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SOME ASPECTS OF THE HISTORY OF OCEANOGRAPHY

AS SEEN THROUGH THE PUBLICATIONS OF THE INTERNATIONAL HYDROGRAPHIC BUREAU 1919-1939

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INTRODUCTION

The necessity for some form of international co-operation in maritime affairs, including the provision of satisfactory world-wide sea charts for navigation, developed in the latter half of the 19th Century. A proposal was eventually made at the International Maritime Conference in Washington in 1889 to establish a Permanent International Maritime Commission, but this did not reach fruition.

In 1912 the Russian Government called delegates to an International Maritime Conference in St. Petersburg where delegates from 15 nations took part. Many technical matters were discussed and also the possibility of using Esperanto as an international language of navigation, whilst a further conference was envisaged.

In fact, no further conference was possible until 1919, when the French and British Hydrographers took the initiative by calling an International Hydrographic Conference in London to which 22 nations sent delegations. After passing a number of resolutions concerning the standardization of chart symbols and related matters, the Conference decided to form a permanent International Hydrographic Bureau (IHB). French and English were to be the official languages, whilst the Bureau would become an agency of the newly formed League of Nations.

Admiral Sir John PARRY, the former U.K. Hydrographer, was elected as the first President of a Directing Committee of three which was to establish and

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run the Bureau. Admiral PARRY was instrumental in accepting the invitation of the Principality of Monaco because of its comparative nearness to the League of Nations at Geneva. Furthermore, Monaco was easy of access and its particular status was a guarantee of neutrality from the Bureau's point of view, and had an enhanced reputation due to the high regard in which the Sovereign, His Serene Highness Prince Albert I, was held as a scientist. The Prince was deeply concerned with all problems relating to the sea and took an active interest in the Bureau's creation and had generously proposed that it be established in his own country where he had built the Musée Océanographique in 1910.

The Bureau took up its temporary quarters in Monaco in 1921. In 1929 Prince Louis II, son of Prince Albert who had died in 1922, laid the foundation stone of a building on the Port to be specially constructed and to this the Bureau moved in 1931.

BUREAU PUBLICATIONS

The role of the Bureau was to propose, and use persuasion to implement, hydrographic standardization; also to acquire new information and publicise modern methods, thereby contributing to their development by preventing duplication of technical research.

Promulgation of technical and scientific advances therefore became a major task for the Bureau and for this purpose the twice-yearly publication of the *Hydrographic Review* (hereafter referred to as the Review) was established in 1923. Special Bureau Publications (hereafter referred to as S.P.'s) were also issued from time to time as necessary to cover developments of special interest to hydrographers. All publications are in both English and French:

Thus a study of the pages of the Review, S.P.'s and the published Reports of Proceedings of the 5-yearly Hydrographic Conferences in Monaco, where Member States plan future policy, can provide researchers with a wealth of detail concerning the advancement of sea technology in the 20 years between the two world wars.

Hydrography in the context of the IHB primarily concerns the measurement of the depths of the sea and the delineation of the seabed topography for the compilation of marine charts.

Inevitably, developments in hydrography as a sea surveyor knows it are closely intermingled with those in oceanography, although the practitioners of the latter science attach quite a different meaning to the word hydrography.

Perhaps the most fundamental oceanography parameter affecting the sea surveyor is the tide, for its ever-changing height must always be taken into account when assessing the depth of water available to the navigator.

Commander H.D. WARBURG, the Superintendent of Tidal Work in the British Hydrographic Department, gave the lead at the First International Hydrographic Conference with his submitted "Remarks and Suggestions respecting Tidal

Information" which led to several Resolutions. Among these was that Tidal Datum should be the same as Chart Datum, and should be a plane so low that the tide will not frequently fall below it. Further it was resolved that Hydrographers adopt "a universal datum plan which should be called International Low Water, its plane of reference below mean sea level being determined as follows – take half of the range between mean low water and mean higher water and multiply this half range by 1.5" [1].

Nothing was said at the First Conference about tidal analysis by harmonic constants, although this method had been increasingly adopted by scientists since the beginning of the century. However, in the first ever issue of the Review in March 1923 [2] the Directing Committee gave the text of a Circular Letter which had been sent to Member States which posed, among other questions, whether harmonic analysis was applied to tides in their country. Replies to this early Circular Letter were published in the Review of November 1924 [3], and of the 12 Members replying only Argentine, China, Canada, Denmark, France, Japan and the U.S.A. were using harmonic constants. They were employing a number of different predicting machines among which KELVIN's Tide Predictor seems to have been the one most widely in use. The United Kingdom does not appear to have answered the Circular Letter.

