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JOURNAL OF THE TRANSACTIONS
OF
THE VICTORIA INSTITUTE.

VOL. XXXI.

MOUNT SINAI

REDUCED FROM THE ORDNANCE SURVEY

Scale One Inch to 1 Eng. Stat. Mile

FURLONGS 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 MILE



From Dr. Wm. Smith's Ancient Atlas.

with Mr. John Murray's permission

TO ILLUSTRATE A PAPER BY PROFESSOR HULL, LL.D. F.R.S.

JOURNAL OF
THE TRANSACTIONS
OF
The Victoria Institute,
OR,
Philosophical Society of Great Britain.

EDITED BY THE HONORARY SECRETARY,
CAPTAIN F. W. H. PETRIE, F.G.S., &c.

VOL. XXXI.



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**.* The Institute's object being to investigate, it must not be held to endorse the various views expressed at its meetings.*

PREFACE.

THE Thirty-First Volume of the *Journal of the Transactions* of the VICTORIA INSTITUTE is now issued. It is "a record of the various important questions, which are occupying the thinkers of the present day, treated in papers, by competent investigators, and impartially discussed at meetings by those who have studied the subjects considered; to whose opinions have been added the written opinions of others whom distance has prevented attending the Institute's gatherings in person."*

The papers and discussions in this volume are upon the following subjects:—“The Age of the Earth as an Abode fitted for Life,” by the Right Honourable LORD KELVIN, G.C.V.O., F.R.S., whose researches and arguments may well serve to check hasty assumptions in the solution of new problems in Science. Remarks by the Right Honourable EARL HALSBURY, F.R.S. (Lord High Chancellor), Vice-President, the Bishop of DUNEDIN, Sir JOSEPH FAYRER, Bart., F.R.S., Sir H. BARKLY, G.C.M.G., F.R.S., Sir SIDNEY G. A. SHIPPARD, G.C.M.G., Captain CREAK, R.N., F.R.S.

* The careful correction of the papers, discussions, and communications, by their respective authors, often involving repeated communications even with distant lands, and references to the views of other investigators who have made the subjects treated matters of research, is at times a cause of delay in the publication of the *Journal* containing them, but the result is to give the Volume of Transactions the character of a finished work. From time to time Members of the Institute and others have expressed their high sense of the value of the Transactions of the Institute, inasmuch as they contain not the views of any one person only, but the well-considered opinions of many, resident in various and even distant parts of the world. This system, carried on by a competent body, gives a value to the treatment of the several subjects beyond that which any individual author could give.

“Where is Mount Sinai?” an investigation by Professor E. HULL, LL.D., F.R.S., in considering which Sir CHARLES WILSON, R.E., F.R.S., and other explorers took part. “Design as exemplified in the formation of the human foot,” a brief note by Dr. GERARD SMITH, M.R.C.S. “How far the Remarks of Herodotus bearing on Egyptian Geology are reliable in the light of recent Egyptian research,” was discussed by the Rev. F. A. WALKER, D.D., F.L.S., at a meeting presided over by Sir J. WILLIAM DAWSON, C.M.G., F.R.S. This and another paper on botany by the same author—“Herodotus as a Botanist”—bore testimony to that ancient author as a “wonderfully minute observer and accurate reporter.” “On the physical conditions of the Mediterranean basin, which have given rise to a community of some species of fresh-water fishes in the Nile and the Jordan basins,” by Professor E. HULL, LL.D., F.R.S. “Tithe-giving among ancient pagan nations,” by the Rev. H. LANSDELL, D.D., M.R.A.S., F.R.G.S., who viewed the antiquity and prevalence of that custom as showing “that the ancestors of the nations dwelt together,” a fact urged on philological grounds by the Right Honourable F. MAX MÜLLER. “Another possible cause of the Glacial Epoch” was discussed by Professor E. HULL, LL.D., F.R.S., in the consideration of which Professor RUPERT JONES, F.R.S., Professor GRESLEY and WARREN UPHAM, of the United States, took part. “Literature in Egypt in the time of Moses,” by Professor J. N. FRADENBURGH, D.D., Ph.D., LL.D., an important subject, in considering which Colonel C. R. CONDER, R.E., D.C.L., and others took part. “Plan and Purpose in Nature,” by W. A. KIDD, M.D., B.Sc., M.R.C.S., with remarks by Professor LIONEL S. BEALE, M.D., F.R.S., Professor J. H. GLADSTONE, Ph.D., F.R.S., and others. “The Star Worshipers of Mesopotamia,” by the Rev. S. M. ZWEMER, M.A., F.R.G.S., who records the results of his unique opportunities of observing this people. “On the Perception of Colour,” by Sir G. G. STOKES, Bart., F.R.S., *The President*, with remarks by the Right Honourable LORD KELVIN, G.C.V.O., the Right Honourable LORD LISTER, M.B.,

F.R.C.S., LL.D., P.R.S., Sir C. A. GORDON, K.C.B., the Ven. R. THORNTON, D.D., Archdeacon of Middlesex, and others. "On the sub-oceanic terraces and river valleys off the coast of Western Europe," by Professor E. HULL, LL.D., F.R.S., with remarks by Professor ETHERIDGE, F.R.S., General McMAHON, F.R.S., Professor T. MCK. HUGHES, F.R.S., and Cavaliere W. P. JERVIS, Keeper of the Royal Museum, Turin. Professor HULL'S investigations are of great importance not only for the interest of the results arrived at, but still more from their bearing upon other vexed questions in geology and physical geography, such as the causes of the vicissitudes of climate in past ages, and the distribution of land and marine fauna and flora in Upper Tertiary and recent times.

To all who have taken a part in the work done the best thanks of the Members and Associates are due. By their aid the Transactions of the Institute possess a unique value, containing as they do, on each subject dealt with, the opinions, not of one competent investigator, but of many of those whose studies have lain in the direction of the matter taken up.

FRANCIS W. H. PETRIE, *Capt.*,

Hon. Sec. and Editor.

The Autumn, 1899.

JOURNAL OF THE TRANSACTIONS
OF THE
VICTORIA INSTITUTE,
OR
PHILOSOPHICAL SOCIETY OF GREAT BRITAIN.

ANNUAL GENERAL MEETING
HELD AT THE HOUSE OF THE SOCIETY OF ARTS,
WEDNESDAY, JUNE 2, 1897.

The President,
SIR GEORGE GABRIEL STOKES, Bart., LL.D., Sc.D., F.R.S.,
IN THE CHAIR.

Captain FRANCIS PETRIE, F.G.S., &c., Hon. Sec., read the following
Report :—

Progress of the Institute.

1. In presenting the THIRTY-FIRST ANNUAL REPORT, the Council is glad to be able to state that the Institute's practical work is advancing effectually and decidedly. This is mainly due to two causes, the increase in the number of those in the highest walks of science who co-operate with the Institute—thus giving solidity to the Institute and strengthening its power for work, and also to the steady support of all its members and associates, who have thus strengthened the hands of the Council and have made the Institute's existence not only possible, but a fact.

Last year the Council pointed out that membership of the Institute was more than a mere personal advantage—for every member or associate who joins, even if he be not able to give active help in its proceedings, at least increases the Institute's efficiency.

Arrangements have been perfected for enabling country, colonial, and foreign members and associates to take

a part in considering the subjects brought before the Institute: all those interested in the various subjects can now, by intimating their wish beforehand, receive proof copies of the papers to be read, and can send in any comments they may see fit; these comments are brought before the Council with a view to being included in the discussion, which is published after each paper in the Journal. The value of the Journal is thereby enhanced to all, and made to include much that has not been brought before those attending the meetings.

Many leading home and foreign societies exchange Transactions with the Institute, and an increasing number of Universities, Colleges, Royal and Public Libraries in various countries subscribe for its Transactions.

3. The Library of Reference is becoming larger, partly through the increasing number of valuable works presented by their authors; but a Library Fund is desirable, in order to secure a larger number of books of reference. This year a new list of the books has been published for the use of members.

4. The following is the new list of the President and Council:—

President.

Sir George Gabriel Stokes, Bart., LL.D., Sc.D., F.R.S.

Vice-Presidents.

The Rt. Hon. Lord Halsbury, P.C., F.R.S., The Lord High Chancellor.
 Sir H. Barkly, G.C.M.G., K.C.B., F.R.S.
 Sir Joseph Fayrer, K.C.S.I., F.R.S.
 W. Forsyth, Esq., Q.C., LL.D.
 Alexander McArthur, Esq., J.P., D.L.
 The Venerable Archdeacon Thornton, D.D., *Archdeacon of Middlesex*.
 W. H. Hudleston, Esq., M.A., F.R.S.

Trustees.

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Council.

Hon. Treas.—Professor E. Hull, LL.D., F.R.S.

Hon. Sec.—Capt. F. W. H. Petrie, F.G.S.

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 *D. Howard, Esq., D.L., F.C.S.
 Professor H. A. Nicholson, M.D., F.R.S.
 The Bishop of Wakefield.
 Rev. F. W. Tremlett, D.C.L.
 Surg.-Gen. Gordon, M.D., C.B., Q.H.P.
 His Excellency Dr. B. H. Gunning, F.R.S.E.
 *Rev. Preb. H. Wace, D.D.

* *Ex officio.*

Rev. J. J. Lias, M.A.
 *Gen. G. S. Hallows.
 Rev. A. I. McCaul, M.A.
 Capt. Creak, B.N., F.R.S.
 Rev. F. A. Walker, D.D., F.L.S.
 T. Chaplin, Esq., M.D.
 Rev. Canon Girdlestone, M.A.
 Professor E. Hull, LL.D., F.R.S.
 † G. Pinches, Esq. (Brit. Mus.)
 The Ven. Archdeacon Sinclair, M.A.
 Dr. Gerard Smith, M.R.C.S.E.
 †Commander G. P. Heath, R.N.
 †Rev. Canon Tristram, M.A., D.D., LL.D.,
 F.R.S.
 †Rev. G. F. Whidborne, M.A., F.G.S., F.R.G.S.

† New members of Council.

5. The Council regret to announce the decease of the following supporters of the Institute:—

Admiral H. M. Alexander, R.N., *A.* ; T. Barnes, Esq., *A.* ; Captain J. G. Bourke, 3 U.S. Cavalry, *A.* ; Rev. G. B. R. Bousfield, M.A., *A.* ; Rt. Rev. Bishop C. J. Branch, D.D., Antigua, *A.* ; Isaac Brown, Esq., *A.* ; Rev. L. T. Conrad, B.D., *L.A.* ; Rev. Canon C. G. Curtis, M.A., *A.* ; Rev. E. Duke, M.A., F.G.S., *Foundation A.* ; Miss R. Eyton, *A.* ; Chancellor L. C. Garland, LL.D., *A.* ; Admiral H. D. Grant, C.B., *M.* ; Rev. C. Gutch, M.A., *A.* ; G. Harries, Esq., *Vice Patron* ; H. Hutton, Esq., *A.* ; James Johnstone, Esq., *A.* ; Rev. J. G. Kitchen, M.A., *A.* ; W. Klein, Esq., *M.* ; Rev. R. Lloyd, M.A., *A.* ; President G. F. Magoun, D.D., *A.* ; Rev. E. Male, M.A., *A.* ; Baron F. von Mueller, K.C.M.G., F.R.S., *A.* ; Rev. G. H. Muzy, *A.* ; J. H. Phillips, Esq., *A.* ; Rt. Hon. Sir C. A. Murray, K.C.B., P.C., *M.* ; J. H. Raper, Esq., *M.* ; Prof. J. R. Tucker, M.A., *A.* ; Warbreck, Rev. E., *A.* ; W. N. West, Esq., F.R. Hist. Soc., F.R.G.S., a Foundation Member in whom the Institute has lost an earnest supporter who acted as its Honorary Treasurer for a period of twenty-seven years, devoting to the work that ripe and clear judgment which so specially distinguished him ; Rev. B. Whitelock, M.A., *A.* ; Rev. Alban Wright, M.A., *M.*

M. Member.

A. Associate.

6. The following is a statement of the changes which have occurred:—

	Life		Annual	
	Members.	Associates.	Members.	Associates.
Numbers on July 15, 1896	62	49	366	887
Deduct Deaths	1	1	5	24
„ Retirements	—	—	6	18
			— 11	— 42
			355	845
Joined to May 17, 1897	—	2	14	39
	61	50	369	884
	111		1253	
Total	1364			
	Hon. Correspondents, 142.			

Finance.

7. The Treasurer's Balance-sheet for the year ending December 31, 1896, duly audited, shows total receipts £1,166 17s. 6d. ; expenditure £1,020 4s. 7d. ; leaving a balance creditor of £146 12s. 11d., after the payment of all liabilities, except the sum of £144 17s. 4d. due for printing. The amount invested in $2\frac{3}{4}$ per Cent. Consols is £1,365 18s. 9d.

8. The Council desires to urge the very great importance of all subscriptions being remitted

during the first half of the year (Bye-law III, 3). Adherence to the rule on this point would remove a serious difficulty in the management of the Institute. Forms for the payment of the subscriptions through a banker are used by a large number, and may be had at the office.

MEETINGS.

The meetings of the Institute have been specially well attended, the lecture room being almost always fully occupied by the members attending.

HALF-PAST FOUR O'CLOCK MEETINGS.

The subjects taken up during the session have been:—

MONDAY, DECEMBER 7, 1896.—“Biblical Lands, their Topography, Languages, Customs Ancient and Modern.” By H. RASSAM, Esq.

This subject was introduced by Mr. Rassam in consequence of its having been urged that the work of investigating the records on the monuments and their comprehension by others, would be much advanced by a paper describing those manners and customs, traditions, &c., in the east, which are fast dying out, and which he, as a Chaldean, is of all others best acquainted with.

MONDAY, JANUARY 4, 1897.—“Herodotus, and the Botany of Ancient Egypt.” By Rev. F. A. WALKER, D.D., F.L.S.

A subject which was so treated as to be of special use to the student of ancient records.

MONDAY, JANUARY 18.—“The proposed scheme for embanking the Waters of the Nile at Assouan in Upper Egypt” (with special reference to the preservation of ancient monuments, inscriptions, &c.) By Professor HULL, LL.D., F.R.S.

Professor Hull, F.R.S., Mr. Baldwin Latham, C.E., and others considered the importance of the steps taken in a matter involving the preservation of important ancient monuments and records.

MONDAY, FEBRUARY 1.—“The Human Colour Sense.” By J. D. MACDONALD, Esq., M.D., F.R.S.

MONDAY, FEBRUARY 15.—“Are acquired characters inherited?” By Rev. A. K. CHERRILL, M.A. *Lecture.*

MONDAY, MARCH 1.—“Common Errors as regards the Relations of Science and Faith,” by Professor MACLOSIE, LL.D., D.Sc., &c.

This important subject was brought forward by the Professor of Biology at Princeton University, and its consideration by the Institute is most timely, considering the present public tendency to credit statements not based on fact as regards either Science or Faith.

MONDAY, MARCH 15.—“Creation and Evolution,” by W. KIDD, Esq., M.D.

The various views held by men of science and the deductions therefrom were considered. The Duke of Argyll and others contributed their opinions.

MONDAY, APRIL 5.—“Problems of Aboriginal Art in Australia,” by the Rt. Rev. The Bishop of Ballarat.

With reference to the evidence of the presence among the aborigines of Australia at an early period of the people of a higher civilization.

MONDAY, APRIL 12 (*instead of Easter Monday*).—“The Scope of Mind,” by A. T. SCHOFIELD, Esq., M.D.

A subject also carefully considered by Professor Cleland, F.R.S., Professor Lionel Beale, F.R.S., and other members of the Institute.

MONDAY, MAY 3.—“Niffer,” the last excavations there; with readings of inscriptions of historical importance, by THEO. G. PINCHES, Esq., M.R.A.S. *Lecture.*

In regard to a civilization believed to be prior to the Babylonian, explained by the researches of Mr. Theo. G. Pinches, M.R.A.S., Professor Hilprecht, Professor Hommel, and other members of the Institute.

MONDAY, MAY 17.—“The Tamil Caiva Sage,” by Rev. G. U. POPE, D.D.

The author gave a summary of ancient Indian records bearing on the history and times of this early “foe of the Buddhists.” His researches promise to be of special value to those seeking to supplant error and introduce a purer civilization.

WEDNESDAY, JUNE 2.—*The Annual Meeting*, an address by the Right Hon. LORD KELVIN, G.C.V.O., F.R.S., “On the Age of the Earth as an Abode fitted for Life,” at the *Society of Arts House*.

Publications.

The twenty-ninth volume of the Transactions will shortly be in the hands of the members.

It was noted last year that from time to time members of the Institute and others have expressed their high sense of the value of the Transactions of the Institute, inasmuch as they contained *not the opinions of any one single individual, but those of many diligent students of the subjects*, resident in various and even distant parts of the world, whose studies have lain in the direction of the subjects taken up. That a system like this, carried on by a competent body or Society, gives a value to the treatment of the several subjects beyond that which any individual author could give, is evident.

The Journal, which contains the combined opinions of many minds on important subjects—and which has so long been referred to by home and foreign members, and others as “just what is wanted”—continues to be used by members and others in many countries to translate from, or as a basis for lectures. (The office correspondence in regard to matter for lectures, &c., increases both in volume and importance.)

In no year has the Institute received a greater number of congratulatory letters from home, colonial and American members on its usefulness, amongst them an official letter

from the United States Government Bureau of American Ethnology, from which the following is quoted: "We are fortunate enough to have in the library the volumes of the *Transactions* of the Victoria Institute, which are much used and highly prized."

The Special Fund.

This fund was founded with a view to still further advance the influence of the Institute. I. By the publication of the twelve papers in the People's Edition. II. For helping to give grants of papers or volumes of the *Transactions* to those Home and Colonial bodies which may specially need such. (Many applications have been refused of late, as the fund has not been sufficient.) III. To maintain the Institute's Library of Reference.

It has been suggested by many members that the present Jubilee year is a fitting occasion for the members and associates to take some step which may tend to permanently advance the cause which the Institute was founded to promote,—either by adding to the Special Fund or the Gunning Shaftesbury Fund, or by becoming life members or associates.

Conclusion.

The Institute has sought, not without success, to associate men of cultured mind and calm judgment in the investigation of important questions of Philosophy and Science, more especially those which are alleged to bear on the great Truths of Holy Writ—so that hasty conclusions may no longer afford ground for unseemly attack, to the injury both of Religion and Science. It is becoming yearly more apparent that the Institute meets a need felt both at home and abroad, especially in the Colonies and India, where imperfect appreciation of the actual results of philosophic and scientific inquiry has led many of the less informed, to credit such statements as that "Science and Philosophy are alike opposed to Revelation," or that "the progress of Science has given a death blow to all belief in the truth of the Bible"—misapprehensions which, in some cases, have led even to systems of Education divorced from Religion; hence the strengthening by every means of so successful and desirable a movement claims all encouragement, its object being, in the words of the Institute's motto, "*Ad Majorem Dei Gloriam.*"

G. STOKES, *President.*

ANNUAL BALANCE-SHEET, from 1st January to 31st December, 1896.

	RECEIPTS.	£	s.	d.	£	s.	d.		EXPENDITURE.	£	s.	d.
Subscriptions:—												
Balance from 1895				55	12	8		Printing	167	13	1
2 Life Members	42	0	0					Postage	77	5	1
2 Life Associates..	..	21	0	0					Binding	32	17	9
					68	0	0		Reporting	26	5	0
									Typewriting	0	2	5
Subscriptions:—2 Members, 1893..	..	4	4	0					Stationery	27	3	8
4 " 1894..	..	8	8	0					Advertising	22	12	0
20 " 1895..	..	42	0	0					Expenses of Meetings	9	14	10
181 " 1896..	..	380	2	0					Travelling	14	17	10
2 " 1897..	..	4	4	0					Clerk—Salary	78	0	0
6 Entrance Fees	6	6	0					" Extra	24	17	6
1 Associate, 1888..	..	1	1	0					Rent.. ..	180	0	0
1 " 1889..	..	1	1	0					Housekeeper	0	15	7
1 " 1890..	..	1	1	0					Coal and Light	8	12	0
1 " 1891..	..	1	1	0					Library	28	3	8
3 Associates, 1893	3	3	0					Organization	315	0	0
12 " 1894	12	12	0					Insurance	0	12	0
57 " 1895	59	17	0					Bank Charges	0	15	2
408 " 1896	428	8	0					Sundries	4	17	0
9 " 1897	9	9	0					Balance (see note*)	146	12	11
					962	17	0					
Dividend on £1,365 18s. 9d. 2½ p.c. Consols				36	6	0					
The Gunning Fund				20	0	0					
Donations to Special Fund (H. C. Dent, Esq., and R. T. Pain, Esq.)				2	2	0					
Sale of Journals				26	19	10					
					£1,166	17	6					
												£1,166 17 6

We have examined the Balance-Sheet with the Books and Vouchers, and find a Balance in hand of £146 12s. 11d.

5 March, 1897.

JOHN ALLEN,
T. A. LE MESURIER, Lt.-Col. } *Auditors.*

* £144 17s. 4d. of this is due to the printer.

The LORD BISHOP OF DUNEDIN.—I am honoured by being asked to move the following resolution :—

“ That the Report be received and the thanks of the members and associates presented to the Council, honorary officers and auditors, for their efficient conduct of the business of the Victoria Institute during the past year.”

My task in moving this resolution is a very pleasant one, and when you note the way in which the objects of this Institute have been maintained, and that the important work which it has taken in hand, has been carried on successfully, as the first clauses of the Report indicate, then, of course, it follows naturally that a Report relating to such success should be received by this meeting and gladly received, and I think it also equally follows that if such a desirable result as has crowned the splendid labours of its President, Vice-President and Council, then those honorary officers (and it is well for us to remember that they are honorary) are certainly worthy of your thanks. (Applause.) And I must say that the Institute derives much of its efficiency from the generous and persevering and long-continued efforts of its Honorary Secretary, Captain Petrie. (Applause.) It needs very few words of mine to add to what you will find quoted in the Report—that “ the Institute meets a need felt both at home and abroad, especially in our Colonies and India, where imperfect appreciation of the actual results of philosophic and scientific inquiry has led many of the less informed to credit such statements as that Science and Philosophy are alike opposed to Revelation, or that the progress of Science has given a death-blow to all belief in the truth of the Bible.” I am here to say, as representing one of those Colonies alluded to in this Report, that to my mind it is of the utmost importance that there should be a Society such as this, in which the ability of those who come forward to dissipate these misapprehensions cannot be gainsaid or their knowledge disputed.

I suppose the common idea in the mind of most people when a contrast is made (and the contrast is too often made perhaps between the position of the scientist and the position of the professor of religion), is that the scientist has that which is

positive and absolute on his side, while the professor of religion has only subjective emotions or theories that are, at any rate, incapable of proof, and therefore it is said that the scientist has all the advantage, and that science is going a long way to blot out religion, or at any rate Christianity, from the face of the earth. I deny altogether such a contrast, or the right to make such a contrast. When we look more closely into the matter, we shall see that the natural scientist and the professor of religion really proceed on much the same lines—that the scientist has no more absolute and positive basis to go upon than the professor of religion—that the professor of natural science is as much beholden to faith as is the professor of revealed religion. We have had it on the eminent authority of Huxley himself that science advances by steps, and on bases that must be postulated, such as the existence of matter, the universality of the law of causation and the truth for ever of the laws of Natural Science; these are the postulates of the scientist. These things cannot be demonstrated. Professor Huxley himself acknowledges that these matters cannot be proved, and the scientist cannot any more go on without faith in his postulates, than the Christian can in his postulates of the existence of a God—that that Being is the Author of all things that exist and rules over all existence, and lastly, that He cares for His creatures. These are the postulates of Christianity, and they correspond very closely with the postulates of Natural Science; and seeing that, we find no contrast between the one and the other, but that research in both proceeds in the same direction, viz., the inquiry whether acquired knowledge of detail verifies the postulates. We may therefore take it for granted that there is no superior position or advantage to the man of science over the man of religion, as is commonly imagined. (Applause.) I would like to add that it is too commonly supposed that the discoveries of science, as is stated in this Report, have done away with the basis of religion; but I want you clearly to understand, as I have no doubt most of you do, that these discoveries are only so much matter of detail. There is a common impression abroad that the knowledge which we derive from the things of nature is so much knowledge of the forces which give origin to things—they are

merely man's knowledge of phenomena—as, for example, when some man who has investigated a particular line of science tells us that sensation is caused by the vibrations of the molecules of the brain, or something of that kind. I say the discovery of that is nothing more than the knowledge of certain phenomena; that there are those vibrations, but it seems to me, there is no connection, discoverable to our intelligence, between sensation and vibration; and therefore we only go on day by day discovering additional details in phenomena. Therefore there is much happiness in knowing that this Society exists for the discussion of all branches of knowledge and the elucidation of Truth. (Applause.)

Sir H. BARKLY, G.C.M.G., K.C.B., F.R.S.—I have much pleasure in seconding this resolution.

The resolution was carried unanimously.

Professor E. HULL, LL.D., F.R.S.—I have only to thank you, on the part of the Council, for the manner in which you have received this resolution. The Council highly appreciate the honour you have conferred upon them.

The PRESIDENT.—I have now the privilege to call upon Lord Kelvin to give his Address :—

*THE AGE OF THE EARTH AS AN ABODE
FITTED FOR LIFE.* By the RIGHT HON. LORD
KELVIN, G.C.V.O.

[Being the 1897 Annual Address of the Victoria Institute with the author's additions written at different times from June to December, 1897.]

§ 1. The age of the earth as an abode fitted for Life is certainly a subject which largely interests mankind in general. For geology it is of vital and fundamental importance—as important as the date of the battle of Hastings is for English History—yet it was very little thought of by geologists of thirty or forty years ago; how little is illustrated by a statement,* which I will now read, given originally from the presidential chair of the Geological Society by Professor Huxley in 1869, when for a second time, after a seven years' interval, he was president of the Society.

“ I do not suppose that at the present day any geologist would be found . . . to deny that the rapidity of the rotation of the earth *may* be diminishing, that the sun *may* be waxing dim, or that the earth itself *may* be cooling. Most of us, I suspect, are Gallios, ‘ who care for none of these things,’ being of opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits.”

§ 2. I believe the explanation of how it was possible for Professor Huxley to say that he and other geologists did not care for things on which the age of life on the earth essentially depends, is because he did not know that there was valid foundation for any estimates worth considering as to absolute magnitudes. If science did not allow us to give any estimate whatever as to whether 10,000,000 or 10,000,000,000 years is the age of this earth as an abode fitted for life, then I think Professor Huxley would have been perfectly right in saying that geologists should not trouble themselves about it, and biologists should go on in their own way, not enquiring into things utterly beyond the power of human

* In the printed quotations the italics are mine in every case, not so the capitals in the quotation from Page's Text-book.

understanding and scientific investigation. This would have left geology much in the same position as that in which English history would be if it were impossible to ascertain whether the battle of Hastings took place 800 years ago, or 800 thousand years ago, or 800 million years ago. If it were absolutely impossible to find out which of these periods is more probable than the other, then I agree we might be Gallios as to the date of the Norman Conquest. But a change took place just about the time to which I refer, and from then till now geologists have not considered the question of absolute dates in their science as outside the scope of their investigations.

§ 3. I may be allowed to read a few extracts to indicate how geological thought was expressed in respect of this subject, in various largely used popular text books, and in scientific writings which were new in 1868, or not too old to be forgotten. I have several short extracts to read and I hope you will not find them tedious.

The first is three lines from Darwin's *Origin of Species*, 1859 Edition, p. 287.

"In all probability a far longer period than 300,000,000 years has elapsed since the latter part of the secondary period."

Here is another still more important sentence, which I read to you from the same book :—

"He who can read Sir Charles Lyell's grand work on the Principles of Geology, which the future historian will recognise as having produced a revolution in natural science, yet does not admit how *incomprehensibly vast* have been the past periods of time, *may at once close this volume.*"

I shall next read a short statement from Page's *Advanced Students' Text Book of Geology*, published in 1859 :—

"Again where the FORCE seems unequal to the result, the student should never lose sight of the element TIME : *an element to which we can set no bounds in the past*, any more than we know of its limit in the future."

"It will be seen from this hasty indication that there are two great schools of geological causation—the one ascribing every result to the ordinary operations of Nature, combined with the element of *unlimited time*, the other appealing to agents that operated during the earlier epochs of the world with greater intensity, and also for the most part over wider areas. *The former belief is certainly more in accordance with the spirit of right philosophy*, though it must be confessed that many problems in geology seem to find their solution only through the admission of the latter hypothesis."

§ 4. I have several other statements which I think you may hear with some interest. Dr. Samuel Haughton, of Trinity

College, Dublin, in his *Manual of Geology*, published in 1865, p. 82, says:—

“The infinite time of the geologists is in the past; and *most of their speculations regarding this subject seem to imply the absolute infinity of time*, as if the human imagination was unable to grasp the period of time requisite for the formation of a few inches of sand or feet of mud, and its subsequent consolidation into rock.” (This delicate satire is certainly not overstrained.)

“Professor Thomson has made an attempt to calculate the length of time during which the sun can have gone on burning at the present rate, and has come to the following conclusion: ‘It seems, on the whole, most probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say with equal certainty, that the inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless new sources, now unknown to us are prepared in the great storehouse of creation.’”

I said that in the sixties and I repeat it now; but with charming logic it is held to be inconsistent with a later statement that the sun has not been shining 60,000,000 years; and that both that and this are stultified by a still closer estimate which says that probably the sun has not been shining for 30,000,000 years! And so my efforts to find some limit or estimate for Geological Time have been referred to and put before the public, even in London daily and weekly papers, to show how exceedingly wild are the wanderings of physicists, and how mutually contradictory are their conclusions, as to the length of time which has actually passed since the early geological epochs to the present date.

Dr. Haughton further goes on—

“*This result (100 to 500 million years) of Professor Thomson’s, although very liberal in the allowance of time, has offended geologists, because, having been accustomed to deal with time as an infinite quantity at their disposal, they feel naturally embarrassment and alarm at any attempt of the science of Physics to place a limit upon their speculations.* It is quite possible that even a hundred million of years may be greatly in excess of the actual time during which the sun’s heat has remained constant.”

§ 5. Dr. Haughton admitted so much with a candid open mind; but he went on to express his own belief (in 1865) thus:

“Although I have spoken somewhat disrespectfully of the geological calculus in my lecture, yet I believe that the time during which organic life has existed on the earth is practically infinite, because it can be shown to be so great as to be inconceivable by beings of our limited intelligence.”

Where is inconceivableness in 10,000,000,000? There is nothing inconceivable in the number of persons in this room, or in London. We get up to millions quickly. Is there any-

thing inconceivable in 30,000,000 as the population of England, or in 38,000,000 as the population of Great Britain and Ireland, or in 352,704,863 as the population of the British Empire? Not at all. It is just as conceivable as half a million years or 500 millions.

§ 6. The following statement is from Professor Jukes's *Students' Manual of Geology*:—

“The time required for such a slow process to effect such enormous results must of course be taken to be inconceivably great. The word ‘inconceivably’ is not here used in a vague but in a literal sense, to indicate that the lapse of time required for the denudation that has produced the present surfaces of some of the older rocks, is vast beyond any idea of time which the human mind is capable of conceiving.”

“Mr. Darwin, in his admirably reasoned book on the origin of species, so full of information and suggestion on all geological subjects, estimates the time required for the denudation of the rocks of the Weald of Kent, or the erosion of space between the ranges of chalk hills, known as the North and South Downs, at *three hundred millions of years*. The grounds for forming this estimate are of course of the vaguest description. It may be possible, perhaps, that the estimate is a hundred times too great, and that the real time elapsed did not exceed three million years, but, on the other hand, it is just as likely that the time which actually elapsed since the first commencement of the erosion till it was nearly as complete as it now is, was really a hundred times greater than his estimate, or thirty thousand millions of years.”

§ 7. Thus Jukes allowed estimates of anything from 3 millions to 30,000 millions as the time which actually passed during the denudation of the Weald. On the other hand Professor Phillips in his Rede lecture to the University of Cambridge (1860), decidedly prefers one inch per annum to Darwin's one inch per century as the rate of erosion; and says that most observers would consider even the one inch per annum too small for all but the most invincible coasts! He thus, on purely geological grounds, reduces Darwin's estimate of the time to less than one one-hundredth. And, reckoning the actual thicknesses of all the known geological strata of the earth, he finds 96 million years as a possible estimate for the antiquity of the base of the stratified rocks; but he gives reasons for supposing that this may be an over-estimate, and he finds that from stratigraphical evidence alone, we may regard the antiquity of life on the earth as possibly between 38 millions and 96 millions of years. Quite lately a very careful estimate of the antiquity of strata containing remains of life on the earth, has been given by Professor Sollas, of Oxford, calculated according to stratigraphical principles which had been pointed out

by Mr. Alfred Wallace. Here it is* :—"So far as I can at present see, the lapse of time since the beginning of the Cambrian system is probably less than 17,000,000 years, even when computed on an assumption of uniformity, which to me seems contradicted by the most salient facts of geology. Whatever additional time the calculations made on physical data can afford us, may go to the account of pre-Cambrian deposits, of which at present we know too little to serve for an independent estimate."

§ 8. In one of the evening *Conversazioni* of the British Association during its meeting at Dundee in 1867 I had a conversation on geological time with the late Sir Andrew Ramsay, almost every word of which remains stamped on my mind to this day. We had been hearing a brilliant and suggestive lecture by Professor (now Sir Archibald) Geikie on the geological history of the actions by which the existing scenery of Scotland was produced. I asked Ramsay how long a time he allowed for that history. He answered that he could suggest no limit to it. I said, "You don't suppose things have been going on always as they are now? You don't suppose geological history has run through 1,000,000,000 years?" "Certainly I do." "10,000,000,000 years?" "Yes." "The sun is a finite body. You can tell how many tons it is. Do you think it has been shining on for a million million years?" "I am as incapable of estimating and understanding the reasons which you physicists have for limiting geological time as you are incapable of understanding the geological reasons for our unlimited estimates." I answered, "You can understand physicists' reasoning perfectly if you give your mind to it." I ventured also to say that physicists were not wholly incapable of appreciating geological difficulties; and so the matter ended, and we had a friendly agreement to temporarily differ.

§ 9. In fact, from about the beginning of the century till that time (1867), geologists had been nurtured in a philosophy originating with the Huttonian system: much of it substantially very good philosophy, but some of it essentially unsound and misleading: witness this, from Playfair, the eloquent and able expounder of Hutton :—

"How often these vicissitudes of decay and renovation have been repeated is not for us to determine; they constitute a series of which as the author of this theory has remarked, we neither see the beginning nor

* "The Age of the Earth," *Nature*, April 4th, 1895.

the end; a circumstance that accords well with what is known concerning other parts of the economy of the world. In the continuation of the different species of animals and vegetables that inhabit the earth, we discern neither a beginning nor an end; in the planetary motions where geometry has carried the eye so far both into the future and the past we discover no mark either of the commencement or the termination of the present order."

§ 10. Led by Hutton and Playfair, Lyell taught the doctrine of eternity and uniformity in geology; and to explain plutonic action and underground heat, invented a thermo-electric "perpetual" motion on which, in the year 1862, in my paper on the "Secular Cooling of the Earth,"* published in the *Transactions of the Royal Society of Edinburgh*, I commented as follows:—

"To suppose, as Lyell, adopting the chemical hypothesis, has done,† that the substances, combining together, may be again separated electrolytically by thermo-electric currents, due to the heat generated by their combination, and thus the chemical action and its heat continued in an endless cycle, violates the principles of natural philosophy in exactly the same manner, and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going for ever."

It was only by sheer force of reason that geologists have been compelled to think otherwise, and to see that there was a definite beginning, and to look forward to a definite end, of this world as an abode fitted for life.

§ 11. It is curious that English philosophers and writers should not have noticed how Newton treated the astronomical problem. Playfair, in what I have read to you, speaks of the planetary system as being absolutely eternal, and unchangeable: having had no beginning and showing no signs of progress towards an end. He assumes also that the sun is to go on shining for ever, and that the earth is to go on revolving round it for ever. He quite overlooked Laplace's nebular theory; and he overlooked Newton's counterblast to the planetary "perpetual motion." Newton, commenting on his own *First Law of Motion*, says, in his terse Latin, which I will endeavour to translate, "But the greater bodies of planets and comets moving in spaces less resisting, keep their motions longer." That is a strong counterblast against any idea of eternity in the planetary system.

§ 12. I shall now, without further preface, explain, and I

* Reprinted in Thomson and Tait, *Treatise on Natural Philosophy*, 1st and 2nd Editions, Appendix D (g).

† *Principles of Geology*, chap. xxxi, ed. 1853.

hope briefly, so as not to wear out your patience, some of the arguments that I brought forward between 1862 and 1869, to show strict limitations to the possible age of the earth as an abode fitted for life.

Kant* pointed out in the middle of last century, what had not previously been discovered by mathematicians or physical astronomers, that the frictional resistance against tidal currents on the earth's surface must cause a diminution of the earth's rotational speed. This really great discovery in Natural Philosophy seems to have attracted very little attention,—indeed to have passed quite unnoticed,—among mathematicians, and astronomers, and naturalists, until about 1840, when the doctrine of energy began to be taken to heart. In 1866, Delaunay suggested that tidal retardation of the earth's rotation was probably the cause of an outstanding acceleration of the moon's mean motion reckoned according to the earth's rotation as a timekeeper found by Adams in 1853 by correcting a calculation of Laplace which had seemed to prove the earth's rotational speed to be uniform.† Adopting Delaunay's suggestion as true, Adams, in conjunction with Professor Tait and myself, estimated the diminution of the earth's rotational speed to be such that the earth as a timekeeper, in the course of a century, would get 22 seconds behind a thoroughly perfect watch or clock rated to agree with it at the beginning of the century. According to this rate of retardation the earth, 7,200 million years ago, would have been rotating twice as fast as now: and the centrifugal force in the equatorial regions would have been four times as great as its present amount, which is $\frac{1}{89}$ of gravity. At present the radius of the equatorial sea-level exceeds the polar semi-diameter by $21\frac{1}{2}$ kilometres, which is, as nearly as the most careful cal-

* In an essay first published in the Königsberg Nachrichten, 1754, Nos. 23, 24; having been written with reference to the offer of a prize by the Berlin Academy of Sciences in 1754. Here is the title-page, in full, as it appears in vol. vi of Kant's Collected Works, Leipzig, 1839:—*Untersuchung der Frage: Ob die Erde in ihrer Umdrehung um die Achse, wodurch sie die Abwechselung des Tages und der Nacht hervorbringt, einige Veränderung seit den ersten Zeiten ihres Ursprunges erlitten habe, welches die Ursache davon sei, und woraus man sich ihrer versichern könne? welche von der Königlichen Akademie Der Wissenschaften zu Berlin zum Preise aufgegeben worden, 1754.*

† *Treatise on Natural Philosophy* (Thomson and Tait) § 830, ed. 1, 1867, and later editions; also *Popular Lectures and Addresses*, vol. ii (Kelvin). *Geological Time* being a reprint of an article communicated to the Glasgow Geological Society February 27th, 1868.

culations in the theory of the earth's figure can tell us, just what the excess of equatorial radius of the surface of the sea all round would be if the whole material of the earth were at present liquid and in equilibrium under the influence of gravity and centrifugal force with the present rotational speed, and $\frac{1}{4}$ of what it would be if the rotational speed were twice as great. Hence, if the rotational speed had been twice as great as its present amount when consolidation from approximately the figure of fluid equilibrium took place, and if the solid earth, remaining absolutely rigid, had been gradually slowed down in the course of millions of years to its present speed of rotation, the water would have settled into two circular oceans round the two poles : and the equator, dry all round, would be 64·5 kilometres above the level of the polar sea bottoms. This is on the supposition of absolute rigidity of the earth after primitive consolidation. There would, in reality, have been some degree of yielding to the gravitational tendency to level the great gentle slope up from each pole to equator. But if the earth, at the time of primitive consolidation, had been rotating twice as fast as at present, or even 20 per cent. faster than at present, traces of its present figure must have been left in a great preponderance of land, and probably no sea at all, in the equatorial regions. Taking into account all uncertainties, whether in respect to Adams' estimate of the rate of frictional retardation of the earth's rotatory speed, or to the conditions as to rigidity of the earth once consolidated, we may safely conclude that the earth was certainly not solid 5,000 million years ago, and was probably not solid 1,000 million years ago.*

§ 13. A second argument for limitation of the earth's age, which was really my own first argument, is founded on the consideration of underground heat. To explain a first rough and ready estimate of it I shall read one short statement. It is from a very short paper that I communicated to the Royal Society of Edinburgh on the 18th December, 1865,

* "The fact that the continents are arranged along meridians, rather than in an equatorial belt, affords some degree of proof that the consolidation of the earth took place at a time when the diurnal rotation differed but little from its present value. It is probable that the date of consolidation is considerably more recent than a thousand million years ago." Thomson and Tait. *Treatise on Natural Philosophy*, 2nd Edition, 1883, § 830.

entitled, "The Doctrine of Uniformity in Geology briefly refuted."

"The 'Doctrine of Uniformity' in Geology, as held by many of the most eminent of British Geologists, assumes that the earth's surface and upper crust have been nearly as they are at present in temperature, and other physical qualities, during millions of millions of years. But *the heat which we know, by observation, to be now conducted out of the earth yearly is so great, that if this action had been going on with any approach to uniformity for 20,000 million years, the amount of heat lost out of the earth would have been about as much as would heat, by 100° Cent., a quantity of ordinary surface rock of 100 times the earth's bulk. This would be more than enough to melt a mass of surface rock equal in bulk to the whole earth. No hypothesis as to chemical action, internal fluidity, effects of pressure at great depth, or possible character of substances in the interior of the earth, possessing the smallest vestige of probability, can justify the supposition that the earth's upper crust has remained nearly as it is, while from the whole, or from any part, of the earth, so great a quantity of heat has been lost.*"

§ 14. The sixteen words which I have emphasized in reading this statement to you (*italics in the reprint*) indicate the matter-of-fact foundation for the conclusion asserted. This conclusion suffices to sweep away the whole system of geological and biological speculation demanding an "inconceivably" great vista of past time, or even a few thousand million years, for the history of life on the earth, and approximate uniformity of plutonic action throughout that time; which, as we have seen, was very generally prevalent thirty years ago among British Geologists and Biologists; and which, I must say, some of our chiefs of the present day have not yet abandoned. Witness the Presidents of the Geological and Zoological Sections of the British Association at its meetings of 1893 (Nottingham), and of 1896 (Liverpool).

Mr. Teall: Presidential Address to the Geological Section, 1892. "The good old British ship 'Uniformity,' built by Hutton and refitted by Lyell, has won so many glorious victories in the past, and appears still to be in such excellent fighting trim, that I see no reason why she should haul down her colours either to 'Catastrophe' or 'Evolution.' Instead, therefore, of acceding to the request to 'hurry up' we make a demand for more time."

Professor Poulton: Presidential Address to the Zoological Section, 1896. "Our argument does not deal with the time required for the origin of life, or for the development of the lowest beings with which we are acquainted from the first formed beings, of which we know nothing. Both these processes may have required an immensity of time; but as we know nothing whatever about them and have as yet no prospect of acquiring any information, we are compelled to confine ourselves to as much of the process of evolution as we can infer from the structure of living and fossil forms—that is, as regards animals, to the development of the simplest into the most complex Protozoa, the evolution of the

Metazoa from the Protozoa, and the branching of the former into its numerous Phyla, with all their Classes, Orders, Families, Genera, and Species. But we shall find that this is quite enough to necessitate a *very large increase in the time estimated by the geologist.*"

§ 15. In my own short paper from which I have read you a sentence, the rate at which heat is at the present time lost from the earth by conduction outwards through the upper crust, as proved by observations of underground temperature in different parts of the world, and by measurement of the thermal conductivity of surface rocks and strata, sufficed to utterly refute the Doctrine of Uniformity as taught by Hutton, Lyell, and their followers; which was the sole object of that paper.

§ 16. In an earlier communication to the Royal Society of Edinburgh,* I had considered the cooling of the earth due to this loss of heat; and by tracing backwards the process of cooling had formed a definite estimate of the greatest and least number of million years which can possibly have passed since the surface of the earth was everywhere red hot. I expressed my conclusion in the following statement:—

"We are very ignorant as to the effects of high temperatures in altering the conductivities and specific heats and melting temperatures of rocks, and as to their latent heat of fusion. We must, therefore allow very wide limits in such an estimate as I have attempted to make; but I think we may with much probability say that the consolidation cannot have taken place less than 20 million years ago, or we should now have more underground heat than we actually have; nor more than 400 million years ago, or we should now have less underground heat than we actually have. That is to say, I conclude that Leibnitz's epoch of emergence of the *consistentior status* [the consolidation of the earth from red hot or white hot molten matter] was probably between those dates."

§ 17. During the 35 years which have passed since I gave this wide-ranged estimate, experimental investigation has supplied much of the knowledge then wanting regarding the thermal properties of rocks to form a closer estimate of the time which has passed since the consolidation of the earth, and we have now good reason for judging that it was more than 20 and less than 40 million years ago; and probably much nearer 20 than 40.

* *On the Secular Cooling of the Earth*, *Trans. Roy. Soc., Edinburgh*, vol. xxiii, April 28th, 1862, reprinted in Thomson and Tait, vol. iii, pp. 468-485, and *Math. and Phys. Papers*, Art. XCIV, pp. 295-311.

† *On the Secular Cooling of the Earth*, *Math. and Phys. Papers*, vol. iii, § 11 of Art. XCIV.

§ 18. Twelve years ago, in a laboratory established by Mr. Clarence King in connection with the United States Geological Survey, a very important series of experimental researches on the physical properties of rocks at high temperatures was commenced by Dr. Carl Barus, for the purpose of supplying trustworthy data for geological theory. Mr. Clarence King, in an article published in the *American Journal of Science*,* used data thus supplied, to estimate the age of the earth more definitely than was possible for me to do in 1862, with the very meagre information then available as to the specific heats, thermal conductivities, and temperatures of fusion, of rocks. I had taken 7,000° F. (3,871° C.) as a high estimate of the temperature of melting rock. Even then I might have taken something between 1,000° C. and 2,000° C. as more probable, but I was most anxious not to *under-estimate* the age of the earth, and so I founded my primary calculation on the 7,000° F. for the temperature of melting rock. We know now from the experiments of Carl Barus† that diabase, a typical basalt of very primitive character, melts between 1100° C. and 1170°, and is thoroughly liquid at 1200°. The correction from 3871° C. to 1200° or $1/3.22$ of that value, for the temperature of solidification, would, with no other change of assumptions, reduce my estimate of 100 million to $1/(3.22)^2$ of its amount, or a little less than 10 million years; but the effect of pressure on the temperature of solidification must also be taken into account, and Mr. Clarence King, after a careful scrutiny of all the data given him for this purpose by Dr. Barus, concludes that without further experimental data "we have no warrant for extending the earth's age beyond 24 millions of years."

§ 19. By an elaborate piece of mathematical book-keeping I have worked out the problem of the conduction of heat outwards from the earth, with specific heat increasing up to the melting point as found by Rücker and Roberts-Austen and by Barus, but with the conductivity assumed constant; and, by taking into account the augmentation of melting temperature with pressure in a somewhat more complete manner than that adopted by Mr. Clarence King, I am not led to differ much from his estimate of 24 million years. But, until we know something more than we know at present as to the probable diminution of thermal conductivity with

* *On the Age of the Earth*, vol. xlv, January, 1893.

† *Phil. Mag.*, 1893, first half-year, pp. 186, 187, 301-305.

increasing temperature, which would shorten the time since consolidation, it would be quite inadvisable to publish any closer estimate.

§ 20. All these reckonings of the history of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the very sure assumption that the material of our present solid earth all round its surface was at one time a white hot liquid. The earth is at present losing heat from its surface all round from year to year and century to century. We may dismiss as utterly untenable any supposition such as that a few thousand or a few million years of the present regime in this respect was preceded by a few thousand or a few million years of heating from without. History, guided by science, is bound to find, if possible, an antecedent condition preceding every known state of affairs, whether of dead matter or of living creatures. Unless the earth was created solid and hot out of nothing, the regime of continued loss of heat must have been preceded by molten matter all round the surface. *

§ 21. I have given strong reasons* for believing that *immediately* before solidification at the surface, the interior was solid close up to the surface: except comparatively small portions of lava or melted rock among the solid masses of denser solid rock which had sunk through the liquid, and possibly a somewhat large space around the centre occupied by platinum, gold, silver, lead, copper, iron and other dense metals, still remaining liquid under very high pressure.

§ 22. I wish now to speak to you of depths below the great surface of liquid lava bounding the earth before consolidation; and of mountain heights and ocean depths formed probably a few years after a first emergence of solid rock from the liquid surface (see § 24, below), which must have been quickly followed by complete consolidation all round the globe. But I must first ask you to excuse my giving you all my depths, heights, and distances, in terms of the kilometre, being about six-tenths of that very inconvenient measure the English statute mile, which, with all the other monstrosities of our British metrical system, will, let us hope, not long survive the legislation of our present Parliamentary session destined to honour the

* *On the Secular Cooling of the Earth*, vol. iii, *Math. and Phys. Papers*, §§ 19-33.

sixty years' Jubilee of Queen Victoria's reign by legalising the French metrical system for the United Kingdom.

§ 23. To prepare for considering consolidation at the surface let us go back to a time (probably not more than twenty years earlier as we shall presently see—§ 24) when the solid nucleus was covered with liquid lava to a depth of several kilometres; to fix our ideas let us say 40 kilometres (or 4 million centimetres). At this depth in lava, if of specific gravity 2.5, the hydrostatic pressure is 10 tons weight (10 million grammes) per square centimetre, or ten thousand atmospheres approximately. According to the laboratory experiments of Clarence King and Carl Barus* on Diabase, and the thermodynamic theory† of my brother, the late Professor James Thomson, the melting temperature of diabase is 1170° C. at ordinary atmospheric pressure, and would be 1420° under the pressure of ten thousand atmospheres, if the rise of temperature with pressure followed the law of simple proportion up to so high a pressure.

§ 24. The temperature of our 40 kilometres deep lava ocean of melted diabase may therefore be taken as but little less than 1420° from surface to bottom. Its surface would radiate heat out into space at some such rate as 2 (gramme-water) thermal units Centigrade per square centimetre per second.‡ Thus, in a year (31½ million seconds) 63 million thermal units would be lost per square centimetre from the surface. This is, according to Carl Barus, very nearly equal to the latent heat of fusion abandoned by a million cubic centimetres of melted diabase in solidifying into the glassy condition (pitch-stone) which is assumed when the freezing takes place in the course of a few minutes. But, as found by Sir James Hall in his Edinburgh experiments§ of 100 years ago, when more than a few minutes is taken for the freezing, the solid formed is not a glass but a heterogeneous crystalline solid of rough fracture; and if a

* *Phil. Mag.*, 1893, first half-year, p. 306.

† *Trans. Roy. Soc., Edinburgh*, Jan. 2, 1849; *Cambridge and Dublin Mathematical Journal*, Nov. 1850. Reprinted in *Math. and Phys. Papers* (Kelvin), vol. i, p. 156.

‡ This is a very rough estimate which I have formed from consideration of J. T. Bottomley's accurate determinations in absolute measure of thermal radiation at temperatures up to 920° C. from platinum wire and from polished and blackened surfaces of various kinds in receivers of air-pumps exhausted down to one ten-millionth of the atmospheric pressure. *Phil. Trans. Roy. Soc.*, 1887 and 1893.

§ *Trans. Roy. Soc., Edinburgh*

few hours or days, or any longer time, is taken, the solid formed has the well known rough crystalline structure of basaltic rocks found in all parts of the world. Now Carl Barus finds that basaltic diabase is 14 per cent. denser than melted diabase, and 10 per cent. denser than the glass produced by quick freezing of the liquid. He gives no data, nor do Rücker and Roberts-Austen, who have also experimented on the thermodynamic properties of melted basalt, give any data, as to the latent heat evolved in the consolidation of liquid lava into rock of basaltic quality. Guessing it as three times the latent heat of fusion of the diabase pitch-stone, I estimate a million cubic centimetres of liquid frozen per square centimetre per centimetre per three years. This would diminish the depth of the liquid at the rate of a million centimetres per three years, or 40 kilometres in twelve years.

