Krümmel's Oceanography

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Source: *The Geographical Journal*, Vol. 38, No. 1 (Jul., 1911), pp. 60-63
Published by: geographicalj
Stable URL: http://www.jstor.org/stable/1779026
Accessed: 04-05-2016 10:52 UTC

the east coast, the survey of Cowie bay was completed; and plans were made of Saodan, Simatahan, and Serudong rivers; and of Sandakan harbour.

On the *West Coast of Africa*, a plan was made of Sekondi bay; and the plan of King Wills bay was completed.

On the *South and South-East Coasts of Africa*, the approaches to Table bay; and a portion of the Natal coast, from Cape St. Lucia to Durnford point were surveyed.

In the *Straits Settlements*, on the west coast of the Malay Peninsula, a survey was carried out from Pulo Terutau to Pulo Mulun. On the south coast, the western portion of Singapore strait, between Tanjong Kampong and Tanjong Pinjura was surveyed.

In the *Solomon islands*, a survey was made of a portion of the north coast of Guadalcanar island, and the waters between that island and Florida island.

On the *East Coast of Australia*, a survey was carried out of the inner route, Queensland Barrier reef, from Cooper point to Gladys inlet.

On the *North-west Coast of Australia*, surveys were made of the entrance to King sound; and of the coast from Cape Leveque to James Price point.

On the *Coast of Newfoundland*, an area was sounded out across the Gulf of St. Lawrence, between Bonne bay and the Mekattina islands; and the survey of St. John's bay was completed. On the east coast, a survey from Cape Bauld to the southward was commenced; and in addition, lines of soundings 200 miles to the eastward of Newfoundland were undertaken.

The Marine Survey of India for 1910 includes the completion of the Burma coast survey from White point to 14° 35′ N. lat.; and the mouths of the Irrawaddy to 95° 10′ E. long. On the west coast of India, a survey of Nerbudda river, Gulf of Cambay; and the coast survey from Viziadrug to the entrance of Tadri river.

During the year the Hydrographic Department has published 45 new charts, and 490 new editions of charts; 33 plates have been improved by the addition of 46 new plans; 122 worn plates have been improved by being wholly or partially re-engraved; and 8500 corrections have been made to the plates by the engraver.

The number of charts printed for the Government and the general public during the year amounted to 504,231; whilst 1809 Notices to Mariners have been issued.

KRÜMMEL'S OCEANOGRAPHY.

By HUGH ROBERT MILL, D.Sc.

THE standard work on oceanography has long been the book in Ratzel's library of geographical handbooks, of which the first volume by Prof. Georg von Boguslawski appeared in 1884, and the second by Prof. Otto Krümmel in 1887. Both volumes had practically passed out of date, and the time is fully ripe for the appearance in the new series of the handbooks, now under the general editorship of Prof. Penck, of what is in effect an entirely new work by Prof. Krümmel,* though it is modestly called a second edition. The *format* of the

* 'Handbuch der Ozeanographie.' Von Dr. Otto Krümmel. Band I. "Die räumlichen, chemischen und physikalischen Verhältnisse des Meeres." 1907. Band II. "Die Bewegungsformen des Meeres." 1911. Stuttgart: J. Engelhorns Nachf.

volumes has been changed and made more worthy of the high standing of the writers and the reputation of the series, while the growth of the science of oceanography in the last quarter-century is indicated by the second edition containing twice as much matter as the first.

Prof. Krümmel is probably the only geographer who has kept abreast of the flowing tide of oceanographical literature, and how thoroughly he has done this his periodical summaries of recent advances in Wagner's *Geographisches Jahrbuch* have abundantly attested. His close connection with the oceanographical workers of every country in Europe enables him to take wide views, and one of the most conspicuous features of these volumes is the impartial justice he does to the labours of investigators of all nationalities. In his preface to the first volume he refers to the enormous advance in the data during the last twenty years, and to the remarkable increase in the precision in all the observations. The facts as now known demand so much space that Prof. Krümmel regrets the necessity of curtailing the historical notices, to supplement which he refers the reader to Sir John Murray's classical memoir in the concluding volume of the '*Challenger* Reports.' Nevertheless, the historical notes prefixed to the various sections are full of interest and freshness, their conciseness making them only the more effective. He explains that in preparing the book he kept in mind that he was writing as a geographer for geographers.