A paper entitled "International Low Water" by the Dutchman Rear Admiral PHAFF, a Member of the Directing Committee, appeared in the Review for

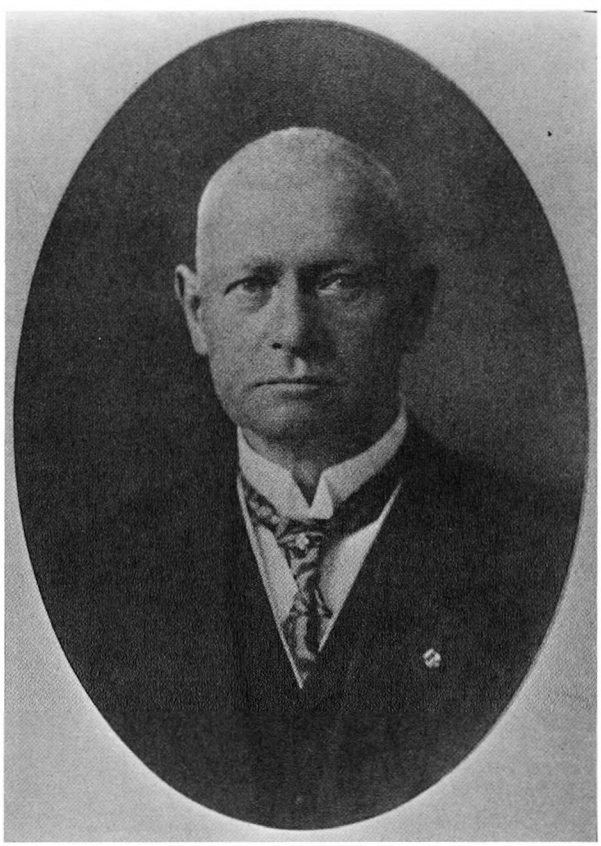

FIG. 1. – Rear Admiral J.M. PHAFF, President of the Directing Committee in 1926.

May 1925 [4], which was followed over a year later by a paper of the same title contributed to the Review in July 1926 [5] by Captain J.L.H. LUYMES, the Hydrographer of the Netherlands. Largely agreeing with PHAFF, LUYMES concluded "International Low Water is an erroneous conception; it is impossible to establish a general hard and fast rule for a level of reduction of soundings which is applicable to every system of tides". He further continued "although theoretical considerations will be of great advantage when choosing a level, it is essential to establish, if possible, its distance below a fixed plane of levelling directly from a series of tide gauge readings made during several years". PHAFF had come nearer to solving the surveyor's problem in his paper when he had written "During an extensive survey the hydrographic surveyor will always have the opportunity to collate a series of observations made at a tide gauge during at least one month and, by the method of approximation, these observations will enable him to deduce, within certain limits of accuracy, the constants of the principal constituents of the tide".

The publication of these two papers had their effect at the 2nd I.H. Conference held in Monaco in 1926 when, among other Resolutions on tidal matters, was one to change the wording of Chart Datum, Captain LUYMES proposing that "Chart Datum should be on a plane so low that the tide will but

FIG. 2. – Captain J.L.H. LUYMES, R.N.I. Navy, Netherlands' Hydrographer 1926-1934.

seldom fall below it", a wording which has endured to the present time [6]. All references to an *International Chart Datum* were dropped.

It was further resolved at this Conference to encourage the use of harmonic constants by seamen for tide predicting and by hydrographers for determining Chart Datum. The Bureau was instructed to prepare and publish a volume containing standard harmonic constants for the whole world as they became available from administrative authorities. The volume was to be kept up to date by annual supplements.

The actual collection of the tidal harmonic constants took a good deal of time to arrange. Pro-forma sheets were issued to numerous authorities world-wide for completion and return to the Bureau. S.P. 26 [7] first made its appearance in 1930 in which was described how the constants would be handled using the symbolic denominations established by Sir George DARWIN nearly 50 years earlier.

From 1931 onwards S.P. 26 was frequently republished to give numerical, geographical and alphabetical listings of the ever-increasing number of stations for which harmonic constants were becoming available. By 1939 S.P. 26 was carrying lists of harmonic constants for well over 2 000 stations and its compilation had received the approval of the 1937 I.H. Conference.