§ 25. Let us now consider in what manner this diminution of depth of the lava ocean must have proceeded, by the freezing of portions of it; all having been at temperatures very little below the assumed 1420° melting temperature of the bottom, when the depth was 40 kilometres. The loss of heat from the white-hot surface (temperatures from 1420° to perhaps 1380° in different parts) at our assumed rate of 2 (gramme-water Centigrade) thermal units per sq. cm. per sec. produces very rapid cooling of the liquid within a few centimetres of the surface (thermal capacity $\cdot 36$ per gramme, according to Barus) and in consequence great downward rushes of this cooled liquid, and upwards of hot liquid, spreading out horizontally in all directions when it reaches the surface. When the sinking liquid gets within perhaps 20 or 10 or 5 kilometres of the bottom, its temperature* becomes the freezing point as raised by the increased pressure; or, perhaps more correctly stated, a temperature at which some of its ingredients crystallise out of it. Hence, beginning a few kilometres above the bottom, we have a snow shower of solidified lava or of crystalline flakes, or prisms, or granules of felspar, mica, hornblende, quartz, and other ingredients: each little crystal gaining mass and falling somewhat faster than the descending liquid around it, till it

* The temperature of the sinking liquid rock rises in virtue of the increasing pressure: but much less than does the freezing point of the liquid or of some of its ingredients. (See Kelvin, *Math. and Phys. Papers*, vol. iii, pp. 69, 70.)

reaches the bottom. This process goes on until, by the heaping of granules and crystals on the bottom, our lava ocean becomes silted up to the surface

PROBABLE ORIGIN OF GRANITE. (§§ 26, 27.)

§ 26. Upon the suppositions we have hitherto made we have, at the stage now reached, all round the earth at the same time a red hot or white hot surface of solid granules or crystals with interstices filled by the mother liquor still liquid, but ready to freeze with the slightest cooling. The thermal conductivity of this heterogeneous mass, even before the freezing of the liquid part, is probably nearly the same as that of ordinary solid granite or basalt at a red heat, which is almost certainly* somewhat less than the thermal conductivity of igneous rocks at ordinary temperatures. If you wish to see for yourselves how quickly it would cool when wholly solidified take a large macadamising stone, and heat it red hot in an ordinary coal fire. Take it out with a pair of tongs and leave it on the hearth, or on a stone slab at a distance from the fire, and you will see that in a minute or two, or perhaps in less than a minute, it cools to below red heat.

§ 27. Half an hour† after solidification reached up to the surface in any part of the earth, the mother liquor among the granules must have frozen to a depth of several centimetres below the surface and must have cemented together the granules and crystals, and so formed a crust of primeval granite, comparatively cool at its upper surface, and red hot to white hot, but still all solid, a little distance down; becoming thicker and thicker very rapidly at first; and after a few weeks certainly cold enough at its outer surface to be touched by the hand.

PROBABLE ORIGIN OF BASALTIC ROCK. (§§ 28, 29.)

§ 28. We have hitherto left, without much consideration, the mother liquor among the crystalline granules at all depths below the bottom of our shoaling lava ocean. It was probably this interstitial mother liquor that was destined to form the basaltic rock of future geological time. What-

* *Proc. R.S.*, May 30, 1895.

† Witness the rapid cooling of lava running red hot or white hot from a volcano, and after a few days or weeks presenting a black hard crust strong enough and cool enough to be walked over with impunity.

ever be the shapes and sizes of the solid granules when first falling to the bottom, they must have lain in loose heaps with a somewhat large proportion of space occupied by liquid among them. But, at considerable distances down in the heap, the weight of the superincumbent granules must tend to crush corners and edges into fine powder. If the snow shower had taken place in air we may feel pretty sure (even with the slight knowledge which we have of the hardnesses of the crystals of felspar, mica and hornblende, and of the solid granules of quartz) that, at a depth of 10 kilometres, enough of matter from the corners and edges of the granules of different kinds, would have been crushed into powder of various degrees of fineness, to leave an exceedingly small proportionate volume of air in the interstices between the solid fragments. But in reality the effective weight of each solid particle, buoyed as it was by hydrostatic pressure of a liquid less dense than itself by not more than 20 or 15 or 10 per cent., cannot have been more than from about $\frac{1}{3}$ th to $\frac{1}{10}$ th of its weight in air, and therefore the same degree of crushing effect as would have been experienced at 10 kilometres with air in the interstices, must have been experienced only at depths of from 50 to 100 kilometres below the bottom of the lava ocean.

§ 29. A result of this tremendous crushing together of the solid granules must have been to press out the liquid from among them, as water from a sponge, and cause it to pass upwards through the less and less closely packed heaps of solid particles, and out into the lava ocean above the heap. But, on account of the great resistance against the liquid permeating upwards 30 or 40 kilometres through interstices among the solid granules, this process must have gone on somewhat slowly; and, during all the time of the shoaling of the lava ocean, there may have been a considerable proportion of the whole volume occupied by the mother liquor among the solid granules, down to even as low as 50 or 100 kilometres below the top of the heap, or bottom of the ocean, at each instant. When consolidation reached the surface, the oozing upwards of the mother liquor must have been still going on to some degree. Thus, probably for a few years after the first consolidation at the surface, not probably for as long as one hundred years, the settlement of the solid structure by mere mechanical crushing of the corners and edges of solid granules, may have continued to cause the oozing upwards of mother liquor to the surface through:

cracks in the first formed granite crust and through fresh cracks in basaltic crust subsequently formed above it.

LEIBNITZ'S CONSISTENTIOR STATUS.

§ 30. When this oozing everywhere through fine cracks in the surface ceases, we have reached Leibnitz's *consistentior status*; beginning with the surface cool and permanently solid and the temperature increasing to 1150° C. at 25 or 50 or 100 metres below the surface.

PROBABLE ORIGIN OF CONTINENTS AND OCEAN DEPTHS OF THE EARTH (§§ 31-37.)

§ 31. If the shoaling of the lava ocean up to the surface had taken place everywhere at the same time, the whole surface of the consistent solid would be the dead level of the liquid lava all round, just before its depth became zero. On this supposition there seems no possibility that our present-day continents could have risen to their present heights, and that the surface of the solid in its other parts could have sunk down to their present ocean depths, during the twenty or twenty-five million years which may have passed since the *consistentior status* began or during any time however long. Rejecting the extremely improbable hypothesis that the continents were built up of meteoric matter tossed from without, upon the already solidified earth, we have no other possible alternative than that they are due to heterogeneousness in different parts of the liquid which constituted the earth before its solidification. The hydrostatic equilibrium of the rotating liquid involved only homogeneousness in respect to density over every level surface (that is to say, surface perpendicular to the resultant of gravity and centrifugal force): it required no homogeneousness in respect to chemical composition. Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid lava and metals, and solidification of liquid from central regions outwards, without finding any thorough mixing up of different ingredients, coming together from different directions of space—any mixing up so thorough as to produce even approximately chemical homogeneousness throughout every layer of equal density. Thus we have no difficulty in understanding how even the gaseous nebula, which at one time constituted the matter of our present earth, had in itself a

heterogeneousness from which followed by dynamical necessity Europe, Asia, Africa, America, Australia, Greenland and the Antarctic Continent, and the Pacific, Atlantic, Indian and Arctic Ocean depths, as we know them at present.

§ 32. We may reasonably believe that a very slight degree of chemical heterogeneousness could cause great differences in the heaviness of the snow shower of granules and crystals on different regions of the bottom of the lava ocean when still 50 or 100 kilometres deep. Thus we can quite see how it may have shoaled much more rapidly in some places than in others. It is also interesting to consider that the solid granules, falling on the bottom, may have been largely disturbed, blown as it were into ridges (like rippled sand in the bed of a flowing stream, or like dry sand blown into sand-hills by wind) by the eastward horizontal motion which liquid descending in the equatorial regions must acquire, relatively to the bottom, in virtue of the earth's rotation. It is indeed not improbable that this influence may have been largely effective in producing the general configuration of the great ridges of the Andes and Rocky Mountains and of the West Coasts of Europe and Africa. It seems, however, certain that the main determining cause of the continents and ocean-depths was chemical differences, perhaps very slight differences, of the material in different parts of the great lava ocean before consolidation.

§ 33. To fix our ideas let us now suppose that over some great areas such as those which have since become Asia, Europe, Africa, Australia, and America, the lava ocean had silted up to its surface, while in other parts there still were depths ranging down to 40 kilometres at the deepest. In a very short time, say about twelve years according to our former estimate (§ 24) the whole lava ocean becomes silted up to its surface.

§ 34. We have not time enough at present to think out all the complicated actions, hydrostatic and thermodynamic, which must accompany, and follow after, the cooling of the lava ocean surrounding our ideal primitive continent. By a hurried view however of the affair we see that in virtue of, let us say 15 per cent. shrinkage by freezing, the level of the liquid must, at its greatest supposed depth, sink six kilometres relatively to the continents: and thus the liquid must recede from them; and their bounding coast-lines must become enlarged. And just as water runs out of a sand-bank, drying when the sea recedes from it on a falling

tide, so rivulets of the mother liquor must run out from the edges of the continents into the receding lava ocean. But, unlike sandbanks of incoherent sand permeated by water remaining liquid, our uncovered banks of white-hot solid crystals, with interstices full of the mother liquor, will, within a few hours of being uncovered, become crusted into hard rock by cooling at the surface, and freezing of the liquor, at a temperature somewhat lower than the melting-temperatures of any of the crystals previously formed. The thickness of the wholly solidified crust grows at first with extreme rapidity, so that in the course of three or four days it may come to be as much as a metre. At the end of a year it may be as much as 10 metres; with a surface, almost, or quite, cool enough for some kinds of vegetation. In the course of the first few weeks the *régime* of conduction of heat outwards becomes such that the thickness of the wholly solid crust, as long as it remains undisturbed, increases as the square root of the time; so that in 100 years it becomes 10 times, in 25 million years 5,000 times, as thick as it was at the end of one year; thus, from one year to 25 million years after the time of surface freezing, the thickness of the wholly solid crust might grow from 10 metres to 50 kilometres. These definite numbers are given merely as an illustration; but it is probable they are not enormously far from the truth in respect to what has happened under some of the least disturbed parts of the earth's surface.

§ 35. We have now reached the condition described above in § 30, with only this difference, that instead of the upper surface of the whole solidified crust being level we have in virtue of the assumptions of §§ 33, 34, inequalities of 6 kilometres from highest to lowest levels, or as much more than 6 kilometres as we please to assume it.

§ 36. There must still be a small, but important, proportion of mother liquor in the interstices between the closely packed uncooled crystals below the wholly solidified crust. This liquor, differing in chemical constitution from the crystals, has its freezing point somewhat lower, perhaps very largely lower, than the lowest of their melting points. But, when we consider the mode of formation (§ 25) of the crystals from the mother liquor, we must regard it as still always a solvent ready to dissolve, and to redeposit, portions of the crystalline matter, when slight variations of temperature or pressure tend to cause such actions. Now as the specific gravity of

the liquor is less, by something like 15 per cent., than the specific gravity of the solid crystals, it must *tend* to find its way upwards, and will actually do so, however slowly, until stopped by the already solidified impermeable crust, or until itself becomes solid on account of loss of heat by conduction outwards. If the upper crust were everywhere continuous and perfectly rigid the mother liquor must, inevitably, if sufficient time be given, find its way to the highest places of the lower boundary of the crust, and there form gigantic pockets of liquid lava tending to break the crust above it and burst up through it.

§ 37. But in reality the upper crust cannot have been infinitely strong; and, judging alone from what we know of properties of matter, we should expect gigantic cracks to occur from time to time in the upper crust tending to shrink as it cools and prevented from lateral shrinkage by the non-shrinking uncooled solid below it. When any such crack extends downwards as far as a pocket of mother liquor underlying the wholly solidified crust, we should have an outburst of trap rock or of volcanic lava just such as have been discovered by geologists in great abundance in many parts of the world. We might even have comparatively small portions of high plateaus of the primitive solid earth raised still higher by outbursts of the mother liquor squeezed out from below them in virtue of the pressure of large surrounding portions of the superincumbent crust. In any such action, due to purely gravitational energy, the centre of gravity of all the material concerned must sink, although portions of the matter may be raised to greater heights; but we must leave these large questions of geological dynamics, having been only brought to think of them at all just now by our consideration of the earth, antecedent to life upon it.

§ 38. The temperature to which the earth's surface cooled within a few years after the solidification reached it, must have been, as it is now, such that the temperature at which heat radiated into space during the night exceeds that received from the sun during the day, by the small difference due to heat conducted outwards from within.* One year

* Suppose for example the cooling and thickening of the upper crust has proceeded so far, that at the surface and therefore approximately for a few decimetres below the surface, the rate of augmentation of temperature downwards is one degree per centimetre. Taking as a rough average '005 c.g.s. as the thermal conductivity of the surface rock, we should have for the heat conducted outwards '005 of a gramme water

after the freezing of the granitic interstitial mother liquor at the earth's surface in any locality, the average temperature at the surface might be warmer, by 60° or 80° Cent., than if the whole interior had the same average temperature as the surface. To fix our ideas, let us suppose, at the end of one year, the surface to be 80° warmer than it would be with no underground heat: then at the end of 100 years it would be 8° warmer, and at the end of 10,000 years it would be $\cdot 8$ of a degree warmer, and at the end of 25 million years it would be $\cdot 016$ of a degree warmer, than if there were no underground heat.

§ 39. When the surface of the earth was still white-hot liquid all round, at a temperature fallen to about 1200° Cent., there must have been hot gases and vapour of water above it in all parts, and possibly vapours of some of the more volatile of the present known terrestrial solids and liquids, such as zinc, mercury, sulphur, phosphorus. The very rapid cooling which followed instantly on the solidification at the surface must have caused a rapid downpour of all the vapours other than water, if any there were; and a little later, rain of water out of the air, as the temperature of the surface cooled from red heat to such moderate temperatures as 40° and 20° and 10° Cent., above the average due to sun heat and radiation into the ether around the earth. What that primitive atmosphere was, and how much rain of water fell on the earth in the course of the first century after consolidation, we cannot tell for certain; but Natural History and Natural Philosophy give us some foundation for endeavours to discover much towards answering the great questions,

thermal unit centigrade per sq. cm. per sec. (Kelvin, *Math. and Phys. Papers*, vol. III, p. 226). Hence if (*ibid.* p. 223) we take $\frac{1}{30000}$ as the radiational emissivity of rock and atmosphere of gases and watery vapour above it radiating heat into the surrounding vacuous space (ether), we find $8000 \times \cdot 005$, or 40 degrees Cent. as the excess of the mean surface temperature above what it would be if no heat were conducted from within outwards. The present augmentation of temperature downwards may be taken as 1 degree Cent. per 27 metres as a rough average derived from observations in all parts of the earth where underground temperature has been observed. (See British Association Reports, from 1868 to 1895. The very valuable work of this Committee has been carried on for these twenty-seven years with great skill, perseverance, and success, by Professor Everett, and he promises a continuation of his reports from time to time.) This with the same data for conductivity and radiational emissivity as in the preceding calculation makes $40^{\circ}/2700$ or $0\cdot 0148^{\circ}$ Cent. per centimetre as the amount by which the average temperature of the earth's surface is at present kept up by underground heat.

—Whence came our present atmosphere of nitrogen, oxygen, and carbonic acid? Whence came our present oceans and lakes of salt and fresh water? How near an approximation to present conditions was realised in the first hundred centuries after consolidation of the surface?

§ 40. We may consider it as quite certain that nitrogen gas, carbonic acid gas, and steam, escaped abundantly in bubbles from the mother liquor of granite, before the primitive consolidation of the surface, and from the mother liquor squeezed up from below in subsequent eruptions of basaltic rock; because all, or nearly all, specimens of granite and basaltic rock, which have been tested by chemists in respect to this question,* have been found to contain, condensed in minute cavities within them, large quantities of nitrogen, carbonic acid, and water. It seems that in no specimen of granite or basalt tested has chemically free oxygen been discovered, while in many, chemically free hydrogen has been found; and either native iron or magnetic oxide of iron in those which do not contain hydrogen. From this it might seem probable that there was no free oxygen in the primitive atmosphere, and that if there was free hydrogen, it was due to the decomposition of steam by iron or magnetic oxide of iron. Going back to still earlier conditions we might judge that, probably, among the dissolved gases of the hot nebula which became the earth, the oxygen all fell into combination with hydrogen and other metallic vapours in the cooling of the nebula, and that although it is known to be the most abundant material of all the chemical elements constituting the earth, none of it was left out of combination with other elements to give free oxygen in our primitive atmosphere.

§ 41. It is however possible, although it might seem not probable, that there was free oxygen in the primitive atmosphere. With or without free oxygen, however, *but with sunlight*, we may regard the earth as fitted for vegetable life as now known in some species, wherever water moistened the newly solidified rocky crust cooled down below the temperature of 80° or 70° of our present Centigrade thermometric scale, a year or two after solidification of the primitive lava had come up to the surface. The thick tough velvety coating of living vegetable matter, covering the rocky slopes under hot

* See for example Tilden, *Proc. R.S.*, February 4th, 1897. "On the Gases enclosed in Crystalline Rocks and Minerals."

water flowing direct out of the earth at Banff (Canada),* lives without help from any ingredients of the atmosphere above it, and takes from the water and from carbonic acid or carbonates, dissolved in it, the hydrogen and carbon needed for its own growth by the dynamical power of sunlight; thus leaving free oxygen in the water to pass ultimately into the air. Similar vegetation is found abundantly on the terraces of the Mammoth hot springs and on the beds of the hot water streams flowing from the Geysers in the Yellowstone National Park of the United States. This vegetation, consisting of confervæ, all grows under flowing water at various temperatures, some said to be as high as 74° Cent. We cannot doubt but that some such confervæ, if sown or planted in a rivulet or pool of warm water in the early years of the first century of the solid earth's history, and if favoured with sunlight, would have lived, and grown, and multiplied, and would have made a beginning of oxygen in the air, if there had been none of it before their contributions. Before the end of the century, if sun-heat, and sunlight, and rainfall, were suitable, the whole earth not under water must have been fitted for all kinds of land plants which do not require much or any oxygen in the air, and which can find, or make, place and soil for their roots on the rocks on which they grow; and the lakes or oceans formed by that time must have been quite fitted for the life of many or all of the species of water plants living on the earth at the present time. The moderate warming, both of land and water, by underground heat, towards the end of the century, would probably be favourable rather than adverse to vegetation, and there can be no doubt but that if abundance of seeds of all species of the present day had been scattered over the earth at that time, an important proportion of them would have lived and multiplied by natural selection of the places where they could best thrive.

§ 42. But if there was no free oxygen in the primitive atmosphere or primitive water, several thousands, possibly hundreds of thousands, of years must pass before oxygen enough for supporting animal life, as we now know it, was produced. Even if the average activity of vegetable growth on land and in water over the whole earth was, in those early times, as great in respect to evolution of

* Rocky Mountains Park of Canada, on the Canadian Pacific Railway.

oxygen as that of a Hessian forest, as estimated by Liebig* 50 years ago, or of a cultivated English hayfield of the present day, a very improbable supposition, and if there were no decay (*eremacausis*, or gradual recombination with oxygen) of the plants or of portions such as leaves falling from plants, the rate of evolution of oxygen, reckoned as three times the weight of the wood or the dry hay produced, would be only about 6 tons per English acre per annum or $1\frac{1}{2}$ tons per square metre per thousand years. At this rate it would take only 1533 years, and therefore in reality a much longer time would almost certainly be required, to produce the 2·3 tons of oxygen which we have at present resting on every square metre of the earth's surface, land and sea.† But probably quite a moderate number of hundred thousand years may have sufficed. It is interesting at all events to remark that, at any time, the total amount of combustible material on the earth, in the form of living plants or their remains left dead, must have been just so much that to burn it all would take either the whole oxygen of the atmosphere, or the excess of oxygen in the atmosphere at the time, above that, if any, which there was in the beginning. This we can safely say, because we almost certainly neglect nothing considerable in comparison with what we assert when we say that the free oxygen of the earth's atmosphere is augmented only by vegetation liberating it from carbonic acid and water, in virtue of the power of sunlight, and is diminished only by virtual burning‡ of the vegetable matter thus produced. But it seems improbable that the average of the whole earth—dry land and sea-bottom,—contains at present coal, or wood, or oil, or fuel of any kind originating in vegetation, to so great an amount as ·767 of a ton per square metre of surface; which is the amount at the rate of one ton of fuel to three tons of oxygen, that would be required to produce the 2·3 tons of

* Liebig, "Chemistry in its application to Agriculture and Physiology," English, 2nd ed., edited by Playfair, 1842.

† In our present atmosphere, in average conditions of barometer and thermometer we have, resting on each square metre of the earth's surface, ten tons total weight, of which 7·7 is nitrogen and 2·3 is oxygen.

‡ This "virtual burning" includes *eremacausis* of decay of vegetable matter, if there is any *eremacausis* of decay without the intervention of microbes or other animals. It also includes the combination of a portion of the food with inhaled oxygen in the regular animal economy of provision for heat and power.

oxygen per square metre of surface, which our present atmosphere contains. Hence it seems probable that the earth's primitive atmosphere must have contained free oxygen.

§ 43. Whatever may have been the true history of our atmosphere it seems certain that if sunlight was ready, the earth was ready, both for vegetable and animal life, if not within a century, at all events within a few hundred centuries after the rocky consolidation of its surface. But was the sun ready? The well founded dynamical theory of the sun's heat carefully worked out and discussed by Helmholtz, Newcomb, and myself,* says NO if the consolidation of the earth took place as long ago as 50 million years; the solid earth must in that case have waited 20 or 30 million years for the sun to be anything nearly as warm as he is at present. If the consolidation of the earth was finished 20 or 25 million years ago, the sun was probably ready,—though probably not then quite so warm as at present, yet warm enough to support some kind of vegetable and animal life on the earth.

§ 44. My task has been rigorously confined to what, humanly speaking, we may call the fortuitous concurrence of atoms, in the preparation of the earth as an abode fitted for life, except in so far as I have referred to vegetation, as possibly having been concerned in the preparation of an atmosphere suitable for animal life as we now have it. Mathematics and dynamics fail us when we contemplate the earth, fitted for life but lifeless, and try to imagine the commencement of life upon it. This certainly did not take place by any action of chemistry, or electricity, or crystalline grouping of molecules under the influence of force, or by any possible kind of fortuitous concurrence of atoms. We must pause, face to face with the mystery and miracle of the creation of living creatures.

* See *Popular Lectures and Addresses*, vol. 1, pp. 376–429, particularly page 397.

The LORD CHANCELLOR (Earl HALSBURY, F.R.S.)—As we have been dealing so lavishly with millions of years, you will not grudge me half a minute to return thanks to Lord Kelvin, and those authors who have taken part in the work of the session.

I am afraid, interesting as have been some of his communications, the subject is of such vastness that, although he has put before us some most valuable propositions, any one of which might form the subject of a most interesting debate and opening up, as he has a whole fountain of learning and science at every turn of his Address, they have been so numerous, that some present may have failed to appreciate them. My own impression at present is (I have not had the opportunity of studying more deeply what my noble friend has said), that he has criticised with great power a number of gentlemen who seem to adopt the principle that if the facts do not accord with the theories, so much the worse for the facts. (Applause and laughter.) I think, under these circumstances, you will agree that we are all deeply indebted to Lord Kelvin for what he has said. Perhaps we are more deeply indebted to him than we appreciate for the moment; for it will be on record here that a gentleman of Lord Kelvin's eminence, learning, and wonderful power of investigating nature has been here delivering an address to a Society of this character the principal function of which, I believe, is to show that there is nothing inconsistent between Revelation and Science, and to show, as he has done, that many of the theories at all events, which are supposed to conflict with that proposition, are utterly without foundation. (Applause.)

Sir J. FATREER, Bart., K.C.S.I., F.R.S.—It gives me much pleasure, as it is a great honour, to be permitted to second the vote of thanks that has been proposed by the noble Lord who has just sat down.

It would be as presumptuous in me, as it would be unnecessary, if I were to try to add anything to what has just been said; but still I should like to remark, from the Victoria Institute point of view—of which I happen now to be a very old member—how very gratifying it is to this Institute that it should have been addressed by the most distinguished leading man of science of the present day. (Applause.) I think this, and many other things that have

occurred of late years, go far to remove any of the false impressions set abroad about the nature, object, and purposes of this Institute. I feel that it is also an endorsement of what we were told long, long ago by Bishop Butler, that we had a perfect right to the due use of our reason—reason being the one only faculty with which the Almighty has endowed us, by which we can understand anything at all, even Revelation itself. Therefore I think, with such an example from such a man, the Victoria Institute may well go on prosecuting the investigations it has been conducting, in my judgment so well, during many past years.

I beg to second the vote of thanks that has just been proposed to Lord Kelvin for his very admirable and interesting Address (applause), and those authors who have taken part in the work of the session.

The resolution was carried by acclamation.

SIR SIDNEY G. A. SHIPPARD, G.C.M.G.—Before we separate I will ask you to join in what I am sure we shall all regard with pleasure, and that is a vote of thanks to our venerable President, who has, at great inconvenience to himself, come forward to indicate once more his great devotion to science and his deep interest in this Institute by presiding upon this occasion. We have in Sir Gabriel Stokes one of the greatest lights of the present day, and I rejoice to see him here, and I hope for many years he will be spared to prosecute his labours and to preside over this Institute. (Applause.)

Captain E. W. CREAK, R.N., F.R.S.—I have the great pleasure of seconding this resolution, and am sure you will all accord your thanks with acclamation.

Carried *nem. con.*

The PRESIDENT (Sir G. GABRIEL STOKES, Bart., F.R.S.).—I thank you much for the great kindness with which you have spoken of myself. It affords me much satisfaction to find that I have been successful in persuading my old friend Lord Kelvin to give the Address on this occasion, to which we have just listened with so much interest.

The meeting is now concluded, and with it the present session, and I hope that next session we shall again resume our labours.

LORD KELVIN ON DESIGN IN NATURE.

In his Presidential Address before the British Association in 1871, Lord Kelvin thus referred to the Argument in favour of Design in Nature (Paley's):—"I feel profoundly convinced that the argument of design has been too much lost sight of in recent zoological speculations. Reaction against frivolities of teleology such as are to be found in the notes of learned commentators on Paley's *Natural Theology*, has, I believe, had a temporary effect in turning attention from the solid and irrefragable argument so well put forward in that excellent old book. But overpoweringly strong proofs of intelligent and benevolent design lie all round us; and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler."—Ed.

ORDINARY MEETING.*

The following paper was read by the Author :—

WHERE IS MOUNT SINAI?

By Professor EDWARD HULL, LL.D., F.R.S., F.G.S.

[WITH A MAP AND SKETCHES.]

1. *Introduction.*—Professor Sayce has put the above question before the public in a recent pamphlet, and after a very learned philological discussion leaves the reader very much in the condition in which he finds him. He merely suggests that some day or other the Mount may be discovered amongst the sterile and sunbeaten heights of Edom. Not having had the advantage, enjoyed by myself in 1883, of personally visiting Arabia Petraea, Professor Sayce naturally hesitates to identify any of the supposed sites with Mount Sinai. Serbâl, Jebel Musâ, and Mount Hor have all been recognized by writers as “Horeb, The Mount of God,” besides two or three others scattered over the region of Arabia Petraea which are altogether too problematical for further reference. Having, as I feel convinced, personally ascended this ever memorable mountain in the year 1883, and satisfied myself that the traditional Sinai, known as Jebel Musâ in the centre of the Sinaitic Peninsula, in every way meets the requirements of the narrative of the Exodus, I venture to reply to the question put by my

* This paper could not be fully discussed when it was first brought forward. The discussion has now been completed and corrected to date, 1899. Any election of members, etc., when it was first brought forward are noted at p. 94, vol. xxix.

learned friend; and to state, not for the first time, the grounds of my belief. I must first premise, however, that I accept the account of the Israelitish Exodus as given in the Books of Exodus and Deuteronomy as a narrative of facts—due allowance being of course made for minor errors of transcription. Nor am I in the least concerned regarding the authorship—whether it was written entirely by Moses, or is a compilation from documents handed down from the time of Moses and arranged historically at a somewhat later period. I regard the events recorded, the words spoken, and the miraculous interposition of Jehovah, as having been faithfully handed down to us. And as we know from recent discoveries amongst the most ancient records, whether engraved in brick or stone, that the art of writing was understood and practised in Egypt at the period of the Exodus, and recollecting how transcendently important to the future of the Israelitish nation were the events of the Exodus, I cannot doubt but that the utmost care was exercised by the scribe, or scribes, of that nation to transmit to future generations a true and faithful record of the wonderful events which were interwoven with that great crisis in their history. This probability is in itself so strong as almost to amount to a demonstration. Guided, therefore, by these postulates, and I know of no others upon which we can proceed,* I will endeavour to answer the question of Professor Sayce, and I shall claim to have done so if I succeed in showing that there is in Arabia Petraea a mountain which answers in situation and conditions the requirements of the narrative. If this can be reasonably demonstrated it will react on the narrative itself in favour of the view of its truth; otherwise we should have to suppose that the inventor had personally visited and examined the localities in order to make his narrative fit in with the topographical details as they existed some 3,000 years ago.† I do not profess to offer anything perfectly new. I am glad to know that the results of personal examination are in accordance with the views of other

* Unless we suppose with some German critics, such as Winckler, that the whole account of the sojourn of the Israelites in Egypt is a pure invention—a view more incredible than the narrative itself.

† The story of the siege of Troy as given in the *Iliad* was formerly considered as a poetic fiction of Homer—but the investigations of Schliemann have proved that the siege of Troy is based on fact, and is in the main topographically correct.

observers even better qualified than myself to maintain the correctness of the traditional site, amongst whom I may mention the late Professor Palmer, who on several occasions visited Arabia Petræa and has recorded his views in his well known work, *The Desert of the Exodus*; Captain (now Major-General Sir Charles) Wilson, R.E., who with several assistants carried out the Ordnance Survey of Sinai in 1868, and had opportunities not surpassed, if reached, by any other Englishman of studying the topographical details*; and Dean Stanley, who took infinite pains to satisfy himself that Jebel Musâ, with its great plain of Er-Râhah lying at its base, agreed with the account of the "Giving of the Law," and departed without a doubt resting on his mind.† Nor may we omit to mention the name of Dr. Robinson, to whose mind the personal observation of Jebel Musâ and its surroundings carried the conviction that it was indeed the Mount of God; the scene of the awful events accompanying the giving of the Law, which he has expressed in the following words:—"We gave ourselves up to the impressions of the awful scene, and read with a feeling of awe that will never be forgotten, the sublime account of the transaction, and the Commandments there promulgated, in the original words as recorded by the great Hebrew legislator."‡

Having thus shown that "the traditional Sinai" (or Jebel Musâ) is recognised by several weighty authorities writing from personal examination of the locality (and others might be cited) as really the Mount of the Law described in Exodus, I now pass on to give my own views on the same subject, also drawn from personal examination. And first it must be ascertained if Jebel Musâ occupies a geographical position consistent with the narrative of the Israelitish journeys after their departure from Egypt and previous to their arrival at Kadesh Barnea. This part of my subject I can only refer to very briefly.

2. *Journey from Moses Wells (Ayun Musâ) to Sinai.*—Assuming, what is scarcely doubtful, that after the passage of the Red Sea (the Gulf of Suez, which I have elsewhere shown, probably extended up the Isthmus into the Great

* The results were published in five folio volumes by authority of H.M. Treasury (1872).

† *Sinai and Palestine*, 5th Edit., p. 75. Dean Stanley was no easily convinced enthusiast, as any one may satisfy himself who reads his book.

‡ *Biblical Researches*, I, p. 129, 130 and 158.

Bitter Lake at this period*), the Israelites appear to have turned southwards along the plain which borders the eastern shore of the Gulf in order to avoid the wild and forbidding line of escarpment of the Wilderness of Shur (or Etham) now called Jebel et-Tih; and they went three days' journey and pitched in Marah. It is reasonable to suppose that this name is retained in the present "Wadi-el-Amâra"—which is 35 miles from 'Ain Musâ—giving about 11 miles for each day's journey.† From Marah they removed to Elim, one day's journey of 12 miles if we adopt the view that Elim is the present Wadi Gharandel, where water (by digging) and vegetation are abundant, though the "twelve wells and three-score and ten palm trees" have disappeared. From Elim continuing their course for a further distance of about 25 miles, they came to their camping ground by the shore of the Red Sea, where they appear to have rested for nearly a month and a half (Ex. xvi, 1). This camping ground has been identified with every probability by Sir C. W. Wilson as the plain of Murkhâh opposite the entrance to Wadi Taiyibeh‡ by which they commenced their journey towards Mount Sinai. Leaving their camp after a seasonable rest, they proceeded in the second important stage of their journey by the Wadies Shellâl, Mokattam and Feirân to Rephidim. The Feirân is the best watered valley in the whole peninsula, and as Wilson has shown is naturally the great highway from the shores of the Red Sea towards Jehel Musâ, and was therefore the most convenient line of march for the Israelitish host. At Rephidim, which is identified by Palmer and Stanley§ as some point near the junction of the W. esh Sheikh with W. Feirân, they were attacked by the Amalekites, who from their camps towards the north had probably watched with jealous eyes the progress of the host. From thence they proceeded by the former valley onwards towards the Holy Mount, and passing through the Grand Gorge of El Watyieh between lofty walls of red porphyry, they finally pitched their tents on the wide plain now called Wadi er-Râha which stretches up to the base of Jebel Musâ (Pl. II, Fig. 2).

* *Mount Seir, Sinai and Western Palestine* (1884).

† The account of the stages given in Exodus agrees with that expressly stated to have been recorded by Moses in Numbers xxxiii, except that in this latter we have mentioned (v. 10) the encampment by the Red Sea and two others, Dophkah and Alush, which are omitted in Exodus.

‡ *Ordnance Survey of Sinai*, p. 151.

§ As Stanley, *Sinai and Palestine*, 5th Edit., p. 41.

It has been doubted whether there is sufficiently extensive camping ground at the base of Jebel Musâ to admit of the long residence of a host such as that of the Israelites, with their flocks and herds.* But I think that anyone who has surveyed this fine valley, nearly a mile in breadth and two miles in length, will admit that the difficulty vanishes, and will be inclined to agree with Dean Stanley when he says, "Considering the almost total absence of such conjunctions of plain and mountain in this region, it is really important evidence of the truth of the narrative, that one such conjunction can be found, and that within the neighbourhood of the traditional Sinai."† For myself I never had a doubt, after traversing this great amphitheatre leading up to the very base of the stupendous granite cliff of Râs Sufsâfeh, that here indeed was the camp, and there the mount from whence Jehovah gave forth His laws amidst the thunders and earthquakes which caused the mountain to rock from its foundations. Thus we see that as far as the journey from Egypt to Jebel Musâ, here considered to be "Mount Sinai," is concerned, the narrative is fairly consistent with the physical features and conditions of the route now sketched out.‡

3. *Journey from Sinai to Kadesh Barnea.*—Before entering upon an account of Mount Sinai (or J. Musâ) itself, in order to show how it corresponds in its physical features with the Bible narrative, I propose to consider the third stage of the journey to Kadesh in order to see whether it also fits in with the narrative.

On leaving Mount Sinai two roads were possible in order to reach Kadesh; one (advocated by Holland) by the Wadies Zelagah and El'Ain and the desert of Et Tih; the other by W. Sa'at and El Huderah§ down to the shore of the Gulf of Akabah, and thence northwards by the Arabah Valley. This latter appears the more probable route, as Ezion Geber (now

* Prof. Palmer has estimated that Wadi er Râha has an area of two million of square yards. The flocks and herds would find pasturage in the neighbouring valleys of Sebayeh, Esh-Sheilch and its branches.

† Stanley, *loc. cit.* p. 77.

‡ Ex. xix, 18. There was a second route, that by the Haj Road from Suez to Akabah across the waterless plateau of the Badiet-et-Tih. This route has been advocated by Mr. J. Baker Greene in his work *The Hebrew Migration from Egypt*. But any one who knows this region is aware that it is perfectly impracticable for a multitude of men, women and children travelling on foot and accompanied by flocks and herds.

§ Identified by Palmer with Hazeroth, Num. xi, 35.

Akabah at the head of the Ælanitic Gulf) is distinctly mentioned in the narrative of Moses bearing on this part of the wanderings between Sinai and Kadesh* ; by this route also there would be better pasturage for the flocks and herds, along the Wadi-el-Arabah itself. The fact that it was after the Israelites had left Mount Sinai that they passed by Ezion Geber on their way to Kadesh is sufficient to prove that Sinai could not have been in the land of Edom, as this mountainous country lies to the east and north of the route towards Kadesh, and Ezion Geber was on its margin. To suppose Mount Sinai was somewhere amongst the Edomite Mountains or (Mount Seir) would be to reverse the order of localities as narrated in Numbers xxxiii. Doubtless it is now impossible to identify more than one or two of the localities referred to as camping ground in the march from Sinai to Ezion Geber, but there is no reason to doubt they are stated in the correct order of succession.† Nevertheless it will be observed that the narrative of events both before and after the visit to Mount Sinai is consistent in showing that Sinai lay in a position intermediate between the shore of the Gulf of Suez, and that of the Gulf of Akabah, both being branches of the Red Sea.

Mount Serbâl.—The only other mountain in this region which can possibly lay a claim to the title of Mount Sinai is Jebel Serbâl, a magnificent serrated ridge which rises to a height of 6,712 feet above the sea, and along the northern base of which winds the Wadi Feirân (Fig 2). Notwithstanding the fact that Serbâl was identified with Sinai by Eusebius, Jerome and other writers down to the time of Justinian,‡ and that (alike with J. Musâ) it is regarded as a sacred place by the Bedouins, it does not appear to answer the requirements of the narrative to the extent of its rival Jebel Musâ. If Rephidim be properly placed in the W. Feirân, as I believe, and if after the events which took place there the Israelites broke up their camp, and as stated “departed from Rephidim and came to the wilderness of Sinai,”§ then clearly Sinai was not Mount Serbâl: for every step they took towards the former left the latter farther behind. In

* Num. xxxiii, 15-35.

† For the origin of some of the names, which have generally only a local meaning derived from plants, rocks, &c., see *The Speaker's Commentary*.

‡ This statement is questioned by Wilson. (*See discussion.*)

§ Ex. xix. 1, 2.

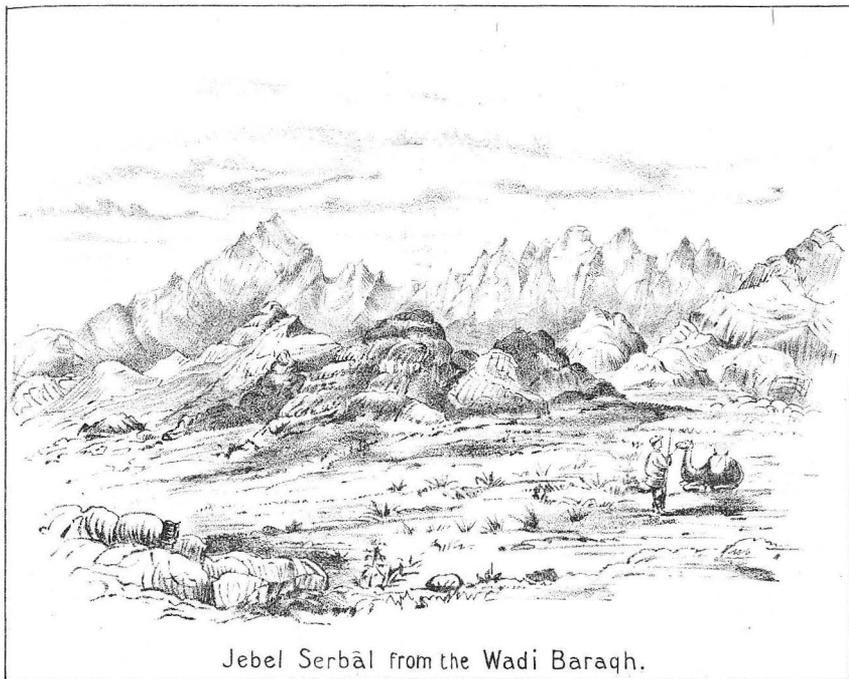


Fig. 2.



the next place there is no camping ground of sufficient extent reaching to the base of Serbâl which can compare with that of the Wadi er Rahâh both for convenience and fitness with the requirements of the narrative. I have not myself traversed the Wadi Feirân, and have only seen the rugged outline of Serbâl at some distance to the west of our route in 1883; but Stanley had visited this mountain as well as J. Musâ, and deliberately rejects the claims of Serbâl, on the ground of topographical unfitness.*

4. *Jebel Musâ*.—We are now in a position to consider the physical characteristics of Jebel Musâ, and to determine whether or not this mountain fulfils the requirements of the narrative of the giving of the Law.

Though Jebel Musâ is a mountain amongst mountains, it stands out clearly individualized by reason of the broad valley of Er Râhah at its confluence with that of Esh Sheikh on the north; that of Wadi ed Dêir by which it is bounded along the east; and the W. Seil Leja which follows its western flank and separates it from Jebel-el-Hôm. In the Wadi ed Dêir is situated the Monastery of St. Catharine.

The summit of J. Musâ reaches an elevation of 7,363 feet, and is formed of fine grey gneiss with slight traces of foliation; and it is crowned by a little mosque, and the ruins of an ancient Greek Church built of marble. A few hundred feet below the summit is a remarkable basin of clear cold water; and in the cliff surrounding it is a cave known as that of Elijah.† The basin gives origin to a small stream and cascade which descends to the base of the mount opposite the monastery, and is a never-failing source of supply. This spring, and three or four others which descend from J. Musâ and J. Katharina, are, according to Wilson, fed by the snows of winter which at these high altitudes rest on the mountain tops, and when melting percolate into the joints and crevices of the rocks. This abundance of water is an important point of evidence of the identification of the

* *Loc. cit.* p. 40; 44, 76. In this I myself concur for reasons to be stated; but probably Serbâl, which is the grandest mountain in the Sinaitic peninsula, partly owing to its isolation, and partly to its extreme ruggedness, will always have supporters to its claim to be the Mount of the Law.

† I have personally little doubt that it is really the cave to which the prophet Elijah fled from the face of Ahab; and also that it was the retreat of St. Paul after his conversion, when he "went into Arabia." Gal. i, 17.

mountain with Sinai, as we read of the brook into which Moses strewed the dust of the golden calf.*

But the summit of Mount Sinai is not visible from the valley of Er Râhah. Although only about a mile distant, the view of the summit is completely cut off by the huge wall of red granite known as Ras Sufsâfeh which springs from the head of the valley with astonishing boldness to a height of about 2,000 feet, Pl. II, Fig. 2. This remarkable feature is in entire accordance with the account in the Bible. Once Moses and Joshua had disappeared in their ascent of the mount behind this rock they were lost to view; and it is not surprising that the people should have exclaimed, "as for this Moses, the man that brought us up out of the land of Egypt, we wot not what is become of him."† Again, on viewing this mural cliff forming the base of the mountain at this spot, we cannot but feel, as it seems to me, that we are in face of the "mount which might be touched," and which was to be warded off by setting bounds to it.‡ It would be impossible to apply such language to the border of a mountain of irregular form and sloping outline.§ This great cliff, between which and the main mass of J. Musâ, there is a depression along which a traveller may descend from the summit, also throws light on the tenour of the remarkable conversation between Moses and Joshua. It is clear from this conversation that the proceedings going forward in the camp were completely hidden from them when on the summit, and it was only when they were descending that even the voices of the singing multitude came to their ears. But on turning by the corner of the cliff (probably by the Wadi el Leja), the terrible scene of idolatrous riot broke upon their view for the first time, and "Moses cast the tables of the Law out of his hands and brake them beneath the mount."||

Vegetation and Water.—The only other point, as it seems to me, requiring notice to confirm the identification is the question whether at the base of Jebel Musâ there was sufficient

* *The Brook that descended out of the Mount*, Deut. ix, 21.

† Ex. xxxii, 1.

‡ Ch. xix, 12, 13.

§ I cannot concur in the view of Dr. Robinson that one of the necessities of the account requires that the summit of the mountain must have commanded a view of the camp, and the converse. The whole narrative appears to infer the very opposite of this.

|| Ex. xxxii, 15-18.

vegetation for the food of the flocks and herds accompanying the host. At the present day the valleys in this district are very far from being deserts. When seen from the summit of the mountain, even at the end of the summer or autumn, their surfaces show a green tinge contrasting with the colours of the naked rocks forming the flanks of the mountains themselves; and, as a matter of fact, there is generally a covering of vegetation over their surfaces, consisting of small plants and herbs upon which the camels mainly depend for their food when traversing the mountain passes. The *Zygophyllum* is generally abundant even in dry localities; and, where there are springs, willows, broom with white blossoms, tamarisks and palm trees flourish; but there is some reason for believing that, 3,000 years ago, the vegetation was more abundant than at the present day.* As regards water, there is no mountain in the whole peninsula better supplied than Jebel Musâ. I have already referred to the fine spring which descends from the pool immediately under the summit of the mountain, but there are several others, especially that which gives origin to the brook of the W. el Leja on the flanks of J. Katharina; without doubt there was no want of water for the necessities of the host of Israel during their encampment.

5. *Conclusion.*—I have thus endeavoured to show that, both as regards geographical position and the physical details to be gathered from a careful survey of Jebel Musâ and its surroundings, this mountain sustains its claim to be regarded as the Mount Sinai of the Bible, from the summit of which Jehovah gave the Law to the Children of Israel. The fact that there is a mountain which in the minuter details of the narrative can be found to meet these requirements, is a strong corroboration of the truth and reality of the events recorded; but only those who have visited personally this wonderful region can realize to their full extent the harmony between the narrative and the physical conditions presented to his view.†

* Mem. *Physical Geology of Arabia Petraea, &c.*, chap. 2, part v (1886).

† I believe Prof. Sayce attaches some importance to the passages in Deut. xxxiii, 2, and Judges v, 4, in which there is an *appearance* of identifying Seir or Edom with Sinai. This appearance of identification seems to me very questionable; but in any case the language of Hebrew poetry can scarcely be admitted as of greater force than a narrative of events.

The CHAIRMAN (T. CHAPLIN, Esq., M.D.)—I am sure that our thanks are due to Professor Hull for the interesting paper he has just read (hear).

Sir C. W. WILSON, R.E., K.C.M.G., K.C.B.—I do not think I can add very much to what Professor Hull has said in his paper, but I would remind you that the question of Mount Sinai being in Edom is not a recent one.

The same question was raised a great many years ago by the late Dr. Beke, who was a very determined man and very certain of his opinions, and before he left England he decided where Mount Sinai was. He went out and made a very short journey across the desert and found Mount Sinai in the mountains in Edom, and came back again fully satisfied that he had found the true mount. He did not go up the mount or examine its environs. He merely encamped about the mountain and looked up at it and was certain that all was right.

There are two points that I should like to mention in connection with the paper, and one is that I think Professor Hull has hardly, or not at all, introduced what I think is a very strong argument in favour of the present Mount Sinai.

There is no doubt that the Jews, during the period of the Kings, knew perfectly well where the real Mount Sinai was, and from the time of the Kings,—if you consider the intimate connection there was between Palestine and Egypt during the latter part of the monarchy—I cannot think that the identification of Mount Sinai could be so completely lost. It is rather the fashion to doubt tradition such as that of Mount Sinai, but I think we may be pretty certain that the tradition has been true, and that in Jebel Musâ, or rather the mountain group of that name, we have the true Mount Sinai of the Israelites. I do not quite know where Professor Hull got his authority for saying that in the time of Eusebius and Jerome, Serbâl was considered the true Mount Sinai: that is not in accordance with my reading of the old authorities, and I do not think it is quite in accordance with the existing remains that are found in the peninsula. When the upper Monasteries were destroyed by the Arabs, a great many hermits were driven out and there was a concentration of hermits round Mount Serbâl, where there is one of the most interesting types of rock steps ever seen laid down from the monasteries to the waters. One of the oldest accounts that has come down to us clearly refers, I think, to Jebel Musâ and not Mount Serbâl.

I am sorry that I did not know that the illustrations of the

lecture were so small, or I would have sent some models of Mount Serbâl and others for the inspection of the meeting. I think anyone looking at the models will come to the conclusion that Jebel Serbâl is in impossible competition with Jebel Musâ. There is the encamping ground on which the Israelites could encamp, but three or four miles off there is the roughest mountain country that anyone could wish to travel over. The actual peak of Jebel Musâ is, in all particulars, in agreement with the Bible narrative. Wadi er-Rabah is, in one sense, the head of the valley; its peculiarity is that it slopes down in the form of the seats in a theatre towards the base of this gigantic wall so that the Israelites standing on that would be arranged in tiers, so to speak, and in absolute view of what was going on on the mount.

The features of Jebel Musâ are entirely in accordance with the Bible narrative. I think that Moses did not come down by Wadi el Leja, as Professor Hull suggests, but there is another valley in which a small stream rises, and it is separated from Wadi el Leja by a spur. The name of that valley is Wadi Feirân, and a stream, in which I believe fragments of the golden calf were thrown, rises in that valley. There is a very easy ascent to the mountain, and consequently an easy descent by which Moses and Aaron may have come down.

The question of the route by which the Israelites left Mount Sinai is rather a difficult one. My own view is that the Israelites went down by the Wadies Zelagah and Elain, and did not turn down to the gulf of Akabah. I think if they had turned down and camped by the water, we should have had a mention of it. I believe they went to Kadesh, invaded it, and being repulsed they went to Ezion Geber after.

Rev. Canon R. B. GIRDLESTONE, M.A.—May I mention that Major H. Spencer Palmer, in his *Sinai*, deals with some objections raised by doubters of the traditional view.* One point has not been touched on to-day; Professor Sayce says that in the time of the Exodus the country that has been described was entirely under Egyptian rule; being held for the sake of the turquoise and the copper mines, by garrisons in places on the western coast of the Red Sea. But what could a handful of troops do against 600,000 fighting men marching out of Egypt?

Professor HULL.—I feel it is a great satisfaction to me, as I am

* See also Professor Palmer's *Desert of the Exodus*. 2 vols.—ED.

sure it is to everyone here, to have had the presence of my distinguished friend Sir Chas. Wilson, who is able to speak from a personal knowledge of this region.

With regard to the reference to Eusebius and Jerome I must say he has driven a wedge into my argument there, for I must confess that he is a more reliable authority as regards those two venerable authors.

Sir Chas. Wilson does not think that Ezion Geber was the Israelites' halting place on the way to Kadesh ; but he will find it so stated by Moses in Numbers (ch. xxxiii, v. 35), and therefore I must assume that to be correct.

The Meeting was then adjourned.

PROFESSOR A. H. SAYCE, D.D., IN REPLY.

Luxor, Egypt.

I have been reading Professor Hull's paper with very great interest, but it does not touch the point I have raised. He shows that if we accept the traditional view of the position of Mount Sinai, Jebel Musâ and the route leading to it will fulfil all the conditions required by the narrative of the Pentateuch. But my point is that this traditional view is not older than the age of the Christian hermits of the so-called Sinaitic Peninsula, and that it is inconsistent with (1) the Biblical geography and (2) Egyptian history.

(1) The *Yâm Sûf* of the Old Testament, mistranslated "the Red Sea," was the Gulf of 'Akabah, according to 1 Kings ix, 26, Deut. i, 1, Numb. xxxiii, 8-10, not the Gulf of Suez, the Hebrew name of which was "the Egyptian Sea" (Is. xi, 15).

Jethro visited Moses at Sinai, which seems to imply proximity to Midian.

At Rephidim the Amalekites were overthrown. The district they inhabited was not in the "Sinaitic Peninsula," but in Edom, and the desert south of Judah which stretched from Havilah to Shur (Gen. xxxvi, 12, 1 Sam. xv, 7, Gen. xiv, 7, etc.) From Exod. xvii, 16, we may gather that the Amalekites defeated by Moses were identical with those whom Saul was ordered to destroy.

The wilderness of Sinai adjoined that of Paran (Numb. x, 12), and Paran lay on the southern border of Canaan, the sanctuary of Kadeshbarnea being in it (Numb. xiii, 3, 17, 22, 26).

In Judg. v, 4, 5, Seir and Sinai are identified, as they are also in Deut. xxxiii, 2. The passages are poetry, it is true, but poetical geography is not necessarily false geography. If Sinai had been miles away in the Egyptian province of Mafket, some indication of the fact must have been given.

(2) From the time of the 3rd dynasty to the age of the Ptolemies, the Sinaitic Peninsula was an Egyptian province, and the copper and malachite mines on the western side of it were strongly garrisoned. To have marched into it, therefore, would have been like going out of the frying pan into the fire, and the Israelitish fugitives, who were ordered to avoid "the way of the Philistines" lest they should "see war," would have shared the fate of Professor Palmer and his companions.

COMMUNICATIONS RECEIVED.

Cannes, France.

