Scottish Geographical Magazine

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsgj19>

Statical oceanography—a review

Hugh Robert Mill D.Sc., F.E.S.E.

Published online: 27 Feb 2008.

To cite this article: Hugh Robert Mill D.Sc., F.E.S.E. (1891) Statical oceanography—a review, *Scottish Geographical Magazine*, 7:5, 260-266, DOI: [10.1080/00369229108732450](https://doi.org/10.1080/00369229108732450)

To link to this article: <http://dx.doi.org/10.1080/00369229108732450>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form

to anyone is expressly forbidden. Terms & Conditions of access and use
can be found at <http://www.tandfonline.com/page/terms-and-conditions>

STATICAL OCEANOGRAPHY—A REVIEW.

By HUGH ROBERT MILL, D.Sc., F.R.S.E.

THE task of writing the first book in any department of science is a serious one, not to be lightly undertaken. Masses of original data which have been accumulated from many sources must be sought out, sorted, and valued. They must be assimilated and elaborated so as to build up a natural system, organised by general laws deduced from many particular cases. A great gulf separates the memoirs of a specialist from a formal treatise on any branch of science. Only second in difficulty to constructing a pioneer work is the authorship of an independent book in a language not hitherto directed to the expression of a particular group of facts, for although similar works already exist in other languages, translations are rarely satisfactory, and adaptations are always clumsy. Professor Thoulet in preparing his treatise on Oceanography¹ was unaided and unembarrassed by any earlier works in French. Indeed the only recent oceanographical books have been produced in Germany, where Boguslawski, Krummel and others had made themselves masters of the subject. In English, even, there are no formal statements of results, although most of the accurate data which make oceanography a science have been obtained by British and American workers, and our language is rich in original researches whence the corner-stones of all future treatises must be quarried.

M. Thoulet fully recognises the difficulties with which he has to contend, and sets about the work not only with the scientific enthusiasm common to his countrymen, but with a frank avowal of his shortcomings and a generous appreciation of the labours of foreign workers which command the highest respect. The important nature of the book justifies a somewhat detailed review in this *Magazine*, from which many of the data for it were taken with due acknowledgment. What has to be said in the way of criticism is meant to be constructive, not destructive: we aim at fault-mending rather than fault-finding.

The volume originated in a course of lectures delivered to naval officers, and first appeared in the columns of the *Revue Maritime et Coloniale*. Its subject-matter is partly derived from the author's original work, and partly from official visits paid to Norway, Scotland, and Switzerland in order to report on the methods of marine and lacustrine research carried on in those countries. This origin accounts for the compilation being a little scrappy and varying in the degree of detail; although, as the author rightly points out, the facts themselves are not yet equally firmly established in all cases. The division into parts, chapters, sections, etc., is difficult to understand, and becomes confusing when subsequent reference has to be made to any passage. A uniform sub-division into consecutively-numbered chapters and paragraphs would be a great advantage. The illustrations are of indifferent merit, although most of them are serviceable. We cannot understand the absence of maps or of an explanation of the

¹ *Océanographie (Statique)* par M. J. Thoulet, Professeur à la Faculté des Sciences de Nancy. Paris: Librairie Militaire de L. Baudoin et Cie., 1890, pp. 492. Price, 10 fr.

omission. If the author had kept before him a set of good bathymetrical, temperature, and salinity charts of the oceans, we think that many of the descriptions would have been far more effective, and that he would have been able to take a wider view of general distributions. Indeed the worst fault we have to find, and this we can scarcely mend, is that too much space is given to the description of methods, and too little to the statement and explanation of the results obtained by means of them. How far equilibrium may be restored by the volume on dynamic oceanography, which the title seems to promise, we cannot say, for the distinction between the static and dynamic parts of such a science is very hard to draw. We regret that M. Thoulet had not the courage to introduce the euphonious and descriptive term *Thalassology*, which he recognises as more in harmony with the genius of the French language, especially since in the form of *Talassografia* it already adorns Italian, and has been adopted in English by Agassiz as *Thalassography*. This backwardness in the adoption of new words is unfortunately too prominent in all departments of scientific geography. French, and still more English, writers are constrained to use awkward periphrases on account of their unwillingness to create terms; in the end they too frequently adopt expressions hammered out of definite shape by use with many meanings, while their German contemporaries, rejoicing in the freedom of a boundless language, make a simple and expressive name for each new fact and idea.

It is time to consider our author's definition of the science for which, bowing to the majority, he has retained the name of Oceanography, and to glance at the way in which he has co-ordinated the facts suggesting it:—

“Oceanography is the science of the ocean; it comprises all the laws applicable to the sea, not only in the domain of chemistry and physics, but also in those of mathematics, mechanics, and astronomy. Oceanography concerns itself with understanding and explaining the form of submarine relief, the nature, mode of deposition and induration of the sediment accumulating in the depths, the chemical composition of the water, the distribution of heat, of salinity and density, the different gases and dissolved solids, the currents which furrow the surface and the ice which covers some parts.”

