Eighth Meeting, 12*th March*, 1877.

SIR RUTHERFORD ALCOCK, K.C.B., PRESIDENT, in the Chair.

PRESENTATION.—*Godfrey Darbishire, Esq.*

ELECTIONS.—*James Coate, Esq.; Charles E. Cooper, Esq.; Edward Prichard Evans, Esq.; Joseph Faulkner, Esq.; Rev. William Theophilus Giles*, M.A.; *Robert Logan Jack, Esq.; James Kennard, Esq.; Colonel Henry Man* (Madras Staff Corps); *John Thomas Howie-McEwan, Esq.; Arthur A. Pearson, Esq.; John Alexander Sandilands, Esq.*

DONATIONS TO THE LIBRARY, 26TH FEBRUARY TO 12TH MARCH, 1877.—Archæological Survey of Western India; Report on the Antiquities of Kâthiâwâd and Kachh, by J. Burgess, 1876 (*H.M. Secretary of State for India*). The Changes of Exmouth Warren, by J. M. Martin, Pt. 2, 1876 (*Author*). Perseverance in Arctic Exploration, by J. O. Chadwick, 1877 (*Author*). The Gem Geography, by J. A. Butterworth, Pt. 1 (*Author*). Charts of Meteorological Data for nine 10-degree Squares of the Atlantic, with accompanying Remarks, 1876 (*The Meteorological Committee*). Catalogue of the Royal Engineer Corps Libraries, 1876 (*The R.E. Corps, per Lieut. F. J. Edwards*). Histoire de l'Asie Centrale, 1153–1818, par Mir Abdoul Kerim Boukhary, Persian text and French translation by Charles Schefer, Paris, 1876, and Persian text of the Relation de l'Ambassade au Kharezm, par Riza Qouly Khan, publications de l'École des langues Orientales vivantes (*The Minister of Public Instruction in France, through H.B.M. Ambassador in Paris, favoured by Lord Tenterden*). Report of the Kew Committee for year ending October, 1876 (*The Committee*). Zur Frage der Meeresciculation, von H. Schmick (*Author*). General Report of the operations of the Marine Survey of India, 1874–76, by Commander A. Dundas Taylor, Calcutta, 1876, and List of Light-houses, &c., in British India, to 1st January, 1877, by R. C. Carrington, Calcutta, 1877 (*Commander Taylor*). Géographie de la Soie, par L. Clugnet, Lyon, 1877 (*The Lyons Geographical Society, per M. A. Brun*). The trade of Central Africa, present and future, by V. L. Cameron, 1877 (*Professor Tennant*).

DONATIONS TO MAP-ROOM, FEBRUARY 26TH TO MARCH 12TH, 1877.—Map of Western Australia, showing Explorations made between the years 1872 and 1876; Surveyor-General's Office, Perth, W.A. (*John Forrest, Esq.*). Four sheets of the Topographical Atlas of Denmark, $\frac{1}{40000}$ (*Royal Danish Ministry of War, through Count von Bulow*). MS. map showing Country round Port Moresby, New Guinea, by Octavius C. Stone (*Author*). MS. map of River Beni, Bolivia, showing proposed routes of exploration, by Juan B. Minchin (*Author*). MS. Sketch-map of Country about the Source of the Joliba, West Africa, by Benjamin Anderson (*Author*). Map of Perak and Sangalore, Wellesley Province and Pulo Penang, by Major McNair, R.A.; Sketch-map of Country round Malacca; Sketch of the Perak River; Survey of River Linghy and of Tracks from Linghy to Rassa, and from Lukut to Rassa, Sunghy Ujong (*W. Barrington d'Almeida, Esq.*).

The President announced that two Papers were to be read; the first by Mr. Buchanan, who had served as chemist on the scientific staff of the *Challenger* Expedition. It related to the distribution of salinity in the ocean, or its saltness at different depths and in different latitudes; and dealt with several interesting problems in Physical Geography, as to the dissolving power of the water, its specific gravity, its effects upon the deposits. The second Paper was by Mr. Allen, of Her Majesty's Consular Service, on an interesting journey he had made into the interior of Formosa, a part of that island, occupied by aborigines and savage tribes. A third Paper on the same island was by Mr. Bullock; extracts from which would be read, if time permitted.

The following Papers were then read:—

1. *On the Distribution of Salt in the Ocean as indicated by the Specific Gravity of its Waters.* By J. Y. BUCHANAN, Chemist in the *Challenger* Expedition.

[ABSTRACT]

THE specific gravity of the water from the surface was determined every day during the cruise when at sea, and from the bottom and intermediate depths as often as opportunity offered. The instrument used was a glass hydrometer, combining the advantages of Nicholson's hydrometer with those of the one with divided scale. The results obtained with it were accurate to 5 in the fifth decimal place. The observations were always made when the water was sensibly at the temperature of the atmosphere, the results so obtained were reduced, by means of the tables of the late Professor Hubbard of Washington, to their value at the standard temperature of 15·56° C. (60° F.), the density of distilled water at its temperature of maximum density being unity. In this way the specific gravity of nearly 2000 different waters was determined. These were all *ocean* waters—that is, they were from localities free from the local effects caused by proximity of land—and the specific gravity of such waters has been found to vary between 1·024 and 1·028, between which limits we may assume with certainty that the salinity varies with the specific gravity.

