

adequate basis for a complete explanation. Darwin's theory invokes widespread earth movements about which we still know very little. Daly's theory involves the Glacial period, as to the cause of which we are in total ignorance. Indeed, it is interesting to note that in a recent paper on the cause of the Ice Age (*Bull. Geol. Soc. Inst. Univ. Upsala*, vol. 13, i. 1916) Enquist suggests that the great extension of glaciated areas in the Pleistocene was due to a tectonic sinking of the level of the sea to the extent of 600 metres, and the puzzling features of coral reefs are brought forward to support the theory. Daly's cart is Enquist's horse, but as we do not really know which *is* cart and which its horse, it is impossible to decide which should come first in the links of causation, the Glacial period or the sinking of the seas.

In the present stage of investigation the only theories that call for serious discussion are Darwin's and Daly's. Neither holds the field completely, nor is it likely that they ever will do so, for it would seem wisest to regard them as complementary, each supplying, in any particular case, the defects or inadequacies of its partner. One should not omit to mention that the Glacial-control theory, independently of its truth or otherwise, is worthy of a hearty welcome as a stimulus to further researches. From the causes of the Ice Age, to the habits of reef-building corals, it arouses interest in a wide variety of problems whose solutions, one and all, lie in the future.

ARTHUR HOLMES.

THE INDO-RUSSIAN TRIANGULATION CONNECTION.

WE have lately received an important volume, 'Records of the Survey of India,' Vol. 6, prepared under the direction of Colonel Sir S. G. Burrard, Surveyor-General of India, and dealing with the completion of the link connecting the triangulations of India and Russia. The Indian Survey has done much splendid work, but none has been carried out under greater difficulties than this, and none is likely to be more valuable. It is the first step to the final solution of important geodetic problems.

During the International Geodetic Conference of 1909, which met in London, the question of a triangulation connection between India and Russia was discussed, and it was suggested that a link might be effected across the northern boundary ranges of India to the Chinese or Russian Pamirs. In the early part of the year 1911 the Surveyor-General of India received a proposal to this effect, and steps were at once taken to organize the work.

In 1909-1911 Gilgit had been connected with Rawul Pindi and the Indian system. In the mean time work on the Russian side, which had been initiated by Colonel Tcheikine, had reached the neighbourhood of

Pamirski port, about lat. $38^{\circ} 13'$, long. 75° . To the north-west of Kashmir, for a distance of about 160 miles between longitudes 72° and 75° , the British and Russian dominions are separated by a strip of Afghan territory not exceeding 40 miles in width. The connection of the Gilgit with the Russian survey, however, presented the most tremendous difficulties. The gigantic range of the Karakoram, with peaks ranging from 22,000–26,000 feet, with hardly any passes, and huge glaciers, filled nearly the whole of the ground that separated the Indian from the Russian survey. The difficulty of extending the Gilgit survey to the Afghan boundary was found to be insuperable. The only feasible route was from Gilgit up the Hunza valley to the Kilik Pass. This meant far more work, as the distance was greater; moreover, it meant surveying for over 100 miles up a narrow gorge such as can only be found in the Himalaya. The mountains on either side rise in precipices for thousands of feet. The bottom of the valley is seldom a mile wide, and in some places the path up the valley rests on pegs and props driven into the face of the cliff. The peaks on each side of the valley that had to be climbed in order to get stations were as a rule 6000–7000 feet above the valley, and were nearly all of them higher than Mont Blanc. The number of stations in the survey is thirty-three; their average height is 16,222 feet, the highest being 19,135 feet. Naturally such a survey entailed work of the most arduous kind, more often than not carried out under difficult conditions of wind and temperature.

A brief summary of the work has already been given by Lieut. Kenneth Mason, R.E., in the *Geographical Journal* (vol. 43, p. 664); this report of the Indian Survey gives the entire results of the expedition. During 1911 and 1912 Lieut. H. Bell, R.E., was in charge, and carried out all the reconnaissance. Only a few passes over the mountains were known, and some of these were inaccessible during the summer owing to rivers swollen with melted snow and unfordable; while beyond them ranges of peaks ("Glorified Matterhorns") entirely stopped further progress. According to Lieut. Bell they appeared inaccessible even to experienced climbers, and it was a physical impossibility to take an instrument up any one of them. It will be remembered that at the end of June 1912 Lieut. Bell was most unfortunately taken ill and died at Lup-Gaz, after having made his way to the termination of the Russian triangulation and met Colonel Tcheikine of the Russian Topographical Service. Early the next year 1913 Lieut. Mason took charge of the parties, and the connection of the English and Russian surveys was accomplished before the end of the year.