The Rev. W. ARTHUR writes:—

With Professor Hull I am entirely agreed in the belief that the true Mount of the Covenant is neither Serbâl nor some unknown peak in the heights of Edom, but is that mountain which I call Sinai and which Professor Hull calls Jebel-Musâ. I always found the Arabs to confine the name Jebel-Musâ to the great summit on the south-eastern side of that mass which altogether has been from time immemorial called Sinai, on the north-western front of which on a level many hundreds of feet lower lie the three minor peaks, of which one is known as Ras-Sufsâfeh. Professor Hull seems to place these at a distance of a mile from each other; my recollections would make it more than two miles, but that is a point to be decided by the Ordnance Survey, of which I have not here any copy. But at all events the distinction between Jebel-Musâ and Ras-Sufsâfeh with its two kindred peaks is as clear and as necessary as that between the dome of St. Paul's Cathedral and the cupolas on the west side overlooking Ludgate Hill; but to make the comparison a good one

the dome ought to stand quite at the end of the structure farthest from the cupolas.

In 1857, when about to start from Cairo for Arabia Petræa, the late Rev. G. S. Drew asked me to take him into my party, which I consented to do on two conditions—first, that he should not object to my taking as much time as I pleased at Mount Sinai and at the supposed passages of the Red Sea, and secondly, that I should take time for a careful ascent of Mount Serbâl.

Mr. Drew, who was subsequently Hulsean Lecturer and author of *Studies in Bible Lands* and other careful and scholarly books on Eastern travel, proved to be a very valuable and soundly critical companion. Arrived at the foot of Serbâl, we spent a Friday in the ascent and examination of that mountain. Personal acquaintance with Lepsius, the German traveller and Egyptologist, and with Dr. Stewart the Scotch traveller, author of *The Tent and the Khan*, had given me somewhat of a bent in favour of Serbâl as being the Mount of the Covenant. But having carefully drawn out from the Bible narrative the conditions required by it in the mountain, I came back to my tent after twelve hours' absence satisfied that in Serbâl those conditions did not by any means meet. The next day, Saturday, we reached Mount Sinai, and did not leave it till the afternoon of the following Thursday. Mr. Drew was at first somewhat impatient at my taking so much time, but I had come determined to pace every yard not only of the mountain but of the Wadi Sebayah, where tradition placed the children of Israel during the giving of the law, and of the Wady Er-Rahah, to which valley Dr. Robinson, the careful and meritorious American traveller, removed the people on the ground that there was not room for them in the Wadi Sebayah, in which removal he had been followed by Stanley and other English travellers. I knew that Robinson's position as to the lesser extent of Sebayah was denied by Mr. Strauss of Berlin, the Court Preacher, and by Mr. Kellogg, an American artist. Moreover, these two gentlemen had been in and examined the Wadi Sebayah, whereas Robinson did not profess to have been in it, and Stanley's own map showed that what he called an hour's walk from the convent, and which he thought to have taken him into the Wadi Sebayah, had only taken him into one of its side openings, from which another quarter of an hour's walk would greatly have astonished him.

One difference between Er-Rahah and Sebayah is this: Er-Rahah runs end on to Mount Sinai at one end, Sebayah runs across it at the other end. From the small peaks of Sufsâfeh the spectator

much nearer the ground than on Jebel-Masâ, looks along the whole length of Er-Rahah and sees every inch of it; while from Jebel-Musâ at an immensely greater height, the spectator looks not along but only across Sebayeh, of which the greater part is hidden by the swellings of the mountain he is upon, so that he sees only its further fringe. It was from this height and under this disadvantage that Robinson and Stanley took their observations, on the strength of which observations the one removed the site and the other followed him. A man on the roof of St. Paul's looking from the western cupolas would know all about Ludgate Hill which he looks along. What would a man on the top of the dome know about the passage at the east end of the Cathedral which he would only look across? Having first traced the valleys to the north and west and south, and also ascended Jebel-Katerina, we ascended Jebel-Masâ; from there saw the eastern fringe of Wadi Sebayeh, and saw even upon that portion of it Bedouin camps and flocks which I am sure no one ever saw in Er-Rahah. This point of contrast between the two was at the moment to me very puzzling. Leaving Jebel-Musâ we descended, traversed the whole length of the mountain until we reached the base of Sufsâfeh, where we had the whole of Er-Rahah spread under our eyes, and so completely were we under the impressions of the Robinson school that there we solemnly read the Decalogue, seeking to realize the scene as written by Moses; but I could not help observing "the people may have assembled in Er-Rahah, but encamp there they never would; it is utterly without anything for the flocks and the herds." It was not till after all our other pacing had been carefully done that on the Wednesday we turned towards Sebayeh, taking note of Stanley's hour's walk from the Convent. For some time after we had passed that point, there seemed to us no room for the people, but everyone who knows either mountain valleys or mountain rivers is aware that, if you follow them up at times, when they seem to promise nothing they may suddenly startle you with their openings; and I shall never forget when I turned back after Sebayeh had so opened up and shown itself to be much larger than Er-Rahah and meeting Mr. Drew, who was following after me, said, "Don't you feel as if you had been imposed upon?" and he said, "Yes, and it is a shame for men like Robinson and Stanley to profess to inform the public about valleys which they have never traversed, but have judged of them from the tops of the mountains." We carefully paced Sebayeh as we had previously done Er-Rahah, and found it by

much the larger of the two. The result of which is this, that whereas certain critics have doubted whether at Mount Sinai any place could have been found for the people, that mountain has two valleys either of which would contain them, but only one of which, as I contend, fulfils the conditions of the narrative, all of which are easily satisfied in Wady Sebayah. These conditions I stated in an article on Sinai in Fairbairn's *Bible Dictionary*, but as to the comparative size of the two valleys, if Sir Charles Wilson's Ordnance Survey were complete and included Sebayah, it would settle the question.* To that authority I have not access here, and in Professor Hull's paper, Sebayah is not mentioned.

The Rev. R. COLLINS, M.A., writes:—

I have read Professor Hull's paper with much interest. No one, who has not actually visited the sites mentioned, can speak with any amount of authority. One difficulty with regard to the route laid out by Professor Hull, Dean Stanley, Mr. Clarke, and others, appears to me to be, that Rephidim, where it is so emphatically said "there was no water," is placed in or near the Wadi Feiran, which is described by Mr. Clarke as the best watered part of the whole peninsula. Mr. Clarke pictures the Amalekites protecting their watered valley against the Israelites; and it is quite *possible* the miracle may have been needed on that account; but the text of the Bible hardly suggests this. The Amalekites seem rather to have attacked the Israelites on the rear (Deut. xxv, 8).

Another point perhaps requires some little explanation. Most of these travellers, I observe, start their own journeys and computations of time and distance from 'Ayûn Mûsa, opposite to Suez, but the crossing of the waters was almost certainly many miles north of this, and even perhaps north of the crossing place of the "Pilgrims' road" from Cairo to Ezion Geber. Did the Israelites at once turn south by the sea? There seems a little difficulty here: "Moses brought Israel *from* the Red Sea, and they went *out* into the wilderness of Shur, etc." (Ex. xv, 22); this suggests, though it does not state, that the beginning of the journey was eastward. I have not noticed any other special difficulties, as to this particular track.

On the other hand, one thing seems certain, that Sinai was in

* For want of funds this survey is still incomplete.—ED.

or near the portion of Arabia inhabited by the Midianites; there (in Midian?) was Horeb, the "Mount of God" (Ex. iii, 1); there Aaron met Moses (Ex. vi, 27); and thither would the Israelites first direct their steps under the guidance of Moses, since God had given a special token to him—"When thou hast brought forth the people out of Egypt, ye shall serve God upon this mountain" (Ex. iii, 12). Is it possible that that "Mount of God" could have been in Edom? If so, then Midian must have extended much further north than we may have been led to suppose.

The encamping of the Israelites so soon again by the "sea" (Deut. xxx, 10) is a strong point for the route indicated by Professor Hull, and is specially remarked upon by Dean Stanley. The encampment at Ezion Geber, after Sinai, is also, as Professor Hull says, another, perhaps, strong point.

The nature of the Râs Sufsâfeh, of the adjacent Wadi er Râhal, and of the whole of the Jebel Musâ, seems to wonderfully coincide with all the demands of the Bible story, though I am not sure that that ought be considered alone enough to close controversy.

FURTHER REPLY BY THE AUTHOR.

May, 1899.

I agree with Mr. Collins that no one who has not personally visited the Sinaitic region ought to be considered as speaking with authority regarding the identification of the site of Horeb or Mount Sinai. On this ground the attempted identification of Professor Sayce must be received with great suspicion. Nor do I admit that the passages he cites from Judges and Deuteronomy—both admittedly poetic—necessarily imply identification of Seir and Sinai; on the contrary, in Deut. xxxiii, 2, the two mounts are specifically distinct. Again, is it likely that after the destruction of the Egyptian host, a fact which would immediately become known to the Egyptian garrison in the Peninsula, this garrison would have been formidable to the Israelites, as Canon Girdlestone has well pointed out? It will be satisfactory to those who hold the traditional site of Mount Sinai to be correct, that this view is supported by Sir C. W. Wilson, the Rev. W. Arthur and his companion Mr. Drew, all of whom, as well as the Author, have personally visited the region in question.

INTERMEDIATE MEETING.*

COMMANDER HEATH, R.N., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following election was announced:—

A. E. Molony, Esq., Indian Civil Service, India.

A lecture was then delivered upon—

DESIGN AS EXEMPLIFIED IN THE FORMATION OF THE HUMAN FOOT. By Gerard Smith, Esq., M.R.C.S.

The author stated that he had selected the human foot as a "concrete example" in proof of a greater "abstract principle," this principle being that the animal body exhibits proof of purpose and design in structure, and of being formed *for* its work, as opposed to the contention that the body is an imperfect result of the actions of environment, and formed *by* its work, not merely modified thereby.

The human foot offered a valuable example in support of this principle, because its mechanical arrangement was so unique, being *human* essentially, and ministering to the unique human physical advantage, that of the perfect erect posture.

He said that the arguments advanced to support the denial of design, or the assertion that design, if present, is a bad one, involved the further assertions that the deformities of the human body—those of the feet specially, when they are of that class due to failure in duly discharging the functions of the feet (not in reference to deformities caused by disease, as paralysis, etc.)—are invited and precipitated by the inherent defects of the structure; defects which, if the foot is designed, have been introduced of set purpose, to inflict suffering, etc.

In justification of these imputations the lecturer brought forward demonstrations that the foundations of such arguments are fallacious, and are entirely misconceptions of the meaning of the structure of the foot.

That, though there exist possibilities of failure, since these are necessary parts of the design, with every one of such possibilities there is an efficient provision against deformity, the disregard of which (or denial of their presence, which must be held to be consistent in holding the major premise of materialism) is the real cause of deformities of this type, and also robs cripples of the provided means for their relief, whilst the methods of physical education of children, based upon theories of the kind, are rendered faulty.

A brief discussion ensued.

* April 13, 1898.

ORDINARY MEETING.*

SIR J. WILLIAM DAWSON, C.M.G., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following Elections were notified :—

ASSOCIATES :—Rev. S. Plantz, D.D., Ph.D., Pres. Lawrence Univ., United States ; Rev. John B. Devins, United States.

HON. COR. MEMBER :—Prof. G. Macloskie, D.Sc., LL.D., Prof. Biology, Princeton Coll., United States.

The following paper was then read by the author :—

HERODOTUS. I.—HOW FAR HIS REMARKS BEARING ON EGYPTIAN GEOLOGY ARE RELIABLE IN THE LIGHT OF RECENT EGYPTIAN RESEARCH. By the Rev. F. A. WALKER, D.D., F.L.S.†

Λίθου Αιθιοπικοῦ ποικίλου.

Hdt., Lib. II, c. 127.

O^F *variegated*, or *many coloured* Ethiopian stone, if we adopt the rendering of Rawlinson who translates *ποικίλος* by many coloured, Herodotus here informs us that the lower tier or basement of the Second Pyramid τὸν πρώτον δόμον was composed of red granite of Syene, and Professor Rawlinson rightly remarks that the historian appears to be correct in saying that the lower tier was of that stone, or at least the casing, which was all that he could see, and the numbers of fragments of granite lying about this pyramid show that it has been partly faced with it. The casing which remains on the upper part is of the limestone of the eastern hills. One of the chief noticeable differences between the three pyramids, irrespective of their size, is in the said various casing of their exterior, that of the first and largest pyramid erected by Cheops consisting altogether of limestone; that of the second pyramid next to it in point of size, erected by Chephren, consisting in the upper part of limestone, and in the lower tier of red granite; and that of the third and smallest pyramid, erected by Mencheres (or Mycerinus) altogether of red granite. There are certain points that we must carefully bear in mind. The first being, that when Herodotus refers to the variegated stone of Ethiopia, he alludes solely to *red* granite, not to granite of another tint or hue. Second, that this red granite

* Subject first introduced at 12th of 31st Session.

† Paper and discussion revised and passed for press 1899.

was obtained for the most part from the time-honoured quarries of Syene or Assouan, which had been worked for centuries for the purpose of obtaining material wherewith to construct the greater part of the colossal edifices of Egypt. Thirdly, that red granite was far more frequently and extensively employed in these buildings than either blue or black granite. Fourthly, that the red granite of Syene must on no account be confounded with the syenite of geologists, which is composed of different minerals, and probably likewise in different proportions, as the syenite of geologists also derives its local habitation and its name from the vale of Syene. Fifthly, that the modern name of Assouan stands in relation to the ancient appellation of Syene precisely as Stasthe does to the older name of Athens. A prefix has been added in each case, and the ultimate syllable has been dropped. Stasthe, in point of fact, is a corruption of ἐς τὰς Ἀθήνας ("To the Athens.") Sixthly, that the famous red granite quarries of Syene are situate at the north end of the valley, just outside the modern Arab town of Assouan, though strata of the same may likewise be noticed throughout the extent of the valley, and that the true syenite occurs in the middle of the vale, and is not nearly so common, plentiful, or generally distributed as red granite. Seventhly, that whereas in Cornwall, or at Peterhead, as I understand, it is impossible to obtain a monolith of red granite without a flaw (or what geologists term a fault) intervening of greater length than 30 feet. Some of the monolith obelisks, certain ones standing, others now fallen, reach, or did reach, a height of upwards of 100 feet, and even of 110 feet, in Upper Egypt. The grain, the colour, and the pattern of the granite will of course vary somewhat according to its particular quarry and country, whether Cornish, Shap, or Aberdeen—whether brought from Sweden, or collected on the banks of the Nile. The Shap granite would seem to present a notable variation, the red preponderating therein, and occurring in large patches or blotches. There are some specimens, again—and I think I recollect coming across such in Sweden—wherein an almost imperceptible gradation of tint is manifested, and the black and white are just suffused with the palest pink.

It would be superfluous, tedious, and in point of fact impossible, to enumerate all the creations of Egyptian art for which, throughout the centuries, the variegated stone of

Ethiopia (*alias* red granite) has been employed. Some of the monuments have always remained *in situ* close to the rock whence they were hewn, notably about the largest obelisk of all, still lying prostrate in the time honoured quarries of Assouan for some unexplained cause, either a flaw in the stone, or from the reverses or death of the monarch who ordered its construction. The real reason will now never be certainly known. Other colossal busts, statues, obelisks, sarcophagi, linings of corridors, &c., &c., still adorn such ancient sites as Karnak, Luxor, Rameseum, Memphis, Mitrahenny, Geezeh, Heliopolis, &c. Other relics of red granite, and of sandstone as well, have long since been removed far away, and now adorn the proudest capitals of Europe, as London, Paris, Rome, and even transatlantic cities as New York. And the Thames Embankment, the Place de la Concorde, the Piazza of St. Peter's, the Mosque of St. Sophia, Constantinople, and other public places in the last named city alike testify to the presence of the spoils of the East, and in the transfer of right ancient monuments from the land of bondage to captivity itself led captive.

Why red granite should have been so extensively chosen in preference to blue, when stone of the latter tint likewise so plentifully occurs in Syene, Philæ, Kalabsheh, it is hard perhaps to say. My own idea is that the effect of the rosy surface when lighted up by the warm glow of the rising sun in the eastern heaven, especially in the case of such edifices as were erected on the west bank of the Nile, or on the plateau of the Pyramids, likewise on the Libyan shore of the great river, was one calculated to excite great admiration on the part of the procession of monarch, white robed priests, and people winding up in solemn procession to the carefully modulated and plaintive strain of flute and of sistrum from the valley of the Nile beneath. That the red granite should have been selected for incised hieroglyphics instead of sandstone is by no means hard to perceive when regard is paid not only to the particular hue, but to the durability of the material.

The structures along the Ethiopian Nile, wherein friable sandstone is, as a rule, more frequently made use of than in Egypt proper for the rough and ill-executed, and not unfrequently coarsely designed, carvings afford striking evidence of the comparative inutility of that stone to resist the effects of the weather, as well as of *tempus edax rerum*.

Yet the sunlit boulders of blue granite show to great advantage, glistening withal as washed ever now and again by the river's spray in the famous gorge of Kalabsheh, where the Nile is only a thousand feet across at the narrowest part. If we imagine the Nile to be introduced through the Valley of Rocks at Lynton, Devon, with an accessory fringe of palm trees, we shall better realise the aspect that one particular portion of the gorge presents; but anon the river widens, and numerous islets, some studded with acacias and palm trees, other smaller ones consisting of mere heaps of granite boulders, meet our view in mid-stream.

A stratum of the granite is also passed at the further end of the valley of Syene before reaching the village of Mahattah, with its swarthy Nubian children.

Description by Dean Stanley.

“The smooth casing of part of the top of the Second Pyramid, and the magnificent granite blocks which form the lower stages of the Third, serve to show what they must have been: all, from top to bottom—the First and Second—brilliant white or yellow limestone smooth from top to bottom, instead of those rude disjointed masses which their stripped sides now present; the Third all glowing with the red granite from the First Cataract. As it is, they have the barbarous look of Stonehenge; but then they must have shone with the polish of an age already rich with civilization, and that the more remarkable when it is remembered that those granite blocks which furnished the outside of the Third, and inside of the First, must have come all the way from the First Cataract.”

Temple of the Sphinx, Nine Hundred Miles up the Nile, p. 89.

“Its walls and vestibules all consist of huge blocks of red granite from Assouan.”

L'Orient, p. 40.

“A building constructed of immense blocks of red granite from Assouan, one even measuring upwards of 18 feet in length and seven in height. The skill, the labour, the cost it must have taken to transport these massive and weighty stones such a distance, and to polish their surface, and dovetail them into position with such perfect exactness and precision, compel the tribute of our admiration.”

Subjoined is a list of the antiquities in red granite that came under my own notice :—

Nubia.

Dakkeh, Temple of,—

Large broken block of polished red granite, possibly part of the original shrine.

Dabod, Temple of,—

One of the smaller chambers contains a broken monolith of red granite that no doubt was originally set up in the adjoining sanctuary.

Great Temple of Isis, Sacred Isle, Philæ,—

On the wall of the north side of the court between the first and second propylon is a large rounded slab of red granite, still forming part of the native rock, whereon is a hieroglyphic inscription, setting forth how Ptolemy Philadelphus assigned the Sacred Isle to the priest for the building of the temple.

Close to the double portico above mentioned are three chambers, of which the innermost contains a granite shrine.

Black granite.

In front of the propylon of the Rameseum is a large sphinx of black granite likewise mutilated, and with the head severed from the body, and on one side of the great hall are the remains of a statue of black granite of Rameses II.

Blue granite.

On the pavement at the north end of the great hall of the Temple of Horus at Edfou is lying a broken statue of a colossal bird in blue granite. In the second hall is the prostrate pedestal, of blue granite, of the gigantic bird above mentioned, and which, with the bird, was discovered by Mariette in the great hall.

Colossal statue of Rameses II,—

In front of the Rameseum (*alias* the Memnonium of Strabo, owing to the title of Mianum, attached to the name of Rameses II, being corrupted by the Greeks into Memnon) are the shattered fragments of the colossal statue of Rameses II, that when entire weighed over a thousand tons, and was the largest statue in Egypt, carved out of red granite.

Karnak,—

Outside the great hall, a few yards further east, were once two obelisks of red granite sculptured all over, and each 75 feet high, and having the name of the founder, Thothmes I of the 18th dynasty. One of them is still standing, but the other is thrown down, and all its huge *débris* lie strewn around. The red granite employed here was all brought from Gebel Sibsileh.

The red granite obelisk known by the name of Hatasu, about 100 yards further east, measures 108 feet 10 inches, and is altogether more massive than those of Thothmes, being the largest obelisk known. It also had a companion, now, alas! thrown down likewise, and in fragments.

Covering of Second and Third Pyramids, Temple of Second Pyramid, Temple of Sphinx and Sarcophagus, Geezeh.

Specimens of red granite.

From

Temple of Second Pyramid,—Karnak.

Medinet Haboo,—Assouan.

Casing of Second Pyramid,—Colossal statue of Rameses II.

Temple of Sphinx.

Specimens of black granite.

Sphinx at Rameseum.

Portion of cover of Sarcophagus, Apis Mausoleum, Sakkarah.

“SHELLS UPON THE HILLS.”

Κογχύλια τε φαινόμενα ἐπὶ τοῖσι οὐρεσι.

Hdt., Lib. II, c. 12.

The whole of the rocky platform whereon the pyramids of Geezeh are situate, westward of the Nile, and also the range of the Mokattam hills eastward of the great river, owing to the prevalence of nummulite limestone everywhere affords evidence of the accuracy of the description given by the father of history. The said fossils, which are termed nummulites by reason of their supposed resemblance to coins owing to their circular shape, constitute by far the

larger proportion of the rock of magnesian limestone wherein they are so numerous imbedded as to be a conspicuous object deserving the epithet of *φαινόμενα* here employed. When placed edgewise or sectionally, their appearance resembles that of lentils, so as to mislead Strabo the historian into the belief that these were the petrified residue of the workmen of the Pyramids. This particular species is denominated by scientists therefore, *Nautilus lenticularis* or *mammilla*, from its supposed resemblance to another well known object. Fossil *Echini* likewise occur in the Mokattam hills, but the above named nummulites being by far the most numerous, are therefore doubtless the ones that attracted the historian's attention, and furnished the subject of his description.

Whereas the soil of Libya is, we know, more of a reddish hue, and more sandy :—

Τὴν δὲ Λιβύην ἴδμεν ἐρυθροτέρην τε γῆν καὶ ὑποψαμμοτέρην.

And that of Arabia and Syria inclines to stone and clay :—

Τὴν δὲ Ἀραβίην τε καὶ Συρίην ἀργιλωδεστέρην τε καὶ ὑπόπετρον εὐόσαν.

Hdt., Lib. II, 12.

If in the district of Arabia Herodotus included the territory situate between the east bank of the Nile and the Red Sea, while he designated as Libya the land on the west bank of the Nile, even as in modern times the east and west banks are termed the Libyan and Arabian respectively, his description can be abundantly verified.

There is, as a rule, much more golden sand of very fresh and recently drifted appearance, and that looks as if it had been finely sifted on the western bank, and the *débris* of volcanic shale are commonly far more numerous on the eastern bank.

Compare as evidence of the above the following passage from *Nine Hundred Miles up the Nile*, p. 192, and in reference to the panoramic view enjoyed from El Ghawarnee in the rear of Korosko, Nubia, about 827 miles distant from Alexandria : “ The golden sands across the western bank contrast beautifully with the blue river ; and the dark volcanic shale, that forms the surface covering of eastern and western hills alike, and on the eastern hills and ravines among which we are now standing, is so plentifully strewn as to give the nearest intervening basin between us and the next range

completely the appearance of an extinct crater." In the above paragraph, it is true, volcanic shale is observed and spoken of as occurring on both sides of the river, but far more plentifully on range beyond range, fold within fold of the amphitheatre of hills on the eastern side. Then, again, the golden sands on the Libyan side are a far more prevalent feature in the landscape, and are noticed as such. Or, to quote again from *Nine Hundred Miles up the Nile*, p. 174, in reference to Assouan at the south limit of Upper Egypt, distant, say, 713 miles from Alexandria, "The golden sand of the Libyan desert presents a very fresh and recently drifted appearance as we approach Assouan." And again, on same page 174, "A very fine contrast of colour is produced by the Libyan sands on one side, the Arabian granite on the other." And, again, from *Nine Hundred Miles up the Nile*, p. 172, in reference to Silsilis, distant in round numbers 650 miles from Alexandria, possibly rather more: "Where also the freshly drifted sand contrasting with that of a dark tint, brings back memories of the aspect of the desert on the banks of the Suez Canal." Of course there are exceptions to this rule. As on the east bank at Luxor, where the shores are low, I have myself noted sand to the amount of many barrow loads, if not carts full, fall with a great swish into the river, and the Nile is making great inroads on Luxor and its neighbourhood, and the gardens and fields once in front of the American Consulate have also vanished and gone. And when gaining the summit of the mountain of Lycopolis, which is on the western bank and at the rear of the town of Assiout, we find it to consist of a perfectly desolate and slightly undulating plateau, covered everywhere with flinty stones. Still, in the majority of instances, as first pointed out by Herodotus and corroborated by the traveller in his steps at the present day, there is Afric's golden sand on the western side and the ejectamenta of long bygone volcanic action on the Arabian.

Efflorescence of salt to such an extent as to injure even the pyramids.

"*Ἀλμην ἐπανθέουσιν, ὥστε καὶ τὰς πυραμίδας δηλέεσθαι.*

Hdt., Lib. II, c. 12.

"That salt exuded from the soil."

Efflorescence of salt.

How far borne out by modern research as correct.

HELWAN SULPHUR SPRINGS.

The sending of the leprous persons to the sulphur springs, east bank of Nile, by Amenophis III, B.C. 1403 (last king but one of 18th dynasty) is a misrepresentation of some real event, not a mere fable, as proved by recent discovery of the springs at Helwân.

There is a small ancient column that is now walled in, and may have dated from the establishment of the baths in the days of old, with palms, tamarisks, and pepper trees growing around.

A considerable tract of ground here on the edge of the desert is covered with beds of rushes, and its sand is damp and spongy, with here and there a patch of saltpetre. These facts point to the existence of other sulphur springs below the surface, and by the limit of the waters we may form a probable conjecture of their extent.

Lower Egypt.

Helwân, *Nine Hundred Miles up the Nile*, p. 103.

“Here and there a patch of saltpetre.”

Ditto.

Ditto.

Ditto.

Here and there strewn about are flints, quartz pebbles, lumps of saltpetre.

Nine Hundred Miles, p. 139.

Upper Egypt.

Karnak. The central area of the large court of the temple is encrusted with a great deal of saltpetre, which crops up through the sand.

p. 142.

Ditto. The hollows in the vicinity are filled with a thick coating of saltpetre.

Ditto. p. 143.

The Sacred Lake may be about 200 yards in extent, and derives its water from infiltration of the Nile, strongly impregnated, however, with nitre and saltpetre, owing to the character of the surrounding soil, so that no fishes are found there.”

The CHAIRMAN (Sir J. W. DAWSON).—We shall be happy to hear remarks, by any present, upon this paper. It raises a great many curious and interesting points in Egyptian geology.

Rev. Canon GIRDLESTONE, M.A.—Perhaps our Chairman would open the subject for discussion. We are all anxious to hear him. (Applause.)

The CHAIRMAN (Sir WILLIAM DAWSON, C.M.G., LL.D., F.R.S.)—I may say, that having studied most of the rocks referred to in Dr. Walker's very charming and suggestive paper, I find that he has brought before my mind a great many things that I noticed when in Egypt, and to which I perhaps gave less attention than I should have done; and further, his remarks have given, I think, a very clear proof of the close observation of the old Greek father of history when he visited Egypt. He lived in days before the rise of modern geology; but nevertheless he had the natural gifts of a geologist, and he noticed many points which have escaped the attention of most travellers, except where, like Dr. Walker, they have been bent on following up the notes he made.

Dr. Walker referred to the celebrated granite of Syene or Assuan, a magnificent material which the Egyptians utilised to the utmost. I think anyone who has seen the obelisks (I do not refer to the somewhat smoked one on the Embankment here) in the eastern sunlight, with their beautiful rosy colour, would easily understand why the Egyptians made choice of so beautiful and durable a stone as this of Syene, which is like that we have from Peterhead in the North of Scotland.

In regard to the differences of these granites, I may say that the term "syenite" has now been restricted to the granitic rocks which contain only two of the ordinary constituents of granite, viz., felspar and hornblende. The older geologists, however, called the hornblendic granites by this name, and I am not sure that they were not right, for these have a very varying quantity of quartz, and this is the case with the granite of Egypt as well as that of other countries. The great broken statue of Rameses II, on the southern side of Thebes, is composed of gneiss, a laminated variety of granite. When polished you can see the lines of lamination, whereas true typical granite is a perfectly uniform stone, and has no such lamination. Whether that lamination is a sign of stratification, or whether it is merely the effect of com-

pression when the granite was in a semi-liquid state, is a matter of question amongst lithologists at the present day. I examined a section of the little railway at Syene which cuts through this rock. It shows the laminated varieties we call gneiss, and others which could be distinctly called granite, but both were quarried by Egyptians, who used indifferently true granite and the allied rock to which we give the name of gneiss. The grey granite to which the paper referred contains a considerable amount of mica, and was used by the Egyptians, but not to a great extent, partly because it is difficult to procure in large blocks, and partly, also, because it is a less attractive stone and is less easily dealt with in taking a fine polish. When they used a dark stone they preferred another rock consisting of hornblende and white felspar of a distinct species, a white and black stone with a uniform grain, or sometimes with white spots of felspar in it. This is a Diorite, and is found at Assouan near the granite.

Some of the largest and finest of the older statuary, such as that of the statue of Chephren, the builder of the Second Pyramid, is made of another stone (Anorthosite), composed of a peculiar glistening felspar with small quantities of dark hornblende in it, and which, when polished, has much the aspect of a grey marble, though more lustrous and much harder.

There is another question which is of interest, and which no doubt attracted the attention of Herodotus, and that is the success of the Egyptians in cutting the immense blocks of this refractory stone, and engraving on them their hieroglyphics in such a beautiful way. As the author has pointed out, the quarries at Assouan afforded large blocks of stone without joints or flaws, but there was connected with this property the labour—so patiently and carefully performed in drilling holes in these great stones and driving wedges into them and breaking them off little by little and carrying them on rollers down to the banks of the river at times of inundation, and then working them up into their beautiful obelisks. If you look at the obelisk on the Thames Embankment you may wonder how they cut such deep and beautiful carving on it, and you may wonder more when you hear it was set up by Thothmes III, one of the greatest of Egyptian kings, and pro-

bably a contemporary of Joseph, who according to the best chronology, lived at that time and not at the time of the Hyksos kings, as you are often told. Thothmes engraved the characters on the middle of each face. Those on the two sides were cut for Rameses II, the oppressor of the Hebrews, and whose sister or daughter was foster-mother to Moses.

I think Professor Petrie has shown how the work was done. The Egyptians used hollow drills, and so worked holes into the granite and these drilled holes corresponding with the figures or hieroglyphics, they broke away the cores and connecting pieces, and thereby cut these deep and enduring inscriptions. No doubt Rameses' workmen went up to the top of the obelisk, held up by stages and ropes, and so drilled the characters without taking it down.

One of the pieces on the table is from one of the pair of obelisks at Karnak, which are the largest in Egypt, and were set up by the great Queen Hatasu. One has fallen and the other is standing. I looked at the top of the fallen one, and I can assure you that the surface of that stone is most carefully worked and polished, and in that fine climate it remains so to the present day. There is no scamped work about it. At the top of the monument, which no one could see closely, the whole surface is beautifully cut. That is the style of work that these people carried out. No wonder that Herodotus was astonished at it! and we, too, when we see this monument on the Embankment, which, I believe, is the largest quarried stone in Great Britain, and yet it was probably quarried at a time when Joseph was Prime Minister of Egypt, or perhaps before. So you see it is an illustration of what these people could do with their comparatively small mechanical means. It is also commemorative of two of the most important points where, according to Bible history, early Israel came into contact with Egypt.

The author has made some remarks of great interest on other things as well: amongst them, the fossil shells of Egypt. These attracted the attention of Herodotus, as well as of later students. The greater part of them belong to the lower tertiary, of the same age as the London clay. These fossil shells are very abundant on the banks of the Nile, and especially near Cairo. But other

specimens that have been passed round belong to a later formation—the pleistocene formation. Herodotus may have seen these also, for on the hills near the pyramids are raised beaches, piled up with shells of a modern species of oyster, and these oysters lived there at a time when the sea extended over the pyramid plateau.

Dr. Walker also referred to the sulphur springs. These sulphur springs of Helwân are very curious. The phial which Dr Walker handed round is a strong solution of sulphuretted hydrogen, which any one can smell for some distance, and it was no doubt used for cutaneous diseases in the old times as it is to-day. These very strong sulphur baths and springs are connected with the occurrence of gypsum in the neighbouring rocks, and were no doubt known from time immemorial.

Soda is commonly found, as carbonate, in the desert waters of the region, and was largely used by the Egyptians and other ancient people for detergent purposes, for preparing mummies, and also in the manufacture of glass, which was probably first made by the natives of Egypt. You see this good old traveller, 450 years B.C., noticed a great many of these things. He was not so excited by the evidences of art that he saw in Egypt as to fail to notice the works of nature in Egypt. I think we also should consider what these people had to do with, and the natural gifts of that wonderful country, while admiring what they did. There are few countries in the world so richly endowed, and perhaps no country in the world where those natural endowments were turned to such wonderful account as by those industrious, thoughtful, and careful old Egyptian people, who, in early times, were much secluded from intercourse with other nations of the world, and yet developed for themselves an original civilisation different from that of any other part of the world. (Applause.)

Between Herodotus and our friend here, there is a great temptation to speak on a subject so large and curious as this is, and especially with reference to the supposed volcanic phenomena at Jebel Ahmar near Cairo, as to which some of us might differ in some respects from both Herodotus and the author of the paper, but there are others present who may be prepared to take up these points.

Rev. S. KINNS, Ph.D.—May I refer to the perfection which the Egyptians attained in cutting stones? In the British Museum we have, in red granite, a magnificent arm of Thothmes III, the cutting of which manifests great skill, and apparently the use of excellent tools. There is also, in that Museum, a very fine bust and head of Seti I, sculptured in that black granite which Dr. Walker has mentioned, and also some very fine specimens in pink granite. A visit to the Museum after this excellent paper would enable one to see illustrations of the various coloured granites in which the monuments are chiselled. [After some remarks involving an earlier date for Joseph's time, Dr. Kinns said]:—I would suggest that the princess who was Moses' foster-mother was not the daughter of Rameses II, but of Seti I, for the monuments tell us that Rameses II died at the age of 79, and that he reigned for 69 years. Now Moses was 80 years of age when he returned to Egypt, and Rameses, who had just died, was one year younger than Moses.

Canon GIBBLESTONE, M.A.—I think we owe a debt to Dr. Walker for rehabilitating Herodotus, the father of history. I need not remind you that Herodotus lived about the time of Malachi, so that he was the father of Greek and Hebrew history. It reminds us how far back Old Testament history runs, seeing it closes at the beginning of what we ordinarily call the Greek historical research period. One other point in the paper I should like to mention. People are often surprised that there are not more monuments in Palestine. The reason is simply a geological one. Palestine has not got the kind of stone which is calculated to be monumental. The stone of Palestine is limestone and of a very crumbling nature; so that the old statues and carvings there have, for the most part, perished. You have to go north-east of the Jordan to get basalt, and that class of stone out of which such monuments as the well-known "Moabite stone" might be made. One word more and I have done. About twenty-five years ago the truth of the Old Testament was contested in certain quarters. The whole story of Creation, of the Deluge and other events, and the treatment of history in connection with what is usually called the spiritual, was scoffed at *by some* as impossible. In consequence, the Old Testament, which is the foundation of the New, seemed, in the eyes of some inquirers, to be in a perilous position. There was wanted some one who would stand up boldly, a man of science, an archæologist, a geologist, a theologian,

and a Hebrew scholar, one who had the courage of his opinions, and one who had Christian experience and common sense. Now it was not easy to find such a man; but there was such a man in Canada, the discoverer of the earliest form of life amid the rocky deposits of that vast continent. We remember him as a few years ago the President of the British Association, and we welcome his arrival amongst us again to-day, as that of one who by his many valuable works has done more than almost anyone else to confirm the faith of doubters. (Applause.)

[Sir William Dawson was among the first to join the Victoria Institute, of which he has now been a leading member for twenty-seven years, and to him the Institute is specially indebted for many papers and communications.—Ed.]

Dr. MACGREGOR.—I desire to congratulate my friend, Dr. Walker, on his interesting and instructive paper. Though I am not, perhaps, an Egyptologist, I can corroborate everything that he has said, having lived for some time in Egypt.

The CHAIRMAN.—Allow me to thank Dr. Walker for his excellent paper. In regard to the remarks made by Canon Girdlestone, I think I may return them with interest, for if there is anyone to whom I am indebted for guidance in Biblical matters, it is to Canon Girdlestone. I think he is a very earnest and successful defender of the Old Testament. With regard to Dr. Kinns' remarks, I am quite prepared to concede the parentage of the finder of Moses—that she may have been Rameses' sister and Seti's daughter; but it would take a somewhat longer argument to induce me to yield to the earlier date of Joseph. My own idea is that the earlier date has been breaking the link of connection unnecessarily between Egyptian and Hebrew history; but if that subject be brought up at some future time, it may be an opportunity for arguing a somewhat important question. I finally ask those present to testify, by a vote of thanks to the author of the paper, their interest in what he has read to us, and their appreciation of the value of this rehabilitation of Herodotus, as it has been very properly called to-day.

The Author, having expressed the great pleasure it had afforded him to read his paper, the Meeting was then adjourned.

INTERMEDIATE MEETING.*

**THE VEN. R. THORNTON, D.D., V.P., ARCHDEACON OF
MIDDLESEX, IN THE CHAIR.**

The Minutes of the last Meeting were read and confirmed, and the following elections were announced :—

**MEMBERS :—Rev. D. B. Mulford, D.D., United States ; Miss Partridge,
Monmouthshire.**

A lecture "On Early Civilizations" was then given by the Rev. J. Tuckwell, upon which a brief discussion took place.

* January 3rd, 1898.

ORDINARY MEETING.*

D. HOWARD, ESQ., D.L., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and after the announcement of the receipt of a letter from Her Majesty the Queen accepting the last issued volumes of the Transactions of the Institute, the following elections were announced :—

ASSOCIATES :—D. B. Hewitt, Esq., B.A., L.R.C.P.D., L.R.C.S. ; J. P. Cheshire ; Rev. J. Hartley, D.D., United States ; Rev. P. H. Cole, D.D., United States.

The following paper was then read by the Author :—

HERODOTUS. II.—AS A BOTANIST. (VIEWED IN THE LIGHT OF RECENT TRAVEL AND INVESTIGATION OF PLANTS AND TREES OF EGYPT.) By the Rev. F. A. WALKER, D.D., F.L.S.

HERODOTUS ON CASTOR OIL.

THE Egyptians who live in the marshes use for the anointing of their bodies an oil made from the fruit of the sillicyprium, which is known among them by the name of *kiki*. To obtain this they plant the sillicyprium (which grows wild in Greece) along the banks of the rivers and by the sides of the lakes, where it produces fruit in great abundance, but with a very disagreeable smell. This fruit is gathered, and then bruised and pressed, or else boiled down after washing. The liquid which comes from it is collected, and found to be unctuous, and as well suited as olive oil for lamps, *only that it gives out a grievous odour.*

Herodotus, Lib. II, c. 94.

* Subject introduced 4 Jan., 1897.

† Paper and discussion finally corrected by the Authors 1899.

Note in Rawlinson's Herodotus on the Castor Oil Plant.—The *Ricinus communis*, the castor oil plant, or the *Palma Christi*, in Arabic Kharneh, was known by the names of Croton, Trixis, wild or tree-sesamum, and (according to Dioscorides) of *σέσελι κύπριον*, which was doubtless the same as the *σιλλικύπριον* of Herodotus. It grew abundantly, according to Pliny, as it still does, in Egypt. The oil was extracted either by pressing the seeds, as at the present day, when required for lamps, or by boiling them and skimming off the oil that floated on the surface, which was thought better for medicinal purposes. Pliny was not singular in his taste when he says (xv, 7), "*Cibis fœdum, lucernis utile,*" "Disgusting for food, useful for lamps."

Note in Rawlinson's Ancient Egypt, Vol. I, p. 54, on the Castor Oil Plant.—The sillicyprium, or castor oil tree (*Ricinus communis*), grows abundantly in Egypt. It is a plant of a considerable size, with leaves like those of the vine, and bears a berry from which the oil is extracted. This has medicinal qualities, and was used anciently for medical purposes; but its main employment has always been as a lamp oil of a coarse kind. According to Strabo, the common people in Egypt applied it also to the anointment of their persons.

My own observations of the Castor Oil Plant in Egypt.—The cultivation of the castor oil plant along the banks of the Nile, alike in Upper Egypt as well as in Nubia, is in fact quite as much an every-day sight to the modern traveller as in the days of Herodotus 460 B.C. However narrow the strip of cultivated land along the banks of the Nubian Nile may be, and all unite in testimony to its very limited dimensions for the most part, room must be found not only for the growth of lentils, lupins, and such like, but also for the inevitable castor oil within the scanty plot of ground. With this nauseous fluid the Nubians of to-day just as the Egyptians in the marshes of old steep their raven tresses, and plaster their copper-coloured complexions till their locks as well as their naked bodies are glistening all over with, as well as strongly redolent of, the compound. In my work, *Nine Hundred Miles up the Nile*, p. 176, the following passage occurs: "Until we emerge in the village of Mahattah, prettily situated in groves of date and dom palms, as well as sycamore figs, where the little swarthy Nubian children pop their heads over the clay

parapets of their dwellings, with their plaited tresses stiff and glistening with castor oil, and uttering the stereotyped cry of 'Baksheesh ya Howaga.'" Once more, in the outskirts of Muniéh, half veiling our first glimpse of the Rameseum on our approach up stream, here represented by tall plantations, and again on the sandy slopes below the rock temples of Ipsambol, these only consisting of tiny plants, and in many another spot besides, *Ricinus communis* may be seen, and is moreover utilised to such an extent that not an article purchased from the inhabitants of Lower Nubia but what has to be hung over the rail of the steamer, or exposed on the paddle-box for days in order that the direful scent, in which they delight, may exhale.

HERODOTUS ON THE LOTUS.

But for greater cheapness of living the marsh men practice certain peculiar customs, such as these following:—they gather the blossoms of a certain water lily, which grows in great abundance all over the flat country at the time when the Nile rises, and floods the regions along its banks—the Egyptians call it the Lotos—they gather, I say, the blossoms of this plant, and dry them in the sun, after which they extract from the centre of each blossom a substance like the head of a poppy, which they crush and make into bread. The root of the lotus is likewise eatable, and has a pleasant sweet taste; it is round, and about the size of an apple. There is also another species of the lily in Egypt, which grows, like the lotus, in the river, and resembles the rose. The fruit springs up side by side with the blossom, on a separate stalk, and has almost exactly the look of the comb made by wasps. It contains a number of seeds, about the size of an olive stone, which are good to eat, and these are eaten both green and dried.

Herodotus, Lib. II, c. 92.

Various relations of the Lotos to Egyptian life.—The Lotos plant is so intimately and variously connected with the sundry phases of Egyptian life, that it is difficult to unravel and enumerate all the thoughts and associations to which the mention of this flower gives rise.

(1) The Lotos as a model for art.

The blossoms furnished an artistic model for the

decoration of the columnar capital of the Egyptian shrine.

- (2) The Lotos as an article of food.

Its seeds, and likewise its roots and stalks, served as an article of food.

- (3) The Lotos as used for garlands on festive occasions.

It is connected with the season of festivity, as the Lotos flower was always presented to guests at an Egyptian party, and garlands were put round their heads and necks.

“Multæque in fronte coronæ.”

- (4) The Lotos furnishes a wreath for the departed.

It was constantly used in the hour of sorrow, and in connection with the departed, as it was thought to be a flower of Hades or Amenti, the unseen realm, and I can personally testify to having seen dried wreaths of the buds and tendrils of this plant that were placed centuries since round the necks of the deceased, exposed to view along with the royal mummy so decorated, in the Boulak Museum.

- (5) *The Lotos*. Its mystic symbolism and mythology.

There is a great deal of mystic symbolism and mythology connected with the Lotos, and in the cult of more than one nation, moreover, probably such as can never fully, or in every instance be now comprehended, and both the Latin and the Arabic names of the water lily genus are full of significance.

Certain facts, however, are alike beyond the region of fancy or possibility of doubt, and therefore may be appropriately adverted to here.

The Lotos. The time of its appearance.—As regards the time of the appearance of the Lotos, Herodotus informs us that it corresponds with the annual inundation of the Nile. In a note on page 127 of Vol. II of Rawlinson's Herodotus we read, “This *Nymphæa Lotus* grows in ponds and small channels in the Delta during the inundation, which are dry during the rest of the year; but it is not found in the Nile itself.” It is nearly the same as our white water lily.

Two varieties of the Egyptian Lotos.—There are two varieties, the white, and that with a bluish tinge, or the *Nymphæa Cærulea*.

My own testimony as to the time of its appearance, and as to

the bluish variety.—On referring to *Nine Hundred Miles up the Nile*, p. 65, the following passage occurs: “These swamps (*i.e.*, swamps on the Cairo side of Damanhoor, distant at a rough estimate from forty-five to fifty miles from Alexandria) are covered with the plants of the water lily, but there are only a few—very few, and those white ones—in bloom. I do not think that they are the same as our English species, but it is difficult to determine from the railway carriage. (I have since learned that they are the true Egyptian lotos.) Over and above this passage in my book I may add that my recollection of these flowers is that though similar in shape to our own white water lily they were somewhat smaller in size, and that some of them at any rate had the “bluish tinge” recorded in Rawlinson’s notes, and were therefore probably the var. *cœrulea*. The time of its appearance (November 28th) will also correspond with that noticed by Herodotus, as even towards the close of the year the annual inundation of the Nile has not altogether subsided, and certain of them may have been in flower for several days before my arrival.

The statement of Herodotus above quoted in reference to “another species of lily” probably refers to the *nelumbium* or *nymphaea nelumbo*, a species common in India, and introduced into Egypt. Herodotus further states that there is another species of lily which contains a number of seeds about the size of an olive stone, which are good to eat, and these are eaten both green and dried. According to the note in Rawlinson’s Herodotus this is perhaps the *nymphaea nelumbo* or *nelumbium*, which is common in India, but which grows no longer in Egypt. I may here remark that the *nymphaea nelumbo* is as conspicuous in Hindoo mythology as the *nymphaea Lotus* in Egyptian, and that Rawlinson is quite correct in his statement that it is evident that the lotus is not borrowed from India, as it was the favourite plant of Egypt before the Hindoos had established their religion there. He likewise announces that the care taken in planting the *nymphaea nelumbo* formerly seems to show it was not indigenous in Egypt. Crocodiles and the *nelumbium* are represented, with the Nile god, on the large statue in the Vatican at Rome and in many Roman-Egyptian sculptures, but it is remarkable that no representation of the *nelumbium* occurs in the sculptures, though the common *nymphaea lotus* occurs so often. I cannot agree with the Professor as to its being remarkable. It is all but certain

that the native *nymphaea* Lotus was carved in periods long anterior to the introduction of *nymphaea nelumbo* at all, and also subsequently to its disappearance. The form of an indigenous plant would obviously be more familiar, more universally present to the eye, and for a longer period than that of a foreign species introduced. And no nation was more given than that of the Egyptians to representing creatures of the animal, bird, and reptile world, or species of plant life, whether through gratitude for benefits, or to deprecate noxious and baneful influences.

“O sacrosancti, quibus hæc nascuntur in hortis Numina,”

scornfully exclaims Juvenal. So we behold multitudinous delineations of the jackal, the baboon, the hippopotamus, the owl, the vulture, the ibis, the crocodile, the cobra, the lotus, the papyrus, the palm, every-day objects for the beholder, always at hand for the artist, and esteemed and revered by the common people, and in many cases deified. Thus in Baalbec I have seen carved in stone on the lintels and above the porches of the Temple of the Sun in gratitude to the warming and maturing powers of the God of Day, a perfect flower garden and orchard of the rose, the poppy, the tulip, grapes, figs, gourds, pomegranates, &c., but all representative of the locality.

Account of the three species of Egyptian lotus (two native, and one introduced), in Rawlinson's "Ancient Egypt," Vol. I, pp. 56, 57, 58.

I.—The *nymphaea* lotus, which nearly resembles our white water lily, grows freely in the lowlands of the Delta during the time of the inundations, being found at that period in ponds and channels which are ordinarily dry. In ancient times the peasants collected and dried the seed vessels of this plant, which they crushed and made into cakes that served them for bread. They also ate the rest of the plant, which was considered to have a pleasant sweet taste, and was eaten either raw, baked, or boiled. A recent writer compares the flavour to that of a bad truffle, and complains that the taste is exceeding insipid, but it seems to have commended itself to the Egyptian palate, which was probably less fastidious than that of modern Europeans.

II.—The Lotus *cærulea* is scarcely more than a variety of the *nymphaea*. Its blossoms, which are of a pale blue colour, have fewer petals than those of the ordinary plant; its

leaves have a somewhat more oval shape, and are darker on their under surface. The seed vessels and roots are almost exactly similar, though the Arabs pretend to make a distinction, and to prefer the blue variety, which they call *beshnin a' raby*, the lotus of Arabs, while they term the white *beshnin el khanzyr*, "the lotus of pigs." Both the ordinary lotus and the *cærulea* were valued on account of their flowers, which were employed at banquets, and woven into garlands for the guests.

III.—The *nelumbium* or *nymphaea nelumbo*, though not now found in Egypt, nor indeed in Africa, was beyond all doubt a denizen of the country in ancient times, though it may not have been indigenous. The Greeks and Romans knew it as the Egyptian bean, and the latter people regarded it as so characteristic of Egypt that they used it constantly where they wanted an Egyptian emblem. It has the general features of the lotus tribe, growing in water, with round leaves which float on the top, and having a large conical bud from which bursts a corolla of petals, that curve inwards, and form a sort of cup. The peculiarities of the *nelumbo* are the large size of its leaves, and the size and lovely colour of its blossoms. The diameter of the leaf varies from a foot to a foot and a half, the petals are six inches in length, and of a beautiful crimson or rose-purple hue. They are arranged in two rows, one inner and one outer, while within them at their base is a dense fringe of stamens, surrounding and protecting the ovary. Here the fruit forms itself. It consists of a fleshy substance, shaped like the rose of a watering-pot, and studded thickly with seeds, which project from the upper surface of the fruit, a circle about three inches in diameter. The number of the seeds is from twenty to thirty. They are about the size of a small acorn, and contain inside their shell a white sweet-flavoured nut or almond divided into two lobes, between which is a green leaf, or *corculum*, which is bitter, and should be removed before the nut is eaten. This nut, and also the root of the plant, were employed as food by the poorer classes among the ancient Egyptians.

Instances of my own observation of the representation of the lotus in Egyptian art.—As illustrations of the frequent employment of the lotus blossom in Egyptian art for painting and for sculpture as well, the following instances may serve as examples: on the end wall of the eastern chamber of the small temple of Dayr el Medineh, the lowest compartment

of sculpture is formed by a dado of lotus leaves and fruit. The westernmost chamber contains by far the most interesting series of carvings, because on its western and northern walls is sculptured the Last Judgment of Man. On the northern wall Osiris with scourge and crook, and again on the western, awaits those souls who are ushered before him in Amenti. Before him stand the four genii on a lotus blossom. (See *Nine Hundred Miles up the Nile*, p. 156; and again p. 178 of same work.) "On the eastern side of the island (*i.e.*, Philæ) is the temple commonly known as Pharaoh's Bed, a beautiful building of late date, possessing fourteen large sandstone columns with the usual lotus and papyrus capitals." But the lotus is not only reproduced in art owing to the gracefulness of its petals and general shape, it is intimately and mysteriously connected with the entrance of the soul into another world. One instance of this has already been given above in the representation in the shrine of Dayr el Medineh. Also in the copies made of coloured plaster that I obtained in Cairo of the ancient frescoes in the Tomb of Tih at Sakkarah, the lotus blossoms occur among the various hieroglyphics that form the border. Yet again, the buds and tendrils of the lotus previously alluded to as beheld in the mummy case of Amenophis I of the XVIIIth dynasty show that the lotus is connected with the ancient conception of the last journey, possibly as an offering to the deities of the nether realm. Anyhow it frequently figures in the mural paintings of the temples,* along with sundry other offerings to the gods. These instances might be multiplied indefinitely. It may be noticed once more with regard to the figuring of the lotus in sculpture that as the lotus is a native of Egypt and the favourite flower of that country, so the representations of the lotus, of the palm leaf, and of the papyrus as decorations of the capitals of columns,

* So too in the temple of Edfou a monarch makes libation and offers the lotus, and here again are three jackal-headed deities and three hawk-headed deities after them, who are all bearing a long-stemmed lotus between them (*Nine Hundred Miles*, p. 169), typical once more of the connection with Amenti, of which not only Horus, the hawk-headed god, to whom the temple of Edfou is dedicated, was symbolical, but the jackal, whose figure of wood is often found in mummy cases painted black to denote consecration. And so hawks on a jewelled necklace or corselet bearing the crown of Upper Egypt have been recently discovered in tombs of the XVIIIth dynasty, guarding on either side the grave of Osirtasen II, depicted on said trinket.

are purely local and Egyptian, and never to be found in Greece, where the corresponding embellishments in architecture consist solely of the Ionic egg, the Corinthian acanthus, and the Doric curve. The relation of the lotus to Hindoo mythology will shortly be considered.

