

*Twelfth Meeting, 8th May, 1865.*

SIR RODERICK I. MURCHISON, K.C.B., PRESIDENT, in the Chair.

ELECTIONS.—*The Hon. Reginald Abbot; William Eassie, Esq.; John Myer Harris, Esq.; A. S. Robertson, Esq., M.D.; Edward Sercombe, Esq.; John Stewart, Esq.; and Capt. J. C. Wilson, R.N.*

ACCESSIONS TO THE LIBRARY.—‘*Travels and Researches in Crete,*’ 2 vols., by Capt. T. A. B. Spratt, C.B. ‘*Nivellement Barometrique dans les Provinces d’Alger et de Constantine,*’ par M. le Dr. Paul Marès. Both presented by the authors. ‘*Astronomical and Meteorological Observations, made at the Radcliffe Observatory, Oxford, in the year 1862,*’ Presented by the Radcliffe Trustees. Continuations of ‘*Journals,*’ ‘*Transactions,*’ &c., &c.

ACCESSIONS TO THE MAP-ROOM.—Ordnance Survey—Parishes, on 22 sheets.

The first Paper was—

1. *On the Specific Gravity, Temperature and Currents of the Seas between England and India.* By HENRY TOYNBEE, Esq., F.R.G.S., F.R.A.S.

THE author in this paper recorded the principal observations which he had made with instruments supplied by the Board of Trade, during five voyages to India, leaving England July 1st and returning about the middle of April. It was the constant recurrence of certain phenomena in the condition of the sea, in the same place and at the same time of the year, that had led him to think they might be interesting to the public as pointing to some important conclusions regarding the Physical Geography of the sea. He found, in the Atlantic, that the specific gravity of the sea decreased on approaching the equator—a result due to the rains falling between the North-east and South-east Trades; and in the Southern Indian Ocean in the rainy season (January and February), the whole ocean was affected by the rains then falling south of the Line. In the Bay of Bengal the specific gravity was still lower, which is attributable to the freshets which flow from the Ganges, Godavery, and other large rivers in October, as well as to the large amount of rain at that season. With regard to temperature, his numerous observations during the five voyages, the chief results of which he had tabulated, in the first place threw some light on the cold current which swept in August northward along the west coast of Africa; this he found reason to conclude curved sharply to the westward shortly after crossing the Line in about 17° w. long.: the farther east of this the colder was the water; once, between 1° 30' N. to 0° 30' s. lat., he found its temperature to continue as low as 70° (Fahr.),

making the air quite cool and damp. He was not able to say how near the coast this cold current ran; but he supposed, from the low temperature of the water on the Agulhas Bank and in Table Bay, that it kept close to the land. Capt. Maury had represented a current travelling south along the west coast. In March this current is of a higher temperature, because it has then flowed from the south after the southern summer. The author confirmed the views of Towson regarding the direction of the tracks of icebergs in the South Atlantic, and showed that the very low temperature of the Sea in Table Bay ( $51^{\circ}$  in February) was most likely due to a current setting from the ice-bearing sea, and that this was also the source of the great West African current. A few miles to the south-east of the Cape the sea greatly increases in warmth, and along the parallel of about  $40^{\circ}$  running from the meridian of Greenwich to  $50^{\circ}$  E., there was found in each voyage a succession of lanes of hot and cold water—the hot as high as  $67^{\circ}$  (Fahr.), and the cold sometimes as low as  $40^{\circ}$ . Were it not for the rush of warm water down the Mozambique Channel, the ice-streams travelling north-eastward from Cape Horn would not be deflected, as now, to the south-east, but would go forward and render the passage round the Cape much more dangerous than it is. After giving further details on this important subject, the author concluded by recommending outward-bound ships to delay crossing the fortieth parallel till the longitude of  $10^{\circ}$  E. is reached. As the sea on the Agulhas Bank is always several degrees colder than that to the eastward of it, the thermometer is a good guide to tell a ship when she is coming near the land.

The PRESIDENT said every geographer must be aware of the great value of the paper. In his time few papers had been submitted to the Society which were more entitled to their approbation, as throwing important new light on the physical geography of the sea, and the temperature and density of the ocean. These observations were of the greater value, from the fact that they are the result of five voyages.