This is comprehensive and satisfactory; but we cannot agree with the statement which follows, that “Oceanography is not physical geography even restricted to the sea.” We believe that oceanography is a department of physical geography, because we deny that physical geography is, as M. Thoulet suggests, concerned with the earth only as the theatre of human history. While geography in its widest sense has as its aim the ultimate relations of the earth to man, the department of *physical* geography is set apart as a description of the earth in its natural conditions with no more special reference to man than to any of the other mammalia.

A brief historical summary in the Introduction might be advantageously extended and carried back at least to the time of Boyle and Hooke, who devised many valuable and ingenious pieces of apparatus for marine research. It is scarcely surprising to find Sir John Ross confounded with Sir James Clark Ross; but an error in enumerating the *Challenger* staff (p. 15) should be corrected: Captain Tizard was a naval

officer, not on the scientific civilian staff, to which the name of Professor Moseley ought to be added. The statement that the days of *Challenger* and *Gazelle* expeditions are past needs a word of explanation. We fully realise the importance of detailed work in small areas, such as that of the Norwegian North Sea Expedition, the United States Fish Commission, the Kiel Commission, the Scottish Marine Station, and the Fishery Board for Scotland, the last of which is not referred to. But an expedition on the *Challenger* scale is still required to clear up many problems connected with the Pacific, unless we are content to wait until the Hawaiians, Samoans, and Fijians commence explorations on their own account. Antarctic research also, if it is to be successful, must be carried out on a large scale, and with well-equipped vessels.

A good *résumé* of the geological changes of the ocean, the influence of earthquakes, and the gravitational distortion of sea-level, leads up to a particularly interesting and able statement of the methods of deep-sea sounding. Most of the apparatus is well figured, but the sketches of the Prince of Monaco's sounding-rod are unsatisfactory, from the want of reference-letters to the various parts described. As a striking instance of the improvement in quick sounding, it is mentioned that Sigsbee's piano-wire sounding machine required 29 m. 45 s. for the lead to descend to 2900 fathoms, and 34 m. 35 s. to heave in; while the *Challenger's* hemp line took 33 m. 35 s. to sink to 2400 fathoms, and required 2 h. 2 m. to draw up again.

The Ocean Basins might possibly have received fuller treatment, but the descriptions are well up to date, and include an abstract of Dr. John Murray's calculations of volume and depth translated into metric units. In describing the continental shelf (p. 109), it is a mistake to say that New Zealand, Madagascar, and the Antilles are brought in touch with their nearest continents by means of it; as all these islands are separated by water much more than 100 fathoms deep.

The description of deep-sea deposits and their analysis is full and interesting; but more might have been said regarding the use of the microscope, and a notice of the ingenious process devised by Mr. Pearcey, of the *Challenger* Office, for hardening and cutting sections of muds and oozes would be of value. In mentioning the occurrence of shark's teeth and whale's ear-bones in the Red Clay, the author reveals a strain of humour:—" Might not one explain the abundance of these remains, far from land, by the instinct which impels all the higher animals, on feeling the approach of death, to flee to the most distant places?"

"Marine Chemistry" is a title which demands three divisions each of several chapters, or sections, or paragraphs to exhaust; and in its consideration we again find great detail in the description of methods, and far too little generalisation, or even statement of conclusions. The methods, although usually more amply treated than the general reader requires, are rarely detailed enough to enable a worker to dispense with the original papers referred to. The historical account of water-bottles for collecting samples below the surface could be made more complete.¹

¹ See, for example, *Proc. Roy. Soc.*, xiii. 539.

Mill's water-bottle is described and figured in a transition form, now discarded for an arrangement by which the sample of water is automatically locked into the enclosing cylinder when the bottle is shut. In the description of sea-water analyses, Gibson's exceptionally fine work for the Fishery Board for Scotland should be mentioned; and in order to be complete, Dittmar's discussion of Buchanan's method for determining carbonic acid ought to find a place. None of the chemical methods described is more simple or beautiful than M. Thoulet's own process of estimating the suspended matter in sea-water by filtering a little of the liquid through a porous porcelain disc under pressure, and determining by ignition the proportion of organic and inorganic sediment. The importance of such a quick, cleanly, and accurate method, can only be realised by those who have been driven to despair by many filter-papers. Speculations on the solution and precipitation of solids in sea-water (p. 269), would be more intelligible if M. Thoulet had given an abstract of his experiments on the subject, which is one of much importance and great difficulty.

