six weeks, and preparations made for the extension of the work into Cutch during 1879-80. A revenue party was employed in continuation of previous seasons in the Ahmadabad and Puná Collectorates of the Bombay Presidency, where the work is now fast approaching completion. Arrangements have therefore been made for the transfer of this party to the Konkans, where there is enough to occupy the two so-called "Deccan" parties for four or five years to come. Up till the 11th of September, 1878, the party was under the charge of Captain E. W. Samuells, but on the outbreak of the Afghan war this officer was ordered to accompany the Khaibar column. After narrowly escaping from the enemy's artillery fire while surveying at the battle of Ali Musjid, this brave and zealous surveyor unfortunately fell a victim to fever, on the 21st December. The other Deccan party was under the charge of Major Hutchinson, its regular chief, Major H. C. B. Tanner, having been also called to the seat of war in Northern Afghanistan. The operations were chiefly confined to the Sholapur district. *Muzawar*, or village surveys, on the four-inch scale, progressed in the Dera Ismail Khan, Bannu, Rawalpindi, Sirsa, and Jhelum districts of the Punjab, and cadastral surveys in the Banda, Mirzapur, Jaunpur, Budaun, and Ghazipur districts of the North-West Provinces. Besides these, cadastral surveys of the Khorda Government estate (Puri district) and of certain irrigated tracts in the Cuttack district were conducted, as well as in Cachar, where a resettlement of the district is pending, in certain estates of the Lohardugga district and in the Hanthawaddy (late Rangoon) district of British Burma. For this last survey Burmans were employed as field-surveyors instead of Hindustanis, and this measure has been found both politic and economical, though the Burmese are said to be difficult to keep at work and to be adepts at "fudging." Finally, revenue surveys of certain estates in the Kamrup district of Assam, and of various tracts around Darjiling, including one of the town itself, were in progress. Lieutenant Harman, R.E., under whose charge the last-named survey was placed, is now carrying on a topographical survey of Native Sikkim, of which our knowledge has hitherto been derived from Dr. Hooker's survey, and of which a better acquaintance was very desirable. He anticipates acquiring in the course of his operations much geographical information respecting the adjacent trans-frontier districts, without being compelled to cross the British frontier.

Geographical Operations in Afghanistan.—Geographical science has benefited greatly from the very complete arrangements for surveying which have been made in connection with and consequent on the military campaign in Afghanistan. On the outbreak of the war experienced surveyors were attached by the Surveyor-General of India to each of the four columns formed, and the results have been to enlarge

most considerably our knowledge of a country respecting which we had been compelled to remain in comparative ignorance for many years.

Captain Beavan carried a route survey from near Kusmore along the Dera Bugti road as far as Lehri, from the foot of the Bolan Pass to within a short distance of Quetta, and from Quetta to Candahar. He then accompanied General Biddulph's force to Girishk, the well-known fort which commands the passage of the Helmund on the road to Herat, surveying the line of road and also as much of the country round Girishk as opportunity afforded. On returning to Candahar he was employed with other officers in making a survey of the country round Candahar within a radius of 12 miles. Captain M. W. Rogers carried a route survey from Quetta to Candahar, and also accompanied General Hughes' force on its march from Candahar to Kelat-i-Ghilzai by the direct route up the Tarnak, returning by the Argand-ab River. Captain W. J. Heavyside carried a route survey from Quetta to Candahar, checked by occasional latitude observations, besides surveying the Kadanai Valley, lying north-east of the Kwaja Amran range, with the aid of Captain T. Holdich (who has since been deputed to Kabul) and subsequently, still in company with the last-named officer, carrying a rapid but most valuable survey of the new Tal-Chotiali route from Balozai in the Pishin Valley to Fort Munro on our frontier. The rapidity with which this important survey was made, the march being executed at the average rate of 12 miles a day, made it impossible to carry a continuous triangulation across the entire breadth of country; thus after a time Captain Holdich had to depend on his plane-tableing alone without any extraneous check, but its eventual connection with the trigonometrically fixed point of the Sulimanis shows that the work was fairly accurate. From first to last it embraced an area of about 5000 square miles. Lieutenant Gore had been specially deputed to Quetta in order to make a survey of the Pishin Valley, which he accomplished on the half-inch scale. He also accompanied an exploring party under Captain Wylie over the Toba Plateau, and another under Captain Showers (since unhappily slain by Kakars) round the east and north boundaries of Pishin, and across a new tract of country stretching from Quetta into the Kadanai Plains. Lieutenant Hobday was also usefully employed in carrying a route survey from Chaman to Candahar, and in the operations round the last-named city. The general control of the survey operations in Southern Afghanistan rested with Lieut.-Colonel W. Maxwell Campbell, who took advantage of a visit to Shorawak to make a route survey of about 150 miles, closing on Quetta, through new country between Pishin and the great southern desert of Afghanistan. He then took observations at Quetta for determining the difference of longitude between that place and Candahar by means of the newly-established telegraph line, and subsequently accompanied Captain Wylie and Lieutenant Gore on their trip to the Toba plateau. Colonel Campbell also visited Kalat-i-Ghilzai in company with General Hughes' force in October last, after which he returned to India.