Presentation of the lotus on festal occasions.—In Rawlinson's Herodotus, Vol. II, p. 127, may be seen an illustration of an attendant placing a garland round the neck of one of the guests. Another attendant in the rear carries another garland in his left hand, while he bears a lotus flower for presentation in his right.

Review of the scientific names of the lotus.—I fear that I shall have to bespeak a great deal of patience on your part if I am ever to make clear the confusion that would otherwise prevail respecting the generic and specific names of the lotus, and the many different plants to which the word lotus (or lotos, if the Greek form be retained) has been applied. To take the word *Cyanon* in the first place, which is a name given by Pliny to the *nymphaea nelumbo*, and of course signifies "blue." The name is appropriate enough in itself, only that the Latin equivalent *cærulea* has been given to the variety of the *nymphaea* lotus with a bluish tinge, called accordingly *nymphaea cærulea*. The adjective *κυάνεος* is employed of steel in Homer, and the appellation, simple and compounded, is now used so frequently in entomology and botany too, to designate various blue or bluish species, that its retention in every case is obviously of very dubious utility. Thus among plants we have *centaurea cyanus*, the corn blue bottle. *Æschna cyanea* is quite the commonest of the large long-bodied dragon flies that arrest our attention in the hedgerows every summer, while butterflies possess the generic as well as the specific name of *cyane*, and the following additional specific names *cyanea*, *cyanipardus*, *cyanippe*, *cyaniris*, *cyanomelus*, and *cyanus*. (*Addenda I.*, p. 106.)

It was only to be supposed that the purity, the beauty, and the grace of the water-lily tribe should lead to the generic name of *nymphaea* being assigned. Indeed, the appellation of a "nymph" has been frequently bestowed on slender, fitting inhabitants of the air as well as on graceful plants in science, and accordingly we have large families of butterflies classed as *nymphalideæ*, and *nymphalinae*, while smaller sub-genera are termed *nymphalis* and *nymphidium*, and individual species are known as *nympha*, *nymphalides*, *nym-*

phosa, and *nymphala*; on the same principle, that most graceful and lovely genus of dragon flies, *calepteryx*, is known in common parlance among the French as *les demoiselles*. Here again a too lavish use of the same word, or of kindred words with the same derivation, is to be deprecated.

There is good reason for terming our white water lily (*nymphæa alba*) by a Latin generic name *nymphæa*. Water nymphs were imagined to be beings of surpassing grace, and so, beyond all question, is the white lily of our lakes and rivers. There is also good reason for terming our yellow water lily (*nuphar luteum*) by another appellation, an Arabic generic name *nuphar* (*nufar*—related to *nofr*, good). For whatever the scientific affinities of *nuphar luteum* are, or are not, it is obviously not nearly so closely related to our white water lily as is the *nymphæa* lotus of Egypt, and probably the *nymphæa nelumbo* of India, too. But again we are confronted with the difficulty of the Egyptian species having both the Latin generic name (*nymphæa*) of our white water lily, which it does resemble, and the Arabic generic name (*nuphar*) of our yellow water lily, which it does not resemble. The Buddhists of Tibet and others call it *ne-nuphar*. The Egyptian god Nofr-Atmoo bore it on his head, and so its name *Nufar* is connected with his title *Nofr*, or good, and the compound of Nofr Nofretari occurs in the title (Nofretari) of an Egyptian queen Nofretari, the wife of Rameses II, as given in another paper that I have had the honour of reading before a meeting of the Institute.

Symbolism of the Lotus.—On this flower the Egyptian lotus, also, Harpocrates is often seated. He was the Egyptian Aurora, or day spring, not the God of Silence, as the Greeks supposed, but figured with his finger in his mouth, to show one of the habits of childhood, of which he was the emblem. Hence he represented the beginning of day, or the rise and infancy of the sun, which was typically portrayed rising every morning from that flower, or from the water, and this may have given rise to the notion of Proclus, that the lotus flower was typical of the sun. Eratosthenes also says this son of Isis was the "God of Day."

EGYPTIAN MYTHOLOGY NOT NECESSARILY DERIVED FROM THAT OF THE HINDOOS.

It is not a matter of necessity to suppose, as some have held, that because, in the representations of Egyptian, as of

Hindoo mythology, a deity was seated on the lotus, that therefore the conception of the former people was derived from that of the latter. Given two nations surrounded by similar external objects at a similar period of their civilization, and in the dawn of history, and it will be found in many instances that there is a striking family likeness between the images that occur to their respective minds. The famous hill that is covered with obsidian (*alias* vitrified lava) in the north-east of Iceland, and is said to present the appearance of a quantity of broken beer bottles jutting out from the soil beneath the rays of the sun, has been termed *Hrafnukryggr* by the natives, or mountain of the raven's wing, from a supposed resemblance to the glossy plumage of that bird, while the Peruvians, between whom and the Icelanders there can scarcely by any possibility have been any communication in the days of old, and in whose land obsidian is also found, have dubbed that formation by a name of similar import. Besides *Horus*, or *Har*, in other words *Harpahrat* (in the Greek form of the word, Harpocrates), is by no means to be regarded as the same deity as the Indian Cupid. The common legend runs as follows:—Osiris is king of Egypt, rules beneficently, goes upon his travels, leaves his wife Isis to conduct the government, which she does with vigour and prudence. Set, the principle of evil, conspires against Osiris, murders him, and having cut his body into fourteen pieces, disposes of them in various parts of the country. Isis collects the remains, and revivifies them, while Horus, to avenge his father, seeks out Set, and engaging him, brings him under. Apropos of this I may mention that I have myself inspected the sacred chamber of Osiris on the roof of the temple, known as "Pharaoh's Bed," in the island of Philæ, and formerly regarded as so sacred that even Strabo, the Roman historian, was not permitted to enter it, and I have there seen the celebrated bas-relief when he is recalled to life by Isis, his wife, at the head, and Nephthys at the foot of his couch, and is commencing to move his left arm and left leg in consequence. In another carving Pasht, the cat-headed goddess, stands at the head of his couch, where he is extended in death, and Horus, his son, wearing the combined crown at the foot. (*Addenda II.*)

Position of the lotus in Egyptian mythology.—It is just at this point that I think we have the clue as to the part the Egyptian lotus plays in the popular myth, if after having given much thought to the subject, I have the good fortune

to obtain your assent to the conclusions I am about to deduce.

Osiris is regarded by some as the sun, while others have seen in him the Nile inundation. Both theories are, in my humble estimation, compatible. Osiris is the beneficent principle. The vivifying power that the burning sun exercises on the Nile mud and the fertilising material annually left behind by the river as it sinks down once more into its normal channel are both productive of incalculable good. The two influences are inseparable. It is just when the summer is well advanced, and the sun is at its greatest power, that it melts the snows on far distant mountains in Central Africa, which in their turn cause the Nile to rise and overflow his banks in all his downward course. But simultaneously with the rising of the river comes the rising of the lotus during all the period of the inundation, ever extending its stalks, and lengthening its tendrils, and so keeping its snowy bloom on the surface in proportion as the water increases in height, of either lake or canal wherein it is wont to flourish. In its golden disk we behold the colour, in its star-shaped petals we recognise the shape of the rays of the sun overhead, a product of life renewed, and thus we comprehend why a lotus in mural painting and sculpture is so often offered to Osiris, lord of Amenti, the unseen realm, and why the lotus wreaths encircle the necks of mummies as though to accompany them on their last long journey, for the lotus is a sign of life renewed, of life beyond the grave, that the sun yet has power. Thus once more Set is the night or darkness which destroys the sun and buries him, but is in its turn slain by the reappearing, rejuvenated sun of the next day, Horus of the horizon, who thus avenges his father. Proclus's notion that the lotus flower was typical of the sun has already been referred to, and in the fact that a flower shaped like the sun rises from the water, we have a typical portraiture of the beginning of day, or rise and infancy of the sun, and we comprehend the import of Edgar Allan Poe's lines in *At Aarauf* quoted along with passages from other poets at the close of this paper.

"And Valisnerian Lotus, thither flown
From struggling with the waters of the Rhone."

It should ever be borne in mind that in connection with the myth of Osiris, Horus is indeed the offspring of Osiris, but still only a child, the youthful or rising sun, and is spoken

of as Harmachis (*Har-em-akhu*), Horus in the horizon, just elevated above the flood and no more, seated on the blossom that oscillated on its eddies. So too the frog was also an emblem of man as yet in embryo, as Herapollo and the Egyptian monuments show, and I, for one, can testify to its being no uncommon sight to behold a frog seated on a water lily leaf in our ponds at home.

There may likewise, as in the case of the Indian Cupid, in the appearance of the youthful Horus, be a reference to "Ἐρως or Love, dissipating the shades of night. "*Auditis, an me ludit amabilis Insania?*" (*Addenda III.*)

Is it a stretch of imagination on my part to conceive that the ordinary Egyptian, in whose case the rising Nile was freighted with all the hopes of a plenteous harvest, and the annual subsistence of his people thereby, as he watched the flower bud rising too to escape being smirched by the mud so copiously deposited or being soaked by the overflowing wave; as it reflected in its development the fostering influence of the god of day, and in its graceful form the rays of the orb on high, and in its lovely purity unfolded its individual and unique image; that such an one could refrain as he called to mind the exceeding serviceableness of that plant as an article of food as well, from the exclamation *nofr*, oh good—good exceedingly—meet offering for the gods?

So, as repeatedly elsewhere, have I seen in the temple of Esneh—dedicated to Kneph or Shoo, the ram-headed deity, soul of this world, the capitals of the columns of the portico carved in imitation of the lotus, so on its eastern wall of entrance do three lotus blossoms form part of the head-dress of a female figure in relief.

And hence its perpetuated, generic name of *nuphar*.

More than one tribe of plants is designated as the lotus alike in ancient and modern times.

As a necessary precaution against ambiguity we must all of us recall this important fact—

- (1) That more than one tribe of plants is designated as the "lotus" by ancient poet and historian in the classics.
- (2) That more than one tribe of plants is designated as the "lotus" by modern poets.
- (3) That more than one tribe of plants is designated as the "lotus" by modern botanists.
- (4) That the tribe of plants however most widely and

generally recognised as the "lotus" is that of the water lily, and especially the famous Egyptian species, *nymphaea* Lotus, in particular.

The Duke of Westminster's famous collection of aquatic plants at Eaton Hall, comprising not only the Egyptian lotus but sundry other species of water lily, too, is known as the Lotus house.

The accompanying enumeration may serve to throw some light on the subject:—

- (1) *Lotus*, λωτὸς (lotos), the *water lily* mentioned in Herodotus, II, 92; Edgar A. Poe's *Al Aaraaf*; T. Moore's *Lalla Rookh*.
- (2) *Lotus*, the *Greek lotos*, a kind of *clover* in meadows round Sparta and Troy. Perhaps *Trifolium melilotus*. Homer *Il.* 21, 351; *Od.* 4, 603.
- (3) *Lotus*, Cyrenean lotos, an African shrub whose fruit was the food of certain tribes on the coast, hence called *Lotophagi*. Herodotus, IV, 177; Homer, *Od.* IX, 84; Tennyson, *Lotos-eaters*. In the *Od.* its fruit also is called λωτὸς μελιηδής, "sweet as honey."

And Herodotus compares it in size to the fruit of the σχῆνος (as large as the mastich), in taste to the date (φοῖνιξ) and says that wine was made of it.

"*Ανθινον* εἶδαρ in the *Odyssey* refers not literally to the flower being eaten, but to the vegetable nature of the food. (*Addenda IV.*)

Lord Tennyson has not helped to make matters clearer, when in his *Lotos-eaters* he has sung of the *galingal* in North Africa. *Galingal* is the κύπειρον of Homer mentioned along with the abundance of clover (*Od.* IV, 603) in the description of the realm of Menelaus of Sparta.

Σὺ γὰρ πεδίῳ ἀνάσσεις
Ἐυρέος, φῖ ἐνὶ μὲν λωτὸς πολλὸς ἐν δὲ κύπειρον.

Thus *galingal*, which is a kind of sedge, and that I have myself gathered both north and south of Naples, at the Solfatara, and at Massa, the *Cyperus esculentus* of botanists is mentioned in Greece as growing along with lotos, the clover, by Homer.

Tennyson has spoken of it in Cyrene as growing along with lotos, the shrub. Yet again, he has described the

habitat of the lotos, the shrub, in one line that can only properly refer to the lotos, the water lily.

“The lotos blows by every winding creek.”

Homer, on the contrary, never mentions the lotos, the water lily, or hints that any other plant save lotos, the shrub, occasioned among the Lotophagi oblivion of country, friends, and home.

Herodotus, who does both mention lotos, the water lily of Egypt (Lib. II, 92), and Lotos, the shrub of Cyrene (Lib. IV, 177), keeps the mention of the two plants and their two countries quite apart and distinct. Also in this line of Tennyson's:—

“The yellow down

Bordered with palm.”

Egypt is vividly recalled to our mind's eye. The description may haply suit Cyrene too. But unless my judgment is greatly at fault, “the Lotos-eaters” combines the imagery of Greece with its Lotos the clover, Cyrene with its Lotos the shrub, and Egypt with its Lotos the water lily. Cyrene, wherein Homer and Herodotus unite to place the Lotophagi, may likewise possess the Egyptian water lily. For argument's sake let us suppose so. But which plant is it that Tennyson would assume occasioned the reckless forgetfulness? Lotos the shrub? or Lotos the water lily? In one passage his description can only refer to the shrub.

“Branches they bore of that enchanted stem
Laden with flower and fruit.”

In another the language would apparently indicate the yellow pollen of the corolla of Lotos the water lily.

“Round and round the spicy downs the yellow Lotos-dust is blown.”

To resume, a fourth species of lotus was known to the ancients, and likewise a fifth, though it may not be so generally famous, or celebrated in classical or modern literature.

IV.—A North African tree, according to Sprengel the *celtis australis* of Linnæus, mentioned both by Theophrastus and Pliny, like a pear tree with serrated leaves, bearing leguminous fruit without taste or smell, distinguished by its hard black wood, of which statues, flutes, etc., were carved. Hence *Λιβὸς λατὸς* is often used poetically by Euripides for a flute.

V.—Another lotus tree, *Diospyrus lotus*, which grew in Italy, had a short stem with polished bark. Its luxuriant

branches were trained upon houses (Columell, 7, 9). Its leaves were ovate, downy underneath, and its berries red and sweet tasted. I may now conclude this enumeration by remarking that there are two common and well known wild flowers in our English botany, that both possess the generic name of Lotus, and were recorded by me in the list of plants occurring in my Cambridgeshire parish.

(1) *Lotus eu-corniculatus*. The common birdsfoot trefoil.

(2) *Melilotus officinalis*. Common melilot.

As likewise both of the papilionaceous order, they are akin to, if not the same as, the Greek lotos, the clover of Menelaus of Sparta, and which is perhaps the *Trifolium melilotus* of Linnæus.

In the compound "*Meli-lotus*" we may perhaps trace some reminiscence of the *μελιηδέα καρπὸν*, honey sweet fruit of the Lotos in the land of the Lotophagi (Hom. *Od.*, Lib. IX, 94).

LOTOS THE WATER LILY.

It may not be out of place here to mention the passages wherein the poets have celebrated the blossoming of the Lotus.

There is found in the Rhone a beautiful lily of the Valisnerian kind. Its stem will stretch to the length of three or four feet, thus preserving its head above water in the swellings of the river.

"And Valisnerian Lotus thither flown
From struggling with the waters of the Rhone."

It is a fiction of the Indians that Cupid was first seen floating in one of these down the river Ganges, and that he still loves the cradle of his childhood.

"And the Nelumbo bud that floats for ever
With Indian Cupid down the holy river."

EDGAR ALLAN POE, *Al Aaraaf*,* p. 147.

* Or according to the different dictum of another poet,

"Love still has something of the sea
From which his mother rose."

It is noteworthy that the *Al Aaraaf* of Mahometans and Amenti of Egyptians, both probably signifying Hades or realm of the unseen, are both mentioned in connection with the lotus.

"Hence over Egypt's palmy groves,
 Her grotts, and sepulchres of kings,
 The exiled Spirit sighing roves
 And now hangs listening to the doves
 In warm Rosetta's vale, now loves
 To watch the moonlight on the wings
 Of the white pelicans that break
 The azure calm of Moeris' Lake.
 'Twas a fair scene—a land more bright
 Never did mortal eye behold !
 Who could have thought, that saw this night
 Those valleys, and their fruits of gold
 Basking in heaven's serenest light,
 Those groups of lovely date trees bending
 Languidly their leaf crowned heads
 Like youthful maids, when sleep descending
 Warns them to their silken beds,
 Those virgin lilies all the night
 Bathing their beauties in the lake,
 That they may rise more fresh and bright
 When their beloved Sun's awake."

T. MOORE, *Lalla Rookh*, p. 257.

"Farewell, ye vanishing flowers, that shone
 In my fairy wreath, so light and brief,
 Oh ! what are the brightest that e'er have blown
 To the lote-tree, springing by Alla's throne,
 Whose flowers have a soul in every leaf." (*Addenda V.*)

Lalla Rookh, p. 261.

"And amply Selim quaffs of each
 And seems resolved the floods shall reach
 His inmost heart—shedding around—
 A genial deluge, as they run,
 That soon shall leave no spot undrown'd
 For Love to rest his wings upon,
 He little knew how blest the boy
 Can float upon a goblet's streams,
 Lighting them with his smile of joy ;
 As bards have seen him in their dreams
 Down the blue Ganges laughing glide
 Upon a rosy lotus wreath,
 Catching new lustre from the tide,
 That with his image shone beneath."

Lalla Rookh, p. 299.

"Lakes that endlessly outspread
 Their lone waters, lone and dead,
 Their still waters,—still and chilly,
 With the snows of the lolling lily.

“Their sad waters, sad and chilly,
With the snows of the lolling lily.”

EDGAR ALLAN POE, *Dreamland*, p. 86.

The above description, in reference to the Lotos tribe, is so beautifully true to nature that it must not be passed over in silence. Much more is delicately hinted at here than is perhaps at first apparent. The time of year is late autumn—this is indicated not only by the chill here spoken of, but by the “lolling” of the lily. It trails along the wave, or droops beneath the surface, it can no longer bear up its head erect into air and light. The scene is accurately and vividly depicted—true to life in every particular, or perhaps I should rather say to death, for we seem to scent the incipient decay of vegetation, and the expression “sad waters” aptly portrays the gloom settling down over the wave on a late autumnal eve, when the sun has set, or is veiled in mist. (*Addenda VI.*)

LOTOS THE SHRUB.

The Lotos blooms below the barren peak,
The Lotos blows by every winding creek,
All day the wind breathes low with mellow tone
Thro' every hollow cave, and alley lone,
Round and round the spicy downs the yellow lotos dust is blown.
We have had enough of action and of motion, we
Rolled to starboard, rolled to larboard, when the surge was seething free,
Where the wallowing monster spouted his foam-fountains in the sea.
Let us swear an oath, and keep it with an equal mind,
In the hollow lotos-land to live and lie reclined
On the hills like gods together, careless of mankind.

The charmed sunset lingered low adown,
In the red west thro' mountain clefts the dale
Was seen far inland, and the yellow down
Bordered with palm, and many a winding vale
And meadow set with slender galingale,
A land where all things always seem'd the same.
And round about the keel with faces pale,
Dark faces pale against that rosy flame,
The mild-eyed melancholy Lotos-eaters came ;
Branches they bore of that enchanted stem,
Laden with flower and fruit whereof they gave
To each, but whoso did receive of them
And taste, to him the gushing of the wave
Far, far away, did seem to mourn and rave
On alien shores, and if his fellow spake
His voice was thin, as voices from the grave,

And deep asleep he seemed, yet all awake,
And music in his ears his beating heart did make.

TENNYSON, *Lotus-eaters*, pp. 59, 60.

By way of still further illustration of the symbolical connection of the lotus with Amenti, the unseen realm, compare the scene in Rider Haggard's *Cleopatra*, wherein (p. 37) Harmachis invokes the deities. (*Addenda VII.*)

"O Amen Osiris, the supreme in Amenti, hearken unto me.
"O Isis, great mother goddess, mother of the Horus, hearken unto me.
Let a sign be given me even now to seal my life to the life above.

* * * * *

"Behold a sign! Possess thyself in patience, Harmachis.'

"And as the voice spoke, a cold hand touched my hand, and left somewhat within it. Then the cloud rolled from the face of the moon, the wind passed, the pylon ceased to tremble, and the night was as the night had been. As the light came back, I gazed upon that which had been left within my hand. It was a bud of the holy lotus new breaking into bloom, and from it came a most sweet scent, and while I gazed, behold, the lotus passed from my grasp, and was gone, leaving me astonished."

HERODOTUS ON DIFFERENT KINDS OF GRAIN.

Others make barley and wheat their food. It is a disgrace to do so in Egypt, where the grain they live on is spelt which some call *zea*.—Herodotus, Lib. II, 36.

This statement of Herodotus has a foundation in fact, but is only partially true.

In the first place, Pliny shows that the *olyra* here mentioned is not rice nor the same as *zea*, as Herodotus supposed. And it is an idea equally extravagant to imagine that the Egyptians considered it a disgrace to live on wheat and barley.

Though the *olyra* or *doora* bread was eaten by the great mass of the Egyptians (the *olyra* being in point of fact the *doora* of modern Egypt, *Holcus sorghum*), and poor people may have used *doora* as at the present day, when they could not afford wheaten bread, as we are informed by Rawlinson, who also states that the *doora* is the only grain besides wheat and barley represented in the sculptures.

That both wheat and barley are noticed in Lower Egypt long before the time of Herodotus, we have the testimony of

Scripture, where in Exodus ix, 31, 32, in reference to the plague of the thunders and the hail it is recorded that "the flax and the barley was smitten, for the barley was in the ear, and the flax was boiled. But the wheat and the rye were not smitten; for they were not grown up." The barley harvest is the earliest of all, and takes place in the plain of Jericho at the close of the month of March.

Pliny's testimony, too, goes to show that *doora*, wheat, and barley, were all employed for food in Egypt, when (xviii, 7) he says "Far in Egypto ex olyrà conficitur," but not, of course, to the exclusion of other grain, as he notices wheat and barley there, and adds (xviii, 8), "Ægyptus similaginem conficit e tritico suo," and the paintings of the Thebaid prove that wheat and barley were grown extensively in that part of the country; they were among the offerings in the temples; and the king, at his coronation, cutting some ears of wheat, afterwards offered to the gods as the staple production of Egypt, according to the note in Rawlinson's Herodotus, vol. ii, p. 50, shows how great a value was set on a grain which the historian would lead us to suppose was held in abhorrence. It is likely enough that the attention of Herodotus might be chiefly arrested by the *doora*, as the appearance of that grain unseen in Greece and other more northerly climes, and reaching a great height, would present a novel sight to him.

With regard to the time of the *durra* harvest, my own observation scarcely tallies with the statement made by Rawlinson (*Ancient Egypt*, vol. i, pp. 160, 161), but discrepancy of impressions can, I take it, readily be reconciled if the information received be correct that the *durra* harvest in Upper Egypt takes place three times a year. This grain, according to Rawlinson, takes from three to four months to ripen, and if sown in October might be reaped in February. It is now, however, not sown till April, and we may perhaps conclude that the primary attention of the husbandman was directed in ancient as in modern times to the more valuable cereals, wheat and barley, which were required by the rich; and that the *doora*, which was needed only by the poor, was raised chiefly as an after crop. Wheat and barley would be put into the ground in November, and would then be left to the genial influences of sun and air, which under ordinary circumstances would ripen the barley in four, and the wheat in five months. No hoeing of weeds, no frightening of birds, no calling upon heaven for rain seems to have been

required. The husbandman might safely trust to nature for an ample return. Bounteous Mother Earth gave from her teeming breast "the staff of life" in prodigal abundance, and corn was gathered "as the sand of the sea," very much, till he "left numbering" (Gen. xli, 49). According to Pliny (*Nat. Hist.*, xviii, 7), the return on the corn sown was a hundred-fold. The grain, however was light.

In *Nine Hundred Miles up the Nile*, p. 115, I have recorded my first impressions of the *durra* fields. (*Addenda VIII*.)

Several *durra* fields succeed along the western bank. Respecting this grain, which is a species of millet, it may be mentioned that its growth is similar to that of the Indian corn, but that the plant reaches at least twice the height, and that the seeds, which its heavy head contains, are much smaller. The said head consists of a mass of seeds, not placed in regular rows, as is the case with Indian corn, but forming a densely packed cone. The harvest of the crop is going on now, but its cultivation would seem to be confined to some distance up the river, as it hardly if at all occurs in the neighbourhood of Cairo. I may mention here that the date was December 19th, and that the *durra* fields in question were situate from fifty to one hundred miles south of Cairo. Just as the lentils sold in the bazaars are of two colours, red and brown, so the heads of *durra*, consisting of masses of seeds, are of two colours, also red and yellow, but the yellow is by far the most ordinary and common tint. By yellow I do not mean of a bright yellow like Indian corn, but of the same colour as an ordinary grain of wheat. Each ripe head of *durra* must contain many hundreds of seeds, circular like small peas, constituting probably a far more prolific return than any other grain with which I am acquainted, but quite impossible to count, the head is so densely packed, unless it be picked to pieces while deliberately enumerated for the purpose. We are further informed in Rawlinson's *Ancient Egypt* that the *doora* harvest is represented on the monuments as taking place at the same time as the wheat harvest, but this is perhaps not intended as the assertion of a fact. In modern Egypt the chief harvest (namely, of the *doora*) is sown in April and reaped in July, and the ancient practice may have been similar. That the simultaneousness of the two harvests is not intended to be asserted as a fact I, for one, fully maintain. Ripe *durra* was sold in the bazaars of Keneh during my visit there in the month of December, but wherever

wheat is noticed or spoken of in the pages of my journal it is always "young corn," consisting of the tiny blade, whether in the plain of Geezeh or as forming part of the panorama obtained from the mountain of Lycopolis or elsewhere. Of course this verdant carpet, though consisting largely of wheat, did not consist solely of that grain, but of clover, lupins and vetches, beans and lentils, etc., too. To advert once more to *Nine Hundred Miles*, p. 160, on passing El Mataneh, say at a rough estimate, situate at a distance of a little under six hundred miles south of Alexandria, on December 28th, sugar-cane and *durra*—these two plants are the chief products planted in the neighbourhood, and the *durra* harvest is now in progress in several places on the eastern bank, and again pp. 171 and 172 of the same work, in connection with our visit to the temple of Edfou, "By reason of the toughness of the stem," the *durra* is cut with a short sharp sickle with serrated edge, and the heads are collected in palm-leaf baskets, while buffaloes, dromedaries, donkeys, and black goats browse eagerly on its refuse stalks that are lying about the stubble fields.

There is abundant evidence, carved as well as pictorial, on the ancient Egyptian monuments, that the Pharaohs themselves took part in the reaping of the harvest, as in one of the side chambers, for example, opening out of the fifth room in the temple of Edfou, is a monarch grasping ears of wheat with his left hand, while he cuts it with the sickle in his right. He is depicted with the ram's horns and orb of Ra, while another monarch stands before him wearing the combined crown. Several other side chambers and corridors contain the same sculptures again and again. To quote from Rawlinson once more, the wheat grown was always bearded, and comprised numerous varieties, one of which bore several ears upon a single stalk. It is, at any rate, always represented as bearded on the monuments. In Greece, moreover, while traversing the plain of Marathon on the 5th of June, I noted that the wheat in the corn fields there, while considerably exceeding in its height the stature of a man, and of which I gathered specimens of the ears, was likewise bearded. This variety is termed "rabbit wheat" in Cambridgeshire. While inspecting the monuments at Edfou, I noted, what Rawlinson has also observed, that the wheat therein represented was cut with a toothed sickle in the days of old as well as the ripened harvest of to-day during my visit. Possibly the toughness of the stem, which required the employ-

ment of such a reaping hook, may be due to the presence of silex which the stalk has incorporated with itself out of the surrounding soil. To resume, my own observation respecting the various cattle greedily devouring the stems of the *durra* in season of harvest is corroborated by Wilkinson in vol. iv of his *Ancient Egypt*, when he states that the wheat straw which was cleared from the fields after the reaping of the ears was used as well as clover, lupins, and vetches to furnish provender for the cattle during the time of the inundation.

The seeds of the Indian corn furnish a large portion of the food of the Nubian population at the present day. Circular woven disks, which form the sole furniture of several of the Nubian dwellings, and are often stained in patterns, are suspended like shields against the wall, and not unfrequently hung horizontally from the ceiling, and then employed for the purpose of holding dates or Indian corn, which is for the most part consumed just as taken from the husk, without even being ground into flour. These circular disks are called *moholads*, and I have one or two of them hanging up against the wall of my hall at the present moment.

HERODOTUS ON THE PAPYRUS.

The byblus (papyrus), which grows year after year in the marshes, they pull up, and cutting the plant in two, reserve the upper portion for other purposes, but take the lower, which is about a cubit long, and either eat it, or else sell it. Such as wish to enjoy the byblus in full perfection, bake it first in a closed vessel heated to a glow.—Herodotus, Lib. II, c. 92.

The *Cyperus papyrus* now only grows in the Anapos, near Syracuse, being no longer a native of Egypt. It is said to have been found in a stream on the coast of Syria as in Pliny's time (xiii, 11). The use of the pith of its triangular stalk for paper, made it a very valuable plant, and the right of growing the best quality and of selling the papyrus made from it, belonged to the government. It was particularly cultivated in the Sebennyitic nome, and various qualities of the paper were made. Herodotus is wrong in calling it an annual plant.

In addition to the above note is Rawlinson's Herodotus, vol. ii, the author again refers to the plant in his *Ancient Egypt*, vol. i, p. 55: "The byblus or papyrus (*Cyperus papy-*

rus), anciently so common in Egypt, is not now found within the limits of the country. It is a tall smooth flag or reed, with a large triangular stalk, inside of which is contained the pith from which the Egyptians made their paper. The paper was manufactured by cutting the pith into strips, arranging them horizontally, and then placing across them another layer of strips, uniting the two layers by a paste, and subjecting the whole to a heavy pressure. The upper and middle portions of the reed were employed for this purpose; the lower portion, together with the root, was esteemed a delicacy, and was eaten after it had been baked in a close vessel. The papyrus needed a moist soil, and was carefully cultivated in the shallow lakes and marshes, more especially those of the Sebennytic nome in the central part of the Delta. There was a second coarser kind, probably the *Cyperus dives* of botanists, which was employed in the construction of boats, of sails, of mats, baskets, sandals, and the like.

Extinction of the papyrus foretold by Isaiah, xix, 7.—"The paper reeds by the brooks, by the mouth of the brooks, and everything sown by the brooks, shall wither, be driven away, and be no more."

Habitat of the papyrus.—Theophrastus is correct in saying it grew in shallow water, or in marshes, according to Pliny, and this is represented on the monuments, where it is placed at the side of a stream or in irrigated lands.

Present localities of the papyrus.—The famous papyrus of Egypt, which formerly grew like a forest on the banks of the Nile, is now extinct in Egypt, though still found in the marshes of Nubia. It grows luxuriantly in a swamp at the north end of the plain of Gennesaret, and covers acres of marsh by the water of Merom, but exists nowhere else in Asia. It is called by the Arabs *babeer*, *i.e.*, papyrus. It has a triangular stem eight to ten feet high, with bushy top.

My own observation of the papyrus.—The only place where I ever saw papyrus growing in the East was the small garden in front of Maurice Bey's house in Cairo. The said residence was decorated and furnished in the Persian style, and is a perfect museum of art treasures. The papyrus was growing by the edge of a small basin of water, and if not actually the famous species, was at any rate a species closely allied to it.

Confusion between the Cyperi.—It is evident that other *cyperi*, and particularly the *Cyperus dives*, were sometimes confounded with the *Cyperus papyrus*, the papyrus or *byblus*

hieraticus of Strabo, and when we read of its being employed for mats, sails, and baskets, we may conclude that this was an inferior kind mentioned by Strabo, and sometimes a common *cyperus* which grew wild, as many still do, was thus employed in its stead.

The true papyrus a cultivated species.—Pliny says the papyrus was not found about Alexandria, because it was not *cultivated* there, and the necessity of this is shown by Isaiah's mention of the paper reeds by the brooks and everything *sown* by the brooks.

Mode of making the paper.—According to Pliny (xiii, 11), by cutting thin slices of the pith, and laying them in rows, and these being crossed with other slices, the whole was made to adhere by great pressure.

Mention of the papyrus in Scripture.—According to the list of trees, plants, flowers, etc., in the Teacher's Bible, there are six Hebrew words used of the rush genus, and variously translated somewhat indiscriminately.

The first is göme, employed Exodus ii, 3, of the ark of bulrushes, and Job viii, 2, "Can the rush grow up without mire?" This is θίβη πάπυρος, *Cyperus papyrus*.

According to the same authority the Aröth of Isaiah xix, 7, is wrongly translated *paper reeds*, as the papyrus has already been mentioned. It is τό ἄχι τὸ χλωρόν, the green herbage, which abounds in marshy places.

The third kind is achu, or ἄχι βούτομον. Achu is not a Hebrew word but an Egyptian. The plant is either the *Cyperus esculentus*, the κύπειρον of Homer, a species of sedge above noticed as not only found at Sparta but common in South Italy, or else the *Butomus umbellatus*, the flowering rush, occurring in Egypt as well as in Britain, and on the continent of North Europe. Cf. Job viii, 11, "Can the flag grow without water?" The same word is translated "flag" in Job, but "meadow" in Genesis xli, 2, as that on which Pharaoh's fat kine fed.

The fourth word is το ἔλος, which in Exodus ii, 3, 5, is rendered "flags," in which Moses's ark was concealed by the river bank, but more correctly "weeds" in Jonah ii, 5, at the bottom of the sea. "Ἐλος is a general term for water weeds, whether seaweed or the rank marsh vegetation of the river's bank; and with regard to the above-mentioned achu, the rendering of "flag" is clearly the correct one and not that of meadow, as it is plainly a specific plant, and classed with the papyrus.

The fifth word, *agmôu*, reed or cane, occurs twice in a proverb, Isaiah ix, 14, and xix, 15, "Head and tail," "Branch and rush," *i.e.*, top and bottom. It occurs in Job in the phrase "bowing the head like a bulrush," whence it evidently had a high stem surmounted with a tuft. It is the *arundo donax* of botanists, and probably the common reed of Egypt and Palestine, a tall thin cane, 12 feet high, with a bushy blossom bending flat before the wind and rising again. "The reed shaken with the wind," Matthew xi, 7, growing luxuriantly by the Dead Sea and by the Jordan. On December 29th, 1883, I myself gathered the bushy blossoms of this *arundo* at Esneh, where it grew to twice the height of a man in the shallow waters by the west bank of the Nile.

The sixth word is *κάλαμος*, *calamus*, a reed, and this is the general term for a stem or stalk, as a stalk of wheat in Pharaoh's dream (Genesis xli, 5, and 22). It is also used (Exodus xxv, 31) for the stem of a candlestick (Ezekiel xl, 5), for a measuring rod.

Ancient date of the papyrus.—The use of the papyrus as writing material was common (together with the reed pen, palette, and other implements of later Egyptian scribes, in the time of the earliest Pharaohs, at least as early as the IIIrd and IVth dynasties.

Different qualities of the papyrus according to Pliny.—(1) Largest in old times, the Hieratic (for holy purposes).

- (1) Afterwards the best was called the Augustan.
- (2) The Livian.
- (3) The Hieratic.
- (4) Amphitheatric (from the place where made).

Fannius at Rome made an improved kind called Fannian. That not passing through his hands being still called Amphitheatric.

Saitic, a common kind from inferior stalks.

Emporetic of shops for packing, not for writing upon.

Breadth of best 13 fingers (about $9\frac{3}{4}$ inches) broad.

Hieratic	11	„	„
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Fannian	10	„	„
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Amphitheatric	9	„	„
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Saitic less.

Emporetic, used for business, not above 6.

But some sheets of Egyptian papyrus were much larger than the best of Roman time. The Turin papyrus, dating

from the early part of the reign of Rameses II, was at least $14\frac{1}{2}$ inches in breadth, and other extinct ones of the time of the XIXth dynasty are reported to be 17 and 18 inches respectively.

Papyrus as furnishing a model for artistic representation.—The instances wherein the papyrus is copied as a device for the columnar capitals in Egyptian architecture are too numerous to be referred to here. The brief mention of the fact that I noticed it in the shrines of Esneh, Edfou, and Philæ will suffice. Nor are the pictorial representations of it less abundant in the mural paintings and hieroglyphics of the ancient monuments.

HERODOTUS ON THE ACACIA.

It is noteworthy to allude to the vessels used in Egypt for the transport of merchandise, as Herodotus, Lib. II, c. 96, speaks of them as made of the *Acantha* (Thorn), a tree from which there exudes a gum. It is the modern *Sont* or *Mimosa* (*Acacia*) Nilotica, groves of which are still found in Egypt, as according to Strabo, Athenæus, and others of old. This was Pliny's *Spina Ægyptiaca*, called by Athenæus "*Acantha*," and described by him as a round fruit on small stalks. The Bedouin dragoman of the present day calls it *sont*, or gum arabic, and there are two or three circumstances of interest in connection with this tree, first, that the boats of the Nile are still built with planks of the *sont*, as in the days of Herodotus, second, that there is to a certain extent the same arrangement in building the boats now as then, for according to Rawlinson's Herodotus, the planks, arranged as Herodotus states, like bricks, appear to have been tied to several long stakes, fastened to them internally. Something of the kind is still done when they raise an extra bulwark above the gunwale. Then again the *sont* tree, occurring as it does in considerable numbers, presents quite a noticeable feature in the landscape, with the vivid green of its foliage contrasting with the darker hue of the palm trees. In its growth and size as a rule the *sont* tree bears some resemblance to a hawthorn, and the blossoms of the two trees, which in the case of the *sont* are of a dusky white, are of about the same dimensions. But the surpassing interest of the *sont* tree rests in the fact that the formidable prickles, an inch or more in length, with which this shrub is armed, are commonly supposed to have furnished the crown of thorns. Its fre-

quency in the desert has already been referred to, and it is likewise far from uncommon in South Europe, where I have noticed it fringing the ascent to the old quarter of the gipsies in the outskirts of Granada, and have likewise gathered it on the approach to Baiæ in the Bay of Naples. The species of acacia or mimosa, to which genus the sort tree belongs, are numerous in the Nile valley, and form no inconsiderable part of its characteristic vegetation, though differing greatly in size and form of foliage and flower in the respective dimensions of the trees, and indeed in most superficial points of likeness. I append a list of those that I have personally observed.

Acacia Farnesiana, Isle of Roda, Fitneh.

„ *Lebbek*, Geeseh and Port Said, etc., Lebbekh.

Parkinsonia aculeata, Road to Heliopolis.

Sesbania Ægyptiaca „ „

Acacia tortilis „ „

Cassia obovata, Minieh, Upper Egypt and Gerf Hossayn,
Nubia.

THE TAMARISK.

μυρίκη (*Myrica Lat.*).

The tamarisk, a shrub of common occurrence in the desert, as also on the shores of the Mediterranean, is referred to by Herodotus, Lib. II, 96, in his description of Egyptian boats on the Nile. Down stream, he says, they are managed as follows: There is a craft belonging to each made of the wood of the tamarisk, fastened together with a wattle of reeds, and also a stone bored through the middle, about two talents in weight. In a footnote appended to this chapter Rawlinson informs us that the tamarisk raft before the head of the boat is dispensed with by modern Egyptian boatmen, but that they make use of the stone in coming down the stream, to impede the boat, which is done by suspending it from the stern. When the rowers are tired and boats are allowed to float down, they turn broadside to the stream, and it was to prevent this that the stone and tamarisk raft were applied. The Professor in another work (vol. i of his *Ancient Egypt*) gives another use to which the tamarisk is applied, inasmuch as he includes it in a list of medicinal plants. In traversing the Suez Canal the tamarisk (*Tamarix macrocarpa*) was a most familiar and frequently recurring shrub.

Thus in *L' Orient*, p. 16, the following notices of it occur:—

“The only shrub to be seen on either hand is dwarf tamarisk, sometimes consisting of a mere fringe, and anon widening into an extensive low growing scrub, like a furze common.”

“The clumps of tamarisk in the distance resemble small islets in a lake, owing to the mirage occasioned by the heat.”

And again, p. 19:

“Endless slight undulations and sandy ridges clothed with clumps of tamarisk in blossom, and other shrubs gray-green in tint and with prickly stems.”

“These clumps of tamarisk, etc., often surround conical mounds of sand, where it has been silted up by the winds in the middle. The mud bank on the east side is now covered with a continuous belt of tall flags, and the tamarisk, of course, interspersed as before.”

My own specimens of *Tamarix macrocarpa* were gathered in the desert close to El Ferdane on the Suez Canal 33 miles south of Port Said. Though occurring frequently at our own seaside resorts, it is only naturalised and not a native of the English coast. It is somewhat remarkable that a well known shrub growing abundantly on our moors

and marshy districts should derive its ordinary name, "Bog Myrtle," from the myrtle of which the Greek appellation is *μυρσίνη* or *μυρρίνη* in Attic Greek, probably from the fact of its foliage exhaling a powerful scent, and its botanical title *Myrica gale* from *μυρίκη*, which is, as above stated, the Greek for tamarisk. To avoid any confusion, however, be it noted, *en passant*, that *μυρρίνη* and *μυρίκη*, the myrtle and the tamarisk, have no similarity except in their respective names.

It is worth remarking in conclusion that Odysseus (*Iliad*, Lib. X, 465-467) raises aloft and casts spoils and armour of the dead body of the spy Dolon whom he had just slain on the tamarisk bed, heaping over them reeds and blooming sprigs of the tamarisk. Reeds or flags are mentioned here in conjunction with the tamarisk, just as I noticed their joint growth on the banks of the Suez Canal. And the Scholiast on the passage describes *μυρίκη* "tamaricem seu tamariscum, humida loca amantem. Cogitandum autem est eos incedere locis paludosis, in quæ exundare solet Simois."

So in Lord Derby's rendering of the passage—

"Thus as he spoke, amid the tamarisk scrub
Far off he threw the trophies; then with reeds,
And twigs new broken from the tamarisk boughs,
He set a mark, lest in the gloom of night
Returning they might haply miss the spot."

So once more in *Iliad*, xxi, 350-352, *apropos* of the banks of the river Xanthus, elms and willows are mentioned along with the tamarisk, and moreover, the lotus, rushes, and galingal, Lord Derby's version—

"Burnt were the willows, elms, and tamarisk shrubs,
The lotus, and the reeds, and galingal,
Which by the lovely river grew profuse."

And to end a long story, Roman bards, equally with those of Greece, have been fain to celebrate the tamarisk, inasmuch as Virgil sings of it in four passages of his *Eclogues*—

"Non omnes arbusta juvant humilesque myricæ."

Ecl. iv, 2.

"Te nostræ, Vare, myricæ,
Te nemus omne canet."

Ecl. vi, 10, 11.

"Pinguia corticibus sudent electra myricæ."

Ecl. viii, 54.

"Illum etiam lauri, etiam flevere myricæ."

Ecl. x, 13.

HERODOTUS ON CASTOR OIL.

Ἀλείφατι δὲ χρέωνται Αἰγυπτίων οἱ περὶ τὰ ἔλαια οἰκέοντες ἀπὸ τῶν σιλλικυπρίων τοῦ καρποῦ, τὸ καλεῦσι μὲν Αἰγύπτιοι κίκι, ποιεῦσι δὲ ὄδε. παρὰ τὰ χεῖλα τῶν τε ποταμῶν καὶ τῶν λιμνέων σπείρουσι τὰ σιλλικύπρια τὰυτα, τὰ ἐν Ἑλλησι αὐτόματα ἄγρια φύεται· ταῦτα ἐν τῇ Αἰγύπτῳ σπειρόμενα καρπὸν φέρει πολλὸν μὲν, δυσῶδεα δέ· τοῦτον ἐπεὰν συλλέξωνται, οἱ μὲν κόψαντες ἀπιποῦσι, οἱ δὲ καὶ φρύξαντες ἀπέψουσι, καὶ τὸ ἀπορρέον ἀπ' αὐτοῦ συγκομίζονται. ἔστι δὲ πῖον καὶ οὐδὲν ἦσσον τοῦ ἐλαίου τῷ λύχνῳ προσηνές, ὁδμὴν δὲ βαρέαν παρέχεται.

Herodotus, Lib. II, c. 94.

HERODOTUS ON THE LOTUS.

Ἀτὰρ πρὸς εὐτελέην τῶν σιτίων τάδε σφι ἄλλα ἐξεύρηται. ἐπεὰν πλήρης γένηται ὁ ποταμὸς καὶ τὰ πεδία πελαγίσῃ, φύεται ἐν τῷ ὕδατι κρίνεα πολλὰ, τὰ Αἰγύπτιοι καλέουσι λωτόν. Ταῦτ' ἐπεὰν δρέψωσι, αὐαίνουσι πρὸς ἥλιον, καὶ ἔπειτα τὸ ἐκ τοῦ μέσου τοῦ λωτοῦ, τῇ μήκῳ ἐὼν ἐμφερές, πτίσαντες ποιεῦνται ἐξ αὐτοῦ ἄρτους ὀπτοὺς πυρί. ἔστι δὲ καὶ ἡ ῥίζα τοῦ λωτοῦ τούτου ἐδωδίμη, καὶ ἐγγλύσσει ἐπιεικέως, ἐὼν στορογγύλου, μέγαθος κατὰ μῆλον. Ἔστι δὲ καὶ ἄλλα κρίνεα ῥόδοισι ἐμφερέα, ἐν τῷ ποταμῷ γνωόμενα καὶ ταῦτα, ἐξ ὧν ὁ καρπὸς ἐν ἄλλῃ κάλυκι παραφυομένη ἐκ τῆς ῥίζης γίνεται, κηρίῳ σφηκῶν ἰδέην ὁμοίωτατον· ἐν τούτῳ τρωκτὰ ὅσον τε πυρὴν ἐλαίης ἐγγίνεται συχνά· τρώγεται δὲ καὶ ἀπαλὰ ταῦτα καὶ ἄνα.

Herodotus, Lib. II, c. 92.

HERODOTUS ON DIFFERENT KINDS OF GRAIN.

Ἀπὸ πυρῶν καὶ κριθέων ὄλλοι ζώουσι, Αἰγυπτίων δὲ τῷ ποιευμένῳ ἀπὸ τούτων τὴν ζῶην ὄνιδος μέγιστόν ἐστι, ἀλλὰ ἀπὸ ὀλυρέων ποιεῦνται σιτία, τὰς ζειὰς μετεξέτεροι καλέουσι.

Herodotus, Lib. II, c. 36.

HERODOTUS ON THE PAPYRUS.

Τὴν δὲ βύβλον τὴν ἐπέτειον γινομένην ἐπεὰν ἀνασπάσῃσι ἐκ τῶν ἐλέων, τὰ μὲν ἄνω αὐτῆς ἀποτάμνοντες ἐς ἄλλο τι τράπουσι, τὸ δὲ κάτω λελειμμένον ὅσον τε ἐπὶ πῆχυν τρώγουσι καὶ πωλέουσι. οἱ δὲ ἂν καὶ κάρτα βούλωνται χρηστῇ τῇ βύβλω χρᾶσθαι, ἐν κλιβάνῳ διαφάνει πνίξαντες οὕτω τρώγουσι.

Herodotus, Lib. II, c. 92.

DESCRIPTION OF THE LOTOPHAGI.

Αὐτὰρ δεκάτη ἐπέβημεν
γαίης Λωτοφάγων, οὔτ' ἄνθινον εἶδαρ ἔδουσιν.

Hom. Od., Lib. IX, 83, 84.

Οὐδ' ἄρα Λωτοφάγοι μῆδονθ' ἐτάροισιν ὄλεθρον
ἡμετέροις, ἀλλὰ σφι δόσαν λωτοῖο πάσασθαι.
τῶν δ' ὅστις λωτοῖο φάγοι μελιηδέα καρπὸν,
οὐκέτ' ἀπαγγεῖλαι πάλιν ἤθελεν, οὐδὲ νέεσθαι·
ἀλλ' αὐτοῦ βούλοντο μετ' ἀνδράσι Λωτοφάγοισιν
λωτὸν ἐρεπτόμενοι μενέμεν, νόστου τε λαθέσθαι.

Hom. Od., Lib. IX, 92-97.

Ἄκτῃ δὲ προέχουσαν ἐς τὸν πόντον τούτων τῶν Γινδάνων νέμονται Λωτοφάγοι, οἱ τὸν καρπὸν μῦνον τοῦ λωτοῦ τρώγοντες ζώουσι· ὁ δὲ τοῦ λωτοῦ καρπὸς ἐστὶ μέγαθος ὅσον τε τῆς σχίνου, γλυκύτητα δὲ τοῦ φοίνικος τῷ καρπῷ προσείκελος. ποιεῦνται δὲ ἐκ τοῦ καρποῦ τούτου οἶ Λωτοφύγοι καὶ οἶνον. Λωτοφάγων δὲ τὸ παρὰ θάλασσαν ἔχονται Μάχλυες, τῷ λωτῷ μὲν καὶ οὗτοι χρεώμενοι, ἀτὰρ ἦσαν γε τῶν πρότερον λεχθέντων.

Herodotus, Lib. IV, 177, 178.

THE LOTUS.

Kingsley's *Hypatia*, pp. 176 and 177.

“Yes”—she went on, after the method of her school, who preferred, like most decaying ones, harangues to dialectic, and synthesis to induction. “Look at yon lotus flower, rising like Aphrodite from the wave in which it has slept throughout the night, and saluting, with bending swan-neck, that sun which it will follow lovingly around the sky. Is there no more there than brute matter, pipes and fibres, colour and shape, and the meaningless life-in-death which men call vegetation? Those old Egyptian priests knew better, who could see in the number and the form of those ivory petals, and golden stamina, in that mysterious daily birth out of the wave, in that nightly baptism, from which it rises each morning, reborn to a new life, the signs of some divine idea, some mysterious law, common to the flower itself, to the white-robed priestess who held it in the temple rites, and to the goddess to whom they both were consecrated . . . The flower of Isis! . . . Ah!—well. Nature has her sad symbols, as well as her fair ones. And in proportion as a misguided nation has forgotten the worship of her to whom they owed their greatness, for novel and barbaric superstitions, so has her sacred flower grown rarer and more rare till now—fit emblem of the worship over which it used to shed its perfume—it is only to be found in gardens such as these,—a curiosity to the vulgar, and, to such as me, a lingering monument of wisdom and of glory passed away.”

Philammon, it may be seen, was far advanced by this time, for he bore the allusions to Isis without the slightest shudder. Nay—he dared even to offer consolation to the beautiful mourner.

“The philosopher,” he said, “will hardly lament the loss of a mere outward idolatry. For if, as you seem to think, there were a root of spiritual truth in the symbolism of nature, that cannot die, and thus the lotus flower must still retain its meaning, as long as its species exists on earth.”

Whittier's Poetical Works, p. 166

The World's Convention.

“Nor all unmindful, thou, the while,
Land of the dark and mystic Nile!
Thy Moslem mercy yet may shame
All tyrants of a Christian name,
When in the shade of Gizeh's pile
Or where from Abyssinian hills
El Gezek's upper fountain fills,
Or where from mountains of the moon,
El Abian bears his watery boon.
Where'er thy lotus blossoms swim,
Within their ancient hallowed waters,
Where'er is heard the Coptic hymn,
Or song of Nubia's sable daughters,” etc.

p. 354. *Summer by the Lake side.*

“This western wind hath Lethæan powers,
Yon noonday cloud nepenthe showers,
The lake is white with lotus-flowers.”

ADDENDA I.