In reading the history of marine thermometry, we are struck with the small place given to the magnificent work of Saussure and Aimé, and still more by the inadequate description of modern instrumental methods. On p. 286 a Miller-Casella thermometer is figured, with a serious error in drawing the protecting bulb, which vitiates the description. No notice is taken of Tait's study of the pressure correction of these thermometers, nor of Buchanan's ingenious use of the piezometer to check their readings at different depth when the temperature varies unequally. The accuracy of the instruments is also under-estimated, as Buchanan's improvements have made them capable of being read easily to a much smaller fraction than the half-degree (C.°) which is here assigned. The uncertainty of the Magnaghi frame for reversing Negretti and Zambra's deep-sea thermometer is not referred to, and although the Scottish frame is described and figured, its prototype, invented by Rung, is passed over in silence. In speaking of self-registering instruments, the author, curiously, does not refer to Richard's thermometers. The tables of specific heat for sea-water, deduced from M. Thoulet's own experiments, are of much value; but in describing the work done in determining the coefficient of dilatation, he should not have omitted the important results of Dittmar, published in the *Challenger* reports.

The study of deep lakes, we are told in a particularly happy expression, affords information intermediate between that drawn from laboratory experiments and actual observations in the open ocean. On this account M. Thoulet rightly devotes a good deal of space to lacustrine conditions, based mainly on the admirable work of Forel and others in Switzerland. Full and deeply interesting as the account is, it might be extended, and the conclusions perhaps modified by taking account of the work of Aitken, Buchanan, Murray, and others on the deep lakes of Scotland, where the practical importance of the maximum density point has been shown to be much overrated, and the influence of wind has come into prominence.

When M. Thoulet criticises "Boguslawski's Laws"—which are

simply a formal statement of the *Challenger's* temperature results—we disagree with his interpretation of observations. It has been generally conceded by physical geographers that there is evidence to establish the greater volume of the surface currents from the Equator poleward than in the opposite directions. And it is believed that there is direct evidence for the necessary inference that a slow mass-movement throughout the whole depth of the ocean takes place from the Polar regions toward the Equator, chilling the bottom-water in all the oceans. This postulates vertical as well as horizontal circulation in the oceans; and by the researches and observations of Murray and Buchanan the old theory of the dependence of surface circulation on the winds has been confirmed and extended so as to explain movement at all depths. M. Thoulet, in opposition to other oceanographers, asserts that it is impossible to believe that zeolites and manganese nodules could form in the Red Clay unless the oceanic depths were absolutely stagnant. He fails to recognise any force adequate to produce vertical circulation (p. 318) in the basins, shut off from each other by sills which form the floors of the oceans; but in another place (p. 368) he gives an interesting figure to demonstrate how change of surface density alone can give rise to complete vertical circulation in a deep basin. We cannot deny his hypothesis that the low temperature of the deepest ocean may be due to the unabated legacy of cold left by the Glacial Period, but surely the suggestion is very far-fetched. The arguments which to us appear conclusive against M. Thoulet's theory of oceanic stagnation are briefly these. The basins and sills of the ocean-floor are in almost all cases very gentle hollows and very gradual rises; and wherever the sills or bars are at all abrupt or continuous the mass-movement of the ocean is stopped, as, for example, by the Wyville-Thomson Ridge and in deep enclosed seas. Again, if the ocean had been stagnant since the Glacial Period, the dissolved oxygen would long ere now have been absorbed by the creatures which live, or at least decay, at all depths; but the *Challenger* investigations failed to find any samples of water free from dissolved oxygen, which must have been absorbed at the surface. Crystals form readily in evaporating dishes, in which convection currents due to evaporation keep up slow circulation, and there seems no reason to believe that the very slow movement on the bed of the ocean would put a stop to the chemical processes going on there. M. Thoulet refers to the *Challenger* temperature data as competent to throw light on the matter, but does not attempt their discussion. When the official Report on Oceanic Circulation is published we believe that it will entirely substantiate the views of the physical geographers of Britain and Germany. It may be that we are unjust to M. Thoulet in interpreting his statements so rigidly as we do; the whole subject of oceanic circulation belongs properly to the dynamic rather than the static aspect of oceanography, and is thus probably reserved for exhaustive treatment in a future volume.