Volume **1** deals with the size, boundaries, and subdivisions of the oceans, the nature of the water which fills them, the configuration of their beds, the deposits, the distribution of temperature and salinity, and sea-ice. The whole subject of dynamical oceanography, including waves, tides, and oceanic circulation, is dealt with in volume **2**.

The treatment of the classification of seas is a fair sample of the author's comprehensive and impartial method. He describes six different systems of classification—by position, by size, by form, by salinity, by circulation, and by origin—each having its own special usefulness. He points out that the classification of geographical forms cannot be carried out on similiar lines to the species or genera or even the orders of natural history, for there is as a rule only one individual of a geographical species, and that individual must be viewed from many different sides. Nevertheless, some natural order of classification may be hoped for, and Prof. Krümmel has prepared one which he hopes may present at least a first approximation to a final system, and this is worthy of quotation.

I. Oceans.—These are independent on account of their size, their general salinity, their peculiar and powerful system of tidal waves and currents; they originated in the most extensive and deepest depressions of the Earth's crust which have been permanent since Mesozoic times. They are (1) the Pacific; (2) the Atlantic; (3) the Indian ocean.

II. Seas (*Nebenmeere*).—These are dependent divisions on account of their small size, receiving their sea-water at second hand and much influenced by land water, subject to reduced tidal waves and currents derived from the ocean, owing their origin to local depressions of the crust not entering deeply into the continental mass, in the geological sense of ephemeral duration, usually very recent, and often post-Glacial.

A. Enclosed seas (*Mittelmeere*).

(*a*) Intercontinental enclosed seas lying between two continents: (1) the Arctic; (2) the Australo-Asiatic; (3) the American (Caribbean); (4) The Roman (Mediterranean).

(*b*) Intracontinental enclosed seas, relatively small, running into the land with only one access to the ocean.

a. Shallow fresh enclosed seas of high latitudes with surface water flowing out to the ocean: (1) the Baltic; (2) Hudson bay.

β. Deep salt enclosed seas of lower latitudes with the surface water flowing in from the ocean: (1) Red sea; (2) Persian gulf.

B. Fringing seas (*Randmeere*).

(*a*) Longitudinal fringing seas, the outline and isobaths of which are parallel to the main dislocation lines of the neighbouring land masses; (1) Bering sea; (2) Sea of Okhotsk; (3) Japan sea; (4) East China sea; (5) Andaman sea; (6) Gulf of California.

(*b*) Transverse fringing seas, the main lines of which are transverse to those of the neighbouring land: (1) The German sea (North sea); (2) The British sea (Irish sea); (3) The Gulf of St. Lawrence; (4) Bass strait.

This example is a fair type of the logical classification which characterizes the whole work, and if we were to venture to criticize the method of presenting the subject it would be by suggesting that in some instances the ramifications of subdivisions are carried rather farther than is necessary. We must, however, recognize that a too severe systematization is better in a scientific work than anything approaching to vagueness or slovenliness of grouping.

In the classification of deep-sea deposits Prof. Krümmel quotes Sir John Murray's well-known double classification into Pelagic and Terrigenous with the cross-classification according to the depth of the sea in which the deposit is formed; but he gives the preference to a new classification into more numerous groups with less familiar names. Thus he recognizes three great groups of deposits: *Littoral*, divided into shore and shelf deposits; *Hemipelagic*, including Blue, Green, and Calcareous sands and muds; and *Eupelagic*, or those deposits which are formed far from land, divided into—A, Epilophic formations, divided into Calcareous oozes, including Globigerina and Pteropod ooze, and Silicious oozes, including Diatom ooze; B, Abyssal formations, including Red clay and Radiolarian ooze. After all, there is here only a slight re-arrangement of Murray and Renard's grouping, the essential dividing lines of proximity to land and depth of water being preserved.