Only three of these seven specific names occur in classical Latin, to wit, cyane, cyaneus, cyanus. As in the classics cœruleus is so often used as Latin equivalent of *κυάνεος* that cyaneus is rarely employed.

Only three also of the nine scientific terms in connection with nymphæ occur in classical Latin, to wit, nymphæ, nymphalis, and nymphæa.

In classical Greek there are about 30 words compounds of cyanos and cyaneos, and a similar number of words, compounds of *νύμφη*.

But the classical compounds are for the most part not the same as the scientific ditto.

ADDENDA II.

His (namely, of Horus) is the office assigned to Hermes in Greek mythology, that of *πομπαῖος*, the escorter, *ψυχόσποπος* escorter of souls, *ψυχάγωγος*, leader of souls to the nether world into the presence of Osiris. He is seated on the flower that his sire Osiris calls into being from the depths of the river's flood, or he bears it in his hand as an offering or the departed ones, whose souls he is supposed to conduct, have, as a latest tribute, wreaths of its buds and tendrils twined around their necks in the vague undefined yearning for another life.

ADDENDA III.

Ερως or Love dissipating the shades of night. So in the celebrated Parabasis of the chorus of the birds of Aristophanes. “Love with his pinions all glittering with gold is hymned as springing from the wind egg of Chaos and of Night.”

ADDENDA IV.

"*Ἀθῶνον εἶδαρ*. Vegetable as opposed to animal food is simply meant according to Liddell and Scott, referring to this passage where the esculent lotus is termed *Ἀθῶνον εἶδαρ*.

ADDENDA V.

"To the *lote-tree* springing by Alla's throne,
Whose flowers have a *soul* in every leaf."

Lalla Rookh, p. 261.

Undercurrent of thought here connecting the lotus with the unseen world. Cf. Rev. xxii. Leaves of tree of life for healing of the nations.

ADDENDA VI.

Another typical tending towards the unseen. The waters are sad, are chilly, flower no longer erect, no more the sunlit sparkle of the wave. As the world's inhabitants wax feeble, the world loses its delights for them.

Utter confusion of localities in Tennyson's poem of the *Lotos-eaters*. "The Lotos blows by every winding creek." This must refer to the water lily, and to Egypt. "The yellow lotos dust is blown." This also must refer to the pollen from off the corolla of the water lily. On the other hand "the spicy downs" are typical of Greece and the Greek islands from the scented undergrowth of cistus, myrtle, etc., so abundant there.

Again,

"In the red west thro' mountain depth the dale was seen far inland,"
may refer to Cyrene but cannot possibly to Egypt.

"The yellow down bordered with palm,"

may be true of Cyrene as well as of Egypt, but the picture of

"Meadow set with slender galingale,"

is that of Italy or Greece.

And once more—

"Branches they bore of that enchanted stem
Laden with flower and fruit,"

can only refer to North Africa, where both Homer and Herodotus agree to place the Lotophagi.

Yet again, in reference to pages 90 and 91, the essential point of Tennyson's poem is that he appears constantly to link the idea of the Lotos-eaters to that of another life. Witness such expressions as,—

"Enough of action and of motion."

"Charmed sunset."

"Red west."

"Faces pale."

"Alien shores."

"Voice was thin."

"As voices from the grave."

"Deep asleep."

"Yet all awake."

ADDENDA VII.

When Harmachis prays, "Let a sign be given and even now to seal my life to the life above." The sign granted, lo and behold! is the lotus.

Harmachis disappears from sight of men while initiated into the mysteries of Isis concerning the higher life. The vision he is accorded of the same is soon lost to his view, and the lotus, type of the unseen, vanishes from his hand. Not without significance is he named Harmachis (Hor-em-akhu), Horus on the horizon. Like his namesake Horus, the divinity not in full light of the zenith, not surrounded by the midday blaze.

ADDENDA VIII.

Respecting *yellow durra*, compare Virg. Gen., S. 73.

"Ibi *flava* seres mutato sidere farra."

The CHAIRMAN (D. HOWARD, Esq., F.C.S.).—It is always particularly interesting, when those who have the skill, will study the side-notes of Herodotus, that wonderfully minute observer and accurate reporter. The interest of these little notes on plants is very great, especially throwing so much light, as they do, on ancient botany. How it came about that Herodotus stated that wheat and barley were not eaten or were not appreciated in Egypt, one does not quite discover, but no doubt he was told so. I believe nowadays it is considered that his Greek injures the correct Attic Greek of the modern school boy; happily in my days Attic Greek was not thought much of, and we were allowed to read Herodotus, to our great enjoyment.

T. CHAPLIN, Esq., M.D.—I think I may venture to say that we may believe Herodotus was not altogether misinformed or mistaken about the disgrace which attached to the eating of wheat and barley. Something of the same kind exists at the present day in Oriental countries. It comes about in this way; wheat and barley are cultivated by the poor inhabitants of Eastern

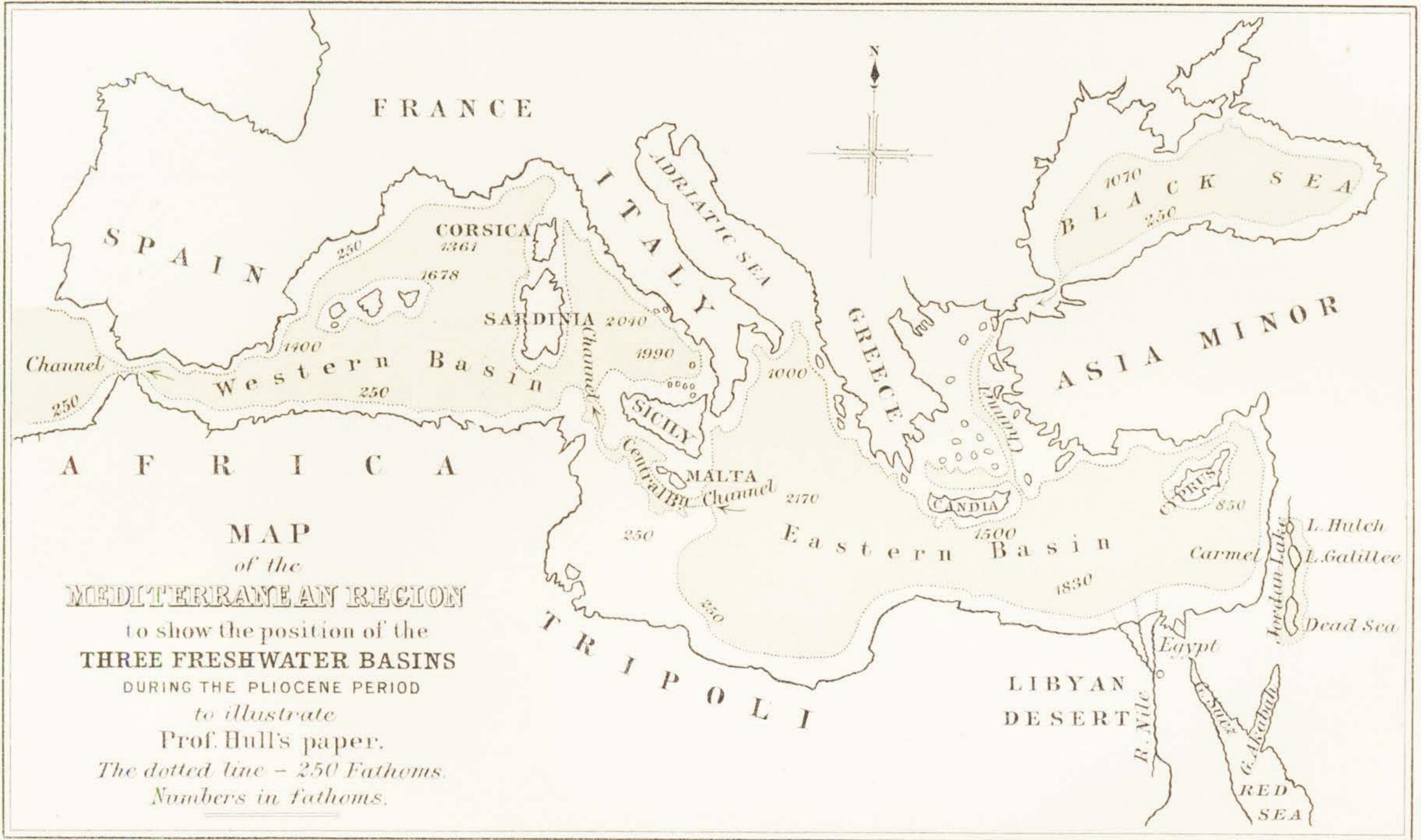
countries and are looked upon as the diet of the rich, and for the poor man to consume the diet of the rich is considered a disgrace. In the same way it is considered a disgrace, or disgracefully extravagant for the fellah to eat fowls or their eggs, which are regarded as the food of the rich. It is not that the poor peasants do not like them, but they would not like to eat them any more than a poor person in Whitechapel would like to dress in silks and satins. We are much indebted to Dr. Walker for his paper and its interesting and valuable information. I was almost in hopes that he would have said something about the castor oil plant having been regarded by many people as Jonah's gourd. It is a very old opinion that the castor oil plant was the gourd which the Almighty caused to grow up to give shade to the disheartened prophet. In one of the Mishna treatises the question is asked, "With what should lamps be lighted on the Sabbath?" And one answer is, that they are not to be lighted with the oil of *kik*, which is considered to be the castor oil plant, and to be identical with the word used in the Bible for the gourd of Jonah. A celebrated Rabbi explains that the oil drawn from this plant is meant, and it is curious that the Greek word *κικι*, which means the castor oil berry, is almost identical with this ancient Hebrew word *kik* or *kikion*. The Latin term *Ricinus*, the castor oil plant, is not very improbably a corruption of the word *kiki*, the first *K* being turned into *R*. The Greek *κικι* also is equivalent to *κροτών*, which signifies a *tick*, and this word used to be applied to the castor oil plant, probably because the seed of the castor oil plant does strongly resemble a tick, as shown in the bottle before us. The Latin word also signifies a *tick*, as well as the castor oil plant.

I should like to hear a little more about the Lotus-eaters. I am rather interested in those people, and have a sympathetic feeling with them. They were usually contented if they had something sweet to eat, so much so that they were ready to abandon the cares and anxieties of life and even were willing to hear nothing more of their own country. I wish the author would tell us what he thinks the plant is that furnished the sweet fruit to the Lotus-eaters. It is often considered to be the tree known as the *dóm*, the fruit of which is certainly very sweet, though I should not say so sweet and pleasant as to cause men to forget everything else but the pleasure of eating it. Not improbably the lotus was the date fruit, which is very abundant in the island of Jerbá, where was the chief resort of the Lotus-eaters.

The AUTHOR.—I think most probably that *kiki* is the gourd of Jonah.

With regard to the Lotus-eaters, the shrub that produces the lotus, there is an ancient belief that it occasioned complete lethe or forgetfulness of all past life. (Lib. ix, 83-102.) Tennyson follows the old idea evidently, from the 9th Book of Homer's *Odyssey*, though he made such a strange combination of different kinds of plants and the scenery of various countries. In reference to the passage from Homer's *Odyssey* as quoted in this paper concerning the people, $\delta\iota\tau' \alpha\nu\theta\iota\nu\omicron\nu\epsilon\iota\delta\alpha\pi \epsilon\epsilon\theta\upsilon\sigma\alpha\iota\nu$, Herodotus (iv, 177) mentions these same Lotophagi as occupying the coast that projects to the sea in front of the Gindanes. They subsist only on the fruit of the lotus, and the fruit of the lotus is equal in size to the mastic berry, and in sweetness it resembles the fruit of the palm tree. I do not know of any author who has alluded to the fruit of the lotus being the produce of either the date or the *dóm* palm. I think it is generally regarded as having been the fruit of a plant, not that of a full-sized tree. He speaks of another people, the Machlyes, adjoining the Lotophagi on the sea coast, who also feed on the lotus, but to a smaller extent than those already mentioned.

The Meeting was then adjourned.



MAP
of the
MEDITERRANEAN REGION
 to show the position of the
THREE FRESHWATER BASINS
 DURING THE PLIOCENE PERIOD
to illustrate
 Prof. Hull's paper.
The dotted line - 250 Fathoms.
Numbers in fathoms.

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ORDINARY MEETING.*

SURGEON-GENERAL SIR C. A. GORDON, K.C.B., Q.H.P., IN
THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following Elections were announced :—

MEMBERS :—Rev. P. Prescott, M.A., Oxon, Middlesex ; Rev. B. N. Switzer, M.A., Middlesex.

ASSOCIATES :—M. V. Portman, Esq., Andaman Islands ; Mrs. A. Du Sautoy, Middlesex.

The following paper was read by the author :—

*ON THE PHYSICAL CONDITIONS OF THE
MEDITERRANEAN BASIN, WHICH HAVE
GIVEN RISE TO A COMMUNITY OF SOME
SPECIES OF FRESH-WATER FISHES IN
THE NILE AND THE JORDAN BASINS.* By
EDWARD HULL, M.A., LL.D., F.R.S., F.G.S. (With Map.)

SOME years ago I brought before one of the sections of the British Association, a paper in which I endeavoured to account for the origin of the peculiar forms of some of the fishes of the Lake of Tiberias which have been recognised by Lortet, Tristram, and others.† I suggested that these special forms were the modified descendants of those which had inhabited it at the time, namely, the Eocene, when the whole region was occupied by the waters of the ocean, and that upon the elevation of the land of Western Palestine, and the formation of the Jordanic depression during the Miocene and Pliocene periods, these ancestral forms were imprisoned within the waters of the inland lake thus formed. It

* 11th of 30th Session. Paper as finally passed for press.

† *On the origin of the fishes of the Sea of Galilee*, Rep. Brit. Assoc., 1885, p. 1066.

appeared to me conceivable, that the Eocene fishes of oceanic habitat may have undergone modification in their characters during the gradual freshening of the Jordanic waters.

But the problem we have here to deal with is somewhat different from that above stated. Besides the special and peculiar forms above referred to, it has been shown that some of the fishes and other forms (such as the crocodile) of the Jordan basin are identical with those now living in the Nile and other African streams entering the Mediterranean.* It is needless to observe that these freshwater forms are now absolutely isolated from each other, by the intervention of the salt waters of the Mediterranean, as well as by the land barrier of Western Palestine. Yet so considerable is the number of species common to the African and Asiatic fresh waters, that it can scarcely be questioned that they had a common origin, and that the waters they inhabit were once physically connected.

In the words of Dr. Lortet, the crocodile has migrated along with the papyrus from the Nile to the Zerka, and the lake of Huleh is full of the African *Chromis*.†

If this be admitted, it becomes a very interesting problem how, and at what geological period, this intercommunication took place. It is a problem which has long been before my own mind, and to which I have given much thought; but it is only recently that I have begun to see my way towards its solution on grounds which can be substantiated step by step.

The following table shows the distribution of the Palestine Forms as gathered from the works of Lortet and Tristram:—

	Total (Species).	Palearctic.	North African and Nile.	Indian.	Peculiar.
REPTILIA, CHE- LONIA AND AMPHIBIA.	91	49	27	4	11
PICES (Fresh- water).	49	8	8	7	26

* L. Lortet, *Poissons et Reptiles du Lac de Tiberiade*, Archives du Musée d'Histoire Naturelle de Lyon, t. III (1883). Tristram, *Fauna and Flora of Palestine*, Mem. Palest. Explor. Fund (1884).

† *Loc. cit.*, p. 122.

The Crocodile (*Crocodylus vulgaris*, Cuv.) and fishes of the genera *Chronis* and *Hemichromis*, which occur in such numbers in the waters of the Jordan basin, are the forms which especially establish the former connection of the waters of the Jordan and the Nile; but there are also other forms of fishes which, according to Lortet, are common to the Palestine or Syrian streams and those of Tripoli in Northern Africa. The common specific forms are as follows:—

- Blennius vulgaris*. Pollini. Nahr el Bared and Tripoli.
Mugil curtis. Yarrel. Nahr el Kadisha, Nahr el Bared, and Tripoli.
Mugil octoradiatus. Günther. Nahr el Bahsas and Tripoli.
Mugil capito. Cuv. Nahr el Kelb, Nile and Mediterranean embouchures.
Chromis Niloticus. Hasselquist. Jordan, L. of Huleh, and Nile.
Hemichromis sacra. Günther. Sea of Galilee. (Allied to Nile species.)
Clarias macracanthus. Günther. Sea of Galilee and Upper Nile.

I have now to lay before the Institute the view according to which the waters of the Jordan basin were formerly connected with those of the Nile by way of the Mediterranean; and in the attempt to work out the problem we shall have to follow as briefly as possible the course of the physical changes which the Mediterranean basin has undergone during Tertiary times. The problem is intimately connected with the history of this great inland sea itself.

Condition of the Mediterranean area at the commencement of the Tertiary period.—It is generally admitted that up to the close of the Cretaceous epoch the Mediterranean Sea and the adjoining land areas formed a portion of the great ocean in which were deposited chiefly limestones characterised by *Hippurites*. It is unnecessary that I should attempt to define the limits of this vast oceanic region, which extended over large portions of the three continents.

At the close of the Cretaceous epoch certain movements of the crust occurred, chiefly of an elevatory character, which resulted in the destruction of nearly all the forms which had inhabited the Cretaceous waters, and converted certain areas into either land-surfaces, or into tracts of very shallow water. But in the Eocene epoch subsidence again became general,

and the inflowing oceanic waters brought with them new specific and generic forms, of which the most remarkable were the Nummulite foraminifera. Throughout the region of Northern Africa and Western Asia, there does not appear to have been much flexuring, or denudation, of the Cretaceous strata previous to the overspread of the Eocene waters; so that the junction of the two formations bears the character rather of a *hiatus* than that of unconformity of stratification.

The Miocene period.—We have now arrived at an epoch which by universal consent is recognised as one of great terrestrial changes in the region here described. To the close of the Eocene period we may refer not only the uprising of the Alps, Pyrenees, Carpathians, and other ranges having E. and W. axes, such as the Atlas in Africa, but also the great subsidence along the line of the Mediterranean basin. Large portions of Africa and Western Asia became dry land for the first time, and the chief physical features of the Palestine area may be considered to have received their incipient outlines. To this epoch may also be referred the Jordan-Arabah depression along the line of the great fault, or system of faults; and the formation by upheaval on the one hand, and depression on the other of the Gulfs of Akabah, of Suez, and the Red Sea. However, depression of a local kind again ensued, for marine strata of Miocene age are found in detached areas over parts of Northern Africa and the Libyan Desert, as Zittel has shown,* as also in the Isle of Cyprus,† along the shores of Asia Minor,‡ in Italy and Sicily, Candia, the South of France, Algeria, and other tracts; while the whole of the island of Malta is formed of strata referable to this (Miocene) period.§ It is therefore probable that this central part of the Mediterranean area remained submerged during the period of post-Eocene movements.

We are now approaching the critical point of our inquiry, but the preceding statements seem necessary in order to lead up to it.

* Zittel, *Ueber den Geologischen Bau der Libyschen Wüste*. München, 1880.

† Spratt, *Quart. Journ. Geol. Soc.*, vol. xxiii, p. 283. Gaudry, *Géologie de l'île de Chypre*, Mem. de la Soc. Géol. de France (1862). Unger and Kotschy, *Die Insel Cypern*. Wien, 1865.

‡ De Tchibatcheff, *Sur les dépôts de l'Asie Mineure*, Bull. de la Soc. Géol. de France, 2 ser. 1850.

§ Spratt, *supra cit.*, p. 295; Prestwich, *Geology*, vol. ii, p. 409. 1883.

Post-Miocene stage.—This epoch is characterised as is well known by movements of the crust of extraordinary intensity. In the Alps, as abundantly illustrated by Professors Heim, Schardt, C. Schmidt, and Baltzer,* we have exhibitions of prodigious movements of the crust resulting in flexures, inversions, and lateral displacements or overthrusts, seldom reached and never exceeded in magnitude. These Alpine movements had their counterparts in the Mediterranean area but in greatly diminished intensity. The general effect was to elevate large areas into dry land, and to cause adjoining tracts to undergo subsidence. This we may infer was the epoch when the Mediterranean was converted into three distinct basins separated by intervening land-ridges, or causeways, by which Europe was united to Africa, and by which, according to Dr. Alfred Wallace, in later Pliocene times the land animals of the former migrated across into the African continent. The islands of Sicily and Malta afford the clearest evidence of such a connection; and although the evidence has been fully discussed by the late Admiral Spratt, and Dr. Leith Adams, I will venture briefly to recapitulate it here.†

Ossiferous Caves of Malta and Sicily.

The evidence to which I refer is derived from the occurrence of numerous remains of elephants, hippopotami and other forms in the caves of Malta, and in those of the north of Sicily. Two species of *hippopotami* have been described from the Malta caves by Leith Adams and Spratt, a larger and smaller, as also two species of elephant (*Elephas antiquus* and *E. Melitensis*). They appear to have inhabited the district in enormous numbers, remains of several hundred distinct individuals having been collected by Adams alone.‡ In the Sicilian district these inhabitants were not less abundant. From the Grotto di Maccagnone near Palermo, Dr. Falconer collected large quantities of bones of elephants and hippopotami, amongst which were two species of the

* See sections and descriptions in the *Livret-Guide Géologique dans Le Jura et Les Alpes de la Suisse*. Lausanne, 1894.

† Adams, *Notes of a Naturalist in the Nile Valley and Malta*. Edin., 1870; also, *On the dentition of the Maltese fossil Elephants*. *Trans. Zool. Soc.*, Lond., vol. ix, 1873.

‡ Dr. Leith Adams considers these two varieties of pachyderms lived together; on the other hand Admiral Spratt believes they inhabited the region at successive intervals of time.

latter, *H. antiquus* and *H. Pentlandi*, together with remains of *bos*, *cervus*, *ursus*, *canis* and a large species of *Felis* (*F. spelæa*?). Similar remains were also obtained from another cave near San Ciro.* In his excavations Falconer was assisted by Baron Auca di Mangalaviti, who subsequently recovered from another cave overlooking the Bay of Palermo a large number of bones of carnivores.† These caves are hollowed out of Cretaceous limestone at levels of 200 to 250 feet above the present surface of the Mediterranean, and a little above the upper limit of the Pliocene strata which descend from the cliffs to the water edge. Miocene strata do not appear to be present on this northern coast of Sicily, but the ossiferous caves of Malta, being hollowed out in Miocene strata, show that the caves in that island are of post-Miocene, or early Pliocene age, and we may fairly infer this to be the date of the caves on the Sicilian coast, containing similar remains.

The conclusion arrived at both by Leith Adams and Spratt with regard to the conditions under which these large animals lived and multiplied is identical, and is one which can scarcely be gainsaid. They consider that there was a general upheaval of this part of the Mediterranean basin at, or towards, the close of the Miocene period, by which Europe was joined to Africa, those portions of the bed of the sea surrounding Sicily and Malta having been at this epoch in the condition of dry land: the extent of the upheaval between Sicily and Tunis would be 250 fathoms (1500 feet) as compared with the level of the present sea-bed.‡

Three Mediterranean Basins.—We may assume with these authors, supported by Dr. A. Wallace and Sir A. C. Ramsay, that the great uprise at the close of the Miocene period resulted in the conversion of the Mediterranean area into three distinct basins, connected with each other by channels through which the waters passed from one to the other and ultimately into the Atlantic. One of these channels through the “Medina Bank” has been identified by Admiral Spratt, and is clearly indicated in his map as connecting the central

* Spratt, *Quart. Journ. Geol. Soc.*, vol. xxiii, pp. 288, 291.

† “Une prodigieuse quantité d’os des Carnivores,” accompanied by stone weapons, quoted by Dr. Falconer, *Quart. Journ. Geol. Soc.*, vol. xvi, p. 106. Coprolites of hyæna were exceedingly abundant in some of these caves.

‡ Ramsay, *Europe. Compendium of Geography and Travel*, Stanford, p. 8, 1885.

with the eastern basin; the other connecting with the western basin was discovered by Admiral Smyth.*

This chain of inland lakes was supplied not only by the streams directly entering from Europe on the north, and from Africa on the south by the Nile, but with the central Asian drainage, so that there was a continuous flow from the Caspian, through the Black Sea, the Dardanelles, the Sea of Marmora into the Mediterranean lakes. Ramsay infers that the waters of this great chain of lakes emptied themselves into the Atlantic, but he is in doubt whether the waters were salter or fresher than they are now; and he adds, "that they were not fresh we may be certain;" though he modifies the statement by saying that "it may be, that like the Black Sea now, these inland Mediterranean lakes were gradually freshening."†

It is at this point, which is of the highest importance in our present inquiry, that the evidence to be gathered from the abundance of hippopotami and freshwater turtles comes to our aid.‡ Doubtless at the commencement of the elevatory period the waters of the whole area were salt; but the ultimate effect of the establishment of the conditions above described must, as it seems to the author, have resulted in the formation of freshwater basins; and it was only in waters of this kind that (judging by the present habits of the animal) hippopotami could have lived and multiplied.

In the first place the evaporating area was greatly contracted as compared with that of the present day. We cannot say exactly to what extent as compared with the present surface of the Mediterranean and its offshoots, but we shall probably not greatly err in considering the evaporating surface to have been about two-thirds that of the present day. (See Map.) In order to establish land communication between Sicily and Tunis an elevation of the seabed to the extent of 250 fathoms would be necessary; but the chain of lakes connected by river channels as indicated by Spratt would be established by a rise of 200 fathoms. Such a

* Spratt, *loc. cit.*, p. 292.

† *Ibid.*, p. 8, the depth of the shallowest portion of the Straits of Gibraltar is a little over 400 fathoms, so that the rise of the bed of the Mediterranean Sea by 250 fathoms would allow of a channel 150 fathoms deep to carry the waters into the ocean.

‡ We might also add elephants, as the large herds of these animals which, with the hippopotami, must have occupied the Maltese region, would have required a considerable extent of fresh water for their enjoyment.

physical change over the central and eastern area of the Mediterranean would (as will be seen by the accompanying map) reduce the evaporating area very largely, and would extend the present land surfaces proportionately. At the present day the Mediterranean waters are a little saltier than those of the ocean, owing to the constant inflow of these latter, produced by excess of the evaporation over supply from rivers over the Mediterranean basin; but under the conditions here indicated the process would be reversed, as the supply would exceed the loss from evaporation, with the result that the waters would become fresher, and the flow would be outwards into the ocean.

Such was presumably the land and sea distribution during one of the phases of change of the post-Miocene or Pliocene period. The land communication between Europe and Africa at Gibraltar and Sicily may have been complete at one time and broken in another. But it is unnecessary to investigate these changes further than to assure ourselves that they are consistent with the conclusion that a chain of freshwater lakes was established into which flowed the waters of North Africa from the south and those of Europe and Asia Minor from the north.* If this be so, then we have a sufficient explanation of the community of some of the species of freshwater fishes inhabiting these rivers, such as those of Tripoli and Syria at the present day, and now separated by a barrier of highly saline waters. But we have still to account for this community as it occurs in relation to the waters of the Jordan Valley.

The Jordan Valley Lake.—On a former occasion I have shown that there is clear evidence that the whole valley of the Jordan, from the Lake of Huleh on the north to the Arabah on the south, was the bed of a lake over 200 miles in length, and 1,300 feet (or more) above the present surface of the Dead Sea.† A few feet higher would have caused the waters of this lake to surmount the rim of the basin (as it is at present) and to have escaped by the bed of the Kishon, or some antecedent stream, into the Eastern Mediterranean basin, through the plain of Esdraelon. In this way a connection may have been established between the waters of

* The Straits of Gibraltar by which the waters of the freshwater lakes entered the ocean have a depth of 400 fathoms. This would allow abundant passage for the waters even with a shallowing of 250 fathoms.

† *Phys. Geol. and Geog. of Arabia, Petraea, and Palestine*, Mem. Palestine Exploration Fund, pp. 99, 111, and 113. 1885.

the Jordan-Arabah basin and those of the Mediterranean, and the fauna would have had a means of spreading itself throughout the whole system of waterways.

There is of course a little uncertainty as to the exact time when the waters of the Jordanic basin reached their highest level. In the memoir above referred to I have assumed that this took place during the Pluvial Period, which may be regarded as including the Glacial Epoch, but the filling up of the Jordan valley with water may have commenced at an earlier stage, namely, the Pliocene, concurrent with the general elevation of the Mediterranean area, when the rainfall must necessarily have been augmented and the decreased temperature would have resulted in diminished evaporation. It may be desirable that I should give some description of the Plain of Esdraelon, through which it seems probable that the physical connection of the outer and inner waters was carried out.

The Plain of Esdraelon.—When we examine an orographical map of Palestine, we observe that the central table-land extending from the Sinaitic Peninsula by Hebron, Bethlehem, Jerusalem and Nablus (Sichem) breaks down along the northern base of Carmel, which rises above the southern shore of the Bay of Acre (Haifa) on the Mediterranean coast. From this bay stretches the rich plain of Esdraelon, composed of deep alluvial material,* and it gradually ascends inland towards the margin of the Jordan depression till it reaches a level of about 150 or 160 feet above the Mediterranean.† It is drained by the Kishon, which flows westward into the Mediterranean; but at least two streams rising along the summit-level, namely, the Nahr el Birreh and the Nahr el Jalud, flow in the opposite direction into the Jordan. The sources of these respective streams are not far from each other, and were the Jordan basin filled up to the brim, as we have reason to believe was the case in late Tertiary times, it might well have become a tributary of the Mediterranean through a primeval Kishon. Through such a channel we may infer the Nilonic fishes, crocodiles and other forms may have found their way into the Jordan basin, connected as the two river systems were by the great freshwater lake which occupied the Levantine basin of the Mediterranean.

* The railroad to Damascus now in course of construction passes over this plain.

† As I am informed by Mr. G. Armstrong of the Palestine Survey.

Such were the conditions under which a community of freshwater faunas amongst the tributaries of the Mediterranean seems to have been brought about; at least, such is the view which I venture to submit to the Institute; and having thus brought my proposed task to a conclusion, I might leave the matter as it stands, but I may be permitted before I conclude to refer briefly to the subsequent changes which the region of the Mediterranean area underwent after the post-Miocene epoch.*

Pliocene submergence.—Amongst the numerous changes which this region has undergone, none are better established than the submergence to a limited extent in the later Pliocene times. With this submergence the waters of the Atlantic flowed into the Mediterranean basin in one direction and those of the Red Sea in the other, and permanently established marine conditions. The upper limit of this depression is marked throughout Egypt, Palestine and Syria, Cyprus, † Sicily, and the bordering tracts of the Mediterranean by beaches of sand, gravel and marls with sea-shells, rising from 150 to 300 feet above the present surface of the waters. To this stage belong the raised beaches of Jebel Mokattam at a level of 220 behind Cairo, and the border districts of Philistia and the coast of the Lebanon.‡ Whether the salt waters of the Mediterranean at this period entered the Jordanic valley by the Esdraelon plain cannot be determined, but it may be supposed that they were to a great extent excluded owing to the higher level of the Jordanic waters themselves. In any case, the narrow channel of connection, if such existed, appears to have been insufficient to destroy the fishes of the great lake, which was over 200 miles in length, 40 in breadth, and about 2,500 feet in depth.

This late Pliocene submergence, extending into the Pleistocene epoch, was followed by a final uprising of the sea-bed, and the establishment of the existing conditions of land and sea over the region bordering the Levant. There are few regions on the surface of the globe in which the oscillations of the land can be so clearly followed as in that which is the subject of this paper.

* During the period of elevation we have been discussing we may suppose that the Nile waters eroded their channel down to the solid limestone floor, which at varying depths underlies the modern alluvial deposits.

† Albert Gaudry, *Géologie de l'île de Chypre*. Wien, 1865.

‡ Sir J. W. Dawson, *Modern Science in Bible Lands*, pp. 448, 456. 1888.

The CHAIRMAN (Sir C. GORDON, K.C.B.) conveyed a vote of thanks to the author for his paper, and the Chair was then taken by

Dr. T. CHAPLIN, who remarked on the value of Dr. Hull's paper. He referred to the "Crocodile River" in the Holy Land, the existence of crocodiles in which had been drawn attention to by "Rob Roy" MacGregor, and a stuffed crocodile was now in the rooms of the "Palestine Exploration Fund" which had been found and killed on that river bank in 1893. He added that the Egyptians were alleged, with what truth he could not say, to have brought crocodiles to that river, and it was curious, in connection with St. George, the patron saint of England, that he was said to have slain the dragon in this locality. Crocodiles now were only heard of west of the central chain of hills in Palestine.

General A. B. TULLOCH, C.B., C.M.G., spoke of having caught trout in Morocco which Dr. Buckland had recognised as "true trout."

Other speakers referred to considerable terrestrial changes having taken place in North Africa, also a tradition of the sea having covered the Sahara Desert, the truth of which was shown by the presence of sea-shells there. It was stated that the late Rev. J. G. Wood had spoken of fish being gradually accustomed to change from living in salt to living in fresh water, and *vice versá*; and Mr. F. W. Kirby spoke of being under the impression that a chain of lakes may have extended from the Mediterranean to the Arctic Ocean.

The AUTHOR—referring to Mr. Kirby's remark—said that no doubt there had been, so far as one could judge, a considerable elevation of land in Central Asia; as to the crocodile, Dr. Lortet, in the passage he had quoted, said "the crocodile has migrated along with the papyrus from the Nile to the Zerka, and the lake of Huleh is full of the African *Chromi*." The author concluded by thanking Dr. Chaplin for occupying the Chair, adding, "most of us are aware that he has spent some twenty years in the Holy Land, in doing valuable medical and religious work amongst the inhabitants, and it is a gratification to see that he is able to return, after that long period of arduous work, in that health and strength which we hope may long be accorded to him."

The Meeting was then adjourned.

COMMUNICATION.

Among the communications received since the subject was first brought forward :—

Dr. R. T. SCHARFF, curator of the Natural History Department of the Science and Art Museum in Dublin, writes :—

Dr. Hull's connection of Greece with Asia Minor agrees exactly with my own views derived from the distribution of the mollusca, etc., but I think for part of the Pleistocene period, Sicily and Tunis and Spain and Africa must have been connected.

ORDINARY MEETING.*

COMMANDER G. P. HEATH, R.N., IN THE CHAIR.

The Minutes of the last Meeting were read and the following elections were announced :—

MEMBERS :—Surgeon-General S. B. Partridge, F.R.C.S.E., C.I.E., Kent ;
Rev. E. Blakeslee, D.D., United States ; Rev. L. T. Townsend, D.D.,
LL.D., United States.

LIFE ASSOCIATE :—J. D. Logan, Esq., South Africa.

ASSOCIATES :—W. D. Drake Brockman, Esq., Kent ; T. Garnet, Esq.,
Kent ; Rev. J. Hall, Doncaster ; H. Hutton, Esq., Rhodesia ; Rev.
W. H. Hanham, Natal ; Rev. W. Maxon, D.D., United States ;
J. Rutland, Esq., New Zealand ; Rev. M. Rainsford, M.A., London ;
Rev. G. R. Thornton, M.A., London ; Miss S. Waller-Lewis, London.

The following paper was then read by the author :—

TITHE-GIVING AMONGST ANCIENT PAGAN NATIONS. By the Reverend HENRY LANSDELL, D.D., M.V.L., M.R.A.S., F.R.G.S.

By ancient Pagan nations is meant, in this paper, the early Egyptians, the Babylonians, Phoenicians, Arabians, and certain Semitic peoples of Western Asia, together with the Greeks, Romans, and some few other nations of Pagan Europe. The object of our inquiry is to learn, if possible, how far these heathen nations recognised it as a duty to offer a part of their property to their gods, and in what proportion they did so.

We commence then with Egypt, where we read of first-fruits being offered to the gods so far back as the thirteenth dynasty (or say 2,500 years before the Christian era). Dr. Brugsch, speaking of the tomb of the high priest Anubis at Lycopolis, says :

“[Anubis] takes occasion for fixing the kind and number of the sacrifices ; he speaks of the feast-days on which they are to be offered, and gives us evidence, for the first time in an Egyptian inscription, that the ancient inhabitants of the Nile

* December 6th, 1897.

valley, great and small, were accustomed to dedicate the first-fruits of their harvest to the deity.*

The testimony of Erman is to the same effect, who says :

“The worshippers of these (Egyptian) gods were always faithful to them . . . Each brought the firstfruits of his harvest to the servants of his god . . . he made the furthest room of his house into a little chapel . . . In the court of his granary, or near his wine-press, he erected a little sanctuary to Renenutet, the goddess of the harvest, and placed there a table of offerings with wine and flowers.”† These and other evidences of private piety were, however, quite eclipsed by the state offerings of the Pharaohs, during the ninth historical dynasty (1700–1400 B.C.), the enormous lists of which offerings, as given by Rameses II and III, still remain on the outer wall of the temple of Medinet Habu, and in the great Harris papyrus.

During this period the temples were enriched, not only by first-fruits, but by occasional offerings ; for the priests enjoyed permanent endowments bestowed alike by king and people. It was incumbent, for instance, on the head of the treasury department personally to endow one of the great temples in Egypt with the precious things he brought from foreign countries.‡

In fact, so vast were these endowments, that Professor Maspero§ informs us that “The domain of the gods formed, at all periods, about one-third of the whole country.”

There was yet another source of income by means of which the ancient Egyptians recognised their dependence on the deity in presenting sometimes the whole, but more commonly a portion, of their spoils taken in war.

Professor Maspero says,|| “The gods of the side which was victorious shared with it in the triumph, and received a tithe of the spoil, as the price of their help.”

Again he says,¶ “A revival of military greatness was followed by an age of building activity. Claims of the gods had to be satisfied before those of men, etc. . . . A tenth, therefore, of the slaves, cattle and precious metals was set apart for the service of the gods, and even fields, towns and provinces were allotted to them, the produce of which was

* Brugsch, Heinrich, *History of Egypt under the Pharaohs*, vol. i, p. 225.

† Erman, A., *Life in Ancient Egypt*, tr. by Tirard. Lond. 1894, p. 272.

‡ Erman, p. 96.

§ *Dawn of Civilization*, p. 303.

|| *Dawn of Civilization*, p. 302.

¶ *Struggle of the Nations*, p. 91.

applied to enhance the importance of their cult, or to repair and enlarge their temples."

This repeated mention by Professor Maspero of a tenth of the spoils is noteworthy; though he does not say that the people generally, in Egypt, paid tithes to the temples.

Upon my inquiry as to this point from several Egyptologists, Professor Sayce wrote to me, "Though gifts were made to the Egyptian temples on a large scale, there does not seem to have been any tithe."

Professor Flinders Petrie also wrote, "I do not remember any tithing allusions. . . . The Egyptian system of priestly revenues was by estates, and not by taxes or tithes."

Again, in a short conversation I had on the subject with Dr. Budge, superintendent of Egyptian and Assyrian antiquities in the British Museum, he seemed to doubt, concerning Egypt, whether the gifts to the temples represented a definite proportion of income. He thought they amounted to more than a tenth, and seemed convinced that, in constantly and regularly recurring festivals, it was obligatory by custom, if not by law, to make offerings to the priests.

I inquired of Professor Mahaffy, who replied—"in Egypt one-sixth seems to have been the old *ἀπόμοιρα*, or God's portion, levied upon all property not specially exempted." For confirmation of this, in Ptolemaic times, he referred me to the "Revenue laws of Ptolemy," published by Mr. Grenfell, but the Professor adds that he cannot possibly imagine this sixth to have been an invention of the Ptolemies, and therefore believes it to have been an old Egyptian tax.

If, then, it be asked, whether the Egyptians recognised it as a duty to offer a portion of their property to the gods, it would seem that the Pharaoh and his officials, with many, if not all, of the people, annually offered the first-fruits of their crops to the temples, which they permanently endowed for the education and support of the priests, as well as for temple repairs and enlargements, together with the furniture and accessories of worship. They offered also a portion of their spoils taken in war, and on various other occasions made further offerings of the most varied kinds. If it be further asked as to what proportion these offerings bore to the offerers' incomes, it seems to have been not less than a tenth, and in some epochs certainly reached a sixth.

We now pass from the valley of the Nile to that of the Euphrates, and pursue our inquiry among the ancient Babylonians.

Long ago, Josephus told us that Nebuchadnezzar "with the spoils he had taken in war, adorned the temple of Belus and the rest of the temples in a magnificent manner."*

But to us, of the nineteenth century, new sources of information have been unveiled, such as Josephus could not read; and we owe not a little to Assyriologists who have deciphered for us the cuneiform inscriptions on whole libraries of tablets found throughout a large part of Western Asia, many of which tablets have made their way to the museums of Berlin, Paris, and London. These tablets were anciently preserved as records connected with temples; as hymns to the gods; calendars, works of history, and chronology; and also as merchants' accounts and contracts.

Upon my asking Dr. Budge for "chapter and verse," that is, translations from a few original tablets in the British Museum, and their bearing upon tithe-giving, he has been good enough to inform me concerning the meaning of the word *eshru*, or tenth, that:

On one tablet [82, 9, 18, 74^a] Nabonidus [555-538 B.C.] paid to the temple of the sun god on the xxvith day of the month Sivan, in his accession year, six mana of gold *eshru* [as tithe] the gold being paid in the great gate of the temple.

Another tablet records that Belshazzar (son of Nabonidus) paid 27 shekels of silver as the *eshru*, or tithe, for a daughter of the king, on the fifth day of Ab, year 17 of Nabonidus.

A third tablet states that Nergalnatsir gave an ox to the temple for his tithe.

A fourth tablet says that a governor and another official paid a tithe; besides which other examples of combined tithe-paying occur.

A fifth tablet states that two-thirds of a mana, and five shekels of silver were given to the gods Bel, Nebo, Nergal, and Ishtar as tithe.

I ought to say that Dr. Budge adds a doubt whether *eshru*, though meaning literally a tenth, was an actual tenth of the person's income or property; and there is no evidence, he says, known to him, which shows that the tithe was obligatory. But there is evidence, he says, that the tithe could be annual; that it could be, and was, commonly paid in kind: that two or more individuals could unite in paying a tithe; and that a tithe could be offered to a number of gods

collectively; so that, from the foregoing facts, it seemed to him that the *eshru* partook more of the nature of a freewill offering than of a literal tenth part, the payment of which was obligatory.

I am indebted further to Mr. Theophilus G. Pinches, also of the Assyrian Department in the British Museum, who tells me that the mention of "tenth parts" (*éšrētu*), with allusion to paying a tenth, occurs on tablets which are undoubtedly copies of Akkadian and Assyrian bi-lingual phrase tablets drawn up 2200 B.C. or earlier, and representing the legal expressions current among the scribes at that time.

I am further informed that when more of the tablets, now in the British Museum, are transcribed and published, it will be clear that tithes were given in Babylonia to the temples of the gods 2100 years B.C., and probably earlier.

Meanwhile Professor Maspero also tells of religious endowments in ancient Chaldea; and, he says, of spoils of war:

"As soon as he [the king] had triumphed by their [the gods'] command, he sought before all else to reward them amply for their assistance. He paid a tithe of the spoil into the coffers of their treasury, he made over a part of the conquered country to their domain, he granted them a tale of the prisoners to cultivate their lands and to work at their buildings."* In his later volume Maspero furnishes some interesting items upon tithe-giving by Tiglath-Pileser, saying that Tiglath-Pileser, after fighting in the country north of the Tigris, consecrated the tenth of the spoil thus received to the use of his god Assur and also to Ramman.† Further examples might be quoted from Maspero, and others of a similar character from that eminent Assyriologist, the late George Smith; but I hasten to quote again from the letter written to me by Professor Sayce.

"The *esrá*, or tithe," he says, "was a Babylonian institution. The temple and priests were supported by the contributions of the people, partly obligatory and partly voluntary. The most important among them were the tithes paid upon all produce. The tithes were contributed by all classes of population, from the king to the peasant; and lists exist which record the amounts severally due from the tenants of an estate. The tithes were paid for the most part in corn: thus we find a Babylonian paying about eleven bushels of

* *Dawn of Civilization*, p. 706.

† *Struggle of the Nations*, p. 644.

corn to the temple of the sun god [at Sippara] as the tithe required by him for the year. The tithes paid to the same temple by Nabonidus just after his accession [555 B.C.] amounted to as much as six manehs of gold. Voluntary gifts also were common and were often made in pursuance of a vow or in gratitude for recovery from sickness.”*

Professor Sayce observes also, in his *Patriarchal Palestine*,† that Cyrus and Cambyses did not regard their foreign origin as affording any pretext for refusing to pay tithe to the gods of the kingdom they had overthrown.

The mention of Cyrus takes our thoughts to Persia (or Elam), where tithe-giving seems to have been known before the days of Cyrus, for Maspero says:

“These deities [of Elam dwelling near Susa] received a tenth of the spoil after any successful campaign—the offerings comprising statues of the enemies gods, valuable vases, ingots of gold and silver, furniture and stuffs.”

Let us now pass to the Phœnicians, or Canaanites, who dwelt on the coast of Southern Syria, and were the manufacturers and merchants of antiquity.

It was a colony of these Phœnicians from Tyre who founded Carthage—say about 900 B.C. They brought with them the custom of tithe-giving; and, from the outset, used to send the tithe of all their profits and increase to Tyre, for Hercules, by one clothed in purple and priestly robes, and so likewise they did with their spoils of war taken in Sicily.

There remain now two other nations to be referred to in connection with tithe-giving, namely, the Arabians and Ethiopians.

Pliny‡ mentions an Arabian law whereby the owner of frankincense had to pay tithe of it to the god Sabis, whose priests received it, not by weight, but by measure. Nor might any sale of it be made till the tenth was paid.

Again, the late Dr. Robertson Smith, Professor of Arabic at Cambridge, speaking of sacred tribute in Arabia, says: “The agricultural tribute of first-fruits and tithe is a charge on the produce of the land, paid to the gods as Baalim or landlords.”§

Once more, what Pliny says of the Arabians and their

* *Social life among the Assyrians and Babylonians*, p. 121.

† p. 166.

‡ *Hist. Nat.*, lib. 12, cap. 14, § 63.

§ *Lectures on the religion of the Semites*, p. 441.

frankincense, he repeats, in substance, of the Ethiopians and their cinnamon, which they did not eat, but with prayers made first to their gods, and a sacrifice of forty-four goats and rams; then the priest, dividing the cinnamon, took that part belonging to their god Assabinus and left them the rest to make merchandize of.*

If, then, it is asked of the Babylonians and the other peoples just alluded to, whether they recognised it as a duty to offer a part of their property to their gods, and in what proportion they did so, we see Tiglath-Pileser, Nebuchadnezzar, Nabonidus, Belshazzar, Cyrus, and other sovereigns, offering their spoils, and often the tithe. But we have mention also of various classes of people in the Euphrates Valley, as well as Phœnician colonists in Carthage, annually offering a tenth of their increase, whether from fruits of the ground or profits by merchandize; whether from spoils of war or other sources of income, whereby the temples were furnished and endowed, the priests supported, and the gods honoured; all this being done, partly as a matter of obligation, and partly voluntarily as in payment of vows or giving of thanks.

We now turn to the Greeks, Romans, and some few other pagan nations of Europe. The earliest allusions to tithe-giving in Greece go back to mythological times, cluster round the oldest writers and lawgivers, and include such legendary names as that of Evander.

Evander, in classical legend, was a son of Hermes, and the leader of an Arcadian colony into Latium sixty years before the Trojan war, or say about 1300 B.C. Cassius (in Aurelius Victor) reports that in Evander's day, one Recaranus, a shepherd of Greek extraction (called Hercules because of his strength) having recovered his oxen that Cacus had stolen, dedicated an altar under the Aventine Mount, *Inventori Patri* (that is, probably, to Jupiter), calling it the greatest, and teaching people to consecrate their tithes there, for it seemed to him more fit that the gods should receive that honour than their kings, whence it came to pass, after the said Hercules was deified, that it grew into a custom to consecrate to him a tithe.†

It is related also by Diodorus Siculus, of the Argives, that

* Pliny, lib. xii, cap. 19, § 89.

† Cassius, *ap. Aurel. Victor, in orig. Gent. Rom.* Comber's *Historical vindication of divine right of tithes*, p. 37.

having subdued the Myceneans, they consecrated a tenth out of their goods to the god. (B.C. 473.)*

Diodorus mentions, too, that the Liparians, or Greeks who colonised the Lipari Islands, having overcome the Etruscans in many sea battles, sent the tithe of the spoil to Delphi.† We may further observe, before passing from this early period to Spartan times, that Ares himself is recorded to have dedicated his tithe to one of the genii who first taught him to be a soldier,‡ which is another indication of the great antiquity of tithe-giving among the Greeks.

Again, Pisistratus writing to Solon, the famous Athenian lawgiver (born about 638 B.C.), touching the tribute of a tenth, which certain former princes had seized for their own use, says that he took tithes of every one of the people, not so much for his own use as for public sacrifice or the use of the gods in general.§

If, next, we ask concerning spoils taken in battle, we have Agesilaus (King of Sparta from 398 to 361 B.C.), who during his wars in Asia Minor, within the space of two years, sent more than 100 talents of tithe to Delphi, as Xenophon testifies.||

Lysander, another Spartan general (killed 395 B.C.), is mentioned by Maximus Tyrius as offering the tithe of his gains in war to the gods.¶

So, too, we have a similar instance in Cimon, the Athenian general, who, after defeating the Persians at Eurymedon in 466 B.C., took out the tenth of the spoils, and dedicated them generally to the Deity, but did not name Apollo or any other.

About this same period probably we may place the vow of the Crotonians of a tenth of the spoil to Apollo at Delphi, before their war with the Locrians, whilst the Locrians, not to be outdone, vowed a ninth.**

Pausanias, the Spartan general (who died 466 B.C.), gave, after his victory over Mardonius, out of the tithe of the spoil, a tripod of gold to Apollo at Delphi, and two brazen statues, one to Zeus Olympius, the other to the Isthmian Poseidon.††

* Diodorus Siculus, v. 11, c. 65.

† Diodorus, v. 9.

‡ Lucian de saltatione. Comber, p. 33; Selden, p. 31.

§ Selden's *History of Tithes*, p. 33.

|| Herodotus, lib. 9, c. 81.

¶ *Agesilaus*, c. 1, § 34.

** Max. Tyr., *Dissert.*, 14.

†† Trogus Pompeius, *Histor.*, Selden, p. 30.

This brings us to the period of the Greco-Persian wars, in the early years of which flourished Herodotus. He travelled widely and records the customs of many nations. Of the Phocians he relates that out of the tithe of money gained by their victory over the Thessalians they made four statues to Apollo.*

The same writer tells of a small people, on the Island of Samos, in the Ægean Sea, that they yielded at one time six talents for the tithe of their gain gotten by merchandize.

A case still more extraordinary, and which may be regarded perhaps as the working of a heathen conscience, is related by Herodotus of a woman of Thracia, a courtesan named Rhodophis, who sent a tenth of her gains, in the form of spits for sacrifices, to the temple of Apollo at Delphi.† That this was not unusual seems to be suggested by the case of another of the same class, who, in an old Greek poem, vowed to offer the tenth of all her gains to Aphrodite.‡

Herodotus§ tells, too, of the Siphnians, who paid tithes of their gold and silver mines. It is worthy of note also that Pausanias, who lived in the second century A.D., said of these Siphnians that “when through greediness they failed to pay their due, the sea overflowing hid their mines from sight.”||

But perhaps the most noteworthy instance of tithe-paying in this period was that of Xenophon, who, after his return with the ten thousand Greeks, having first given a part of the tithe of his portion of the spoil to Apollo at Delphi, with another part purchased land and built a temple and altar to the goddess Artemis; after which he consecrated the tithe of the fruits of the fields for sacrifices, and instituted a feast, wherein Artemis, out of this land and these tithes, furnished all that came there with meal, bread, wine, junkets, money, and with her part of the cattle fed in the sacred pastures, or taken in hunting.¶

And near the temple, Xenophon set up a pillar with this inscription, “Ground sacred to Artemis. Whosoever pos-

* Herodotus, lib. 8, c. 27.

† Herodotus, lib. 2 : 135.

‡ *Antholog.*, lib. 6 ; Comber, p. 31.

§ iii, 57.

|| Pausanias. *Descriptio Græciæ*, x, 11, § 2, Spelman, *Larger Treatise concerning tithes*, p. 124.

¶ Xenophon, *Anabasis*, lib. 5, c. 3, § 4-13.

sesseth it, let him pay the tithe of his yearly increase; and, out of the remainder, maintain the temple. If he neglect this, the goddess will require it."

So here was a temple, fully endowed with tithes for the benefit of priests, people, and repairs!

Nor must we forget how Pliiny records of Alexander the Great, that, having conquered the countries of sweet odours and frankincense, Alexander sent a whole shipload thereof to Leonidas, in Greece, that he might burn it bountifully unto the gods *

Let us now advance to the next Grecian period, the hegemony having passed from Sparta to Athens, and during which Greece produced some of its greatest men.