In 1975, as a result of a Resolution at the 1972 Conference [8] this world-wide collection of harmonic constants was transferred to a computer-controlled data bank operated on behalf of the IHO by the Canadian Hydrographic Service. The data bank catalogue which is now available [9] enables those requiring print-outs of harmonic constants to be quickly supplied in respect of 4 000 stations world-wide. So has come to fruition a modest beginning made by the IHB in 1926.

Other Bureau S.P.'s concerning tides published during the period under review included S.P. 28 [10] and S.P. 28a [11] being a *Vocabulary Concerning Tides* in French, English, German, Dutch and Spanish. S.P. 31 [12] was a remarkable *General List of Tidal Authorities and Tidal Records* which gave details of tidal stations world-wide and the type of records available from each; whilst for the Congress of Geodesy and Geophysics held in Edinburgh in 1936 the Bureau prepared charts showing the location of the stations listed in S.P. 31 so that new locations for tidal observations could best be chosen to augment the existing records and close the gaps.

S.P. 13 [13] published in 1926 was a notable report on *Tide Predicting Machines* currently in use in different parts of the world compiled by Henri BENCKER, a technical assistant in the Bureau. The Report, which carries a number of illustrations, begins with a description of an early machine developed for the British Association for the Advancement of Science by Sir William THOMSON (later Lord KELVIN) in 1873. It concludes with a description of a tide predictor only recently presented to the Liverpool Tidal Institute by the Shipowners of Liverpool and the Tidal Committee of the British Association.

With this major concentration on tides during the 1920's and 30's it is not surprising to find in the Review during these years a number of papers on tidal analysis, current meters and tide gauges, including a seabed gauge, by such writers as MARMER, RUDE, WÜST and others.

The latter years of World War I saw the tentative use of underwater sound for locating submarines and this led in the immediate post-war years to the first real developments in echo-sounding. By the 1930's the echo-sounding machine had become a major tool for both hydrographers and oceanographers.

Numerous papers in the Review and S.P.'s concerned with the development of echo sounders reflect the importance of this revolutionary equipment. The first shot was fired, so to speak, by the Hydrographer of the U.S. Navy in the first issue of the Review in 1923 [2] when he reported briefly on the taking of a line of soundings across the Atlantic from Newport to Gibraltar by U.S.S. *Stewart*. The Navy Sonic Depth Sounder was used which measured the time required for an emitted sound signal to travel to the seabed and return to the ship as an echo. Soundings could be taken at minute intervals but neither the acoustic source nor the method of measuring the time of sound travel were described.

Under its Statutes the IHB was adjured to collect and publicise information on technical developments which would increase the efficiency of sea surveying, and echo sounding surely came within this category. However, the Directing Committee did not find at first the collection of such details a simple matter, as is pointed out in the Introduction to S.P. 1 (1923)[14]. "In connection with marine invention of most descriptions it is distinctly noticeable that the majority of nations are treating such matters as confidential : this, no doubt, as the result of the War in which it was obviously essential to keep all new inventions as secret as possible".

As time went on, however, things began to open up and S.P. 1 (1923)[14], S.P. 3 (1924)[15], S.P. 4 (1925)[16] and S.P. 14 (1926)[17] each gave increasingly complete descriptions and assessments of the various new echo-sounding machines as they developed.

From the historical point of view, the early, somewhat tentative, reports in S.P. 1 are worthy of some brief quotations. A report by the French Hydrographer was the first to appear in S.P. 1, a portion of which reads as follows :

"Professor LANGEVIN's method of sounding at sea by Hertzian waves is but one of the new systems of sounding by sound-waves, the development of which is being closely watched by my Office.

In spite of the results obtained by means of the Langevin apparatus we are of the opinion that this system is too complicated to be taken into general use. Besides, we are certain that we shall succeed in sounding by means of much more simple acoustic arrangements, having discovered that a light blow with a hammer on the hull of a ship transmits to the water sufficient sonorous energy to make the echo from the bottom of the sea audible to a depth of 200 m (110 fm). The Scientific Research Department of the French Navy is now engaged in the perfection of a sounding apparatus based on this principle.

In greater depths, for the last year, we have been using an acoustic sounding instrument devised by an Officer in my Service, Monsieur MARTI, which employs the sound made by detonation. In depths up to 1,000 m (545 fm) an ordinary rifle, suitably shortened, is used and is fired straight into the water. Beyond this depth a small gun of 37 m/m bore (3 pr.) firing blank, also straight into the water, is employed. This apparatus was used for the first time to obtain

a section-profile from Marseilles to Philippeville... We are now using this apparatus in one of our surveys on the coasts of Algeria; it is easy to use and gives satisfactory results. We recommend it for the exploration of the depths of the oceans which, up to now, has been a difficult and lengthy matter by means of sounding by wire".