Objection has been made more than once in England that the discussion of the deposits and of the salinity of the ocean is not a legitimate concern of geographers; but we consider that Prof. Kümmel's handling of these matters amply justifies the position taken up thirty years ago by Sir John Murray and Mr. J. Y. Buchanan, and it is a curious though perhaps a characteristic circumstance that in no country has the geographical bearing of such researches been contested, save in our own, where this important branch of physical geography was introduced and brought to perfection. Although Krümmel marshals a vastly larger array of facts than Murray and Buchanan could command, his results are merely expansions of theirs; and, as we have indicated as a general characteristic of his work, the fullest credit and honour are given to the first masters of the science of the sea. The line must be drawn somewhere, and whereas Sir John Murray would probably treat at length of the formation of coral islands in a treatise on oceanography, tracing their origin to the same causes as produce deep-sea deposits and the chemical changes of sea-water, Prof. Krümmel leaves this large question out of account, fully as he deals with other matters of a similar kind.

While volume 1 contains little that is unfamiliar to those who have followed

the progress of oceanography in the scientific journals of London and Edinburgh, volume 2 gives in scientific form the facts which in English must be sought for chiefly in official publications of the Hydrographic Department of the Admiralty and in Sailing Directions, or in papers by physicists and mathematicians read to various learned societies. It is divided into three great "chapters" dealing respectively with waves, tides, and currents, and each subdivided and redivided with systematic thoroughness. The treatment of the tides in the various oceans and seas is completely new, and although the irregularities of the tidal phases and amplitude cannot yet be fully explained, Prof. Krümmel is thoroughly persuaded that the key is to be found in geographical considerations, mainly in the configuration of the respective basins. A notable advance in the treatment of ocean currents consists in the simultaneous consideration of horizontal and vertical movements, dealing with the circulation of the ocean as a whole, and the various theories of the cause of this circulation are fairly discussed. It is in the second volume rather than the first that we see the importance of the geographical standpoint adopted by the author, for here he has restated the work of the physicists and mathematicians who have investigated the facts, and puts it forward in a form specially designed for geographers.

The volumes are illustrated freely with diagrams and diagrammatic charts representing details not to be found even in German physical atlases; but there is no attempt to give such maps of ocean depths or currents as have now become common in our school atlases. Prof. Krümmel says that if he had acceded to the wishes of many friends he should have produced a great atlas of oceanography as a companion to his book, which would be quite out of place in the series to which that belongs. Such an atlas remains a great desideratum, and without something of the kind it is difficult to appreciate to the full the remarkable compendium of information regarding the oceans which these volumes present. Although a compendium, Krümmel's 'Oceanography' is not a mere huddle of facts, but an array marshalled by science, the ranks defined by many judicious omissions to which the bibliographical footnotes furnish an admirable index. To have acted otherwise and striven after absolute completeness of statement would, as the author well puts it, have been to place registration instead of science on the throne.

REVIEWS.

EUROPE.

'THE Building of the British Isles.' By A. J. Jukes-Brown. (3rd edit. London: Stanford. 1911. Pp. xv., 470. *Maps and Illustrations.*) A change of publishers and the addition of over half a hundred illustrations are the chief superficial alterations in the third edition of this well-known work. The extension and rewriting which the text has undergone are so considerable that in many respects the book may be considered to be a new work. In the preface the author speaks of rewriting every chapter. To many students unversed in field-work the series of restoration maps at various periods will prove even more impressive, in respect of the wonder and immensity of the changes in the Earth's surface, than even the inspection of a denuded land surface or of flexured strata. The gratitude of geographical students is due to author and