The distribution at the surface of saltness thus indicated was

exhibited on a chart by means of differently coloured areas, and the vertical distribution was shown in the diagrams representing meridional sections of the Atlantic and Pacific Oceans respectively.

As far as the surface is concerned, the general results were as follows. The concentration of the waters of the Atlantic is greater than that of either the Pacific or the Southern Ocean, and it is greater in the North Atlantic than in the South Atlantic, although the actual maximum may be slightly higher in the South Atlantic. In the North Atlantic the maximum was observed in 22° N. latitude and 40° W. longitude, from which point it diminishes in all directions. The maximum in the South Atlantic was 1·02785 off the coast of Brazil, in latitude 17° S. In the Pacific the areas of concentration are much less pronounced, the maximum of 1·0272 occurring near the island of Tahiti. In the North Pacific the maximum is under 1·0265, and situated about 22° N. Between the north and south maxima in these oceans is situated the area of equatorial dilution. Following the equator from east to west in the Atlantic, the water increases markedly in saltness: in the Pacific the same is the case, though in a less degree. On the polar sides of the areas of concentration the saltness diminishes as the latitude increases, at first rapidly, then more slowly. The whole of the Southern Ocean between the parallel of 40° S. and the edge of the ice appears to have a very uniform surface specific gravity of about 1·0250. In the North Pacific, to judge from Lenz's observations, it is lower, and in the North Atlantic higher.

If we consider the water below the surface, as shown in the vertical sections, we find, in the Atlantic, that in the concentration-areas the specific gravity diminishes until a minimum is reached at a depth of about 800 or 1000 fathoms, after which it increases slightly down to the bottom where, in the South Atlantic and in the Pacific, a tolerably uniform specific gravity of 1·0257 to 1·0259 is observed. In the areas of equatorial dilution the specific gravity first increases to a maximum at a depth of 50 to 100 fathoms, after which it follows the same law as the water north and south of it. In the North Atlantic the bottom specific gravity is comparatively high. In investigating the causes of the variations in specific gravity in the ocean, we find that they depend on the means available for removing or supplying *water*. Thus the areas of greatest concentration coincide with those where the dry trade-winds are constantly blowing, taking their rise in the lower temperate latitudes, and proceeding in their course always from colder to warmer regions, so that, for the first part of their journey, at least, although they are continually taking up moisture, their capacity for doing so is continually increasing. Hence the great concentration of the water in the steady Trades of the Atlantic. On the other hand, the westerly winds of the higher temperate latitudes which take their rise at the same source, proceeding in the first part of their course from warmer to colder latitudes, are soon comparatively saturated, and incapable of concentrating the waters over which they blow. The moisture taken up by the trades is wrung out in the equatorial calms, where it descends as heavy rains, and dilutes the sea water. Comparing the salinity of the sea surface with the distribution of barometric pressure, we find that the maximum of saltness lies in the northern hemisphere to the south-west, and in the southern hemisphere to the north-west, of the barometric maxima. Concentration is also brought about by the formation of ice, and in regions where more ice is formed in winter than melts in summer, which in the southern hemisphere would enclose a very large area, the effects must be cumulative. In the Southern Ocean the specific gravity of the bottom-water was always much higher than that of the surface.

The high-bottom specific gravity in the North Atlantic depends not only on the lake-like form of the basin in which the water is kept by tangential winds and currents from getting out of the concentrating effects of the trade-winds, which effect is propagated downwards to a great extent by the difference between the summer and winter temperatures, but also on the fact that all the accumulations of salt brine from the Mediterranean are emptied into it through the Straits of Gibraltar. It is probable that a similar effect is produced on the Indian Ocean by the proximity of the Red Sea.

The observations make it probable that in the Atlantic the water from the surface, down to a depth of 1000 fathoms, has on the whole a flow *inwards*, or from south to north, and below that depth and down to the bottom it appears to have an opposite flow, thus providing for the removal of the salt which otherwise would accumulate in the North Atlantic. The Atlantic thus presents on a larger scale what is observed in the Mediterranean, where the mean drying power of the atmosphere is higher than even in the North Atlantic. In the Pacific, owing to its form and general climate, these conditions are not so evident.

[The above Paper will be printed *in extenso* in the 'Journal,' Vol. xlvii.]

Mr. FRANCIS GALTON asked Mr. Buchanan whether, as a rule, in passing from one ocean-current to another, his instruments gave any indication of the change. It was obvious that two adjacent currents must usually have different amounts of salt in their composition, and he would like to know if, with the very delicate instruments used by the *Challenger* Expedition, and the great precautions which were taken in making the observations, such differences became sensible.