Then follows an interesting report from the *Nautical Magazine* (British) of March 1923 :

"In a popular lecture delivered recently by Mr. J.F. SIRKS, Engineer, under the auspices of the Nautical Institute and Museum at Rotterdam, the Behm depth indicator was described. The instrument serves to measure the depth of the sea by sound, viz., by observing the difference in time between the detonation of a sound signal and the return of the echo from the sea bottom. The whole instrument can be worked from the bridge of a vessel and consists of a rifle, loaded with a detonator signal, two microphones fitted, below the waterline, to the side of the ship, and a recorder on the bridge. The rifle is fixed on the side of the ship above the waterline, and can be loaded from the bridge by a pneumatic tube and fired by electric contact. The explosion is received by the port microphone, which closes a contact of a small motor rotating a circular mirror mounted on a vertical shaft on the bridge, the maximum angle of rotation of the mirror being 90 degrees. This mirror reflects a beam of light to a scale, divided in a scale of linear measures. On the return of the echo from the bottom, same is received in the starboard microphone which, through an electric contact, engages a powerful brake, instantly stopping the rotation of the mirror. The actual depth can be immediately read off from the recorder on the bridge by noting the position of the beam of light reflected by the mirror on the scale. For great depths a photographic recorder has been patented. Experiments are now being carried out to adapt the device for measuring the height of flying machines above the land".

S.P. 1 concludes with a fuller report from the U.S. Hydrographer on the Navy's Sonic Depth Finder, which was being investigated by a number of European Hydrographic Offices. The Bureau had been informed that the American Government had specially despatched to Australia the *Milwaukee,* one of the latest Scout Cruisers of 10,000 tons displacement, with a speed of 35 knots, to demonstrate the Sonic Depth Finder to the Delegates of the Second Triennial Pan Pacific Science Congress which was held in Melbourne and Sydney in August 1923.

From S.P. 3 onwards the Directing Committee attempts to describe the theory of echo-sounding as well as keeping track of developing systems. In S.P. 4 (1925) an apparatus developed by the British Admiralty and reported by F.E. SMITH gets its first mention and description. This apparatus was destined to become a highly successful machine for survey work when manufactured and marketed by Henry Hughes & Sons.

By 1926 (S.P. 14) MARTI had developed his Continuous Sounding Recorder which enabled depths to be marked every 3-5 seconds on a continuous roll of paper. Before use, this paper had to be blackened by means of a petroleum lamp, "its wick purposely set to smoke abundantly... It is important to place the flame in such a way that it will not set fire to the paper".

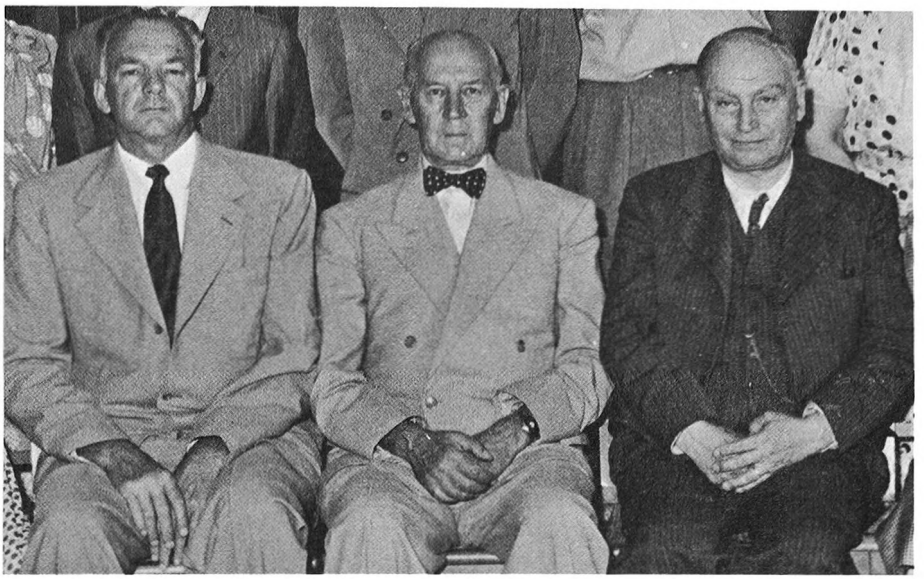

FIG. 3. – From right, Captain H. BENCKER, French Navy (Ret), when Secretary General, with Vice-Admiral J.D. NARES, D.S.O., R.N. (Ret.) and Rear Admiral C.L. NICHOLS, U.S.N. (Ret.).