Thucydides (born about 471 B.C.) tells us that when the Athenians had divided the island of Lesbos into 3,000 parts, they consecrated 300, that is the tenth, generally, to the gods.†

Reference has already been made to what Pisistratus wrote to Solon, which seems to show that the Athenians usually paid tithe of their goods at home alike in peace and in war. Even a tenth of the meat killed in Athens was given by the cooks to the magistrates, and this was spent, in the case of Pisistratus at all events at the festivals of the gods.‡

We may see, too, another confirmation that the general tithing of all gains was usual in Athens, from the jeering comedy of Aristophanes (450-380 B.C.), for he represents Cleon complaining of Agoracritus for detaining the tithe of his sausages belonging to the gods.§

A century later, Demosthenes calls it sacrilege in Androtion and Timocrates to retain the tenths due to Pallas; and, if this be taken in connection with the complaint, or threatening of Cleon just referred to in Aristophanes, it would almost suggest that defaulters might be complained of, and perhaps punished in Athens for not paying tithes.||

We now pass from the Greeks to the Romans, amongst whom we trace the practice of tithe giving to their earliest or legendary history.

* Pliny, lib. xii, cap. 14, Spelman, p. 120.

† Selden, p. 33.

‡ Aristoph., *Equites*, v. 283; Selden, p. 33.

§ Comber, p. 33.

|| Comber, p. 33.

Hercules is the god most frequently mentioned among them as the receiver of tithes. He was one of their chief and most ancient deities, his rites, as Livy testifies,* having been first taken into use by Romulus, who founded Rome B.C. 753.

Soon afterwards we come to the King, Tarquinius Superbus (616-578 B.C.), who, upon taking Suessa, is said to have paid a tithe of at least 400 talents of silver to the gods in general.†

Next in order of time, perhaps, should be mentioned an incident, as recorded by Plutarch and Livy, which speaks volumes for the reverence and sacredness with which the payment of tithes was regarded by early Romans and Grecians alike.

It happened after the conquest by Camillus of the City of Veii (396 B.C.), that the augurs, or temple prognosticators, made report that the gods were greatly offended, though they knew not for what, but the fact they professed to have discovered by the marks and observation of their sacrifices.

Camillus having informed the senate that, in the sacking of Veii, the soldiers had taken the spoil without giving the tenth to the gods, and that the soldiers had, most of them, spent or disposed of what they had taken, the senate ordered every man to give in, upon oath, how much he had received of the booty, and to pay a tenth of it, or the value of this tenth, if it was spent, to the gods.

Towards this the women brought in jewels and gold of their own free will so readily, that the senate gave them the privilege of having orations in their praise made at their funerals, which honour formerly had been allowed only to great and eminent men. And they appointed three, of the first quality in Rome, to carry this present with the tithe, in a triumphal manner to Delphi.

On the way they were taken, and made a prize by the Liparians, or Greeks who colonized the Lipari Islands, north of Sicily. But, when brought to their city, and when the Liparian governor understood that so great a booty consisted of tithes due to the gods, he not only restored it all, and sent them away with it, but gave them a convoy of his

* *Hist.*, lib. 1.

† Dionysius of Halicarnassus, lib. 4.

own ships to secure them on their voyage, although he was then at war with Rome.*

After the early Kings of Rome we have instances of tithes being offered by more than one of the Dictators, as well as by Roman Consuls and Generals. In fact, Servius says it was a Roman custom, when they made war, to promise some of the spoils to the gods; and therefore there was a temple at Rome dedicated *Jovi Prædatori*, not that he presided over the spoils, but because some of the prey was due to him.†

Nor was it military people only among the Romans who paid their tithe; for Plautus, the Roman dramatist (who died 184 B.C.), refers to Roman merchants, who from very early times, it would seem, used to pay a tenth of their gains.‡

The same custom obtained, presumably, among Roman farmers; for Varro (116–27 B.C.), in his great work upon agriculture, advises every man to pay tithe diligently of the fruits of his ground.§

Also Pliny the elder (23–79 A.D.), who calls the tithes sent to Delphi “first-fruits,” says the Romans never tasted their new fruits or wines till the priests had taken the first-fruits of them.||

And, as if nothing might go untithed, it would seem, according to Papinius, that the Romans paid a tithe of the very beasts they killed in hunting, namely, the skins, to Diana.¶

Nor was the fulfilment, or non-fulfilment, of a vow to pay tithe, treated as a light matter even in Roman law; for Ulpian, the celebrated Roman jurist of the third century, is quoted by Justinian to the effect that if after having made a vow to pay tithe, a man died, his heir, or executor, was bound to pay what had been vowed.**

Having collected these testimonies concerning tithing by Greek and Roman sovereigns, generals, merchants, farmers, and people in general, let us inquire what traces of the custom are to be found among other ancient pagan nations of Europe.

* Leslie, *Divine Right of Tithes*, Toronto edition, p. 43.

† Servius. *Æn.* 3 Com. 21, Comber, *Historical Vindication*, &c., p. 40.

‡ Plaut. *Stich.*, Selden, p. 26.

§ Varro. *De re rustica*, Spelman, p. 120.

|| Pliny, *Nat. Hist.*, lib. 4, cap. 12.

¶ Spelman, p. 121.

** Selden, p. 28 ff.; *Tit. de Politic.*, lib. 2, Sect. 2.

We begin with that very old people the Pelasgi, who spread about the Mediterranean in early times, of whom we read that they gave a tenth of their gains by merchandize, and sent their tithe to Phœbus at Delphi. A branch of these people, settled in Umbria in Italy, in a dearth and great scarcity of all things, vowed upon plenty being sent to them, to give a tenth of all unto Jupiter, Apollo, and the Cabiri (that is, the deities of Samothracia), supposing that this misery and scarcity came upon them for their former neglect and contempt. Upon this vow of amendment, they had their desire, as plenty was sent to them; and then setting aside the dedicated portion, the tenth of all their increase, they offered it to those deities.

After this, we may pass from the Mediterranean, and notice the testimony of Julius Cæsar,* who seems to say of the ancient Gauls, that their custom was to sacrifice the cattle and to give, in effect, not only tithe, but all they took in war, to the gods.

The same custom, probably, extended to the ancient Britons and German Saxons, for Sidonius Apollinaris (born about 430) mentions that the German Saxons were wont to sacrifice to the god of the sea the tenth of all captives taken in these piracies and incursions made by sea, especially upon the Gauls.

Once more, we are told of Cædvalla, last of the British Kings of North Wales, and slain 634, that, during the period of his life when he was a heathen, he was wont to tithe all his spoils of war to the deity. So, at least, says the Monk of Malmesbury.†

If, then, we summarize our testimonies concerning early tithe-giving in Europe, we see that, so far back as 1300 years before the Christian era (if such a date can be trusted); and, afterwards, among the earliest peoples and persons known to us in Europe; we have the Argives, the Pelasgi and the kings of Rome offering tenths of their warlike spoils or of their gains by merchandize.

When, moreover, we reach the period of authentic history, we read of Greek generals; Roman dictators, lawyers, and farmers; herdsman, sailors, merchants, miners, cooks, nay, even the dissolute, thinking it right and religious to offer a tenth of their increase to the gods. This practice of

* *De bell. Gal.*, lib. 6, p. 132.

† Selden, p. 269.

tithe-giving was known and observed also among other European nations such as the Samothracians, Liparians, Gauls, and even Britons and Saxons.

And these facts are witnessed to by the most famous authors of antiquity, such as Herodotus, Thucydides, Xenophon, Aristophanes, Plutarch, and Demosthenes among the Greeks; and, among the Romans, by Varro, Julius Cæsar, Pliny and others; their testimony as a whole tending to show that the Greeks, Romans, and all other principal civilized but heathen nations of early Europe recognized it as a religious duty to offer a part of their property to the gods, the proportion offered being to the whole, rarely less, but in some cases more, than a tenth.

What, then, is suggested by this array of facts, from early Europe, Eastern Africa, and Western Asia, concerning tithe-giving?

When philologists and grammarians observe that many words of a class (belonging, for instance, to agriculture) linger in use among peoples now widely separated, and having no visible connection with one another, these students of comparative tongues infer that at some time, in the remote past, the ancestors of such peoples must have lived together and spoken such words in a common language. And such philological observations, comparisons, and inferences are called "scientific." Let us then be similarly scientific with the facts we have had under review.

We have traced the practice of tithe-giving into almost every known country of importance in what we call the ancient western world. But when did the practice begin? Roman history takes us back only to the day when two boys were suckled by a she-wolf, nor does Grecian lore go far behind the Trojan war.

Egyptian hieroglyphics conduct us further back, and the cuneiform inscriptions of Western Asia, perhaps, further still. But, though the earliest historical records seem to bear witness to the existence of the practice of tithe-giving from the remotest times, yet have we found no secular inscription that tells us when, or where, tithe-giving began, or who issued the law for its observance. Yet here are the facts before us, and they have to be accounted for. If it was originally left to every man to give for religious purposes according to his own inclination as much or as little as he pleased, then how should so many peoples have hit upon a tenth for God's portion, rather than a fifth, or a fifteenth, or any other

proportion? Does not the universality of this proportion among early Pagan nations point to a time when the ancestors of those nations lived together, and so derived the custom from a common source?

I have purposely confined my inquiries to what we understood by heathen testimony, from which we have seen that the practice of tithe-giving was usually, or at all events frequently, connected with the payment of first-fruits; with a priesthood; and with the presenting of sacrifice to a Divine being; all which things point to a religious or divine rather than a human origin.

If then we are disposed to allow that sacrifice was not a human invention devised by the wit of man, but rather of divine origin, is it not reasonable to argue that when the Deity appointed, as acceptable to Himself, certain things that were clean, and others not so, He also appointed the quantity or proportion in which such things should be offered, the overwhelming probability being, in the face of the facts before us, that the proportion so appointed was a tenth?

The CHAIRMAN (Commander HEATH, R.N.).—I am sure all will join in according their thanks for this paper.

Mr. T. W. E. HIGGINS.—The author speaks of payment of tithes in connection (amongst other things) with the priesthood. I notice that Dr. Robertson Smith in his work on the *Religion of the Semites*, says that the "payment of tithes" was rather a modern than an ancient custom; but it appears to me, from this paper, that tithes were not entirely connected with the priesthood.

Dr. Robertson Smith's idea appears to be that tithes only grew up where priesthood originated, and that it was only where the latter had magnificent temples that they were paid. But all the facts of this paper seem to bear the other way. The question, in Babylonia, is treated in detail, and this appears to be a powerful argument; for, as the author says, all these people hit on one-tenth. There must have been some reason for it, for it is clear they would not have hit on that particular proportion merely by accident.

The AUTHOR.—I am much obliged to you, Mr. Chairman, and to the audience, for the appreciation you have expressed of my paper. Of course you will see that in quoting my authorities I have kept strictly to sources outside the Bible. I have purposely done so, for it gives a far stronger vantage ground if one can show that tithes were paid in Babylonia 2100 years before Christ, and if you can show that before Abraham was born tithes were in vogue. We know that Abraham paid tithes, and if we can show that from secular sources, you next open up the question of patriarchal tithe-giving, which is enough for a paper of itself.

We have among the Jews, under the Mosaic Law, the tithe-giving of the Old Testament, and then, if you go on, you find it in the Apocryphal and Talmudic records. Then you may pass on to the New Testament and the early Church, and you find there the custom was practised to a very large extent all through the centuries from the remotest period of history.

The Meeting was then adjourned.

NOTE.

On the last page of his paper the author refers to a time when the evidence collected tends to show that the ancestors of the nations lived together (p. 137). It is interesting to find the fact of the original unity of the human race thus contended for,* urged on other grounds by the Right Hon. F. Max Müller, M.A., D.C.L.

* Again,—“From the most widely separated nationalities of the old world we find proofs of the existence of primeval doctrines, theories of cosmical, religious, political, and even social character, so similar in detail that the hypothesis of their common origin in some region that had been historically and geographically the centre of all their peoples, seems to be completely established.” Article on “Prehistoric civilization,” *Biblia*, vol. xi, p. 195.—ED.

In the inaugural Address of the Congress of Orientalists held in London in 1895, arguing on philological grounds, he said :—

“ It is the study of words, it is the science of language that has withdrawn the curtain which formerly concealed these ancient times and their intellectual struggles from the sight of historians. Even now, when scholars speak of languages, and families of languages, they often forget that languages mean speakers of languages, and families of speech presuppose real families, or classes or powerful confederacies which have struggled for their existence and held their ground against all enemies. Languages, as we read in the Book of Daniel, are the same as nations that dwell on all the earth. If, therefore, Greeks and Romans, Celts, Germans, Slavs, Persians, and Indians, speaking different languages, and each forming a separate nationality, constitute, as long as we know them, a real historical fact, there is another fact equally real and historical, though we may refer it to a prehistoric period, namely, that there was a time when the ancestors of all these nations and languages formed one compact body, speaking one and the same language, a language so real, so truly historical, that without it there would never have been a real Greek, a real Latin language, never a Greek Republic, never a Roman Empire; there would have been no Sanscrit, no Vedas, no Avesta, no Plato, no Greek New Testament.”—ED.

INTERMEDIATE MEETING.*

PROFESSOR E. HULL, LL.D., F.R.S., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following elections were announced :—

ASSOCIATE :—The Right Rev. Charles John Ellicott, D.D., Lord Bishop of Gloucester.

A description of the “Sphinx—its purpose,” etc., was given by Major-General A. B. Tulloch, C.B., C.M.G., and some brief remarks on Science and Faith, by the President, were read.

* March 7th, 1898.

INTERMEDIATE MEETING.*

PROFESSOR E. HULL, LL.D., F.R.S., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following election was announced :—

M. A. Laurence, London.

A lecture “On the Two Babylonian Versions of the Story of the Flood” was then given by Theo. G. Pinches, Esq., M.R.A.S. A discussion followed in which several took part. (It is hoped that this inquiry may soon be satisfactorily prosecuted.)

* March 21st, 1898.

ORDINARY MEETING.*

THE VEN. ARCHDEACON ROBINSON THORNTON, D.D., V.P.,
IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following Elections were announced :—

MEMBER :—Rev. E. Pitcairn Wright, London.

ASSOCIATE :—Rev. I. K. Hill, China.

CORRESPONDING MEMBER :—Pastor Georg Stosch, D.D., Berlin.

The following paper was read by the Author :—

*ANOTHER POSSIBLE CAUSE OF THE GLACIAL
EPOCH.* By Professor EDWARD HULL, LL.D., F.R.S.,
F.G.S. (Plate.)

PART I.—INTRODUCTORY.

IT is known from soundings, carried out by the United States Navy, the British Admiralty and by private enterprise, that the eastern coast of America has for its margin a submerged terrace—known as “the Continental Shelf”—which stretches from the coast outwards to the hundred-fathom line, and terminates along an escarpment going down to about 450 to 500 fathoms, when another terrace is met with stretching for a greater or less distance under the Atlantic with an average depth of 2,700 to 3,000 feet, and in its turn bounded by a steep descent leading down into the abysmal depths of the ocean, which vary from 12,000 to 13,000 feet or more below the present surface. This second and deeper terrace, determined by Professor A. Agassiz, has been named by him “The Blake

* January 17th, 1898.

Plateau.”* Off Cape Hatteras the breadth of the Continental Shelf is 15 miles, but it increases to 100 miles off the coast of New England, and to 200 miles off the coast of Maine.† The slope from 100 to 500 fathoms is often so steep, that the two contours approach very close together. The outer slope of the Blake Plateau is also remarkably steep in some places, so that the contours of 500 and 1,000 fathoms come almost into contact on the charts, as, for example, off Cape Hatteras. These two submarine terraces, with their marginal slopes, are continued around the West Indian Islands, the Gulf of Mexico, and the Caribbean Sea. In the Gulf of Mexico the Continental Shelf, shown by the 100-fathom line, stretches for long distances from the shore, especially from the Northern Coast and Yucatan, where it is distant 150 miles from the coast. Inside Florida the distance is about the same; and as the 100-fathom contour represents very closely the general continental margin, the *massifs* of the peninsulas of Florida and of Yucatan have more than twice their apparent breadth.‡

These two terraces, continuous as they are throughout such a great extent of coast-line, and with levels so generally uniform, naturally suggest formation during one or more periods of emergence and depression, interrupted by pauses; and this impression has been corroborated by the further determinations of Professor J. W. Spencer, drawn from a careful delineation of the physical features of these submarine terraces and their marginal slopes, resulting in a remarkable advance in our views of suboceanic geography.§ Briefly stated Professor Spencer shows that most of the river-valleys of the American continent opening into the Atlantic or the Gulf of Mexico are continued under the ocean, traversing first the Continental Shelf and then passing onwards through deep and wide “embayments” to the Blake Plateau, which they also traverse, until finally lost in the abyssal region,

* *Three Cruises of the “Blake”* (1888).

† Agassiz, *ibid.*, p. 95.

‡ *Ibid.*, p. 102. These terraces are represented by shading on the accompanying map (Plate).

§ “Reconstruction of the Antillæan Continent,” *Bull. Geol. Soc., Amer.*, vol. vi (1895); also, “Terrestrial Submergence of the South-east of the American Continent,” *Ibid.*, vol. v (1893). A copious review of Prof. Spencer’s, *Memoirs* by Mr. A. J. Jukes-Browne, appeared in the *Geological Magazine*, April, 1895. Startling as are the deductions of Prof. Spencer, I am not aware that they are contested by any American geologist of eminence.

which they enter through channels so deep that, if elevated into land, they would resemble the great cañons of Western America. Some of the channels which cross the Blake Plateau are traceable for 200 to 300 miles, and reach depths of 10,000 feet before being lost in the suboceanic embayments. Similar features are presented by the deep channels which furrow the shelf of the Bahama Islands, and also by those of the Gulf of Mexico. But there is one remarkable feature which ought not to be omitted from notice here, viz., that the submerged channel between the peninsula of Florida and the Bahamas appears to have been a saddle or watershed, from which cañons descended eastwards towards the Atlantic, and westwards towards the Gulf of Mexico. Professor Spencer has named the latter the "Floridian" Valley. The Mississippi and all the great rivers which enter the northern shore of the Gulf of Mexico have their apparent prolongations in well-defined submerged river-valleys, to which Professor Spencer has given definite names. They have their final "embayments" at depths of about 9,000 to 10,000 feet. The same is also true of the rivers entering the Atlantic. The submarine cañons are in effect drowned river extensions opening out on the abyssal floor at depths of about 10,000 feet, under the surface of the Gulf Stream. Amongst the West India Islands the "Haitian" cañon passes on to the Atlantic floor between the Bahama Banks and the islands of Cuba and Saint Domingo; other examples might be cited, but enough has been said to give a general idea of the author's determinations. It is now time to state the conclusions at which he arrives. He maintains that the physical features determined by the soundings are such as can only be explained by supposing an uplift of the whole region bordering the Atlantic to the extent of the depth of these submerged river channels, namely, 10,000 to 12,000 feet as compared with the present sea-level, by which the coast of South America was connected with that of the Northern Continent by a plateau of continuous land now constituting the floors of the West India Islands, and converting them into the "Antillean Continent." This uprise gradually lessened westwards, and was counter-balanced by a depression of Central America, owing to which the Gulf of Mexico and Caribbean Sea were connected with the Pacific. From geological considerations this uprise took place at two epochs, viz., the Pliocene and Pleistocene, with an intervening epoch of depression; and the later uplift

was followed by several minor oscillations resulting in the present arrangement of land and sea. The distribution of the land fauna and flora seems also to be corroborative of Professor Spencer's views.

Such conclusions are sufficiently startling; but for myself, I do not see how they are to be controverted. The submerged terraces, and profound valleys by which they are traversed, are such as could only have been formed under sub-aërial conditions; it is impossible to conceive of their formation while under the waters of the ocean.*

The evidence of the former greater elevation of the American coast finds its counterpart in that of Greenland and the plateau on which stand the British Isles and Scandinavia defined by the 100-fathom line. That this plateau was a land surface drained by rivers continuous with the Rhine and others has been shown by Godwin-Austen, Professor T. Rupert Jones, and more recently by Mr. F. W. Harmer†; while as regards Greenland, Mr. T. C. Chamberlin, of America, has recently stated that "there is no ground to question the former elevation of Greenland."‡ It would therefore appear that the elevation which affected the eastern coast of the American Continent was continuous all round the northern and western shores of the North Atlantic. The views of Mr. Warren Upham tend to confirm this conclusion.§

As regards the period when these "stupendous changes of level" took place, Professor Spencer says that they reached their culminating point in the Post-Lafayette, or early Pleistocene epoch of Eastern America.|| For the grounds of this conclusion the reader must be referred to Professor Spencer's memoir itself.

It has been suggested to me by more than one friendly critic that the submerged terraces and river-valleys have required a longer period for their formation than one special

* Professor Spencer considers that the floors of the Gulf of Mexico and of the Caribbean Sea were converted into plains. This does not appear to be a well-founded conclusion; they may have been inland seas during the continental period as shown on the accompanying map.

† "The Pliocene deposits of Holland, etc.," *Quart. Journ. Geol. Soc.*, November, 1896, p. 748.

‡ "Recent Glacial Studies in Greenland," *Bull. Geol. Soc., America*, vol. vi, p. 219. (1895.)

§ "Causes of the Ice Age," *Journ. Vict. Inst.*, vol. xxix, p. 201.

|| *Supra cit.*, p. 307.

epoch of the Pleistocene, in fact, that it may have begun in the Pliocene period, and that their present development is the ultimate outcome of erosive action continued through a very long lapse of time.* This is a view which commends itself to the judgment, and may be readily accepted. Possibly "the continental shelf" may be the result of Pliocene erosion; and the deeper shelf with its cross-cutting channels, that of the Pleistocene epoch. A Pliocene erosion extending down to 100 fathoms, or less, would not have been sufficient to cut off the arm of the Equatorial current from the Gulf of Mexico to the extent effected in the later Pleistocene epoch, but may have done so to some extent. We must not forget that the decrease of temperature due to the diversion of the Atlantic stream from its course into the Caribbean and Mexican Gulfs into the North Atlantic was a slow and gradual change commencing towards the close of the Pliocene and attaining its maximum effect in the succeeding epoch.

In concluding his memoir Dr. Spencer observes that "this study establishes the great mobility of the earth's crust, and opens out many new problems in dynamic geology." I propose to deal with one of the more evident problems arising from this inquiry; namely, the effect of the uprising of the Antillæan continent on the temperature of the Gulf Stream, and on the consequent climatic conditions of Western Europe and the adjoining regions.

PART II.—THE GULF STREAM.

During the uprising of the Antillæan continent, that branch of the great equatorial current which now enters the Caribbean Sea and passes on into the Gulf of Mexico must have pursued a very different course from that of the present day. Its passage into the Gulf was debarred by the coast of high continental land, the direction of which must have caused the current to pass directly northwards into the North Atlantic as shown on the accompanying map (Plate). Such a change in direction would result in a difference of temperature, and we shall endeavour to ascertain, with some degree of accuracy, the amount of variation as compared with that of the present day.

* This, indeed, may be inferred from the language of Professor Spencer himself, when he says that the changes reached "their *culminating point*" in the Pleistocene period.

It is known that the Gulf Stream receives a large accession of heat between the time that it enters the Caribbean Sea and leaves the Gulf of Mexico through the Straits of Florida. Off Cape S. Roque the surface temperature is 73° Fahr., and on issuing from the Gulf it has risen to 86° Fahr. having in its passage gained 13 degrees of heat. Increasing its latitude by ten degrees it loses but two degrees of heat, and with this temperature of 84° Fahr. it crosses the 40th parallel, and spreads itself out over thousands of square leagues—carrying its warmth into the Arctic regions, and giving an increase of twelve degrees of temperature to the climate of the British Isles above that due to latitude.*

Geographers have exhausted the powers of illustration in endeavouring to estimate the calorific effects of this great oceanic river. Croll states that each cubit foot of water carries from the tropics for distribution upwards of 1,158,000 foot pounds of heat.† The estimates of Maury and Herschell are still larger. According to the calculations of Meech the amount of heat transferred to the Arctic regions by the Gulf Stream is nearly half as much as that derived from the sun.‡ Lastly, Professor J. D. Forbes calculated that the quantity of heat thrown off in the Atlantic area by the Gulf Stream on a winter's day, would raise the temperature of the atmosphere which rests upon France and the British Isles from freezing point to summer heat.§ These statements will suffice to represent the effects of the Gulf Stream as it exists at the present day; we have now to inquire to what extent they would be modified under the view of the uprising of a barrier of land connecting North and South America along the line of the Antilles.

We have already seen that the Gulf Stream gains thirteen degrees of heat between C. San Roque and the Florida Straits. If we allow one degree for the increase between C. San Roque and the entrance to the Caribbean Sea, the gain between this point and the Narrows will be twelve degrees. If instead of entering the Caribbean Sea, the stream passed northwards along the coast of continental land, it would have been deprived of twelve degrees of heat, but it would have gained some heat while flowing for

* Croll calculates that on leaving the Gulf the mean temperature of the Stream is not under 65° Fahr.; *Climate and Time*, p. 25.

† *Ibid.*, p. 25.

‡ Meech, *Smithsonian Contributions to Knowledge*, vol. ix.

§ Forbes, *Travels in Norway*, p. 202.

1,000 miles under the rays of a tropical sun. If we allow two degrees for this, then the total loss of heat on passing the coast of Florida will have been ten degrees as compared with that of the present day; and instead of crossing the 40th parallel with a surface temperature of 84° Fahr. as stated above, the Gulf Stream of the period referred to would have only had a temperature of 74° Fahr., which would not be very much in excess of the summer temperature of the waters due to latitude at this parallel.*

We have now to inquire what would be the effect of so great a reduction of temperature upon the climate of the North Atlantic and adjoining regions. A diminution of ten degrees of heat as compared with that of the present day would undoubtedly exercise a very important influence on the climate of the regions bordering the North Atlantic and the coast and islands of the Arctic Ocean. Not only would the annual mean temperature be considerably reduced, but the increase of snow and ice over those tracts which are at present on the verge of perpetually glacial conditions would have the effect of lowering the temperature far beyond their own limits. As Lyell has truly observed, land in Arctic regions conduces to cold; and owing to the great extent of additional land in Europe and Asia which would be brought under the influence of an Arctic climate by the lowering of the temperature, the cold would be increased in the adjoining regions lying to the south.

There is one way, perhaps the only way, by which we may indicate diagrammatically the climatic conditions of which we are in search under the hypothesis of a North Atlantic current taking the place of the Gulf Stream, but with a temperature ten degrees lower than the latter. If we suppose that the annual mean temperature of all those regions influenced by the Gulf Stream as far south as (say) the parallel of 40° N. is reduced by about ten degrees below its present range, then we shall have the present isotherm of

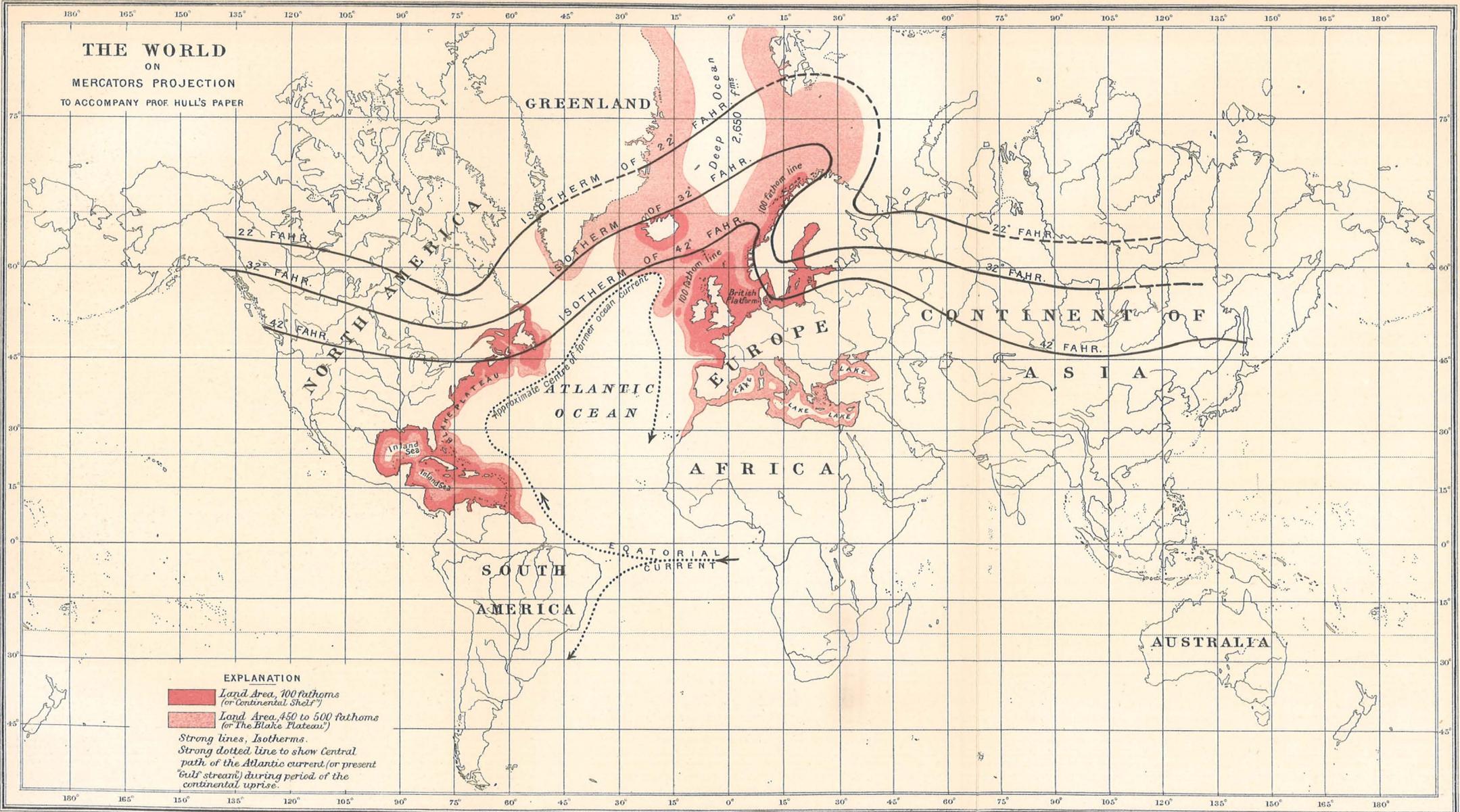
* Rennell has calculated that the waters of the Gulf Stream on leaving the Gulf of Mexico with a surface temperature of 86° Fahr. are 10° above that of the Atlantic in the same latitude; quot. by Lyell, *Principles*; 2nd edition, p. 244. A portion of the waters of the equatorial branch even now passes along the east coast of the West India Islands, ultimately joining the Gulf Stream. All this time however they are acquiring heat, but not to the extent which would be the case if they followed the main stream. The amount, however, is unimportant in its bearing on the question before us, as the conditions of this branch of the Equatorial current would have suffered no change.

(let us say) 32° Fahr. taking the position of that of 42° Fahr., and that of 42° taking the position of that of 52° ; there will, in fact, be a general advance of cold southward. Then by observing the climatic conditions of the regions crossed by the present isotherms of 32° and 42° we shall be able to form an approximate idea of the climate, under the hypothetical conditions of temperature we are here considering. I am well aware that this mode of determination would not, in all cases, give strictly accurate results. Climates depend not only on temperature, but on relations of land and sea, on levels, prevalent winds and other conditions; but temperature is a main factor, and the mode of determination here suggested will probably afford fairly reliable results.

Isotherms.—Of all the isothermal lines representing annual mean temperature that may be drawn across the chart of the northern hemisphere, none is more important than that of 32° Fahr., the freezing point of water. This isotherm, according to Berghaus,* crosses America from lat. 58° N. on the west coast, to Cape Charles, lat. $52^{\circ} 35'$ N. on the east, skirts the southern coast of Greenland and crosses the Atlantic by the northern coast of Iceland, entering Europe near the North Cape; then trending southwards along the coast of Norway to the south of the Arctic circle, it crosses the Europe-Asian continent nearly along the 60th parallel to the coast of China. This isotherm is everywhere to the south of the Arctic circle except in that part of the Atlantic bordering the coast of Norway and lying to the south-east of Iceland, where it passes the circle along the arm of the Gulf Stream which, even in these high latitudes, gives evidence of its power to ameliorate the rigour of the climate.

The isotherm of 32° Fahr. may be regarded as a convenient line of demarcation between the permanently glacial regions and those which enjoy a temperate climate. To the north of this line are situated the frozen regions of Hudson's Bay, Labrador, Baffin's Bay and Davis Straits (regions only accessible during two or three months in the year), the continental-island of Greenland enshrouded in eternal snow and ice, the Greenland Sea blocked by ice-floes, the glacial isles of Spitzbergen and Franz Joseph Land, Novaia Zemlia and Liakov Isles (New Siberia) with the surrounding Arctic sea, whose surface of ice is only penetrable during three

* *Physikalischer Atlas* (Gotha, 1892). See map (Plate).



THE WORLD

ON

MERCATORS PROJECTION

TO ACCOMPANY PROF. HULL'S PAPER

- EXPLANATION**
- Land Area, 100 fathoms (or "Continental Shelf")
 - Land Area, 450 to 500 fathoms (or "The Blake Plateau")

Strong lines, Isotherms.
 Strong dotted line to show Central path of the Atlantic current (or present "cut" stream) during period of the continental uprise.

MAP TO ACCOMPANY PROF. HULL'S PAPER READ BEFORE THE VICTORIA INSTITUTE.

Stanford's Geog. Estab., London.

months in the year; lastly, the mountains of North Norway and Lapland and the frigid tracts of Siberia bordering the ocean, where the soil is permanently frozen a few inches below the surface; of all these regions it may be said, that if their temperature ever rises above freezing point of water, it is only to the extent of a very few degrees during the three summer months.*

Isotherm of 42° Fahr.—Very different is the climate enjoyed by those regions lying under the isothermal line of 42°. Leaving the western coast of America at Vancouver it crosses that continent by the Great Lakes to Nova Scotia in lat. 45° N.; then driven northwards by the Gulf Stream it crosses the 60th parallel half-way between Iceland and Scotland and reaches the coast of Norway a little north of Bergen, then curving round the southern shores of Scandinavia, passes into Russia south of St. Petersburg, and crosses Central Asia near the intersection of the parallel of 45° N. by the meridian of 90° E. This isotherm, except when it passes over the Atlantic, is characterized by extremes of heat and cold; but the heat predominates, and glacial conditions are impossible except at high altitudes such as are afforded by the mountains of Norway.

Effect of the conversion of the isotherm of 42° into that of 32°.—We are safe in supposing that if the isotherm of 32° once occupied the position of 42° of the present day, the climate along this line was very different from that which now prevails; let us endeavour to define its conditions in outline.

As regards America it may be inferred that the Great Lakes were in their northern portions permanently frozen over like the waters of Hudson Bay throughout eight months in the year, while Labrador and the lands lying along the western shore of Hudson Bay and extending to the shores of the Great Lakes were covered by snow which the sun of summer would be unable to melt. There would

* The following are some of the temperature observations within the Polar regions:—

		Three Summer Months.	Three Winter Months.	An. mean temp.
Banks' Land	Lat. 74° N.	+ 35°	— 5·7	+ 1°·8 Fahr.
Parry Island	„ 74° 25'	+ 37°	— 10·6	+ 1°·4 „
Cornwallis Island	„ 74° 45'	+ 36°	— 8·6	+ 2°·5 „
Northumberland Sound	„ 77° 0'	+ 30°·8	— 11·8	— 1°·1 „

not be much change in the condition of Greenland or of the neighbouring seas except in the direction of increase of cold and greater accumulation of snow and ice. As regards Scandinavia we may safely infer that, owing to the increase of cold and the enormous precipitation of snow on the western slopes of the mountains, the snow line would descend far below its present limits, and glaciers would enter the sea north of the Arctic circle, where the ocean would resemble that of Davis Straits at the present day. That the highlands of the British Islands would be sufficiently cold to support perennial snow and glaciers may also be assumed. At the present day some of the highest parts of the Grampians are not much below the snow line, and snow often lies on Ben Nevis and Ben Mac Dhui all the year round. But we need not follow the subject further except to observe that the additional accumulations of snow on the higher regions would tend to intensify the cold throughout all the adjoining tracts of Western and Northern Europe and Asia.

PART III.—EFFECTS OF ELEVATION OF LAND.

But we must not forget that, as shown by Prof. Spencer, and more recently by Mr. Warren Upham, the submerged platforms and river-valleys occur along the American coast at least as far north as the Susquehanna in lat. 42° N., while other drowned "fjords" have been determined by Lindenkohl in connection with the Hudson—descending to 2,250 and 2,844 feet below the surface of the sea.* These features indicate elevation of the American continent—along the Atlantic coast—but, though not to the extent which was indicated in the case of the Antilles, still sufficient to have produced very marked effects on the climate of Eastern America. If this be so, then to the cold produced by the lowering of the temperature of the Gulf Stream must be added that due to increased elevation of the continental land itself. The combined effect of these two factors would, as it seems to me, suffice to call into existence a glacial climate of great severity over the region lying to the north of the St. Lawrence and the Great Lakes.

As regards the area of the British Isles and Western

* *Report U.S. Coast Survey for 1884*, pp. 435-81. J. D. Dana, *Am. Journ. Sci.* iii, vol. xl, pp. 425-437.

Europe a few words may be added to those in a previous page. It has been established as above stated, by the observations of Mr. Godwin-Austen,* Prestwich,† Delesse,‡ and Rupert Jones,§ that the platform upon which they are built was elevated to the extent of the 100-fathom line, owing to which Great Britain was united to Europe on the east and Ireland on the west. The distribution of the land fauna and flora requires such an hypothesis; as does the extension of the glaciers and sheets of ice over the area of the Irish Sea and the isles which border the western coasts of Ireland and Scotland from their centres of dispersion. At the time of this elevation, which, according to Mr. Godwin-Austen, was the close of the Pliocene period, Snowdon would have reached an elevation of 4,200 feet, Ben Nevis and Ben Mac Dhui about 5,000 feet each, and the Reeks, 4,014 feet. The whole region would have suffered a considerable decrease of temperature as compared with that of the present day; and, if in addition to this cause of increased cold, we add that arising from a reduction in the temperature of the Gulf Stream, we seem to be warranted in coming to the conclusion that such physical conditions would have brought about a glacial climate in this region.

Region of the Mediterranean, Southern Europe and Western Asia.—It may be objected that the hypothesis here advocated is insufficient to account for the colder conditions of climate which affected Southern Europe and the regions bordering the Mediterranean and extending eastward to the Himalayas. Throughout all these regions we have evidence that the climate was colder than at present during the Pleistocene period, resulting in the extension of the glaciers in the Alps, the Pyrenees, Caucasus and the Himalayas themselves; while, as Sir Joseph Hooker has shown, glaciers were formed

* *Quart. Journ. Geol. Soc.*, vol. vi, p. 69.

† *Geology*, vol. i, p. 118, and vol. vii, p. 118.

‡ *Lithologie des mers de France* (1871).

§ "Antiquity of Man," *Rep. Croydon Micros. Club*, 1877, p. 2. This paper is accompanied by a map showing the land area produced by an uprise of 600 feet (100 fathoms) above the present sea-level. It is remarkable that this platform corresponds in position to the Continental Shelf of Eastern America above described. The descent from the 100-fathom plateau to that of 1,000 fathoms is remarkably steep along the western margin off the coasts of the British Isles, France and Spain; see Professor C. Wyville Thomson's *The Depths of the Sea*, Plate VII, p. 362 (1873).

amongst the mountains of the Lebanon from which they are now altogether absent.*

To this objection there may be offered two very forcible answers. *First*.—It may be confidently asserted that a general lowering of the temperature and change in the climate of Western Europe would necessarily produce some effect in the same direction on the regions lying beyond. If the climate of Scandinavia, of the British Isles, of France, Spain and Portugal became sensibly more rigorous, it is clear that owing to the circulation of the air currents, the climate of the adjoining regions to the eastward would also experience at least a proportionate change in the same direction owing to the greater accumulation of ice and snow in the higher altitudes. It is impossible to say to what distance this influence would extend, and did extend during the Pleistocene period; especially during the epoch of maximum cold. I think it may safely be assumed that none of the regions above enumerated were altogether unaffected by it; and for my own part I am inclined to believe that the entire northern hemisphere felt the loss of heat due to the diminution of temperature of the Gulf Stream.

Second.—But there remains a still more potent cause for the greater prevalence of glacial conditions than is the case at present in the regions referred to. It is well-known that towards the close of the Pliocene period the vast tract embracing the basin of the Mediterranean and adjoining regions extending eastward was undergoing gradual changes as regards the relations of land and sea. After a slight depression—during which sea-beaches were formed along the old coast lines in the lands bordering the Levant, there ensued a process of elevation ultimately resulting in the conversion of the Mediterranean basin into a chain of fresh-water lakes connected by rivers with the Black Sea and Caspian, and closed against the influx of the Atlantic waters by the uprise of the sea-bed at the Straits of Gibraltar. At this period Sicily was connected with Malta and Tunis, while the island was inhabited by elephants and hippopotami, as shown by Leith Adams and Spratt. The two lakes thus formed were connected by a river channel crossing the “Medina Bank,” which is now submerged to a depth of 250 fathoms.†

* Hooker, *On the Cedars of Lebanon*, *Nat. Hist. Rev.*, 1862; also, Sir W. W. Smyth, *Pres. Address Geol. Soc.* (1868), *Quart. Journ.*, vol. xxiv, p. 58.

† Spratt, *Quart. Journ. Geol. Soc.*, vol. xxiii, p. 292.

Without going further into this very interesting subject, which I have dealt with in a former communication to this Institute,* it must here suffice to state that owing to the uprise of the whole region to the extent of 1,200 to 1,500 feet (200 to 250 fathoms) large tracts now under water were converted into land, and the adjoining land areas were upraised. This uprising of the land necessarily brought certain mountainous tracts within the limits of the snow line—as was the case in the Lebanon—where, as Sir J. D. Hooker has shown, glaciers were formed which have left their old moraines at a level of 4,000 feet above the present surface of the Mediterranean; mountainous regions such as the Caucasus, where perennial snow lies, were subjected to a more rigorous climate. That this general elevation of the Mediterranean and Syrian region extended much farther eastward I cannot doubt; how far it is impossible to say; but there does not appear to be any reason why its influence may not have been felt as far as the Himalayas, where, as we know from the observations of Sir J. D. Hooker, the glaciers once descended far below their present limits.† In all these considerations we must remember that the two possible causes—those of reduced temperature and of land elevation—were acting simultaneously; and it is to their combined influence that I venture to ascribe the general lowering of temperature, and prevalence of more Arctic climatic conditions of which we have evidence during the Pleistocene period.

PART IV.—CONCLUSION.

The causes which have been assigned for a glacial epoch may be arranged under two heads—the astronomical and the terrestrial. Under the former may be placed the theory of the late Dr. Croll, which has the support of Prof. James Geikie, and that of Sir Robert Ball more recently enunciated; under the latter is that of Lyell, who held that “in determining the climate of the globe geographical changes have exercised a preponderating influence.”‡ Croll’s hypothesis has been examined by Lyell, Prestwich,§ and others, who are unable to accept its conclusions, as well on astronomical as on physical grounds. Lyell in the last edition of

* *Trans. Vict. Inst.*, vol. xxix (1895).

† Hooker, *Himalayan Journals*, vols. i and ii (1855).

‡ *Principles*, vol. i, ch. 12.

§ *Geology*, vol. ii, p. 528.

his great work still adheres to his original views, which find support in the conclusions arrived at in the present paper. Few will deny that, but for the Gulf Stream, the British Islands and Northern Europe would now be subjected to glacial conditions; and with the aid of Professor Spencer's researches I have attempted to show how such conditions were brought about.

POSTSCRIPT.—Since the above was written, Mr. Warren Upham, of the United States Geological Survey, has dealt with this subject in an able paper communicated to the Institute in the Session of 1896-7,* and corroborates generally the views of Prof. Spencer, and other American geologists, including Dana and Le Conte, regarding the former great uprise of the continental lands at, or near the commencement of the Glacial epoch; arriving at similar conclusions with those of the author of this paper, but based mainly on the view of the lowering of temperature due to such elevation. In the paper here given to the Institute, I have endeavoured to show how, in addition to the lowering of temperature due to elevation of land in the Northern Hemisphere, the deflection of the Gulf Stream must have also materially influenced the climatic conditions. It need scarcely be stated that both papers were written altogether independently of each other; but their agreement in the conclusions will be regarded as confirmatory of the "epeirogenic" or "earth-movement" hypothesis.

The most able opponent of this hypothesis is Prof. James Geikie, and I have re-read his elaborate communication to this Institute,† dealing with this subject, in order to refresh my memory as regards his views and arguments; which have also been dealt with by Mr. Warren Upham; and as it seems to me, in the main, successfully.‡ I cannot see, for instance, upon what ground Prof. Geikie considers the American uplift to have been long antecedent to the Pleistocene epoch. Of course the uprise of the land around the shores of the North Atlantic was gradual, and the accumulation of snow and ice would also have been a very slow process; but both Spencer and Upham are agreed that this uprise commenced with the close of the Pliocene period; a

* Upham, "Causes of the Ice Age," *Journ. Vict. Inst.*, vol. xxix, p. 201 (1897).

† *Ibid.*, vol. xxvi.

‡ *Ibid.*, pp. 221 and 254, also vol. xxix, p. 237.

view which seems the more reasonable one.* At the same time I agree with Prof. Geikie in doubting that the oscillations of land of the Pleistocene period were to any great extent (if at all) due to the weight of accumulated snow (or its removal), as supposed by Dana. In the view of the occurrence of two cold epochs with an intervening warmer (or interglacial) stage, I have long been a believer, and maintain that it is borne out by the glacial phenomena of the British Isles, as I endeavoured to show many years ago,† but such movements were probably not dissimilar in their origin and cause to those of former geological periods to which the crust of the earth has been accustomed.

POSTSCRIPT.

Although it is some time ago since I received the following letter bearing upon the subject I have taken up in my paper, yet the author is so recognised an authority on Arctic matters that with his permission I quote it.

Col. H. W. FEILDEN, F.G.S., writes to me, December 13th, 1896:—

“I am inclined to think that there is much force in your view that the so-called Glacial epoch was due in a great measure to some deflection of the warm current from the Polar Basin.

“If Professor Spencer is correct the elimination of the Gulf of Mexico would deprive the northern Atlantic of its chief heating apparatus, and might induce glacial conditions over Scandinavia. If a system of glaciation sets in anywhere, where the precipitation exceeds the melting forces, there is no saying where it may end, given sufficient lapse of time.

“There is, however, another side of the proposition, about which I should like your opinion.

* See on this point a more recent paper by Professor Spencer on “The Continental Elevation of the Glacial Period,” *Geological Magazine*, January, 1898. In this paper the author extends his observations on the great continental uprise to the eastern and northern coasts of the Atlantic, suggesting changes regarding the European and British area far in excess of those referred to by myself for these regions.

† *Physical History of the British Isles*, ch. xiii, plates 13 and 14 (1882).

“Undoubtedly, the glaciation of the vast island-continent of Greenland, 1,200 miles in extent, north and south, is due to the refrigerating influences of the great Polar drift of cold water sweeping down its east side, swirling round Cape Farewell, and running up to Holstenborg on the west side. Whilst the icy current coming down Smith Sound plays a similar part on the west side.

“Now, if we could deflect this Polar current, so that it came down the Baltic, as it probably did, and along the west side of Norway, would not Scandinavia be as glaciated as Greenland, and England, Scotland, and Ireland, and the Faeroes, much as Spitsbergen is to-day ?

“Again, is there any proof that the glaciation of North America was coincident with the Glacial epoch of Europe ?

“Most travellers in those regions have pointed to the proofs of remarkable rapid elevation in recent times of the islands of the American Archipelago and of Grinnell Land, where recent shell-beds stand at an elevation of 1,000 feet.

“If we could again sink the American Archipelago 1,000 feet, the fender or buttress which keeps out the Palæocrystic ice would be removed, and that ice would pile up on the shore of the continent of America, much farther south than now, and probably glaciates it.”

Here Colonel Feilden asks my opinion on the question, whether by the deflection of the north polar current down the Baltic and the west coast of Norway, Scandinavia would be as glaciated as Greenland? and he points out that this might take place by the submergence of the islands of the American Archipelago which have recently been upraised to the extent of 1,000 feet, as shown by beds of shells.

The passage of a polar current down the Baltic would require the submergence of Lapland to the extent of over 500 feet, a state of things which in all probability formerly existed, and the passage of a north current would doubtless have the effect described; but it is to be observed that the greater part of Greenland lies further north by 10° than that of Scandinavia, the effect of which would be to cause the climate of the former to be less rigorous under any circumstances; and this result would be accentuated by the prevalent wind-currents.

Colonel Feilden also inquires whether there is any proof that the glaciation of North America was coincident with the Glacial epoch of Europe?

My reply is, that although there may be no proof, the probabilities are in favour of the view, as the uplift of the land and ocean bed seem to correspond on both sides of the Atlantic, as I have endeavoured to show. But it is otherwise with the western side of the American continent, where reciprocal (not simultaneous) conditions appear to have prevailed, as Professor Spencer has recently shown, in his paper on the "Oceanic connection of the Gulf of Mexico with the Pacific" (*Bull. Geol. Soc., Amer.*, vol. ix, 1897).

The CHAIRMAN (the Ven. R. THORNTON, D.D., V.P., Archdeacon of Middlesex), having conveyed the thanks of the meeting to Professor Hull, a discussion on some technical points took place.

COMMUNICATIONS RECEIVED IN REGARD TO THE
PRECEDING PAPER.

Professor T. RUPERT JONES,* F.R.S., writes :—

January 15th, 1898.

I have read Professor Hull's paper with much pleasure. He seems to establish the following facts and conclusions.

If we trace the 100-fathom line around the British Islands, as

* Professor Rupert Jones and Mr. Upham's communications were received in time to be read at the Meeting.

indicated on the Admiralty charts, we notice that opposite to the river-mouths opening out on the coasts there are corresponding indentations. So also off the North-east American and other coasts the deep-sea contour lines run parallel with the bays and river-mouths; and moreover the valleys of the land are continued by definite lines of relative depths (shown by soundings) down the great irregular slopes of the sea-bottom. These lines of valleys and gorges cross plateau after plateau on the ocean-floor, and notch their precipitous edges with successive gaps. These valleys are traced downwards and outwards for more than 200 miles, and even to a depth of two or more miles below the present surface of the water before they are lost on the abyssal floor of the ocean.

These successive submarine plains and plateaux were the result of littoral denudation at times when the continents high above water, were gradually sinking (like the smaller "Raised Beaches" during uprise of land), with such intervals of stability as allowed the destructive action of the air, water, and ice to make great horizontal notches along coasts and across river-channels. Consequently certain portions of the continents have been in former times at least two miles higher above the sea-level than they are now. With this elevation and wider extent of land the climate must have been much colder, even frigid enough for what has been termed a "Glacial Age."

Other points also are considered by the author. It was in late geological times that the coasts of the Northern Atlantic Ocean, both on the American and the European side, and across its northern region, had an elevation high enough for an arctic climate. The equatorial current could not then have had the heat it now obtains by its local confinement in the torrid Gulf of Mexico; and the vicinity of the snow-laden coasts of the North Atlantic would have reduced the equatorial warmth; so that it would have had little influence in ameliorating the climate of North-western Europe in the "Glacial Age."

He also intimates that, on account of the slow and unequal movements of the earth's surface, the coming and going of arctic conditions must have been different at times and places; and the glaciation of one region would not be quite synchronous with that of another. At all events a great part of North America, with North-western Europe, had a glacial climate in late Pliocene or early Pleistocene times.

The author carefully refers to the sources of information in the different parts of the subject of his paper.

Mr. WARREN UPHAM, A.M., F.G.S.A., writes :—

St. Paul, Minnesota.

January 3rd, 1898.

The explanation of the climatic changes and ice accumulations of the Glacial epoch presented in Professor Hull's paper, with its accompanying map, seems to me a most valuable addition to our understanding of this very exceptional and unique geological epoch. There can be no doubt that the epeirogenic uplifting of the lands on each side of the North Atlantic Ocean produced important changes of the Gulf Stream and of its influence on the climate of Europe. The lowering of the temperature of that great sea current may well have been a chief element in the causation of the Ice Age in the British Isles and Northern Europe, supplementing the effect due to the greatly increased altitude of the land, of which the fjords bear testimony.