To the Kurram Valley column, under General (now Sir F.) Roberts, Captain (now Brevet-Major) Woodthorpe was attached as surveyor, he being subsequently joined by Captain Gerald Martin and Lieutenant Manners Smith. Captain Woodthorpe accompanied the first advance of the force up to the Paiwar Pass, and plane-tabled the country *en route*. He was present at, and took part in, the military operations of the 28th November, and 2nd and 3rd December, 1878. In the second of these actions, he had a marvellously narrow escape, as in the dusk of the morning he went up by mistake to a breastwork occupied by the enemy, who did not discover his presence till he was within six yards, when they fired a volley at him. The stock of his pistol was smashed by a bullet which grazed his side and drove a piece of his clothes into his sketch-book, which was considerably damaged, but he himself happily

escaped uninjured. On the advance of the force he continued his plane-tabling up to the Shutar-gardan Pass, the position of which was found to be very erroneous on the old maps. Captain Woodthorpe also accompanied the expedition to Khost, nearly the whole of which was mapped, and made a variety of reconnaissances in different directions, in the course of which many of the adjacent valleys and much of the southern watershed of the Safid Koh was mapped. He also ascended the lofty peak of Sikaram subsequently to Mr. Scott's visit thither, but was unable to do much from that point, owing to the unfavourable condition of the atmosphere. The total area amounted to about 3000 square miles, the scales of survey being one inch for routes and one-quarter inch for the geographical work.

On the formation of the Peshawur Column under General (now Sir Samuel) Browne, Major Tanner, Captain Samuells, and Mr. Scott were attached thereto for surveying purposes. Subsequently Captains Leach and Strahan joined the party. Major Tanner carried a continuous route survey from Ali Musjid to Jalalabad, reconnoitring the ground on each side as far as was practicable; and though it was not found possible to extend a triangulation from the British frontier, the work was nevertheless successfully connected with points fixed several years previously by Captain Carter and other officers. Jalalabad was thus found to be about five miles nearer to Peshawur than previously imagined.

In May, Major Tanner undertook an exploration into Kafiristan through the Kunar Valley and Chuganistan, and after several perilous adventures reached Aret; but there, owing to the hardships and exposures incident to the undertaking, he was attacked by fever, and compelled to abandon his design and return to Jalalabad. Captain Leach joined the force in January, and surveyed a good portion of the Bazar Valley and the country round Jalalabad, chiefly in the Shinwari country and on the northern slopes of the Safid Koh range. His work was cut short by a severe wound received in action with the Shinwaris, in which, however, his gallantry won him the Victoria Cross. His place was supplied by Captain Charles Strahan, who executed a survey of the country between Safid Sang and Surkpul, and also fixed several peaks on the Hindu Kush and in Kafiristan, besides others in the Safid Koh, Siah Koh, and Karkatcha ranges. In traversing the Hisarak district Major Stewart and Captain Strahan were for some time in a position of considerable peril owing to the threatening conduct of the natives, who were within an ace of falling upon the party, but were eventually prevailed upon to desist. Mr. G. B. Scott made a variety of sketches in the country south of the Kabul River, and between Jamrud and Dakka in the Bazar Valley and the Shinwari country. In surveying on the north bank of the Kabul River, Mr. Scott and his small escort were attacked by a strong party of Mohmands, and a hand-to-hand fight ensued, in which he displayed great gallantry and good judgment, thereby probably saving his whole party from destruction. Later on Mr. Scott successfully ascended to the summit of the Sikaram peak of the Safid Koh (15,620 feet high), whence he determined the position of several distant peaks, including a very prominent peak to the north, which he describes as "a pyramid standing far above the heads of all the surrounding peaks of the Hindu Kush." A considerable amount of geographical information was also obtained to the north of Jalalabad in the Dasht-i-Gumberi Plain and Lughman Valley, from the Daronta Pass to the junction of the Alishang and Alingar rivers, and of the adjacent hills and river valleys.

The Surveyor-General of India has recorded in his Annual Report some very important remarks regarding the experience gained during the survey operations in Afghanistan. The result is to show the indisputable superiority of the plane-table for rapid, trustworthy sketching purposes, where this operation starts from a base, the length and azimuth of which are known, and is supplemented by a fair

proportion of commanding positions and hill peaks which are susceptible of identification, and which thus supply a check upon the plane-tabling or theodolite surveys. As a further check on the accuracy of the work, several of the survey officers in Afghanistan were supplied with a 6-inch transit theodolite—an instrument which has a complete vertical circle, and an eye-piece fitted with a pair of “subtense micrometers,” intended to measure small angles subtended by distant objects in the field of the telescope. By means of this “universal” instrument astronomical observations and the ordinary measurement of horizontal angles can be readily determined, as well as the distances of objects of known length; and though the instrument requires delicate manipulation, in skilful hands it is capable of yielding admirable results.