The report is full of interesting detail and makes excellent reading, especially the lively chapters contributed by Lieut. Mason, who went straight to the work from a holiday at Mürren, and tried his *ski* on the passes with some pleasure, but with "a fair number of tosses" and a descent of the Burzil which "left a lot to be desired." His chapter on Geographical Impressions of the Pamirs deserves careful study, and requires

for its full appreciation a better map than is contained in the report. His re-observation of marks placed by the Geological Survey on the snouts of certain glaciers shows the difficulties of satisfactory marking and the very valuable results to be obtained when these are overcome. He has also an interesting chapter on photographic surveying in the Pamirs. With Captain R. W. G. Hingston, I.M.S., he contributes a section on Geology and notes on the Climate and Snowfall. Messrs. V. D. B. Collins and C. S. McInnes describe the stretches of triangulation for which they were responsible.

Captain Hingston made a very complete zoological collection of the fauna of the Taghdumbash Pamir, and a series of observations of the cirrus clouds for the Meteorological Survey of India. A botanical collection was also made, but in such inhospitable wilds it necessarily was small and consisted of only forty-four species.

Captain Hingston's observations on the blood at high altitudes are particularly valuable, and the conclusions he draws from a large number of observations are given by quoting his words: "Increase in altitude means increase in the number of red blood-corpuscles. Normal blood at sea-level contains 5,000,000 red blood-corpuscles per cubic millimetre. During a gradual ascent the number increases until at an altitude of 18,203 feet, the highest point at which I was able to make an examination, the blood contains 8,320,000 corpuscles per cubic millimetre. The manufacture of these corpuscles takes time to develop, and failure in that development . . . means mountain sickness. The number of these red corpuscles in the blood of a dweller at low altitudes can increase until it reaches ultimately the number normal in the dwellers at high altitudes, and the converse is likewise true; and the method by which the body adapts itself to great heights is not by a greater energy on the part of the cardiac or respiratory mechanism, but by a slow and gradual manufacture of the red blood-cells which produce a greater richness of the blood stream and convey a normal supply of oxygen to all the tissues."

In the report are a number of excellent reproductions of photographs. They give a clear impression of the country, but they show it only in fine weather, and fine weather was the exception. Nearly half the days had seen snow falling to a greater or less extent. Naturally one of the greatest difficulties was the rationing the detachments. The Pamirs produce nothing except sheep and goats, and all the flour and other food had to be brought from Gilgit and Hunza; those only who have travelled in the desolate and rugged upper valleys of the Himalaya and Karakoram ranges will understand the immense amount of labour necessary. But in spite of this, in spite of the incessant climbing up and down the peaks from which the observations were to be made, waiting sometimes at the high camps on ice and snow for days till the weather was fine enough to allow angles to be taken, and in spite of numberless difficulties, the expedition was brought to a satisfactory end. Those who shared in the work are to

be congratulated, for not only have they completed a most important contribution to our knowledge of the mountain barrier that lies where "Three Empires meet," and connected two of these empires by survey, but they have also lived amongst some of the grandest scenery on the Earth's surface. In a letter from Captain Kingston to Lieut. Mason the former says, "I shall always look back on my experience on the Pamirs as one of the most fascinating of my life."

The report is dedicated by its authors to the memory of Lieut. Bell, who lies buried at Gilgit next to Hayward. His brother officers and his colleague Colonel Tcheikine bear touching reference to his high qualities of character and intellect. The Sarikolis at Lup Gaz, where he died, have named the valley Bell-Sahib-i-Jilga, and have built a shrine to the memory of the man they reverence for his just and kindly dealing.