In North America, however, where our storms and waves of varying barometric pressure and temperature sweep from west to east and north-east across the country, thence passing over the North Atlantic, we must, I think, ascribe the chief part in the production of the Glacial epoch to the high elevation of the land, probably 3,000 to 5,000 feet above its preglacial and its present height.

Professor Hull's map might indeed well be coloured farther into the present sea area between Europe and Greenland, to the submarine contour of 450 or 500 fathoms, as for the Blake plateau of America. If the preglacial uplift of the sea bed between the Atlantic and Arctic oceans was so great, which is very probable these oceans were completely separated by land, and the Gulf Stream and warm superficial oceanic drift from it were wholly excluded from contact with Scandinavia. That condition, in combination with the high land uplift, gives an ample explanation of the origin of the Ice Age in Europe, which seems to have been essentially contemporaneous with that of North America.

The Rev. R. ASHINGTON BULLEN, B.A., F.G.S., writes :—

There can be but one opinion about the interest and importance

of the theory set forth by Professor Hull. Huxley* leaves undecided the influence of the Gulf Stream in ameliorating the climate of Great Britain, and hints at the possibility of warm currents being due to the dominant south-westerly winds of the temperate part of the Atlantic. Under any circumstances, however, the lowering of the temperature of the Gulf Stream would have a marked effect on the temperature of the ocean and the air in the North Atlantic, and would affect the assumed currents due to the south-westerly winds.

To my mind the amelioration of our climate is mainly due to the Gulf Stream or to subsidiary currents proceeding from it. The existence of such fragile West Indian shells as *Spirula Perouii* on Portrush Beach, N. Ireland, and at Woolacombe, Devon, perfectly uninjured, † points to a branch of the Gulf Stream touching first the Irish and then the Devon coast. Mr. R. Welch, of Belfast, and friends, have collected eight to ten at a time, especially in September. ‡ *Tellina radiata*, another West Indian shell, has occurred at Courtnacsherry Bay, S.W. Ireland and other places. Sir A. Geikie § points to the occurrence of West Indian plants on the Irish coast as having been drifted across the Atlantic from west to east, or north-east.

In September, 1897, in the Allan liner *Parisian* from Liverpool to Montreal, the sea-water temperatures were logged approximately as follows :—

September 10th	about	55° 20' N. lat.	9° 0' W. long.	58° F.
”	12th	” 56° 25' ”	25° 31' ”	55° F.
”	13th	” 56° 23' ”	35° 23' ”	55° F.
”	14th	” 55° 12' ”	43° 6' ”	48° F.
”	15th	” 53° 13' ”	51° 50' ”	35° F.
”	16th,	Gulf of St. Lawrence, Cape		Norman E.S.E. 33° F.

The rapid fall from 48° to 33° F. was due to the Baffin's Bay cold current.

Now, assuming Professor Hull's statement of the lowering of the temperature due to the deflection of the Gulf Stream owing

* *Physiography*, 2nd edit., p. 174.

† *Science Gossip*, 1897, p. 150.

‡ *Ibid.*

§ Geikie, *Physical Geography*, p. 139.

to the elevation of the Antillean continent, the temperature of the waters of Gulf of St. Lawrence even in so warm a month as September would be lowered from 33° to 23° . The St. Lawrence and adjacent seas would be ice-bound, and icebergs would be set adrift, to float even farther southward (probably 1,000 miles) than at present the Greenland bergs do, with a correspondingly lowering influence upon the temperature of sea and air. Judging from the influence of a large number of bergs adrift in the North Atlantic, in producing damp and cheerless summers in the British Isles, *e.g.*, 1877, 1878, 1879, &c., such conditions as Professor Hull supposes would make summer in these islands a thoroughly "glacial" one.

Judging from what I saw of geological phenomena in Connecticut in October last, the glacial conditions further south were even more rigorous than my estimate indicates.

Professor Newcombe and Rev. E. Hill are dissatisfied as astronomers with the astronomical explanation of the cause of the glacial epoch. Sir Joseph Prestwich* has fully discussed the question of recurring glaciations, which Croll's hypothesis renders necessary, rejecting these glaciations as facts either † (1) from want of evidence; or (2) because the geological evidence is all the other way. As this and various other astronomical theories are unable to bear the strain put upon them, we must, I think, conclude that some geographical explanation is the more probable, and that, as an uplift such as Professor Hull postulates would be attended by glacial conditions, his theory, or some modification of it, may be accepted as best satisfying all the conditions of the problem.

The Rev. G. CREWDSON, M.A., writes:—

January 18th, 1898.

May I be allowed to suggest a few considerations which seem to confirm the theory which Professor Hull has so ably expounded in his paper read yesterday on "Another Possible Cause of the Glacial Epoch."

In the present day it will be observed that owing to the Antarctic cold the stream of heated equatorial water is pressed northwards, a greater breadth of the stream being north of the

* Prestwich, *Geology*, ii, p. 527, note.

† Prestwich, *Controverted Questions in Geology*, p. 23.

Equator than south of the line; consequently a larger proportion of water is diverted northwards at Cape S. Roque than would be the case if the stream were accurately equatorial.

If, however, Arctic conditions were to prevail in the North Atlantic, these conditions would be reversed, and a much larger amount of heated water would be diverted into the Brazilian current flowing southwards, than is at present the case, and the North Atlantic would receive less than its due share. This would not only lessen the amount of heat available for raising the temperature of the northern regions, but would also diminish the resistance that would be offered to cold currents from the Arctic Ocean; a point which receives increased importance from the consideration of possible changes in the Pacific area.

For there is another fact which can scarcely be said to be less than paradoxical in its character, that at the time when Northern Europe and Eastern North America were enduring a climate of exceptional rigour, Siberia and Western North America were enjoying a comparatively temperate climate. Somehow or other, therefore, warmth must have been able to find its way into the Arctic regions in that hemisphere at the same time that it was excluded from the European area. Now at the present day Behring Straits are narrow and shallow, and little or no water is able to enter from the Pacific equatorial current. But with the exception of the mountains to the south of Alaska, the land bordering the strait is, generally speaking, low and alluvial. If then this were depressed, a large free access would be opened to the Arctic Ocean on that side; and if this were the case I do not think it unreasonable to suppose that a stronger and more highly heated current would pass through than is found in the Gulf Stream, inasmuch as the Pacific is larger than the Atlantic, and the northward flowing stream would not have to contend with any counter-flowing current, all the water finding its exit by way of the Atlantic channel. It is obvious that by the time the water had reached the Scandinavian coast it would have lost all its heat, and would very largely contribute to further reduce the temperature in the North Atlantic area; and being comparatively unopposed in its southward course, and pressed forward by the floods from the Pacific, it would probably develop a force far exceeding that of the existing Greenland current; a force that would be sufficient in fact to produce those perplexing glacial markings in Scandinavia and elsewhere which Mr. Lindvall has ascribed with much prob-

ability to the action of drift-ice rather than that of a sheet of land-ice.

It is true that the tendency of the south flowing Arctic current would be to trend towards the Greenland side of the channel, owing to the effects of the revolution of the earth on its axis, but if Greenland shared, as it probably did, in the general elevation of the east coast of America, the current would be driven more towards the European shore, and the course of the Gulf Stream itself is an evidence that currents can be diverted by geographical or other causes into other than their natural channels.

This theory also meets another difficulty. Great cold does not necessarily mean abundant snow. A region of evaporation at no great distance is also necessary. A heated Siberian sea would afford just such an area as would be needed to produce a heavy snow-fall in North-West Europe and North-East America. We should thus have every condition for producing a Glacial epoch in these regions.

This seems to me to supply a simple explanation of this remarkable era, without calling in the help of a *Deus ex machina* such as the theory of cold and warm regions in space, or such slow working agencies as the varying eccentricity of the earth's orbit, a theory whose very supporters admit could only have produced the required effects if favoured by other exceptionally propitious circumstances.

Professor W. S. GRESLEY, F.G.S., of Erie, United States, writes:—

In response to your kind invitation to add to the discussion upon Dr. E. Hull's paper, proof of which I have read with much interest, I beg to say:—

1. It seems quite possible that the elevation referred to along the east of North America may have produced the clay-and-débris-filled fissures, known as "clay-veins," by which much of the coal-measures from Pennsylvania to Missouri, but especially in Pennsylvania and West Virginia, are more or less vertically intersected (see my paper, "Clay-Veins vertically intersecting Coal-Measures" in *Bull. Geol. Soc. of America*, vol. 9, pp. 35-58, copies of which I am sending to the Institute, and also to Dr. Hull). While all the evidence so far collected indicates that the origin of these fissures was long after the Carboniferous

period, and also post Appalachian uplift, no clue has as yet appeared giving the approximate age of them.

2. If so much *less* "Gulf Stream" heat went north during the period of elevation indicated upon Dr. Hull's map, the supposition is that, other conditions being the same, so much *more* of it flowed southward; and if so, we may postulate that in those days there was less Antarctic ice than now.

The Cavaliere W. P. JERVIS, F.G.S., Conservator of the Royal Italian Industrial Museum at Turin, writes :—

Few geological difficulties have constantly presented themselves to my mind of such a serious kind as the explanations advanced as to the causes of changes of climate on our globe in geological times, including the intense cold during the Glacial epoch, and the converse warmer temperature during the Miocene epoch. None of the theories elicited have convinced me. But the paper read before the Victoria Institute by Professor Hull, based, as the arguments are on the most forcible logical and palæontological data relating to the entire eastern and southern coast-lines of North America, has dissipated, as by enchantment, all my doubts, and the proofs he adduces of the former non-existence of the Gulf Stream appear to me to throw a bright light upon many obscure points of geological climatology.

Though Lyell laid great stress upon changes in the geographical configuration of our globe at successive periods of its existence, and showed the ever-changing elevation and depression of vast tracts of country, it would appear that enough attention has not been paid to these considerations, and hypothetical astronomical causes have found too much favour with not a few geologists—and in absence of proofs.

River-valleys have been plainly traced by Issel to great depths in the Mediterranean, in prolongation of what are now short valleys in Northern Italy, and doubtless elsewhere much progress will be obtained in our knowledge of the past, of the fauna and flora of geological epochs, and of the erstwhile distributions of land and water, by a more extensive study of soundings of the ocean.*

* One of the most interesting series of six maps exhibited by Dr. Gerard de Geer in the Swedish section of the VIth International Congress, held in London in 1896, showed the glacial regions of Finland and

Professor Cooke describes the abundant fossil remains of elephants which he found in Malta, and draws from this fact, as also from the existence of like fossil bones in Sicily, the conclusion that these islands once formed part of the African continent, previous to a considerable submersion of land now constituting deep sea.

Professor Hull beautifully explains how we can find Arctic forms of marine mollusks in rocks not so far from London, and proves the possibility of there having once been extensive glaciers on loftier mountains in Scotland, and of which we still find the scratches.

Will the professor permit me to suggest that it would be a most important point, in order to corroborate his views regarding the assumption of a mean lower temperature of 10° F., previous to the formation of the Gulf Stream, to take accurately into account the longitudinal breadth of the Atlantic previous to the submergence of the Continental shelf and of the Blake plateau, *i.e.*, during the Pliocene and Pleistocene epochs, by ascertaining whether there are corresponding proofs of submergence of the South American continent, even of the African coast, for evidently *the length of time* the superficial ocean current was subject to the rays of a tropical sun would have an effect analogous to what takes place now in the Gulf of Mexico?

Professor Hull's able paper is calculated to open out a vast field of important geological investigations. The depression of the Atlantic coasts of North America and of North-Western

Scandinavia at different periods; in the first map he endeavoured to prove the existence of a continuous ice barrier from Greenland to St. Petersburg, coming down as far south as Denmark and North Germany. The next map showed the retreat of the limit of eternal snow and ice, the line passing through central Sweden; while in another map the glaciers were confined to certain mountainous tracts of Norway; Sweden and Finland being out of the question. This is no mere conjecture. Professor Neovius, of Helsingfors University, in a prolonged conversation I had with him on this subject, declared that the deductions were founded on the geographical distribution of the granite ice-borne boulders abundantly found along more than 15° of longitude in consecutive order.

I found that glacial boulders of Finnish granite were well known to exist in the neighbourhood of Halle, while I was engaged at work at Eisleben, but in Finland and Sweden the boulders are more common along the edge of the former isotherm of 32° .

Europe has no parallel in many parts of Western Africa. But changes of climate in a reverse direction after the Miocene epoch can be accounted for by the still later upheaval which has left the vast deserts of Northern Africa, Arabia, and Central Asia, as clear proofs of the existence of former seas, permitting elephants to live in the long island of Morocco, Algeria, Tunisia, and Malta, and rendering the climate of Siberia milder than at present.

Geological and physical geography are twin sisters; their requirements are so intimately united that they cannot be too closely associated; the opening or closing of sea communication between two points, as likewise changes in the elevation of land, finally deviations of ocean currents, materially alter the climate of the globe, irrespective of all extra terrestrial agencies.

THE AUTHOR'S REPLY.

The general concurrence in my views, stated by Professor T. Rupert Jones, is a matter of much gratification. He has touched on one of the points referred to by Colonel Feilden above.

I gratefully appreciate the suggestions of Mr. Warren Upham in reference to the greater extension of the emergent land in the North Atlantic area than is shown on my map. I also concur with him that the greater elevation of the land of the American continent had more effect in bringing about glacial conditions in that region than the lower temperature of the Gulf Stream, which more directly affect the climate of Western Europe and the British Isles.

The views stated by the Rev. G. Crewdson seem to me well worthy of consideration, though the subject they open out is too extensive to be discussed here. The depression of the north-western American continent during the elevation of the north-eastern side of the same continent may be accepted as an all but proven fact, and the entrance of large masses of comparatively warm and moist Pacific waters by the enlarged Behring's Straits would doubtless have resulted in abundant snowfall on the Arctic land areas. On the general question regarding the reciprocal

movements of the land on alternate sides of the American continent the recent paper by Professor J. W. Spencer on "Great Changes of Level in Mexico and the Interoceanic Connections" (referred to above), have thrown much light.

The observations of Professor Gresley on the American "clay-veins" of the Pennsylvanian coal measures, an account of which I recollect reading some time ago, show how physical phenomena, apparently widely disconnected, may really have a bearing on each other. I have been much interested by the views of the Rev. R. A. Bullen, in which I fully concur, and am glad to have the support of an observer who has paid so much attention to the physical conditions of the North Atlantic.

The observations of Cav. W. P. Jervis are of much interest and very gratifying. I have had several letters of acknowledgment expressing interest in the subject of my paper from continental geologists, including Professor Dames, of Berlin, Dr. C. Barrois, of Lille, Professor Suess, of Vienna, and Professor Geinitz, of Dresden, and this of Cav. Jervis, of Turin, is a welcome addition to the list. The statement that Issel has traced old river courses to great depths in the Mediterranean in prolongation of valleys in North Italy is new to me, and is quite confirmatory of the results arrived at by the late Admiral Spratt, where he proved by soundings the existence of a river channel joining two of the lakes formed in the Mediterranean basin between Sicily and Africa during the period of upheaval and low water-level. (See *Quart. Jour. Geol. Soc., Lond.*, vol. xxiii, p. 292.) The existence of this channel shows the bed of the Mediterranean to have been upraised over 150 fathoms (900-1,000 feet) at this period.

As regards the points which the writer suggests in reference to the conditions of the Atlantic previous to the formation of the Gulf Stream, I hope to be able to give them attention.

INTERMEDIATE MEETING.*

SIR G. G. STOKES, BART., PRESIDENT, IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following elections took place :—

COR. MEMBER :—Professor R. Etheridge, F.R.S., F.R.S.E., London.

ASSOCIATES :—E. Weightman, M.B.C.M., Lancashire ; Miss I. A. Weightman, Lancashire.

A paper on “The Philosophy of Education” was then read by Dr. A. T. Schofield, and discussed. [The proceedings at the meeting will shortly be ready for publication.]

* May 16th, 1898.

ORDINARY MEETING.*

THE REV. CANON GIRDLESTONE, M.A., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following elections were announced :—

MEMBER :—Rev. A. P. Parker, D.D., China.

ASSOCIATES :—G. Stanley St. Amant, Esq., B.Sc., Paris ; Rev. J. Collins, M.A., Cantab., Yorks. ; Rev. A. Dickens, B.A., Yorks. ; Surgeon-General W. J. van Someren, M.R.C.S., London.

The following paper was then read, the Author being in America :—

NOTES ON LITERATURE IN EGYPT IN THE TIME OF MOSES. By the Rev. J. N. FRADENBURGH, Ph.D., D.D., LL.D.

AT the period of the XVIIIth dynasty, the literature of Babylonia had already become extensive. Two great collections of sacred writings had been produced. The one consisted of magical formulas, by the proper use of which the priestly sorcerer could compel all spiritual beings to obey his will ; the other was made up of hymns to the gods. These two collections, however, were not entirely separate. The invocations and incantations were not without elevated passages ; the hymns sometimes fell away into pure magical mutterings. Perhaps the most remarkable single work in Babylonian literature is the great epic of primitive Chaldaea that probably assumed its present form in the revival of

* February 7th, 1898.

. I have not burthened this paper with references, but among those to whom I am under special obligations in its preparation I may mention Professors Maspero, Flinders Petrie, D.C.L., and Erman.

letters which seems to have been inaugurated in the reign of Khammurabi from 2356 to 2301 B.C. This work celebrates the adventures of Gilgames—the Chaldean Heracles—and consists of twelve books, the subject of each book corresponding with that sign of the zodiac which answers to its place in the numerical order. The Babylonian story of the deluge is introduced as an episode in the eleventh book, agreeing with the eleventh sign of the zodiac, or Aquarius.

A large collection might be made of the epistolary correspondence of Babylonia and Assyria; and another collection would be possible of fables, tales and rustic songs. There is one great astronomical work which consists of seventy-two tablets. Then, too, there are multitudes of commercial and legal documents, medical works, lexicographical tablets, and numerous writings representing other departments of knowledge. The discovery of the celebrated royal library of Khuenaten, at Tel-el-Amarna, is one of the most important achievements of the present century. The tablets of this collection are all written in the cuneiform characters of Babylonia, and most of them in the Babylonian language. They belong to the century preceding Moses, and consist, for the most part, of the official correspondence of distant cities, provinces, and governments with the Egyptian king. They prove that in the century immediately preceding Moses, the Babylonian language was the common medium for commercial and diplomatic correspondence throughout the civilized East.

We need not speak of the vast number of tablets which have already been secured from the old libraries of Mesopotamia. So startling have been the discoveries, in these ancient seats of civilization, that the recent announcement of the acquisition of some thirty thousand tablets from the library of the primeval city of Tel-loh occasions no surprise.

There are indications in the Bible which point to the sites of some of the old libraries in Palestine. The existence of such libraries has found its demonstration in the recent discovery of a cuneiform tablet in the mound of Lachish, a tablet which belongs to the correspondence of Tel-el-Amarna. There must have been such a library at Hebron (? Debir), since its primitive name was Kirjath-sepher, "the city of books," while the same old city is called in one place Kirjath-sannah, "the city of instruction." These old libraries of Palestine may yet yield up their secrets.

Cuneiform tablets have also been found at several sites in

Asia Minor, and some of these were written probably as early as twenty-five hundred years before the Christian era.

Another race which has a literature is now claiming recognition. Hittite inscriptions in native hieroglyphics and monuments with Hittite sculptures may be traced continuously, following the two great highways which formerly led through Asia Minor, even to the shores of the Ægean Sea. The celebrated treaty of peace between Khitasar, King of the Hittites, and Rameses the Great, though it has come down to us in the Egyptian language, was doubtless a Hittite composition inscribed on a silver tablet in the Hittite language when it was first presented to the king or at least a translation from the original Hittite document. It shows not only that its authors were acquainted with diplomacy and held some advanced ideas upon subjects connected with international law, but also that they were accustomed to literary composition.

The explorations of Dr. Edward Glaser in southern Arabia have thrown a new and unexpected light upon another seat of early literary culture.

He has recopied the inscriptions of Yemen and Hadramaut which had already been submitted to modern scholarship, and has added more than a thousand fresh inscriptions to those already known. These inscriptions have been found to belong to two different dialects and to two separate kingdoms, the Sabæan and Minæan, of which the latter is the more ancient. The kingdom ruled by the Queen of Sheba must have bordered close upon the territory immediately south of the kingdom of Israel. Both the Sabæan and Minæan kingdoms seem to have extended over the larger part of the Arabian peninsula, and the latter probably came to an end before the former was founded. Now it is known that the sovereign princes of Saba were preceded by a line of ruling priests or priest-kings; and, furthermore, we have been made acquainted with the names of thirty-three Minæan kings. This would push back the foundation of this latter kingdom to a period much preceding the Exodus. The first Babylonian dynasty which was founded before the migration of Abraham was Arabian in origin. Professor Sayce says: "In days which, if Dr. Glaser is right, were contemporaneous with the exodus of Israel, Ma'in was a cultured and prosperous realm, the mart and centre of the spice merchants of the east, whose kings founded settlements on the frontiers of Edom, and whose people followed the art of alphabetic

writing." Professor Fritz Hommel says: "It is my conviction that Arabia itself will furnish us the direct proofs that the modern destructive criticism of the Pentateuch is absolutely erroneous. The age of the Minæan inscriptions runs parallel with that of the so-called code of the priests. If the former are as old as Glaser believes them to be and the Arabian civilization, as I have proved, already existed at the time of Abraham, then the laws of the priests of Israel are also very ancient." This new argument is worthy of our serious consideration.

Almost innumerable fragments of pottery found by Professor W. M. Flinders Petrie at Kahun and Gurob are unmistakably foreign. The pottery from Gurob in paste, in colour, and in design, is "indistinguishable from the earliest pottery found on Greek soil, at Mykenæ, at Thera, and at Mitylene." Hundreds of these potsherds have certain signs scratched upon their surfaces which are doubtless mason's marks. These characters are of exceptional interest. They may be dated from 2500 to 1300 B.C. Professor Petrie thinks that the signs under consideration represent the stage in alphabetic development which connects the hieratic with modern systems. He says: "The mixture of well-known signs, and of others which have not survived, is only what would be probable during the course of natural selection which was going on during the centuries in which the later order of things was being established. And the mixture of signs known in diverse alphabets of later times is also what we should expect to see at a time when the various alphabets were very likely unseparated, and still in one confused use. In fact, the very confusion of these marks is the best proof of their age being anterior to the clean division into the separate well-defined alphabets that we know in later ages." Miss Amelia B. Edwards says: "Dr. Petrie has brought to light the earliest Greek alphabetical signs yet discovered. . . . The potsherds carry back the history of the alphabet to a period earlier than the date of the Exodus, and six centuries earlier than any Greek inscriptions known." She speaks of some of the characters as being "unquestionably identical with certain letters of the Etruscan alphabet."

A goodly number of the characters from Kahun—reproduced on Plate XXVII of Professor Petrie's *Kahun, Gurob and Hawarâ*—seem to be the originals of Greek alphabetical signs; and there is a lesser number of similar characters from Gurob reproduced on Plate XXVIII. Do not some of

these show too great a departure from hieratic forms to be considered their first derivatives? Would not the Greeks follow out the hint and provide for their own use an alphabet at a date much earlier than that of any known Greek inscriptions? May we not expect that future discoveries will confirm this view of the question?

Egypt, at the time of the Exodus, was brought into close contact with nations and peoples far advanced in alphabetic writing and literary composition, such as Babylonia, Palestine, Asia Minor, Arabia, and possibly also various Mediterranean peoples. The Egyptians had a passion for writing. This was not so clearly shown in the old Empire as during the later periods of Egyptian history. The motives urged in favour of learning were drawn from its practical utility rather than from the ennobling influence or the pleasure derived from its pursuit and acquisition. When the Egyptian sage Dauuf was sailing up the Nile with his son Pepi, whom he wished to enter as a pupil in the "Court School of books," he gave him this paternal advice: "Give thy heart to learning and love her like a mother, for there is nothing that is so precious as learning."

This was the road to independence. The sage expresses the sentiment of the time when he says:

"Behold there is no profession which is not governed,
It is only the learned man who rules himself."

Learning was the road to office and promotion. The ignorant man is compared to a heavily-laden donkey, which must be driven; the learned man may live above work, for his writing materials and rolls of books bring him riches and pleasures. But diligence must be practised. "If the work of books is an abomination to him, then the goddess of fortune is not with him." The wise student will remain faithful to learning, and will pray to Thoth, who will grant him assistance in his studies. This god of letters is sometimes represented under the form of a sacred animal, and is then described as the "baboon with shining hair and amiable face." He is also called the "letter-writer for the gods." The student prays to this god, saying: "Come to me and guide me, and make me act justly in thine office. Thine office is more beautiful than all offices. Let all the world tell of thy might, that all men may say, 'Great is that which Thoth hath done.' Let them come with their children to cause them to be marked as scribes."

In the earliest times the school for the education of scribes was attached to the court, but at a later period such schools were organized in connection with the several departments of the government. Boys were sent to these schools while yet quite young, and were subject to the severest discipline. Their food was scanty, but their floggings were abundant. One of the pupils writing to his teacher, says: "I was with thee since I was brought up as a child; then didst thou beat my back and instruction went into my ear." The fundamental principle of all teaching was the wholesome old maxim, "The youth has a back, he attends when it is beaten." A grateful school boy writes to his old teacher: "Thou hast made me buckle-to since the time that I was one of thy pupils. I spent my time in the lock-up; he bound my limbs. He sentenced me to three months, and I was bound in the temple." By frequent and earnest admonitions the pupil was urged to improve his time and to arouse his energies. "O scribe," the tutor would say, "O scribe, be not lazy, otherwise thou wilt have to be made obedient by correction. Do not spend thy time wishing, or thou wilt come to a bad end. Let thy mouth read the book in thy hand: Take advice from those who know more than thou dost. Be strong and active in thy daily work. Spend no day in idleness, or thou wilt be flogged. For the ears of the youth are placed on the back and he hears when he is flogged. Let thy heart attend to what I say; that will bring thee happiness." Having mastered the art of writing, the pupil is set to copying fairy tales, religious and magical books, poems, the instructions of ancient sages, and fictitious correspondence, either taken from old books in verbatim copy, or paraphrased, or less frequently, original. This practice serves to correct his caligraphy, instruct him in orthography, and perfect his literary style. The door to all Egyptian learning and all Egyptian literature is now open to the earnest student.

When we come to inquire as to the character of Egyptian learning, we are compelled to admit that in some departments at least we have met with not a little disappointment. Although it was taught that the religious books were so sacred that the gods must first purify themselves before they even so much as touched them, these same books were frequently reduced to the most utter nonsense by the commentators. They saw difficulties of interpretation where difficulties did not exist, looked for deep profundity where

there was none, and offered explanations which explained nothing. The result was, in many cases, a very chaos of mysticism and folly. We need not be surprised at this; for we often see examples of such in our own day.

The Egyptians may scarcely be said to have had a written history. A Turin papyrus on its reverse side furnishes us with a list of kings, and various monarchs have left a brief account of their achievements. Other historic events have come down to us under a form more or less legendary in its character. We may add to this the annals of Egyptian temples with tribute lists and assignments of lands. In all this we possess not history but the materials out of which history may be wrought.

The stars were regarded not indeed as divinities, as was the case among the Babylonians, but as the abodes of pious souls, or as the genii which were connected with the sun; so especially the "decan-stars" or thirty-six constellations situated on the horizon. The Egyptians, however, had made a beginning in real astronomy. They had formed charts of different portions of the heavens on a plan which must be pronounced both original and unique. Their permanent and most important work was to lay the foundation of our modern calendar. Each day of the calendar seems to have been connected with one or more good or bad mythological incidents which took place on that day and made it forever lucky or unlucky. Thus the twenty-seventh day of the month Athyr was lucky because on that day peace was concluded between the gods Horus and Set, while the fourteenth day of the month Tybi was held to be unlucky because on that day the sister goddesses, Isis and Nephthys, mourned for their brother Osiris, who had been slain by Set.

Magic was the mightiest influence in the religious and intellectual life of the Egyptians. They believed that there were certain words and actions by which they could control nature, man, every animal, and even every god. The gods themselves depended upon magic to constrain one another. The origin of magic formulas was as follows. The magician would recall some mythological incident which brought good luck to some one of the divine beings, and the special words spoken by the god in connection with this incident. He would then imagine himself transformed into this same divine being, and would utter the same words which had proved powerful in connection with the mythological incident, when they would again serve the same good purpose in any similar

case. A single illustration will suffice. A divine legend relates that once upon a time in the history of the gods a fire broke out upon a mountain, and the goddess Isis called her son Horus to extinguish the flames, using these words: "My son Horus, it burns on the mountain, no water is there, I am not there, fetch water from the bank of the river to put out the fire." Horus responded and the fire was extinguished. Now it was believed that the same words repeated by the magician over a wound would stop its burning or would drive away the raging fever. The magician might possess himself of the magical power of a divinity by using the name of that divinity as his own. If he could but learn that secret name known only to the god himself, he would possess when he uttered it all the power of that god, who, on his part, would become weak and helpless. In one magic formula the magician threatened to pronounce the secret name of the god Shu, and by so doing he would unhinge the world. This threat is found in an incantation against crocodiles. The incantation is poetic in form, which may partially explain its wonderful power; for we have met with some modern poetry which, we are persuaded, would prove too much even for a crocodile. Certain objects could be invested with permanent magical virtue by reciting over them magic formulas. If the crocodile incantation were recited over an egg, and if the pilot of a boat but held this egg in his hand, every crocodile which raised his head out of the water would immediately sink again. This explains the power of amulets and images of wax, or other substance, so widely used by the superstitious. The written magic formulas were invested with the same efficacy as the spoken, and hence the extensive use of holy texts. The use of these formulas accompanied the preparation of medicine and the application of remedies in all cases of disease. The old receipts of Egyptian medical practice, in the number and disgusting character of their ingredients, were certainly enough to raise to highest ecstasy the heart of the most heroic old school allopathic physician. What would be thought, for instance, of a medicine formed by the mixture of twenty or thirty substances of such a character that sweat from the ear of a hog, the toe of a lizard, and the oil of a toad, would change the composition into sweetmeats and delicacies? The witches' broth of Shakespeare would be ambrosia and nectar in the comparison. We must not, however, deny to the ancient Egyptians a knowledge of the healing

qualities of many remedies which still maintain an honourable place in modern medical practice.

In mathematics the Egyptians never advanced beyond the rudiments. Their methods were original and primitive. In geometry they could not grapple with serious problems; and in the most simple problems they were able to reach but approximate results. They seem never to have dreamed of investigations conducted merely for mental discipline or the acquisition of knowledge. They were not devoted to truth for its own sake. They advanced only so far in mathematical science as availed for the solution of the problems presented in every day business life, and even in these problems, accuracy was not reached.

But if in mathematics the Egyptians never emerged from their infancy, in the department of literature their achievements are witnesses to matured powers. Fairy tales and stories of travel were always peculiarly attractive to them. A distinguished courtier of King Amenemhert I, of the twelfth dynasty, has left a record of his adventures. While travelling among the Syrian Bedouin he lost his way, and was surrounded by enemies; his carriage broke down; he was reduced to starvation; thieves stole his coat while he was asleep; he met with a love episode; but all ended well at last. The story furnishes a most interesting portrayal of Palestine in these early times. Another story relates how a poor shepherd fell in love with a goddess. It is said that "he had never spoken to her, but her power pursued his body." He resorted to magic, and early one morning, while standing by the lake, she came to him with all the appearance of being drawn to him by love; but, just as we are listening to hear her words, the tale closes in a way most exasperating. The owner of the manuscript, probably a crabbed old bachelor, has rubbed off the text. One of the sons of Khufu, the builder of the great pyramid, relates this story of a celebrated magician: "He is a young man of 110 years, and eats 500 cakes of bread together with a joint of beef, and drinks 100 jugs of beer, even at the present day. He knows how to set on a head that has been cut off, and he can cause the lions of the desert to walk behind him." This "young man" with a good appetite was called to the king, who proposed to cut off the head of a prisoner and see him stick it on again. He begged to be excused from this; and suggested that a goose would do as well. "Then they brought a goose and cut off its

head; the goose was then laid in the western corner of the hall, and the head in the eastern corner, and Dada—for that was the magician's name—repeated his magic formulas. Then the goose stood up and tripped along, and the head did likewise. When now one part had come to the other, the goose stood there and cackled." And so the story goes, ending with the prophecy of the birth of three children who should inaugurate a new dynasty in Egypt—which was afterwards so.

The land of Punt signifies the coast lands of the Red Sea, Southern Arabia and the opposite Somali coast. This country was considered by the Egyptians as a semi-fairyland. There are accounts of voyages to this divine land, with relations of much which is marvellous. One traveller—he seems to have been a treasurer belonging to the royal court of Egypt—set out for the gold mines of Pharaoh in a strong ship manned by one hundred and fifty sailors, who "knew both the sky and the earth, and in whom the heart was wiser than that of a lion." A mighty storm dashed the ship in pieces and all perished save the traveller, who escaped to land on a piece of wood, at the end of three days spent in the deep. He found abundance of food and after satisfying his hunger, sacrificed to the gods. He then says in his narrative: "Suddenly I heard a noise of thunder, which I thought to be the roar of a wave; the trees trembled and the earth shook. I raised my face and saw that it was a snake approaching; he was thirty cubits in length, and his beard was more than two cubits long. His limbs were inlaid with gold, and his colour was like real lapis-lazuli. He rolled forward and opened his mouth. I threw myself down before him, and he spake: 'Who has brought thee hither? Who has brought thee hither, little one? Who hast brought thee hither? If thou dost not tell me immediately who has brought thee hither, then I will show thee who thou art!' Then he took me in his mouth, carried me to his lair, and laid me down without doing me any harm." Being questioned again the traveller relates the story of his voyage. The snake, judging that the gods must have favoured his visitor, assures him that he shall suffer no harm, and beguiles his weary hours with fascinating stories of the snake island. Formerly there had been a beautiful maiden whom misfortunes had cast upon the island, but she had been killed by lightning. The inhabitants of the island now consisted of seventy-five snakes, all of one family. Thus the

snake talks, and at the first opportunity sends the traveller back to Egypt with rich presents and best wishes for a long and happy life. The story may be compared with that of "Sinbad the Sailor," with this difference that, while the snakes of the island treated the Egyptian traveller well, the monsters which Sinbad the Sailor met were ready to swallow him with a good appetite. From these instances when read in the original, it will be seen that the Egyptian author aimed to perfect his style. One of the stories we have mentioned, the adventures of the Mohar in Syria, seems to have been written in competition for the prize of literary championship.

In the department of poetry Egypt must be given a prominent place. The hymns to the Egyptian deities recapitulate the numerous epithets of the gods in monotonous repetition, and multiply hackneyed phrases of adoration whose reading tests the interest of the enthusiast. There are, however, refreshing oases in the desert. Some of the hymns to the gods may be compared with the psalmody of the Israelites. They have their pure moral teachings, noble passages, and lofty ideals. Again there is displayed a love of nature which always calls forth the best specimens of the poet's art. In a hymn to Amon this god is described as the one

"Who makes the herb for the cattle
And the fruit tree for mankind,
He gives life to the fish of the river
And to the birds under the heaven.
He gives breath to the being in the egg,
And preserves the son of the worm, (?)
He creates that whereon the fly lives,
The worms and the fleas as many as they are,
He creates what the mice need in their holes,
And preserves the birds (?) on all trees."

The Egyptians especially loved trees and flowers, and gardens were the favourite trysting-place of lovers. On a day when the garden was in full bloom the sycamore, which a fair maiden had planted with her own hand, called her to come into its shade. This beautiful love song invites her with most enticing words :

"The little sycamore
Which she planted with her hand,
She begins to speak
And her (words are as) drops of honey.

She is charming, her bower is green,
 Greener than (the papyrus).
 She is laden with fruit,
 Redder than the ruby.
 The colour of her leaves is as glass,
 Her stem is as the colour of the opal,
 It is cool in the shadow.
 She sends her letter by a little maiden,
 The daughter of her chief gardener.
 She makes her haste to her beloved :
 Come and linger in the (garden).
 The servant who belong to thee
 Come with the dinner things ;
 They are bringing her of every (kind)
 With all manner of bread,
 Flowers of yesterday and of to-day,
 And all kinds of refreshing fruit.
 Come, spend this festive day
 And to-morrow and the day after to-morrow
 Sitting in my shadow.
 Thy companion sits at thy right hand,
 Thou dost make him drink."

A beautiful conceit is the form of the love song in which each couplet begins with the name of a flower and a play upon the word lightly connects the whole. The maiden wears a wreath and, as she adds, flower after flower, each one reminds her of her love. Replacing this word-play by one of like import in our own language, Professor Erman renders a couplet as follows, as she picks out a rose and wears it in the chaplet :

"Blush roses are in it, one blushes before thee,
 I am thy first 'sister';
 And thou art to me as the garden,
 Which I have planted with flowers
 And all sweet-smelling herbs.
 I directed a canal into it,
 That thou mightest dip thy hand into it,
 When the north wind blows cool ;
 The beautiful place where we take a walk,
 When thine hand rests within mine
 With thoughtful mind and joyful heart,
 Because we walk together.
 It is intoxicating to me to hear thy voice,
 And my life depends upon hearing thee.
 Whenever I see thee
 It is better to me than food and drink."

We present one more example of Egyptian poetry—the festal dirge of King Antuf of the eleventh dynasty :

" After all, what is prosperity ?
 Their fenced walls are dilapidated,
 There houses are as that which never existed.
 No man comes from thence
 Who tells of their sayings.
 Who tells of their affairs,
 Who encourages our hearts.
 Ye go
 To the places whence they return not.
 Strengthen thy heart to forget how thou hast enjoyed thyself,
 Fulfil thy desire whilst thou livest.
 Put oil upon thy head.
 Clothe thyself with fine linen adorned with precious metals.
 With the gifts of God
 Multiply thy good things,
 Yield to thy desire.
 Fulfil thy desire with thy good things
 (Whilst thou art) upon earth,
 According to the delectation of thy heart.
 The day will come to thee,
 When one hears not thy voice,
 When the one who is at rest hears not their voices.
 Lamentations deliver not him who is in the tomb.
 Feast in tranquility.
 Seeing there is no one who carries away his goods with him,
 Yea, behold, none who goes thither comes back again."

Several works on ethics, teaching good manners, practical wisdom in business and official life, court etiquette, and proverbial sayings of the ancients, have gained a wide celebrity. The only complete work of this primitive wisdom which has come down to us is that preserved in the Prisse Papyrus. It contains the books of two classic writers, one of whom lived probably under the third, and the other under the fifth dynasty. The manuscript was transcribed before the eighteenth dynasty and was a text book in the schools in the time of Moses. The latter part of the Papyrus contains the Proverbs of Ptahhotep, who was called the king's son. He displayed a profound knowledge of men and was on that account appointed to compile and edit the political and moral maxims of the sages—a work which he accomplished in his extreme old age. Says Professor Maspero : " We must not expect to find in this work great profundity of thought. Clever analyses, subtle discussions, metaphysical abstractions, were not in fashion at the time of Phtahhotpu. Actual facts were preferred to speculative fancies. Man himself was the subject of observation, his passions, his temptations, and his defects, not for the purpose of constructing a system therefrom, but in the hope of reforming the imperfections

of his nature and pointing out to him the road to fortune."

This work of Ptahhotep, notwithstanding the subtlety of some of its thoughts, the strangeness of some of its precepts, the obscurity of its style, and the nature of the subjects treated, is well worthy of the high reputation to which it has attained. Ptahhotep gives this wise advice to a prefect when he sits as a judge and listens to the explanations of the parties to a suit: "When thou art a leader of peace, listen well to the words of the petitioner. Be not abrupt with him; that would trouble him. Do not say to him 'thou hast already said this.' Indulgence will encourage him to do that for the sake of which he is come. As for being abrupt with the plaintiff, because he describes what happened when the injury was done instead of complaining of the injury itself, let it not be. The way to obtain a clear explanation is to listen with kindness."

Since the precepts seem to have been addressed only to the learned, the range of subjects is limited. They are such practical maxims as would help the officer of government, the father of a family, and the well-to-do citizen, each to fill his place with respectability and honour; while they would encourage the subordinate and dependent to continue happy in their lot and not become restive under that providence which has ordained ranks in society.

A person high in authority is warned against unprofitable flattery: it will harm but not help. When an opinion is asked in the council of a lord, it should be given frankly and without reticence. A man should deport himself with circumspection in the presence of women. Inspire men with love not with fear—"this is the will of God." Everything, indeed, should be done with reference to God. It is He who gives increase to the flocks and fields; the agriculturist gathers of His bounty and the rich man is but His "steward." Four arguments are used for the enforcement of good conduct; it pleases God, it secures a good place for the docile and laborious student, it attracts good domestics for the family, and it tends to long life. Great importance is attached to the education of children. The mind of the young should be well stored with "the sayings of former days." The family is recognised as the foundation of society, and paternal authority must be maintained. "If thou art a wise man, bring up a son who shall be pleasing to God. If he conforms his conduct to thy way and occupies himself with

thy affairs as is right, do to him all the good thou canst; he is thy son, a person attached to thee whom thine own self hath begotten. Separate not thy heart from him. . . . If he conducts himself ill and transgresses thy wish, if he rejects all counsel, if his mouth goes according to the evil word, strike him on the mouth in return." M. Virey, whose translation we follow, says: "It is probable that there is here a sort of play upon the words." He suggests as the meaning: "Strike directly against a bad direction." The merit of a son is of advantage to his father and is worth more than his father's rank. The son should be so trained that he will remain teachable; in his docility he will exhibit his wisdom and direct his conduct. Knowledge will be his support, while the ignorant will be destroyed. Twice good is the precept of a father; happy the son who obeys. "Verily a good son is one of the gifts of God, a son who does better than he has been told." He does his work with all his heart; he is blessed with a good old age. "The wise man is satisfied by knowledge; he is a great man through his own merits. His tongue is in accordance with his mind; just are his lips when he speaks, his eyes when he gazes, his ears when he hears. The advantage of his son is to do that which is just without deceiving himself."

The wife should be provided for with a liberal hand and treated with all love, respect and tenderness. The wise man makes the best use of his moments, and improves every opportunity to improve his possessions. He looks well to his own house, and loves his own wife without alloy. He clothes her, provides her daily food, caresses her, anticipates her wishes, and tries to make her more contented than any of her neighbours; and in doing this he does honour to himself. The good husband studies to know what his wife desires—"to what she aspires, at what she aims, what she regards."

The man of great soul maintains moderation and calmness. He avoids, on the one hand, pride and haughtiness; and, on the other hand, meanness of spirit. An inferior should avoid offensive words in the presence of a superior; and yet he should speak the exact truth, when called upon to speak at all, and that without fear or favour. A man should not be interrupted when engaged in business; his time has its value. Words should be chosen with wisdom and always carefully guarded. There is even a time to be silent. The love of work transports men to God. He is a wise man who treats

his dependents well, especially "as we do not know the events which may happen to-morrow."

"If thou hast become great after having been little, if thou hast become rich after having been poor, when thou art at the head of the city, know not how to take advantage of the fact that thou hast reached the first rank. . . . Thou art become only the steward of the good things of God. Put not behind thee the neighbour who is like unto thee; be unto him as a companion."

"If thou art one of those who bring messages of one great man to another, conform thyself exactly to that wherewith he has charged thee; perform for him the commission as he hath enjoined thee. Beware of altering in speaking the offensive words which one great person addresses to another; he who perverts the truthfulness of his way, in order to repeat only what produces pleasure in the words of every man, great or small, is a detestable person."

A wise man is a good listener. The duty of listening attentively, retaining in the memory accurately, and transmitting to others fully, clearly and exactly, is insisted upon with all emphasis. Nothing is to be added to the message and nothing subtracted from it; nor yet are the words of the message to be changed. Exact truthfulness is earnestly enjoined. The wise man will learn from the conversation of others and profit from their experience, and thereby make constant additions to his own fund of practical knowledge. Honesty in word and in deed, loyalty to authorities, obedience to superiors whose place it is to command, and affection where affection is due—these are praiseworthy.

We return to the words of the sage as best suited to introduce us to the spirit of his teaching.

"As for the man without experience who listens not, he effects nothing whatsoever. He sees knowledge in ignorance, profit in loss; he commits all kinds of error, always accordingly choosing the contrary of what is praiseworthy. He lives on that which is mortal in this fashion. His food are evil words, whereat he is filled with astonishment. That which the great know to be mortal he lives upon every day, flying from that which would be profitable to him, because of the multitude of errors which present themselves before him every day."

"If thou abasest thyself in obeying a superior, thy conduct is entirely good before God. Knowing who ought to obey and who ought to command, do not lift up thy heart against

him. As thou knowest that in him is authority, be respectful toward him as belonging to him. Fortune comes only at her own good-will, and her caprice only is her law."

"If thou hast, as leader, to decide on the conduct of a great number of men, seek the most perfect manner that thy conduct may be without reproach. Justice is great, invariable and assured; it has not been disturbed since the age of Osiris. To throw obstacles in the way of the laws is to open the way to violence."

"If thou aimest at polished manners, call not him whom thou accostest. Converse with him especially in such a way as not to annoy him. Enter on a discussion with him only after having left him time to saturate his mind with the subject of the conversation. If he lets his ignorance display itself, and if he gives thee an opportunity to disgrace him, treat him with courtesy rather; proceed not to drive him into a corner. . . . Answer not in a crushing manner; crush him not; worry him not."

"If thou findest a disputant while he is hot, and if he is superior to thee in ability, lower the hands, bend the back, do not get into a passion with him. As he will not let thee destroy his words, it is utterly wrong to interrupt him; that proclaims that thou art incapable of keeping thyself calm, when thou art contradicted. If thou then hast to do with a disputant while he is hot, imitate one who does not stir. Thou hast the advantage over him if thou keepest silence when he is uttering evil words. The better is he who is passive, say the bye-standers, and thou art right in the opinion of the great."

"Be not of an irritable temper in regard to thy neighbours; better is a compliment to that which displeases than rudeness. It is wrong to get into a passion with one's neighbours, to be no longer master of one's words."

"If thou art annoyed at a thing, if thou art tormented by some one who is acting without his right, get out of his sight, and remember him no more when he has ceased to address thee."

"If thou findest a disputant while he is hot, do not despise him because thou art not of the same opinion. Be not angry against him when he is wrong; away with such a thing. He fights against himself; require him not further to flatter thy feelings."

"Do not repeat any extravagance in language; do not listen to it; it is a thing which has escaped from a hasty

mouth. If it is repeated, look, without hearing it, towards the earth; say nothing in regard to it. Cause him who speaks to thee to know what is just, even him who provokes the injustice; cause that which is just to be done, cause it to triumph. As to that which is hateful according to the law condemn it by unveiling it."

These selections from his precepts will fully vindicate the right of Ptahhotep to an honourable place among the sages of the ancient world. The wise counsels of Ani, written for the instruction of his son, belong to a much later period. For comparison we present a few of his sayings.

"Drink not beer to excess! The words that come out of thy mouth, thou canst not recall. . . . Thou dost fall and break thy limbs, and no one reaches out a hand to thee. Thy comrades go on drinking, they stand up and say: 'Away with this fellow who is drunk.' If any one should then seek thee to ask counsel of thee, thou wouldst be found lying in the dust like a little child."

"The sanctuary of the god—clamour is an abomination to him. Pray for thyself, with a loving heart, in which the words remain hidden; that he may supply thy need, hear thy words and accept thy offering." He exhorts to industry, "for the man that is idle cometh not to honour." One should not enter the house of another uninvited; it is an honour to be bidden to enter. Be not too inquisitive when in a house of a friend, and do not relate what thou hast seen. "Speak not too much for men are deaf to the man of many words; be silent rather, then thou shalt please, therefore speak not. A man's ruin lies in his tongue."

"Beware of a woman from strange parts, whose city is not known. When she comes do not look at her nor know her. She is as the eddy in deep water, the depth of which is unknown. The woman whose husband is far off writes to thee every day. If no witness is near her she stands up and spreads her net: O! fearful crime to listen to her!"

"Thou shalt never forget what thy mother has done for thee. She bore thee and nourished thee in all manner of ways. If thou forgettest her, she might blame thee, she might 'lift up her arms to God, and He would hear her complaint.' She brought thee up, and when thou didst enter the school, and wast instructed in the writings, she came daily to thy master with bread and beer from her house."

The Egyptian confession of faith is one of the noblest which has been bequeathed to us from the ancient world.

When the soul stood before the judgment seat of Osiris, with uplifted hands he recited his profession of faith: I have not committed iniquity against men! I have not oppressed the poor! I have not made defalcations in the necropolis! I have not laid labour upon any free man beyond that which he wrought for himself! I have not transgressed, I have not been weak, I have not defaulted, I have not committed that which is an abomination to the gods! I have not caused the slave to be ill-treated of his master! I have not starved any man, I have not made any to weep, I have not assassinated any man, I have not caused any man to be treacherously assassinated, and I have not committed treason against any! I have not in aught diminished the supplies of temples! I have not spoiled the shewbread of* the gods! I have not taken away the loaves and the wrappings of the dead! I have done no carnal act within the sacred enclosure of the temple! I have not blasphemed! I have in nought curtailed the sacred revenues! I have not pulled down the scale of the balance! I have not falsified the beam of the balance! I have not taken away the milk from the mouths of sucklings! I have not lassoed cattle on their pastures! I have not taken with nets the birds of the gods! I have not fished in their ponds! I have not turned back the water in its season! I have not cut off a water-channel in its course! I have not put out the fire in its time! I have not defrauded the Nine Gods of the choice parts of victims! I have not ejected the oxen of the gods! I have not turned back the god at his coming forth! I am pure!" This has been called a "Negative Confession," and yet the soul repeats it in substance in a positive form. "He hath spread joy on all sides; men speak of that which he hath done, and the gods rejoice in it. He hath reconciled the gods to him by his love; he hath given bread to the hungry, water to the thirsty, clothing to the naked; he hath given a boat to the shipwrecked; he hath offered sacrifices to the gods." M. Maspero, whose translation we have adopted, says: "If this does not amount to the love of our neighbour as our religions preach it, at least it represents the careful solicitude due from a good lord to his vassals." This confession from the *Book of the Dead* is reinforced from other sepulchral inscriptions in which the virtues of the deceased are described. It were not a difficult task to select from the Book of Psalms a multitude

* Offerings to.

of passages parallel with those which we have presented from the writings of the old sages of Egypt. It were also suggestive of profitable reflections to read the "Negative Confession" in connection with the "Ten Commandments" of the Israelites; and the hymns to the gods contain sentiments which readily suggest the songs of Zion.

The Egyptians were the first nation in the world which held the doctrine of the immortality of the soul as the fundamental article of their religious faith. Not merely the soul but the whole man was believed to be immortal, and it was confidently taught that at the resurrection all the parts which had been separated at death—the body, soul, intelligence, genius or double, shadow, name, husk or mummy, and heart: *khat*, *ba*, *khou*, *ka*, *khaibit*, *ren*, *sahu*, and *ab*—would be reunited. This doctrine was wrought into the whole life of the Egyptians, and it furnishes an explanation for many of their mightiest works. The embalment of the bodies of the dead, the selection of sites for their cemeteries, the massive pyramids and tombs with their secret chambers and passages, the sepulchral offerings, the pictured scenes, the portrait statues of the deceased, the amulets arranged upon the body, the magic texts upon wrappings and coffins, the prayers appointed to be said, the *ushabti*, the preparations made for the repetition of offerings to the *Kas*—the most stupendous and complicated system of magic which the world has ever known permeating everything—all this tells of the hold this doctrine had upon Egyptian religious thought. How is the slight reference which is made to the doctrine of immortality in the Pentateuch to be explained? Is it assumed that the doctrine is too familiar to call for especial mention? Were duties to the dead absorbing the thought and energies of the Egyptians? Was there danger that duties to the living would be forgotten or neglected?