Admiral COLLINSON said the Society had continually brought before them subjects of great interest; but they could not have questions of greater moment to deal with than the facts of physical geography. He hoped Captain Toynbee might long live to continue to prosecute his observations, which he had carried on with so much credit to himself and so much honour to his profession. The observations he had communicated to the Society were of great importance to all who are concerned with Hydrography. He had showed that the instruments which are supplied by the Board of Trade can be turned to good account with regard to both navigation and physical geography.

Staff-Commander DAVIS had himself made a great number of observations on the specific gravity of the ocean, and it appeared to him that a source of error existed in the method of taking the temperatures and specific gravities of the surface of the ocean. We throw a bucket overboard, and take the water directly from the surface. There is no allowance made for the heat caused by solar radiation, or by the descent of rain cooling the waters, or anything of that kind. We have merely the surface of the water acted upon by the local cir-

cumstances of the day or night. He believed greater value would be attached to observations could they be taken from a depth of two or three fathoms; we should then arrive at results that would be of value in the construction of thermal charts. He had himself studied deeply the extensive charts of Maury, extracting every temperature and tabulating them with regard to longitude and latitude, with a view to see how he could make a thermal chart that would be practically useful to a sailor. But he candidly confessed he had failed, owing to the great variety of temperatures obtained at the same place, from the simple fact that the surface-water alone had been taken. With regard to the specific gravity, he had tried this class of observations himself hundreds of times with a very beautiful instrument, on water brought up from a depth of from 300 to 600 fathoms, and he had never found the difference so great as that which Captain Toynbee spoke of, and which led him to suppose that the specific gravity of the sea is also influenced by mere local circumstances, such as a fall of rain.

Mr. GALTON said Captain Toynbee's paper enabled him to understand a phenomenon that had hitherto been unintelligible to himself, with relation to the great cold that is felt on the coast of South-Western Africa, under the tropic. The low land round Walfisch Bay, though apparently hot to a person coming from the sea, is exceedingly cold compared with the temperature of the interior. It is a land that is looked upon with a sort of horror by the natives, on account of the cold. Oxen when driven down to the beach suffer greatly from the chill. He himself, at the end of December, which corresponds with our June, while waiting on the coast, under a clouded, vertical sun, felt the cold so severely, that he was obliged to spend the greater part of the day, huddled under the bed-clothes, half-dressed. He had been aware of the existence of a cold current from the Cape, that passed not far from the shore, but he never had any idea of the lowness of its temperature, nor of the great extension that Captain Toynbee had shown it possessed. Looking at his figures on the map, they seemed quite sufficient to explain the phenomenon he had described, which had formerly appeared so exceptional.

Captain TOYNBEE stated that there were now lying at the Board of Trade a number of observations that he had made on other subjects, which when collated would, he had no doubt, yield similar generalisations to those he had deduced on temperature, with respect to the wind. The winds round the Cape will bear dealing with much in the same way as the waters. With respect to what Captain Davis said, he had himself observed a difference between the temperature at the surface of the sea and that at some depth. He had experimented on water drawn from as low as 100 fathoms, and all his observations on the subject were in the possession of the Board of Trade. He found as much difference as four or five degrees between the temperature of the surface and that at 100 fathoms. Captain Davis remarked as to the difference between the surface and a few feet down. He did not find any difference except when there is a glassy calm, and then the surface is extremely heated, so that it will go up from its normal state to  $80^{\circ}$  and  $85^{\circ}$ . With respect to the specific gravity of the sea, he had remarked in the paper that the cause of the decrease in the specific gravity was the rainfall. It was the recurrence of the same phenomena pretty nearly in the same place during five years in succession, and almost on the same day, that induced him to write the paper; and he believed such a uniform result could not be due simply to accidental or temporary causes. Perhaps Captain Davis had not considered that the temperature of the sea in different places changed at different seasons of the year. He never found, even after a shower of rain, that the temperature on the Equator in March fell so low as  $70^{\circ}$ . It was only in August, after the southern winter, when the current from the southward brought up the cold water, that they had the cold current across the Equator, at which time rain is seldom seen there. In March, after the southern summer, the temperature was seldom if ever below  $78^{\circ}$ . Deep-

sea temperatures were useful in their way. He had adapted an instrument for the purpose, made of bamboo and furnished with two valves. He tried it one voyage and got some satisfactory results, which are now lodged in the Meteorological Department of the Board of Trade.