Mr. BUCHANAN replied that there was no doubt that in the currents of the ocean there was very considerable difference in the specific gravity of the water, as well as in the temperature. In the chart suspended before the Meeting the Gulf Stream was very clearly indicated simply by the specific gravity, or rather the edge of it, where the warm and dense water of the Gulf Stream met what was called the "cold wall" of the Labrador current. The Equatorial currents also were very marked, being fresh. The Agulhas current of South Africa showed similar variations in density.

The PRESIDENT said the Society was much indebted to Mr. Buchanan for his interesting Paper on a subject involving various scientific problems. It was calculated to throw considerable light upon many of those questions, but he was afraid the Meeting was scarcely competent to discuss them at any length. Such Papers, however, must tend very much to improve their knowledge of Physical Geography, precisely on those points on which it was most difficult to collect authentic facts. Such facts could only be obtained by an expensive and elaborate expedition, such as Her Majesty's Government fitted out in the *Challenger*. Mr. Buchanan was one of the body of scientific men who were sent on the three-and-a-half years' voyage, and the Paper which had just been read contained merely a fragment of the valuable results which had been obtained. When the whole of those results were made public, it would no doubt be shown that the Government of a civilised and cultivated country like England could not possibly devote some portion of its funds, and the energies of its scientific men, to a better object.

2.—*Notes of a Journey through Formosa from Tamsui to Taiwanfu.*

By HERBERT J. ALLEN, H.M. Consular Service, China.

LITTLE is known of the interior of Formosa, and a short sketch of a journey from the Treaty port of Tamsui to that of Taiwanfu, in which the heart of the island was visited, will perhaps be of some interest. Formosa, situated about 100 miles from the mainland of China, is about 240 miles by 80 broad. The Chinese name of it, Taiwan, or Bay of the Raised Terrace, probably refers to the square flat-roofed blockhouse, Fort Zelandia, built by the Dutch when they were in possession of the island, and which is now a mark for vessels making the anchorage at the capital, Taiwanfu. The department is, according to Government statistical works, divided into the subdistricts of Komalan, Tamsui, Changhua, Kia-i, Taiwan, Fengshan, and Pênghu, or the Pescadores, of which Komalan is the only one on the eastern side of the island. The Chinese Government charts do not depict the coast-line on that side at all, the boundary being represented by a mass of mountains. The central ranges, the southern and eastern coasts, are principally inhabited by various tribes of aborigines, totally unlike in dress and features to the Chinese, who call them barbarians, and treat them accordingly. Some of the districts have been so enlarged lately by the constant encroachments of the Chinese on savage territory that last year it was deemed necessary to increase the number of governing officials; Komalan and Tamsui districts were abolished, and a department of North Formosa, with three dependent magistracies,

established in their room. The Chinese Government forbade their people to cross the boundary of savage territory, at one time well defined; but since the Japanese expedition against the Bootan tribe of aborigines in the south in 1874, they altered their policy, and, finding themselves looked on as masters of the whole island, took active steps to improve their knowledge of it. Schemes for cutting roads through the hills were set on foot, colonists were bribed to settle in out-of-the-way places, and presents given liberally to the aboriginal chiefs, who were urged to acknowledge Chinese rule. These measures have not been altogether successful, in consequence of the persistent antipathy and mistrust shown by the savages, and the petty war goes on whenever the Chinese try to penetrate into the hills unaccompanied by a large force.

Being invited by Mr. Mackay, of the Canadian Presbyterian Mission in the north, and Mr. Ritchie, of the English Presbyterians in South Formosa, to accompany them on a tour they intended to take to visit their respective stations, I started on the 10th of November, 1875, from the old Dutch fort, then used as a Consular residence, at Tamsui. I crossed the harbour near its entrance, and skirting the western side of the Kuanyin Hill, 1720 feet above the sea, gained the table-land, which stretches some 30 miles down the coast. I halted at the little village of Doaheng for dinner, and went on 10 miles further by moonlight to the inn at Tionglek, where my companions were sleeping, they having earlier in the day left their chapel near Banka, the largest and most commercially active town in North Formosa, 8 miles up the Tamsui River, and gone by another road. The next morning we made an early start, and the air on the plateau being very invigorating, walked 8 miles before breakfast, passing many villages of Hakka Chinese immigrants from Kuangtung Province. The plain was cultivated with paddy and sugar-cane crops, and we constantly met heavy four-wheeled carts with axles, doubtless introduced by the Dutch, which were generally drawn by a buffalo, with two of the ordinary black cattle of the country on each side, yoked abreast. About 8 miles from Tekcham we reached Table Hill, or Windhill Slope, as its Chinese name signifies, which was the termination of the plateau. From this point we got a good view of the sea westward, the valley with its pretty river winding along at our feet, and clumps of bamboos on the opposite bank, which screened the town from sight. Descending the hill, we crossed the river in one of the flat-bottomed boats used here. The ferryman held on to a rattan-rope, securely fastened to stakes at each bank, as he swung his boat across the stream, which in the rainy season becomes a rapid torrent.