With S.P. 33 (1939)[18] "A Summary of Echo Sounding Apparatus", published at the very outbreak of World War II, BENCKER made his second major contribution to the publications of the IHB. This S.P. is a comprehensive contemporary report on the state of echo-sounding technology at the end of a twenty year period which had seen great developments in this field and forms a most useful book of reference for students of oceanographic history. The chronological bibliography consists of 372 references dating from 1827 to 1938.

In his Historical Notes in S.P. 33 BENCKER attributes the first proposal to utilize the propagation of sound for deep sea sounding to Jean-François ARAGO in 1807. He follows these early developments through to the expedition of the German research ship *Meteor* in the South Atlantic in 1925-27 which he considers "the most extensive work ever obtained by the establishment of 14 transoceanic profiles comprising more than 67,430 soundings taken at approximately 34,000 stations with two echo-sounders".

BENCKER lists a number of major deep-sea sounding expeditions which took place in the 1920's and 1930's including those made in *Marion, Carnegie, Willebrord Snellius, Dana, Emden, Discovery II* and others, many of which had been described in papers contributed to the Review. The numerous soundings obtained by these vessels were passed to the IHB, which had been instructed by the 1929 I.H. Conference[19] to centralize oceanic echo soundings in order to keep up-to-date the General Bathymetric Chart of the Oceans (GEBCO). This was originally compiled and published in its First Edition in 1903 by Prince Albert I of Monaco and the responsibility for maintaining it was passed to the IHB by the Cabinet Scientifique of the Prince of Monaco after the completion of the 2nd Edition in 1929.

The 5th Edition of GEBCO, which covers the world on 18 sheets, is expected to be complete by 1982. Whilst the sounding data contributed by Member States is still centralized in the IHB, the formation of a joint IHO/IOC Guiding Committee for GEBCO in 1972 has resulted in the participation of the great majority of the world's leading marine geophysicists and geomorphologists in the compilation of this series of scientifically orientated ocean charts. The Canadian Hydrographic Service is printing the 5th Edition of GEBCO.

Postscript

If there is a place for a hero in this paper, then one is easily found. Stocky, rotund, often untidily or exotically dressed, with an alert scientific mind and a prickly nature, Henri BENCKER, a lieutenant in the French Navy, joined the Bureau in 1924 as a technical assistant when he was pronounced medically unfit for sea service. He remained at the Bureau for 33 years where, by then promoted to Captain, he was elected Secretary General in 1947. Retiring in 1957 he died eight years later. His contribution to the publications of the IHB had been outstanding.

During World War II BENCKER remained at the Bureau, together with the sole Director, DE VANSSAY DE BLAVOUS, during the occupation of the Principality of Monaco first by the Italian and then by the German Armies.

There being practically no input by Member States, and with his salary drastically reduced, BENCKER might have taken life easily, but in fact during these war years he contributed to the Review (published once a year during this period) a series of remarkable papers each of which required copious research and all of which are of lasting interest to historians concerned with navigation or oceanography.

Among the more notable of BENCKER's wartime papers published in the Review are the following :

1941 [20] : Historical and Bibliographic Index concerning the development and improvement of the Compass (sixty pages comprising a chronological list of illustrated references from 2 600 B.C. to 1941).

1942 [21] : Maritime Geographical Terminology relating to the various Hydrographic Subdivisions of the Globe (an early list of the terminology of maritime features covering 14 pages).

1943 [22] : Regimen of the Sea or Nautical Compendium - being a Chronological and Analytical List of various Tables or Treaties on Navigation intended to facilitate Nautical Computations and accelerate ships' position finding (80 pages of References from 640 B.C. to 1942).

1944 [23] : Chronological List of the Main Maritime Discoveries and Explorations (45 pages of References from 861 A.D. : Scandinavian Ships manned by Naddod's men discover the Faroe Islands, to 1940 : Echo-soundings made by U.S.S. *Ramapo* in the North Pacific Ocean).

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[22] IHB Monaco, 1943. *The Hydrographic Review*, Vol. XX.

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