The treatment of Specific Gravity is of much interest, and keeps alive several questions which have not yet advanced beyond the stage of discussion. It is carefully pointed out that the relation of specific gravity to salinity is dependent on the temperature at the time of observation,

and on the chemical composition of the dissolved salts. On this account M. Thoulet is inclined to assign little value to a determination of specific gravity as a measure of salinity, preferring a complete chemical analysis of each sample for that purpose. Here we venture to think that convenience and speed of working turn the balance in the opposite direction. By the use of tables of thermal dilatation, which certainly are to some extent empirical, we can roughly determine the general distribution of salinity over a very large area from numerous hydrometer observations, leaving the laborious and costly complete chemical analysis to fix the exact composition of a few typical samples. Such an expedition as that of the *Challenger* would have left the maps of surface salinity almost as blank as before unless numerous hydrometer readings had been taken, and their indications utilised. The rough results obtained are of the same order of utility as the route-maps of the first traveller over a new country, being invaluable until better are forthcoming. M. Thoulet seems to mistake the purpose of the *Challenger* specific gravity maps, and the value of reduction to a standard temperature. He says on page 352 :

“The specific gravities of the ocean surface during the cruise of the *Challenger* for summer and winter throughout three years are all entered on the same sheet; while it is evident that the density at one point, being a function of temperature, varies according to the season, that is to say continually, and that it is not comparable with the density taken at another point, even near, and at a different period. To be truly useful, a map of this kind should be constructed for one month only.”

It is probably because the data are so scanty that monthly maps of salinity are not given, and in order to reduce the obvious disadvantage to a minimum all the *Challenger* observations were reduced to their value at 60° F. To this M. Thoulet objects very strongly :—

“Even supposing that the densities are observed simultaneously over the whole globe, since we wish to discover the causes and the laws of a variable, we must not make this variable as constant as possible, that is to say, suppress the variation. A map should express the results of observation, as they really exist; and when it is treated as described above, it represents the thing that is not, and that never can be, for it shows a condition of immobility, when the problem is on the contrary to represent and to study movement.”

The same argument, it seems to us, would debar the meteorologist from reducing the pressure of the atmosphere to sea-level, and the chemist from calculating the results of a gas-analysis at a standard temperature and pressure. The variable in the *Challenger* map referred to is not density, but density at constant temperature, or salinity; and we cannot see how the hydrometer readings could be better employed. Failure to perceive that the results aimed at in such representations are essentially static and not dynamic, leads M. Thoulet to object still more strongly to the *Challenger* salinity sections, showing the distribution of density at constant temperature and pressure at all depths. If the effect of pressure and temperature be allowed for in drawing the curves, as in the specimen section which he gives, the variable salinity is entirely masked by the effects of constant fall of temperature and rise of pressure with increasing depth. True, in the dynamic part of the *Challenger* discussion, which is

not yet published, such sections as appear in vol. I. of the *Physics and Chemistry* would be of no use; and we may be sure that, when oceanic circulation is being discussed, care will be taken to use only such data as are applicable, and in the manner best adapted to bring out correct conclusions.

The effect of pressure on sea-water, the action of water on light, and the colours of different seas are treated in a satisfactory way; and a brief sketch is given of the methods of marine biological collecting and the distribution of deep-sea fauna. The volume concludes with a graphic account of sea-ice which might well be supplemented by reference to Buchanan's valuable experiments on the freezing of brines. M. Thoulet refers to, but does not describe, his own theory as to the origin of the Grand Banks of Newfoundland, which differs from that hitherto accepted by physical geographers, the source of the material of the banks being sought, not in Arctic glaciers but on the frost-riven shores of Newfoundland.

We feel strongly that the volume before us is valuable, and capable of being made useful in a high degree. Much of its matter is so open to controversy as to detract from its permanent value; but by directing the attention of oceanographers to the weak places in accepted theories, the bold and ingenious hypotheses of M. Thoulet cannot fail to advance knowledge. He deserves thanks and congratulation for his effort, and we trust that he will be encouraged to extend his researches and his writings to include the more interesting, because more difficult, problems of marine circulation and the inter-relations of sea, air, and land. We believe, however, that it is the geographer, or rather the physiographer, studying the system of the world as a whole, not the mere chemist or physicist, geologist or surveyor, who is likely to be most successful in recognising the elements of oceanography where they now lie scattered, and in combining them to form a whole department of experimental science. In this confidence we would urge on M. Thoulet the importance of approaching his subject from the general point of view, so as to obtain the true perspective, and see how to fill in most effectively the special details, of which he has shown himself so skilful a master.

GEOGRAPHICAL NOTES.

EUROPE.

The Meteorology of Scotland in 1889.—The most remarkable feature of the year was the distribution of temperature. In May and June the heat was quite exceptional, the mean monthly temperature in the former month being $53^{\circ}\cdot 1$, or $4^{\circ}\cdot 3$ above the average; and in June $57^{\circ}\cdot 1$, or $2^{\circ}\cdot 4$ above the average of 1856-88. Then followed a period of abnormally low temperature, lasting to November, when, as well as in December, the temperature was again appreciably above the average. These deviations, however, so nearly counterbalanced one another that the mean for the year ($46^{\circ}\cdot 7$) is only $0^{\circ}\cdot 5$ above the average for the preceding thirty-three years. On the other hand the difference between July and December was $16^{\circ}\cdot 9$ in place of $19^{\circ}\cdot 5$, the average for the same years. The deficiency of rain, which