Captain DAVIS explained that he had not the slightest intention of detracting from the value of Captain Toynbee's observations. Indeed they were invaluable, simply on account of their having been taken so many times in the same place. He was perfectly aware of the difference of temperature at different seasons of the year, because he had studied Captain Maury's charts well. The whole of the seamen of Great Britain could only be thankful to Captain Toynbee for the trouble he had taken. If every commander of a vessel would take observations in the same way, we should soon be able to construct a physical chart of the sea.

The next Paper was the following—

2. *Ascent of the Rovuma, East Africa.* By J. KIRK, Esq., M.D., F.R.G.S.

THE ROVUMA, although a stream of small dimensions compared with the larger rivers which drain the African continent, is yet of considerable interest in a geographical point of view, as the first of importance on 600 miles of coast north of the Zambesi, and opposite that blank on the map where the great problem in African geography remains to be solved, and the head waters of the Congo, the Nile, and the Zambesi yet to be defined. The Tanganyika lake, which lies in this space, finds advocates who drain its surplus waters north, south, east, and west; nor are we even sure that it possesses an outlet.

The Rovuma is an open path by which to settle this mystery, and lead the explorer safely beyond the extortionate tribes and jealous Arabs of the coast. This river opens to the Indian Ocean north of Cape Delgado, within the jurisdiction of the Sultan of Zanzibar. Near its banks geography lost one of her enthusiastic followers in the lamented Roscher: but his fate need not deter others, as with ordinary prudence it might have been averted. Unlike most African streams, the Rovuma opens without bar or surf to a spacious easily-entered bay. Previous to our visit only a few miles near its mouth were sufficiently known; native traders, however, always mentioned the river in its upper course as one of the chief features on the march from the shores of Nyassa to Zanzibar. With a view to ascertain something definite regarding its course, size, navigability, and value as a path to the interior, I accompanied Dr. Livingstone on two separate occasions. With the steam-vessel *Pioneer*, drawing 5 feet of water, we first attempted the ascent in March 1861. In common with other South Equatorial streams, the Rovuma was then in flood, and the large volume of water brought down extended into

the bay and covered its surface with weed and driftwood. So strong was the current then issuing from the mouth, that the vessel did not swing to the tide when anchored a quarter of a mile off in the bay. Everything at first seemed to indicate a large and fine river, but after an ascent of 30 miles, in which considerable difficulty was found in getting a navigable passage, it was thought advisable to retrace our steps lest a sudden fall of water should detain us until next season. On leaving the river fever attacked our crew, and for a time the *Pioneer* was in the hands of those who did not profess a knowledge of seamanship. We returned a second time to explore the Rovuma in the dry season of 1862, and with two of the ship's boats succeeded in reaching the rapids which limit navigation, distant from the coast a little more than 100 miles, and half-way to the Nyassa. On the 9th September, 1862, we left the *Pioneer* at anchor in the bay, and, accompanied for a short distance by Capt. Gardner, of H.M.S. *Orestes*, entered the river. A dark band of mangrove vegetation lines the creeks near the shore, over and beyond which, distant 8 miles, is a long, flat ridge, 200 feet high, broken only where the river enters the plain. Among the mangroves of a tropical coast there is little of interest: a death-like silence there prevails, broken only by the wild cry of the fish eagle or a startled antelope making off through the mud. Yet these desolate and gloomy forests accomplish a great work, growing where no other trees will, they favour the deposit of alluvial sediment and the extension of the land. When this unhealthy region is passed we enter a plain covered with heavy timber, thick bush, and gigantic grass, bound together and festooned by brilliant-flowered tropical plants, teeming with animal life. In the water there are herds of hippopotami, easy of approach, not having been hunted with fire-arms, but sufficiently bold to attack a boat with their formidable tusks. In the maritime region the tree which produced the copal still lingers on, but has died out from the inland district where the semi-fossil resin is dug from the soil.

The Rovuma, within the coast ridge, occupies a wide valley, whose wooded slopes, covered with jungle, are untouched by the hand of man. Having passed about 20 miles up the river, we came to a small lake in an amphitheatre off the northern slope. Here we saw the "tsetse" fly, which was afterwards found to be common near the river, and likely to prove a serious obstacle to the development of its resources. A comparison of the river in flood as seen by us on a former occasion with what it now was, showed that it did not receive any large supply from a distant lake, but consisted of the drainage of mountains. Instead of the channel being filled as then