J. N. C.

The technical results of the survey are described in three appendices, with a chart showing the figures of the triangulation, which has seven quadrilaterals, two tetragons with central points, and eleven single triangles, some of which can hardly be described as well conditioned, though they are far better than at one time seemed possible. Six-inch micrometer theodolites were used, generally with luminous signals. The mean triangular error of the whole series was $3''\cdot33$, and the mean error of an angle $\pm 2''\cdot79$. The Indian calculations are as usual based on the Everest spheroid.

It must be noticed that although a connection has now been made between Indian and Russian triangulation, the Russian work is at present not connected with the general triangulation of the Russian Empire. In an Appendix by General Pomerantsev it is explained that the Russian work starts from the town of Osh, where a base is measured, and proceeds by Lake Kara-Kul and the valley of the Aksu to the junction with India on the side Kukhtek-Sarblok, near which the chain is adjusted to a second base at Kisil-Rabat, where latitudes and azimuths were observed. The mean error of an angle of the Russian triangulation is $\pm 2''\cdot89$, and it is calculated upon the spheroid of Bessel. The side common to the Indian and Russian triangulations has a length of 7134 metres, and the discordance between the two values for this side is 152 metres. These results must be considered preliminary, and the whole will be recalculated when the Russian triangulation is joined to that of Tashkent.

Three peaks intersected from the new triangulation had been previously fixed by the Pamir Boundary Commission of 1895, and the agreement between the two sets of values is very striking. Commenting upon this in the Preface, Colonel Lenox-Conyngham remarks that the work of the Boundary Commission in 1895 was carried on by the approximate methods and expedients which rapidity of movement dictates, but that in skilled hands even these are capable of producing results of surprising accuracy,

so surprising as to have the appearance of lucky accidents were it not that the luck always seems to accompany those who know their art. It is possible that Colonel Wauhope and his colleagues on the Boundary Commission will be less surprised than Colonel Lenox-Conyngham at the excellence of this accordance, which suggests in fact that in course of time a connection will ultimately be established between the Indian and Russian Surveys by the method of re-section from visible but inaccessible peaks, stronger than is possible by the necessarily somewhat weak chain carried on stations which can be occupied in canonical form. It will be remembered also that in the recent work of the Peru-Bolivia Boundary Commission the triangulations north and south of the Cordillera were connected by re-sections with very satisfactory results.

A. R. H.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE meeting of the British Association at Newcastle-on-Tyne was again held under war conditions, and, as was to be expected, the attendance was small. But it is questionable whether the quality of the work done in the various sections suffered much thereby. In Section E, at least, many interesting papers were read, and there were several good discussions. The Presidential chair was filled by Mr. E. A. Reeves. Sir Thomas Holdich, Dr. W. S. Bruce, Mr. Chisholm, and Prof. J. W. Gregory were Vice-presidents. Mr. J. McFarlane acted as Recorder, and Dr. R. N. Rudmose Brown, Mr. B. C. Wallis, and Mr. N. Shaw as Secretaries.

The President's address on "The Mapping of the Earth, Past, Present, and Future" was read at the opening meeting of the Section in the Friends' Meeting House on September 6. It is reported in full in the October number of the *Geographical Journal*.

Prof. H. J. Fleure followed with a paper entitled "France—a Regional Interpretation," in which he dealt with the wealth of the contributions made by France and her people to the heritage of civilization, and endeavoured to interpret this, not as the result of any presumed race-superiority, but as due to much more serious and substantial factors. France is in a sense a goal of many east to west routes in Europe. Across her also run almost the only practicable ways from north to south. These ways are fairly easily graded, and have time after time allowed waves of Mediterranean civilization to adjust themselves gradually to the conditions of the forest and corn lands further north. It has thus come to pass that Northern France has always had a good deal to link it with North Central Europe in peace and in war, while the south has remained essentially Roman in the foundation of its life. Burgundy and Aquitaine are, as it were, go-betweens, and their cities and traditions suggest this. But Aquitaine and Brittany make another contribution to civilization, for they with Ireland and the west of Britain retained the old Celtic-Ægean life of the Bronze Age for centuries after iron had spread into Europe, and their life has much that will be found to have been inherited from that Age. The author then proceeded to discuss the relations of the Paris Basin, the Rhône Corridor, Burgundy, Aquitaine, and other regions to one another, and their reactions one upon another, as shown in their language, the history of their law, their town-places, their cathedral