Trans-Himalayan Explorations.—The last Indian Survey Report contains accounts of these explorations beyond the British frontier, conducted by trained native surveyors. The first of these was a journey along the lower valley of the Sanpo for some distance beyond the easternmost point to which the Tibetan portion of this great river had been traced. By this means the survey of this river, the identification of which with the Indian Brahmaputra has been so long a matter of dispute, has been carried to Gyala Sindong, a fort situated within 100 miles of the highest point to which the Dihong has as yet been ascended. In order to place the identification of the two rivers beyond possibility of a doubt, Lieutenant Harman is arranging for a number of logs of timber to be specially marked and floated down from Gyala Sindong into the Assam Valley. As the intervening belt of country is peopled by wild tribes called Abors, who have always offered a determined opposition to any attempt to pass through their country, this plan is probably the most feasible method of solving the problem.

Another exploration, also in south-eastern Tibet, was made in 1875-6, by a native called L—, who crossed the line of the Great Himalayas by the direct route, between Sikkim and Shigatze, a line over the Kangra lama La pass, which, though it offers but few difficulties, is jealously guarded by the Tibetans, who maintain a fort at Ganpa Jong, just beyond the frontier. From Shigatze the explorer proceeded down the valley of the Sanpo, surveying as he went a previously unknown section of the course of that river as far as the town of Chetang. Eastward of that point he was told it would be impossible to proceed without an escort, so he turned southwards, and with a slight deviation followed the route traversed by the Pundit Nain Singh, as far as Towang. But at this town he was seized and detained, and eventually sent back to Shigatze, from whence he made his way to Darjiling by the way followed by Captain Turner in 1783.

The last piece of geographical exploration on the part of a native deserving mention is an adventurous journey performed by “the Mullah,” an intelligent Mahomedan, whose previous travels had revealed to us a considerable part of the geography of the Kunar and Indus Valley, and of the country about Yassin, all lying in the independent region between Afghanistan and Kashmir. His more recent investigations were carried on in the Swat Valley, which is now mapped out for us for the first time, as well as the Kandia Valley and the north-western part of the Indus Valley where that great river winds its course through independent ground before rejoining the British frontier near Amb. This region is one characterised by considerable wealth of timber, a peculiarity apparently due to the copiousness of the rainfall which is deposited in great quantities south of the great range running south of Mastuj and Yassin, but very sparsely beyond it. In the districts to the north of that chain, Major Tanner successfully carried on a survey embracing an area of about 2000 square miles, about Gilgit and the course of the Hunza River. Hopes are entertained that with the co-operation of our Resident at

Gilgit, Kunjut, Shimshal, and the unknown tracts lying about the western Muztagh may soon be examined by Major Tanner, and that officer may eventually be enabled to enter Kafirstan by way of Gilgit and Chitral, in preference to the more hazardous and difficult way from the Kabul Valley.

This review of the Indian Survey operations may be appropriately closed with a brief reference to the Indian tidal operations which have now been organised on a far more extended scale than previously. Under the superintendence of Captain Baird, tidal instruments were at work during the year 1878-79 at Bombay, Karáchi, Karwar, Madras, Vizagapatam, Paumben, and Beypur, and with the aid of the excellent tide-calculating machine recently constructed for the Secretary of State for India, by Mr. E. Roberts, of the Nautical Almanac Office, tide tables for these ports, computed according to the Harmonic Analysis method, will, as it is anticipated, soon be available for the use of navigators in Indian waters.

Observations on the Western side of Lake Nyassa, and on the country intervening between Nyassa and Tanganyika.

By JAMES STEWART, C.E. (Livingstonia Mission).

(With Maps and Section.)

WE have received, through Dr. George Smith, Foreign Secretary to the Free Church Missions, the following letter from Mr. James Stewart, giving a further account* of his recent explorations north-west of Lake Nyassa, and communicating his valuable longitude observations and maps:—

LIVINGSTONIA, February 18, 1880.

In continuation of my report of December last, I wish now to add a few general remarks, as well as some minor details, which in my hurry I omitted. I have now traversed the whole of the west coast of the lake, and know its character. A concise description of it may be valuable. From the south end of the western bight to Mpemba the coast is fringed by reeds, and swamp extends some distance inland. Landing can be effected at very few points. Between the swamp and the hills (distant from the lake some 10 miles) there is a good deal of very rich and fertile soil. It is inhabited in some places, and in the opinion of the natives, is a most desirable country. For white men, however, I should say the climate would be deadly. It is hot, damp, and close, and for this reason must be rejected as a site for a station. Inland is the Mangone tribe, under Chikuse, with whom we would gladly station a teacher if one were available. Between Mpemba and Kota-kota the country is dry and sterile, and totally uninhabited. At Kota-kota the soil is little if any better. The population is attracted to the place only by the trade, which comes to a focus there, attracted by the safe and spacious harbour. The people draw a miserable subsistence from the soil, cassava being the

* Vide 'Proceedings' R. G. S., *ante*, p. 247.