The civilization of Egypt was in harmony with this early literary activity. Professor Petrie, speaking of the age of the great pyramids, says:—

"This earliest civilization was completely master of the arts of combined labour, of masonry, of sculpture, of metal-working, of turning, of carpentry, of pottery, of weaving, of dyeing, and other elements of a highly organized social life; and in some respects their work is quite the equal of any that has been done by mankind of late ages. Though simple it is of extreme ability; and it is only in resources, and not in skill, that it has ever been surpassed. Certain

products were then scarcely, if at all, known, and it is in the application of these that the civilization of later times shows a difference. No metal was used except copper, and hence flint was largely needed. And glass was probably unknown, although glazes were in use. But in most other respects the changes of later times are rather due to economy of production, and an increased demand for cheap imitations." Concerning the tools which were employed, Professor Petrie remarks: "I found repeatedly that the hardest stones, basalt, granite, and diorite were sawn; and that the saw was not a blade, or wire, used with a hard powder, but was set with fixed cutting points, in fact, a jewelled saw. The saws must have been as much as nine feet in length, as the cuts run lengthwise of the sarcophagi. One of the most usual tools was the tubular drill, and this was also set with fixed cutting points; I have a core from inside a drill hole, broken away in the working, which shows the spiral grooves produced by the cutting points as they sunk down into the material; this is of red granite, and there has been no finching or jumping of the tool; every crystal, quartz or feldspar has been cut through in the most equable way, with a clean irresistible cut. An engineer who knows such work with diamond drills, as well as anyone, said to me, 'I should be proud to turn out such a finely cut core now'; and truth to tell, modern drill cores cannot hold a candle to the Egyptian; by the side of the ancient work they look wretchedly scraped out and irregular. That such hard cutting points were known and used, is proved by clean cut hieroglyphics on diorite, engraved without a trace of scraping; and by the lathe work of which I found pieces of turned bowls with the tool lines on them, and positive proof that the surface had not been ground out." The work upon the lathe is "fearless and powerful," as well as "surpassingly delicate." The great pyramid of Gizeh is a standing monument of the mechanical skill of its builder. Professor Petrie says: "To merely place such stones in exact contact at the sides would be careful work; but to do so with cement in the joint seems almost impossible." Mr. Jomard says: "We are at a loss to know what force has moved, transported and raised so great a number of colossal stones, how many men were needed for the work, what amount of time was required for it, what machinery they used; and in proportion to our ability to answer these questions, we increasingly admire the power which regarded such obstacles as trifles."

We cannot attempt to touch upon all the topics which suggest themselves in connection with our subject. The field is too large. The portrait-sculptures of the Egyptians, their decorative art, the general plan of their temples, the priesthood, and the sacrifices—such topics as these are worthy of careful treatment.

The nineteenth was perhaps, taking it all in all, the most brilliant of the Egyptian dynasties. It might be called the Elizabethan period of Egyptian literature. The princes were educated and maintained at the royal court. Their tutor was called their *nurse*. Under the Old Empire special revenues were put aside for their support, and they received various government appointments—"treasurer of the god, high priest, chief judge, scribe of the divine book, governor of the palace." Under the New Empire they preferred to take service in the army and were invested with military titles. They were called "divine offspring," and could be recognised by their distinctive dress. A prince would enjoy the very best opportunities which the kingdom could afford for acquiring an education. "All the learning of Egypt" was open to him, and abundant resources were at his command.

The exodus of the Israelites was not accomplished in the dark ages of Egyptian history. The art of writing had been practised in Babylonia for probably twenty-five hundred years and libraries had been founded and supported in her principal cities. During the preceding century a brisk commercial and diplomatic correspondence had been conducted in the Babylonian language throughout Western Asia. The governmental and official archives of Khuenaten at Tel-el-Amarna contained portions of this correspondence, and one tablet of the same has been discovered in the mound of Lachish. Tablets in the Babylonian language have also been found in Asia Minor, and these latter may be dated from 500 to 1,000 years before the birth of Moses. At the time he fled into Midian, princes of the old Minean kingdom were practising alphabetic writing in Arabia. A few years preceding this event, the Hittites ratified a treaty with Rameses II. This was written on a silver tablet originally, probably in their own hieroglyphics and language. Greeks in Egypt were becoming acquainted with letters, and may have already formed their own alphabet. Egypt, his own native country, had practised the art of writing for 2,500 years, and had produced a number of works of literary merit. She had already passed through two historic periods

characterized by a highly organized civilization, and now again, in this most brilliant nineteenth century dynasty, was at the very height of her literary splendour. The Egyptians had what Professor Erman calls "a mania for writing." Scribes were at work everywhere. Learning was necessary, if high literary titles were to be secured. In this most literary of the nations of antiquity, with an honoured past, near the period of her best literary achievements, Moses appeared. Though a Hebrew in blood, he was adopted, by the daughter or perhaps the sister of Pharaoh, as her own son, became a member of the royal family, and was educated at the royal court under the best tutors which Egypt could afford.

Neither Greece nor Rome has bequeathed to the modern world so vast an amount of writing as has Egypt.

When we consider the literary treasures which have been permanently lost, we may form some estimate of what must have been available for the education of Moses. He studied the religious systems. He became familiar with the *Book of the Dead*, and perhaps listened to the chanting of hymns to the gods. He knew something of the history of Egypt and surrounding nations, and took a deep interest in the history of his own kindred.* He had studied such branches of science as were known to the ancients. He had read the mythological tales, rustic and love songs, and books of travel which were accessible in his time, and had stored his memory with the maxims of the sages. He had become experienced in the administration of affairs of government, and may have been charged with important military enterprises. He was accustomed to the receipt and despatch of written reports. Moses must have been endowed with learning equal to the composition of the Pentateuch. Is it not probable that the great leader would have caused records to be made of events so closely connected with his own life and the history of his people, and so momentous in their character? The age and country in which he lived, the literary activity of his time, his connection with the royal family, the educational opportunities of his day, and the custom of making records of all, even the most trivial affairs, are in perfect keeping with this view. To suppose that Moses did not cause such records to be made would place him out of harmony with the spirit of the times and the circumstances of the case. The contents of the Pentateuch also are consistent with the view we have

* See Stosch's *Origin of Genesis*.—Ed.

presented. The snatches of poetry in construction are like the poetry of Egypt and Babylonia,* and the priests' code is probably not more complicated than the priestly codes of these countries at the same time.

We will not, however, be led into an extended discussion of these points.

Our object has been attained if we have established the fact that Moses was, in all probability, well equipped, in an educational point of view, for the composition of the Pentateuch; and that he doubtless caused records to be made of the events of his time. Yet if such records were actually made, what was done with them? Were any of them used in the composition of the Mosaic history and legislation? How were they used? These, and many other questions connected with a full treatment of the subject lie outside the purpose of this paper.

The CHAIRMAN (Rev. Canon GIRDLESTONE, M.A.).—Our thanks are due to Dr. Fradenburgh for his able paper and also to Dr. Walker for so kindly reading it. (Cheers.)

The paper throws great light upon the days when Israel was in Egypt and when Moses led them out. We see that the Egyptians of those days were by no means uncivilised—quite the contrary, and it seems clear that they could do some things even better than we can.

With regard to history I think one of the most important points is that contained in the seventh page of the paper. It has always struck me as a very serious defect in the Egyptian system that they had no fixed historical era; until you have a fixed historical era it is impossible to frame anything like a sequence of events or even of the Dynasties, and the history has to be made up piecemeal by comparing the dates in a king's reign and seeing how certain things overlap one thing and another thing. Perhaps the time will come, as suggested by Dr. Fradenburgh, when the materials will be so enlarged that history may be wrought out of them.

* Mr. Theophilus G. Pinches, the Assyriologist, writes:—

“As regards Hebrew and Babylonian poetical compositions, I consider that they owe their likeness to the probability of a common origin, or to the influence of the same original models. The reason for my opinion is that both nations are and were of the same race, and as some of the Psalms are pre-exilic the style could hardly have been copied from that of the Babylonians.”—Ed.

A discussion of a conversational character ensued, after which the meeting was adjourned.

REMARKS ON THE FOREGOING PAPER.

By Colonel C. R. CONDER, R.E., D.C.L.

With respect to the main question treated in Dr. Fradenburgh's interesting paper, there can be no doubt that civilisation and religious thought had by the time of Moses reached a high level in Egypt, and that one learned in the Egyptian knowledge would have been acquainted with such ideas. They were not, however, confined to Egypt. Some of the Akkadian psalms must be older than the age of Moses, and, in thought and language, they show remarkable resemblance to Hebrew psalms, except that they are polytheistic and not monotheistic. The civilisation of Babylonia, Syria and Palestine was as advanced as that of Egypt, and such things as inscribed gems, tents with pillars of gold and silver, altars, and arks, can be proved by existing dated examples, and by contemporary texts, to have been in general use even before Moses.

In respect to the original documents whence the Pentateuch was derived, we know that the Ten Commandments were written on both sides of a pair of stone tablets, and it is probable that the other laws and narratives may also have been so written, since tablets were still in use among the Hebrews down to the time of Jeremiah, though gradually superseded by scrolls. Careful inspection of the various episodes in Genesis, and elsewhere in the Pentateuch, seems clearly to indicate the original existence of such tablets. If they were written in some syllabic character—very probably the cuneiform which was then in use in Egypt itself and all over Western Asia—this would supply a simple explanation of apparent discrepancies in personal names and other words. Thus, for instance, it is possible to write, in cuneiform, a name which could be read either "Jethro priest of Midian" or "Reuel Prince of Midian" as two renderings of the same group of signs. And what so applies to the two names of Moses' father-in-law will be found to apply equally to many other names. The discrepancies arose in copying the original documents, and need not be regarded as evidence of distinct authorship. The average length of any episode in the earlier parts of the Pentateuch does not exceed what could have

been included in each case on a single tablet. This view I have briefly explained in a recent work "The Bible and the East."

Many of the supposed anachronisms which, according to eighteenth century criticism, marked a late date in the Penta-teuch writings are, by such evidence, proved not to be anachronisms at all, but to show an intimate knowledge of contemporary civilisation on the part of the writer, and an ignorance on the part of the critic, only excusable because the external monumental evidence, now available, was then entirely unknown.

Colonel Conder has added a few incidental remarks which will be of interest to the reader.

The incidents, mentioned in the 9th page of the paper, seem to be those of the Mohar's journey in Palestine, supposed by Chabas to belong to the time of Rameses II., and are not found in the story of Saneha, who appears to be the traveller alluded to in the time of Usertesen I.

Personally, I do not believe that the alphabet existed in the time of Moses, as cuneiform seems to have been the character then in use. I think that Glaser has failed to satisfy specialists as to the antiquity of his Arab texts. The characters can hardly be as ancient judging from their forms, and the thirty-three kings of the Minæans may only carry us back to about 600 B.C.

I think also it is too positive an assertion that the Tell-el-Amarna tablets are older than Moses. Dr. Winckler and Dr. Zimmern in Germany have, I understand, pronounced in favour of their being as late as the Hebrew conquest of Palestine, which is the view I have always held, and they agree that the Hebrews are often mentioned in these letters, and that Mineptah found Israel inhabiting Palestine.

Bunsen's view as to the late date of the Exodus does not agree with Old Testament chronology and it rests on no monumental foundation, but is indeed discredited by the later monumental discoveries.

The fact of Greek letters in Egypt resembling the Etruscan is only natural since the two alphabets were nearly akin, but it does not establish any very great antiquity for these as the Etruscan letters are not the oldest known by any means.

Finally, I cannot understand how Hummurabi can be placed as early as 2356 B.C. The Babylonian statements place him (by two separate reckonings) about 2150 B.C. These, of course, are only small points not really important to the question discussed.

ORDINARY MEETING.*

PROFESSOR E. HULL, LL.D., F.R.S., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed.

The following paper was read by the Author :—

PLAN AND PURPOSE IN NATURE. By WALTER KIDD, M.D., F.Z.S.

THE existence of Design in Nature is the “*quod semper, quod ubique, quod ab omnibus,*” which scientific teachers may as well make up their minds to entertain. It is their province to ascertain, if they can, the modes in which this Design has been carried out. At the same time it must be acknowledged that the conception of purpose and plan immanent in and pervading Nature, is the insurmountable barrier to the reception of the doctrine of evolution, as “rightly conceived” by Mr. Herbert Spencer. Darwin’s discoveries, which at first logically involved some sort of teleology, by reason of his supposed four or five primordial forms of life, are supposed to have given the *coup de grâce* to the old teleology. All the structures and parts of plants and animals are supposed to exist only by reason of their value in the struggle for existence to their possessors, or as survivals of some that were of use to remote ancestors, and myriad adaptations of means to ends throughout nature are attributed to a *mechanical law*. At this amazing position

* Feb. 21st, 1898.

stands the evolutionary Luther with his modern "Here I am, I can do no otherwise." One of the most fearless of the Reformers stated it clearly enough in his earlier days when speaking of this 'mechanical theory':—"It endeavours to comprise all the facts of adaptation in organic nature under the same category of explanation as those which occur in inorganic nature—that is to say, under the category of physical, or ascertainable, causation. Indeed, unless the theory has succeeded in doing this, it has not succeeded in doing anything—beyond making a great noise in the world. If Mr. Darwin has not discovered a new mechanical cause in the selection principle, his labour has been worse than in vain." As to the noise which it has made there is no doubt. But apart from the great attempted revolution which he set on foot, the bye-products of Darwin's work have been of imperishable value and wide interest, and his central theory has at least set in motion a host of workers in biology. But when the gifted disciple of Darwin went further still and said that "Science" (by which, of course, the subject matter of his brilliant advocacy—evolutionary doctrines—was represented), had "rendered impossible the appearance in literature of any future Paley, Bell, or Chalmers," he failed to see that every evolutionist of them all is a Paley, Bell, or Chalmers *malgré lui*.

2 In these remarks upon the evidence for Design upon the earth that familiar side of the question, under which occur the adaptations of organisms to their environments and needs, will not be considered. This side is being daily reinforced by a host of biologists, whose labours resemble for industry and unconscious benevolence that of the bees among entomophilous plants, laudable enough in its primary object, but of wider import than they at present know. Professor Schiller has lately† discussed "Darwinism and Design" from this point of view of the adaptations of living nature, as the title indicates. He finds Darwinism, as formulated for the purpose of a working theory, destructive of all teleology, not avowedly hostile to the conception of a Creator, but promoting views of the origin of living things which rendered a Designer or Creator superfluous, the facts of animated nature being supposed to be sufficiently accounted for in other ways. Professor Schiller

* Romanes, *Darwin and after Darwin*, part 1, p. 402.

† *Contemporary Review*, June, 1897.

shows with valuable clearness the inadequacy, which all are now recognizing, of Darwin's postulate of indefinite accidental variations concerned under the action of natural selection in the origination of new forms of life. He himself appears to incline to a view of evolutionism, in which the argument for Design is materially strengthened, *positively* because evolutionism, as he says, lets us behind the scenes and shows how means are adapted to ends in the gradual process of evolution; he would probably approve of Drummond's *naive* way of putting it, "Why was evolution the method chosen?" *negatively* because evolutionism greatly weakens the objections to the teleological argument based on the imperfection of the existing adaptations.

3 It is perfectly true, as we are often being reminded by current teachers, that the argument for Design in nature is not in fashion at present, and Dr. Johnson spoke with his customary wisdom when he said: "He that contradicts acknowledged truth, is always sure of an audience." The scientific exponents of evolutionary doctrines are listened to with the respect due to their attainments as they discourse in lectures, addresses, periodicals and larger essays. Their audience is great indeed. Teachers of these views are even to be found tickling the ear of the public in popular magazines for the laity, in illustrated weeklies and in novels. But the bulk of those who read, are interested, amused, and impressed, betray a healthy degree of scepticism as to current science on these grave questions, a scepticism encouraged with a singular candour by their teachers themselves in such admissions as, "All our knowledge is and remains throughout provisional."*

4 To those who have obediently, and a little hastily followed current doctrines as to life in nature, this note of transitoriness cropping up from time to time in the seeming certainty of that gospel of evolution, upon which their whole mental and spiritual fortune has been staked, is not a little startling. Drummond was even more alarming to the wayfarer, who for long past has taken in such guidance as he could find from evolutionary teachers, when he said—"This is the Age of the Evolution of Evolution." . . . "even were his theory perfected, its first lesson would be that it was itself but a phase of the evolution of further opinion, no more fixed

* Weismann on *Germinal Selection*, 1896, p. 37.

than a species, no more final than the theory which it displaced.* The reference here to species is singular, for if the progress of knowledge as to species has taught one thing more than another it is the truth of *specific stability*. Modification of species in remarkable degrees, especially by artificial selection, has done wonders. What it has *not* done, in the production of a new "physiological species," is equally wonderful. But, leaving such debatable ground, we may be thankful to Drummond for his reference to "the theory which it displaced." He utterly mistakes the theory which for the time science by the fiat of her leaders has agreed to ban, that theory under which the very best of his spiritual knowledge was nurtured. The essence of the "theory" that reigned till Darwin, and that may ere long emerge from the present upheaval of thought, thereby much purified from dross—that of creation—is its finality. Mr. Herbert Spencer calls it "special creation," but unless the adjective be meaningless it is not warranted by Revelation as rightly expounded.

5 Turn from the vast system of hypotheses piled upon innumerable facts in nature, and loose analogies without end, to the simple view which is the essence of creation, and say which of the two rival theories better meets the mental needs of human beings. Say that "in the beginning God created the heaven and the earth," and in their place and time every new form of life as the changing conditions were fitted for it, that this great drama of creative action proceeded through all the geological ages and in all parts of the globe as it seemed best to One of infinite wisdom, that the production of fresh forms ceased with that of Man, the head of the sentient world, that marvellous laws for the working of this complex system of being were laid down, and that Struggle, Heredity, Variability, were its working principles, and that within these immense boundaries the improvement of fauna and of flora, with extinction of obsolete forms, was carried on, and at least you have left your disciple an universe, which does not shock his very elements of knowledge. You have not forced him in "the evil days" and after death to a bland Nirvana, where Nature, and Development, rather than God, "shall be all in all." You have not offered him a cup of optimism, which personally he will never taste, in the one hand, and of despair for his shat-

* *Ascent of Man*, 1894, p. 9.

tered faith in the other. Your average disciple, if you press him will regretfully say, "The endless redistribution of matter and motion in stupendous cycles of evolution and dissolution would be a world without any justification to offer for its existence—a world which might just as well not have been."* No—let evolution be more philosophically confined to that of the individual—let Ontogeny be recognised for what it is, the development of the individual plant or animal, and no fancied epitome or picture of the development of the race which has preceded the individual; and let "phylogeny" stand as but another name for the necessary relationships of innumerable forms of life introduced successively in the past ages of the globe, *varieties* and *races*, such as are seen in the case of Man, climax of all this vast stream of life, serving to fill the numerous gradations between species and species. If the existence of a Divine First Cause be admitted, it is difficult to see what *a priori* objection can lie against this view of the seed-plot of life, of which this globe may perhaps be but a part.

6 It is not less difficult to see what ascertained facts as to life and its manifestations forbid this view, harmonious at once with Revelation, Reason, and scientific knowledge.

7 When it is further borne in mind that *degeneration* plays a part in life, and must have done so from its early days, of profound and far-reaching importance, we feel we are not shut up to the system, which has usurped for a time the place of the doctrines of Creation and Design in Nature. It was lately pointed out that in scientific questions, the arguments—perhaps even the strongest—cannot always be stated in express terms. And this consideration accounts partly for the element of scepticism and amusement that an observer detects in the tone of the man in the street when the teachers of current science undertake to instruct him in primers, periodicals, addresses and romances. Would not the palladins of evolution who have passed away, and perhaps some who are still living, sigh for the good times when "natural selection" reigned in sole power—for the early days when they had made of biology a solitude and called it peace. But Ossa has been heaped on Pelion in heroic fashion by the demi-gods, who would thus scale the heaven of truth. Those simple times of the nonage of Darwinism are no more. One "factor of organic evolution"

* Professor Seth, *Man's Place in the Cosmos*, p. 27.

after another is being devised, as the issues widen, and the goal is as far off as ever.

8 The very magnitude and shifting character of these doctrines and their complexity, at least justify the naturalist in falling back on creation by an Intelligent Being, and a Being with Will as well as Power, and Morality crowning all—that he may again turn to the study of a cosmos rather than a chaos.

9 Thus will Professor Schiller's timid references to the imperfection of existing adaptation, or those of Dr. Courtney at this Institute as to the non-validity of the teleological argument by reason of that imperfection, find their adequate answer. Such arguments as Helmholtz sanctioned by his proof of the imperfection of the human eye as an optical instrument, are met on the threshold by the terms of the theory of Creation and Design, involving as they do Supreme Will as well as Power. From the physicist's point of view there is nothing perfect in Nature. But such an organ as the human eye may, without contradiction, be considered adequate to the varying needs of the human race. Were it the case that the human eye in palæolithic times was perfect in its adaptation to the needs of those days, this organ would certainly not be such in the present day, were it not for the *adaptability* of the mechanism bestowed upon it by a Supreme Intelligence. In such departments of life as this, again development finds its legitimate sphere. We may be thankful for the power of development, even if it be strangely near to a process of degeneration, under which the emmetropic or hypermetropic eyes of our ruder ancestors could be accommodated in the progress of ages to the study of books, pictures, and microscopes, unknown in early days. As much perfection is found in higher animal life, especially that of man, as a wise Creator bestowed, Who foresaw the value of struggle in the strengthening and improvement of physical, mental, and moral characters. Adequacy and adaptability are its limits. Perhaps the nearest approach to perfection of adaptation is found in parasites.

10 After this digression from the province of Design, the other side of our time-worn subject will be shortly studied. It is one which is strangely ignored, and may be simply illustrated from one of the favourite lines of argument for evolutionary doctrines, embryology.

11 A mammalian embryo when fertilized undergoes in the

early period of its life-history processes called karyokinesis, segmentation, gastrulation, formation of blastoderm with primitive entoderm and ectoderm. Then further differentiation of its cells into organ after organ takes place. The ovum becomes attached to the protecting and nourishing maternal walls. Expansion of these and enlargement of vessels, which are eventually massed together for the placenta, takes place. At this period the growing ovum requires a change in its environment, though it must still be attached to the maternal surface. A group of vessels intertwined with fibrous tissue becomes the placenta, a cord containing an artery and vein supplies a direct communication of its blood with that of the mother, by which means oxygenation of the foetal blood takes place. The ovum is delicate and requires protection. Fluid forms round it. The maternal parts, its temporary habitation, enlarge; muscular tissue, perhaps dormant for many years before, becomes enormously enlarged for *future use*. In due time the need for all these elaborate contrivances comes to an end. Means are ingeniously provided for the extrusion of the ovum when mature, and its other life when born. Such a remarkable process as this, preordained from the moment of fertilization, in which, strange to say, Huxley could almost, but not quite, see "the Hidden Artist" at work, with the eyes of his faith, may be repeated in identical fashion many times in the life of one animal. But these and many other changes in the ovum which have not been referred to, and the discovery of which constitutes some of the most brilliant and exact results of biological science, could not proceed beyond a few halting steps were it not for the preordained conditions for its coming life, meeting it at every stage of its development. Indeed a most apposite comment upon the cogency of the argument here maintained is supplied by an experience, happily rare, known to medical men as ectopic gestation. Here the ovum is diverted from its suited and preparing home: it develops up to a certain lamentable degree in its abnormal position, an exile from its home, until a fatal result to mother and ovum is seldom averted, and then only by the exhibition of surgical skill brilliant among many brilliant triumphs; which is a sad and apt comment upon the interruption of Design on the one hand, and on the other upon the power of mind, albeit a human mind.

12 The length and simplicity of this illustration may be pardoned for the sake of the light thrown by it on one aspect

of the evidence for Design in animated nature. Let the Darwinian study his plants and animals, and let him prove to the hilt the necessity of his "teleology," and call it what he likes, even to Germinal Selection. Upon this side of the question all one need say is "*Fas est ab hoste doceri.*" It is, however, a totally one-sided view of the matter to contemplate the *adaptation of organisms to environments*, even from Pre-Cambrian times to 1897.

13 Now, environments provided and pre-arranged, as in the case of our mammalian embryo, lead the mind to a correspondence growing from the dawn of Creation, under which organisms are adapted to environments and *environments produced for organisms*, and this has proceeded in a majestic, orderly manner. It is a spectacle known only in the present century through the labours of geologists, one which poets, sages, and scientists of old desired to see but saw it not. Yet for all this interminable progression of nature, which has already required some millions of years for its passing, is ample room allowed, with divine insight, in the first two verses of Genesis. Be it remembered that the age of Moses was one in no way enlightened, but rather darkened by the science of the time, nor was the veil lifted in later days, when Isaiah, with wisdom not his own, summed up in prophetic words some of the results of geological science—"He formed it to be inhabited."

14 In the earliest times it was not enough that the little molten mass, which became our planet, should cool down to the required temperature for the existence of life. Lord Kelvin lately pointed out at this Institute on the one hand the necessity of an atmosphere encircling the globe, in which a due proportion of oxygen should exist for the purpose of animal life, and on the other that this probably could not have come from the previously molten and now cooling crust of the earth. Introduction of free oxygen from some other source in a suited form was essential, and he suggested that this was supplied by the prior creation of vast quantities of low plant life, algæ and the like, which, growing in the seas, should by their own vital processes supply for the *coming* animal life that oxygen without which this could not be. If this were so the great rôle which plant life of all kinds was in coming ages to exercise, that of commissariat department for the animals of earth, air, and water, was remarkably foreshadowed and initiated. And it is equally remarkable that the Mosaic cosmogony declares the precedence of plants in the order of production of organic existence.

15 At this rudimentary stage in the "development" of life shone forth that Design which was never to be suspended to the present time.

16 So the azoic ages were at an end, themselves equal it is thought to a third of all those that were to come, and there commenced in Palæozoic, Mesozoic, and Cainozoic times, as men call them, the formation of those successive forms of life, vegetable and animal, rising from lower to higher, ever inter-related and inter-dependent, with environments suited to their growing needs. The Age of Invertebrates found the warm and quiet Laurentian, Cambrian and Silurian Seas ready for their coming denizens, much as did our mammalian embryo find ready a soft, vascular mucous membrane for its quiet habitation and supply. The first of these three periods with its two vast lines of evidence for extinct plant and animal life, viz., quantities of graphite and limestone, shows us the earliest annals of invertebrate history, and the immense preparations made for material upon which these earliest organisms must have fed, and with which constructed their simple skeletons. The prolific outburst of marine invertebrate life in Cambrian times is very remarkable, and still more in Silurian—so much so that in the Silurian all the subkingdoms of Invertebrates, whether reckoned as eight or five, were represented. This was so varied that the Silurian basin of Bohemia alone is described by M. de Barrande as affording a thousand species of Nautilus.

17 In the succeeding periods of the history of the globe, Devonian and Carboniferous, warmth and moisture prevailed extensively, and the making of supplies, which coming Man for his higher development would need, was not neglected. The scene shifted in these ages from the sea to the dry land, from the Devonian age of Fishes to the long Carboniferous times. In the latter, marshy ground and peat-beds, formed after slow submergence of the land, teemed with insect and reptile life, and luxuriant vegetation. Ferns and club-mosses of vast size lived, died and decayed into those peat-beds where the coal of various kinds, of European and American coal-beds, was laid down for far-future use. The Mesozoic or Secondary Age, the Age of Reptiles, was one of the great prolific periods of life, such as that of the marine invertebrates of Cambrian and Silurian times, or the Fishes in Devonian. Here was manifested a remarkable development of land flora and fauna, with corresponding outburst of marine life; crabs, gigantic sea-lizards,

and mollusca, for example, now reached their zenith with ammonites and belemnites. On land appeared butterflies and various insects, enormous amphibians, true reptiles, huge dinosaurs, crocodiles, winged reptiles, small mammals of marsupial type, and a few birds. The earliest leaf-bearing plants also came forth. In this period again, as with the invertebrate fauna of Silurian times, all vertebrates with their five orders were represented. And how were these new denizens, many of them appearing suddenly upon the scene of life, greeted in the home where they found themselves? There were warmth, excessive moisture, equability of conditions provided for this exuberant vegetable and animal life, and as in other times *scope for expansion* rather than struggle for existence, according to Sir William Dawson, was the order of the day. Increasing definition of land and sea which began in Palæozoic, continued slowly through this Mesozoic period, and took its more modern form in Cainozoic times, and slow development of climatic conditions ensued. During this age the great chalk formations of the world were being laid down in the sea for immense periods of time, constructed from the minute shells of foraminifera, and the flint from innumerable polycystina, spicules of sponge and diatoms; these tiny creatures subserving the Design prevailing through all geological time, which could anticipate the day of Man's growing ability to make use of these stores of flint and chalk. At the close of this long stretch of time, in which the British seas were warm enough for coral reefs and the Arctic Zone for great reptiles, a period of much greater cold prevailed. At any rate this is presumed as the only known reason for that remarkable extinction of species which took place over the large continents, when the giant forms of the Age of Reptiles largely disappeared. The cold termination of the Secondary period served its purpose in preparing the way for a higher scale of life on land and sea. The birds and mammals, which in secondary times had been represented in low and less perfect forms, became highly specialized as the great colossi of Saurian type gave way to their nobler if weaker successors, and the Cainozoic became the Age of Mammals. The new order of creatures of this important epoch were again gently dealt with by a supreme Intelligence. The fresh outburst of vertebrate life, and forests with large proportion of warm-climate types, were not at once subjected to that severity of condition which closed the

Cretaceous period. Again in the opening eras of the Eocene and in the Miocene warmth of climate and much moisture prevailed. Higher life of animal and plant flourished abundantly on the continents now largely increased in area by elevation since the later Mesozoic times. The excessive moisture of the latter diminished, specialization of climate increased, lower temperatures gradually prevailed. A force, which is never a convenient one for strict uniformitarians either in geology or palæontology to entertain, became remarkably prominent in the later Miocene times. In quiet Mesozoic ages volcanic action, though existing in all ages, was little pronounced. But in Cainozoic times it became of immense importance in the making of mountain ranges and valleys. It is difficult to say whether the results of its working upon the face of the earth, or the *restraint* of its power, is the more remarkable. The effects at least were of supreme importance to more specialized groups of inhabitants, and in due time the geography of the earth and sea came slowly to its present limits, and in this result volcanic action found its beneficent purpose. The important remark of Sir William Dawson must here be borne in mind in the study of environments adapted to coming requirements:* "We also see that, not the adverse conditions of struggle for existence, but the favouring conditions of scope for expansion, were, as might rationally be expected, the accompaniments and secondary causes of new inbursts of life." This principle is seen carried out in the equable and comparatively uniform character of the home into which the Cambrian and Silurian invertebrates were introduced; in the warm marine environment with teeming supplies of food which greeted the Devonian fishes, the moist marshy and mild terrestrial climate for the flora of those days, the restrained action of volcanoes and increasing emergence of land. How suited were such free and luxuriant conditions of life to the marvellous fauna and flora peculiar to the Mesozoic period! The value of the Sub-Carboniferous period of that era, with its long submergence of the land in shallow water, paving the way for the luxuriant land vegetation of the Carboniferous period, and the significant introduction of vast quantities of insects pregnant of benevolence for future plant life, withal unconscious of their honoured position, may be borne in mind in illus-

* *Modern Ideas of Evolution*, p. 118.

tration of this principle. It is also seen in the gradual slow changes of climate, the slow emergence and submergence of land, the restrained volcanic action of these early days.

18 But equable conditions such as these suited not the prolific outburst of higher life among animals, soon to appear in early Cainozoic times, and the more hardy forms of plants. The climate gradually altered from the mildness of Eocene and Miocene times, when palms flourished in Great Britain and Siberia was a temperate abode much like that of the Continent of Europe at the present time, to the gradual cooling of Pliocene climate. Then became defined, much as now, the frigid and torrid zones. Then arose the mountain chains of California, Mexico, the Rocky Mountains and Alps, Pyrenees, and Apennines. Volcanic action extensively prevailed, more especially along the land-borders. The definition of land and sea proceeded till, "hitherto shalt thou go, and no further, and here shall thy proud waves be stayed," was the beneficent fiat to the restless ocean in the approaching Quaternary Age of Man. During the Cainozoic period a vast population, largely new to the world, was introduced to this prepared home. Its name, the Age of Mammals, indicates the predominant type, and these were now placental mammals of a higher scale than the marsupials of the Mesozoic. Lower vertebrates also of all kinds prevailed in profusion; reptiles, such as crocodiles, lizards, snakes, and turtles; birds such as owls, eagles, cranes, pelicans, ibises; mammals such as the earlier herbivores, tapirs, hogs, rhinoceros, deer, and the supposed ancestors of the horse; carnivores with forms like those of wolves and dogs, greater mammals such as mastodons, elephants, thus representing in earlier forms all the great brutes which in the Quaternary times were to reach their climax. Monkeys appeared in Miocene times so widely as to give occasionally the name "Age of Monkeys" to this period, and a few anthropoid apes, and extensive timber forests.

19 When the last geological age, in which we ourselves are living, was ushered in, the gradual cooling of the Pliocene period culminated in the glacial period of the Quaternary Age. The effects of this time of low temperature with, it is believed, more than one glacial period were of profound importance. The increasing cold killed off many forms of life unsuited for coming days, and man now entered upon the scene with, for the first time, more difficult environments to test this "fitness." Transportation of great masses of rock,

grinding of surfaces to gravel and clay, immense action of increasing river systems took place, all of which led to that valuable mantle of alluvial soils which clothed the earth's surface for the profit of Man and his subject creatures. Whether we adopt the extreme views held by some as to the omnipotent action of ice alone, or with Sir Joseph Prestwich, Sir William Dawson, Sir Henry Howorth, look also for the immense dispersion of rocks, sifting of gravel into sand and loam, and deposit of alluvium to the action of a Flood, or floods by which "the delicate handling of soft fingered water" served its useful purpose, and which, as many believe, led to the fertility of surface of the earth, and the alluvial richness along valleys, producing the higher possibilities of cultivation of the soil—whether we look to ice alone or to Diluvial action as well—the purposeful results are as plain as need be.

20 In considering the preparation of the home for coming Man we must not lose sight of the remarkable fact of the existence of those plants, which he found ready to his hand, which he was able to cultivate as cereals, nor of the equally noticeable production of the great classes of domesticable animals among the Ungulates and Carnivores. The more subtle agency which the genius of Darwin in the course of thirty years' study brought to light, that of the earthworms, became of immense importance. By the beneficent work of these animals was caused much of the breaking up of mould, smoothing down of surfaces of soil, and its opening up to the fertilizing influences of warmth and moisture.

21 The position here maintained is that the argument from the slow and orderly preparation of the environments for coming life on the globe necessarily implies the existence of Design. The succeeding changes of those environments through the geological ages, ever leading to conditions and potentialities for organic existence; rising, pausing, and ever-rising towards those in which human life was possible, is unmistakable in its significance—"evolution," "development," or "creation" apart. Here design, though infinitely long-drawn, is the only conceivable explanation of things. All the changing fashions in biological speculation from *natural selection*, *sexual selection*, *histological selection of Roux*, *germinal selection of Weismann*, *physical selection of more stable elements of Karl Pearson*, to *selection in general*, suffice to keep fully employed the acute and hungry intellects of the present generation of biologists, and these deal in their way with the

more accessible side, viz. :—the adaptation of organisms for the conditions which they find *somehow or other*, ready for their life. These conceptions repose upon a vast body of facts, interpret the latter how we may.

22 But when these have given way to some fresh theory, which shall continue the strangling of all teleology, no theory is possible which will exclude design from the other side of the question dealt with here. Teachers of current science may find it necessary to promulgate edicts proclaiming “no thoroughfare here,” for the enquirer who may ask for the evidence connecting one side with the other. Such statements as those of Weismann published two years ago in his essay on *Germinal Selection* (*pref.*, p. XII.), where he says of teleological principles—“*Their introduction, however, is the ruin of science*”—would perhaps afford a preamble for such proclamation worthy of notice. And yet if it be not too much to say, Weismann has become the most outspoken teleologist since the Bridgewater treatises—except perhaps Huxley. Doubtless these two learned and fearlessly candid men dismiss what they call teleology with a few contemptuous words. But strangely enough there are some “chartered libertines” of science who may, with Huxley, speak of Man as a “conscious automaton endowed with free will,” or with Weismann proclaim, “Everything is adapted in animate nature and has been from the first beginnings of life”* in the very same essay in which all teleology is ruled out of science-land. Weismann also says there, “Outward conditions only apparently determine the direction of variations, whilst in truth it is the adaptive requirement itself that produces the useful direction of variation by means of selectional processes within the germ,”† and “But even taking the very simplest cases of selection, it is impossible to do without this assumption, that *the useful variations are always present or that they always exist in a sufficiently large number of individuals for the selective process.*”‡ (Italics not in the original.) These few quotations from Weismann need no comment. Teleology so transcendent justifies the above description of the great Freyburg biologist as a teacher of teleology. In connection with this aspect of veiled teleology, it is worthy of remark that the campaign of evolution has changed from an aggressive movement to that of an inter-necine strife, especially in the matter of variation. Darwin’s

* *Op. cit.*, p. 42.

† p. 50.

‡ p. 14.

accidental indefinite variations have had their day and ceased to be. Bateson finds a large number of variations to be sudden, considerable, and discontinuous. Weismann finds the cause of variations to be in the germ-substance, and his most recent view is, that "it is the adaptive requirement itself that produces the useful direction of variation by means of selectional processes within the germ,"* as quoted above. If from all this "adaptive requirement," "variations arising when and where needed," "everything adapted in animate nature," the light of Design be excluded it is pertinent to remember the story of Richelieu with a troublesome suitor for pecuniary help, whose final argument on his own behalf, "But, Sir, one must live," was met with the characteristic answer, "*I do not see the necessity!*" Why indeed should the multitudinous organisms of earth, air and water so successfully struggle to live and change if the doctrines of Darwin, Weismann, Bateson and others, even if true, be not teleological in the profoundest sense?

23 Even the familiar and well worn subject of artificial selection, so elaborately handled by Darwin, instead of supporting a view of life, in which chance reigns, only constitutes, by its analogy with the wild life of plants and animals, a powerful argument for the operation of mind. The very essence of artificial selection is that it proceeds from Design on the part of an intelligent being; the unconscious selection of domesticable animals in earlier days being but a small part of this subject.

24 It is in this obscure field of the origin of variations that the battle of evolution must next be fought. Mr. Bateson indeed said "variation, in fact, *is* evolution."† The theory of organic evolution, under whatsoever of the many existing forms it may appear, is compelled to assume the origin from uni-cellular organisms, or even from non-cellular masses of undifferentiated bioplasm, of all the plants and animals known to-day ranging from protozoa to man, and from protophyta to oaks, yews, and olive trees. To the ordinary man this is a large order upon his faith. But, to begin with, hundreds of millions of years are granted to the evolutionist, or taken by him, and Mr. Herbert Spencer presents him in his Synthetic Philosophy with an analogy, which is of a character most compromising to his own views. The words, in connection with our subject of Design, deserve to be written in letters of gold. They

* *Op. cit.*, p. 56. † *Materials for the Study of Variation*, p. 6.

are given in the section dealing with the evolution of life,* and this is alleged to be "mentally representable in outline if not in detail," and declared to be "a legitimate symbolic conception." Perhaps so, perhaps not. The illustrative words are, "*If a single cell, under appropriate conditions, becomes a man in the space of a few years, there can surely be no difficulty in understanding how, under appropriate conditions, a cell may in the course of untold millions of years give origin to the human race.*" (The italics are not in the original.) It would be difficult for an opponent of Design in Nature to make a more damaging analogy than meets one in this short sentence, well thought out and expressed, as is everything which Mr. Spencer writes. "Appropriate conditions" indeed! Why, it is these very "appropriate conditions" which furnish the other side of the argument for Design, which is being here considered, and which, except for a necessity to exclude design from the side of the organisms, cannot be gainsaid. The fundamental difference between those environments, stable and slowly varying according to well-known definite laws, encountered by a fertilized ovum in its course to adult life, and those encountered by organisms in general, is sufficiently clear. In the case of the latter, the homogeneous marine conditions of pre-Cambrian times, the varied terrestrial and marine "climates" of Devonian and Carboniferous, the more differentiated complex Mesozoic, the still more elaborate Cainozoic, more diverse and difficult, with growing competition for existence, changing climates, Ice Ages, volcanoes, earthquakes, destruction and cultivation at the hand of man—all these, with many more changes of condition which have marked the fitful course of life from Protozoa to Man, in spite of their outward complexity, are clear to the teleologist as evidence for Design in Nature. But he would hardly have looked for such an unintentional admission from analogy as Mr. Herbert Spencer furnishes in his comparison of the "appropriate conditions" of the individual and those of the race. In the case of both individuals and race the environments in their orderly production furnish a strong proof for Intelligent Design in a world which is "not chaos but cosmos," to say nothing of the pre-ordained direction of development and degree of growth contained in the "sealed orders" delivered to every ovum embarked upon the troubled sea of life. The teleolo-

* *Epitome of Synthetic Philosophy*, Sect. 118, p. 109.

gist cannot but be grateful for such a sentence from such a source. It is needless to say, however, that Mr. Herbert Spencer does not consider Design, as such, worthy of mention in his *Synthetic Philosophy*.

25 After this digression we must return to the uni-cellular or non-cellular organisms which arose *somehow* after the globe had cooled down to the temperature at which low life was possible. How they arose we may not prove; Darwin even called the question "mere rubbish." These tiny creatures, supposed ancestors of ours, must have then, because they do now under our microscopes, propagated themselves by "fission" or division, by "gemination" or budding—the two lowest forms of reproduction. The particular problem in building the tree of Man's ancestry from such elements as these which here meet us, is that in this rudimentary method of propagation there is no conceivable place for the occurrence of that cause of variation called by Mr. Wallace* the primary one, viz., amphigony. Darwin† takes a less extreme view of the necessity of amphigony for the production of variability but admits its immense importance. He then proceeds to speak of bud-variations as an exception, but says they occur "rarely under nature." He says also as to the influence of conditions of life on variability,‡ "We clearly see that the nature of the condition is of subordinate importance in comparison with the nature of the organism in determining each particular form of variation; perhaps of not more importance than the nature of the spark, by which a mass of combustible matter is ignited, has in determining the nature of the flames." Darwin also says,§ "Hence, although it must be admitted that new conditions of life do sometimes definitely affect organic beings, it may be doubted whether well-marked races have often been produced by the direct action of changed conditions without the aid of selection either by man or nature." These admissions of Darwin may be taken as specimens of what is generally allowed by naturalists as to the small influence of change of environment on the production of

* *Darwinism*, p. 439.

† *Origin of Species*, 6th Edition, p. 7.

‡ *Ibid.*, 8.

§ *Animals and Plants under Domestication*, vol. ii, p. 292.

variations. Weismann will admit no influence whatever. Much has been written by him and his opponent, Romanes, upon the knotty point of the difference between uni-cellular and multi-cellular organisms in this respect, and one cannot but see that Romanes has much the best of it at all points in his "Examination of Weismannism."

26 But whether or not Weismann be allowed to call uni-cellular organisms "immortal," and multi-cellular organisms "mortal" for the sake of providing bases for his complex superstructure of theories on Heredity, or whether or not the criticisms of Romanes have pulled down this basis as well as others the importance here of the question is only academic. Even for the sake of a great theory in distress our uni-cellular or minute masses of undifferentiated bioplasm can never be brought within the range of amphigony. Accordingly the main, or even paramount factor in the production of variations will not serve in the variations required by the hypothesis in these tiny dots of matter, in earliest geological times. The moving force, which is to move upwards in the scale of organized life these microscopic structureless beings, must be something else than amphigony with all its promising paper potentialities. The only resource left is to invoke "Lamarckian factors" at this stage, in other words the effects of the environments upon *individuals* of these tiny dots, which must be supposed to have carried on a struggle for existence in the infinite bosom of the primeval seas! Thus certain of them must be supposed to have become better fitted to survive than the remainder, and so crept into a higher place and form of life.

27 Now, out of such a totally inconceivable state of things even if this theoretical transformation is to begin at all, we are to believe that a little greater or less salinity, temperature or motion of the sea did verily cause such variations in our "dots," during the ages which succeeded the Azoic, as eventuated in Diatomaceæ with their perfect skeleton, or such as Venus' Flower Basket among the sponges of early Cambrian times.

28 The only alternative mode, in which the transformation of Monera such as these into the Nautiloid Foraminifera, to take one of multitudinous forms of surpassing beauty, can be conceived (Mr. Spencer, I believe, will not allow that this is even a conceivable or legitimate symbol) is that direct creative acts took place at this and every other suited stage

in the great drama of Nature, as environments for coming life were prepared, up to that period when Man, the only creature who "looks before and after," came upon the scene of his unique career. The argument for Design, furnished by the orderly sequence of environments for coming organisms, touches closely the question between the views of Creation or Evolution of life-forms themselves. The principles of the older view are indeed not more stifled at present than were the forms of constitutional freedom in the House of Lords under the Tudor despotism, which proved themselves of such solid value as bases of a struggle for freedom and a purer government, which men were yet to wage in England. It is of great importance at the present juncture to keep in a simple form before the minds of men, in spite of the weight of current authority against it, the view of creation apart from development, the latter being but one of the tributary forces of the former.

29 It may then be that in due course of time the great structure of the cosmic theory of evolution shall fall to pieces by internecine strife, and the older conception, purified indeed by scientific progress, and yet substantially unaltered, will remain.

30 We have come to this pass that, if we are to look for any "law" governing the growing suitability of the environments for organisms, it is rather one of death and destruction than any evolution or life-process such as, on their side, the organisms require. Which then of the gods of the evolutionary pantheon shall bring to pass this wondrous cycle of cosmic phenomena? Shall it be Struggle, Survival, Heredity, Variability, Selection (natural, sexual, histological, germinal, or physical, of Karl Pearson), all with their capital letters, suggestive of the bearskins, which Huxley remarked seemed to be put on the Grenadiers to make them look much finer fellows than they were? None of these will do. We can but say then of these adapted environments, with a well-known "sceptic" of old, who had an awkward way of looking for himself at facts which he could verify and comprehend, "Why herein is a marvellous thing that ye know not whence they are, and yet they have opened the way for life to come forth and flourish."

31 Shall we listen for an answer to the expert in geology, who tells us of the metamorphosis of the primary rocks by heat and pressure, of the mode of origin of the plutonic and volcanic rocks, of the action of ice and floods, of the sedi-

mentary rocks littered with and often composed of the carcasses of bye-gone generations of beings, the chalk of skeletons of globigerina, the long-buried flints of polycystina and diatoms, the carboniferous beds of ancient decaying vegetation, endowing our little island with a wealth greater than of the Indies, by which of old Spain was both enriched and emasculated, the alluvial richness of drift-deposits, the vegetable mould formed in later days by "natural" means? The geologist and physicist will give us valuable information as to the "natural laws" under which all this earth-making has been conducted. But when the dissertation is over, we can only say in the hardness of our hearts that all this decomposing, destructive, cataclysmic action, disclosed for us by his special skill, looks perilously like the direct reverse of those processes of life, which the Evolutionist cosmogony has glorified as effectual in the production of the world and the things that are therein. It can never be wrong in these discussions to revert to Mr. Herbert Spencer's description of evolution given in the last edition of the *Epitome of Synthetic Philosophy*.* —"Throughout the universe in general and in detail, there is an unceasing redistribution of matter and motion. This redistribution constitutes evolution, where there is a predominant integration of matter and dissipation of motion, and constitutes dissolution where there is a predominant absorption of motion and disintegration of matter." In the history of the environments there is doubtless a change in the main from the homogeneous to the heterogeneous, from simple to complex. But it is hardly too much to say, as to their *production*, that by evolution the organic life of the globe, and by dissolution the environments for that life have been produced, according to the cosmic theory of evolution. Thus it would require the strange assumption that, on the one hand, the processes of life and, on the other, mainly those of death, are concerned in the orderly bringing forth of an inhabited world.

32 There is one remaining point in the controversy as to Design in Nature, to which attention may once more be directed. It is one early brought forward by Darwin and held by his followers as an argument against supernatural design of overwhelming weight. Darwin invited his opponents to adduce a single instance in the vegetable or

* Pref. viii. ix.

animal kingdom of a structure or an instinct, which should be shown for certain to be of exclusive use to any other plant or animal than the one presenting it, and committed himself to the bold statement that he would surrender his whole theory of natural selection upon the production of a single true instance of this occurrence. He was so assured of the truth of his theory that he could not accept for a moment the belief that natural selection could ever have *permitted (sic)* an adaptive structure or instinct to occur in one species for the exclusive benefit of another. Others have followed in the same strain, and the gage of battle is supposed to be lying where Darwin threw it forty years ago, no champion being prepared to take it up.

33 Romanes* even carried this argument and challenge further, thinking that Darwin did not make a sufficient weight of evidence from this point. He triumphantly supposed it to be unanswered and unanswerable, and his remarks upon it are highly interesting. The only two instances in all the millions of vegetable and animal structures of adaptation which he would consider, and these he firmly set aside, are the sweet secretion of aphides which ants cultivate for their own advantage, a case produced by Darwin himself and disallowed, and the formation of vegetable galls which are of value to the nurture and protection to the larvæ of insects. This case Romanes also set aside as explicable by natural means; or, failing this, as the result of accident.

34 Milnes Marshall in his able lectures on the Darwinian theory also disposes of this argument in a very summary fashion. He says,† “that there is evidence that any animals or plants are specially designed to satisfy the wants or to delight the senses of man is most absolutely denied; and could such cases be proved, they would be fatal to the whole theory. In nature those characters alone are preserved which are advantageous to the species.” But this old and fair argument on behalf of the evolutionist, and against the teleologist, is not to be disposed of in this summary style. We are not shut up to a few trifles such as the “milk” of aphides, or vegetable galls. It is possible to state an argument with apparent candour, and with a desire for information which would do credit to Rosa Dartle. However, if the argument be put forward at all we cannot be forced into a corner, dazzled with the light of a

* *Darwin and after Darwin*, vol. i, pp. 286 to 295.

† *Lectures on the Darwinian Theory*, 1894, p. 171.

great name and learning, and deprived of our weapons of defence—or offence, without a little preliminary struggle in the open. What right has Darwin, Romanes, or Milnes Marshall to demand that we accept the arbitrary terms in this duel which they choose to offer. What right have they to demand that we show single adaptive structures or instincts which are for the exclusive use of other species? Is this the kind of peddling to which a Divine Being, concerned in the age-long production and superintendence of the inhabited world we see around us, can be supposed to have condescended! Even in a great factory such trivial contrivances are not carried out. Romanes himself, in the heat of his triumph, furnished us with a passage of noble insight as to what might have been, had beneficent design been the rule of the universe. He said,* “For how magnificent a display of divine beneficence would organic nature have afforded if all—or even some—species had been so inter-related as to have ministered to each other’s wants. Organic species might then have been likened to a countless multitude of voices, all singing in one great harmonious psalm. But, as it is, we see absolutely no vestige of such co-ordination: every species is for itself, and for itself alone—an outcome of the always and everywhere fiercely raging struggle for life.” We might even present him with the beneficent action upon the soil of the earthworm and white ant, but prefer to leave aside such details. Species indeed! and why species only! And why not genus, order, family, class, sub-kingdom and kingdom? What possible claim can even the greatest naturalist the world ever saw yet have upon the terms of controversy, that he and his followers shall lay down impossible terms, and then blandly proclaim that the battle goes by default. It is more arbitrary, even if conducted in as dignified and calm a manner as the scene immortalized by Scott, than the Grand Master’s proclamation on behalf of the persecuted and despised Rebecca, whose case so nearly went by default.

35 If we wish to give full weight to the objection here raised to the argument for Design in Nature, we have a wider, a greater, a more unimpeachable witness than aphides and galls. We hardly need to dwell upon the admitted fact that in the realm of nature the vegetable world stands in a position intermediate between inorganic nature and the

* *Darwin and after Darwin*, p. 288.

animal kingdom. As the globe is constituted, were it not for plants animals would never have been or continued to be. Plants alone can extract nutriment from the soil, and by their life and death supply for animals the needed protoplasm. And, with little exception in earth, water or air, animals live by the beneficent silent work of the present or past life of plants. It were wearisome to elaborate this well-known cosmic fact. The simple fact remains, and no scientific explanations of the "natural" laws, under which this fact takes place, touch for an instant the striking value of the fact as a broad argument for design in nature. We have got beyond species and genera to a vast food-factory for the whole animal creation, of surpassing complexity and profusion, pervaded by evidences of Mind and Will, one-thousandth part of which in a nineteenth-century factory would excite our highest admiration. The objections of Darwin, Romanes, and Milnes Marshall by the very earnestness of the challenge and the magnitude of the answer afforded by the whole vegetable kingdom, constitute a body of evidence against the blind mechanical force, which they deify, of obvious cogency.

36 There is a singular degree of mental short sight somewhere in this question of design in nature, and it cannot be better illustrated than in the simple words of the second greatest of English schoolmasters, Edward Thring of Uppingham,—“Take an example to illustrate this truth, set a little child at the end of the furrows of a field of young wheat at the sower's point of view, and as the sower walked, and he sees at once from mere sight without any exercise of intellect at all, the whole order and plan of the field. Whilst the hardest head and most trained intellect that philosopher ever owned, shall not puzzle out any clue to the seeming confusion, the hopeless entanglement, the absolute disorder that is there, so long as he stands at the side, and looks crossways aslant the furrows. But the child can see it, because he stands at the sower's point of view, and follows the sower's mind. Such a field is the world, such a seed-plot of life and power is the creation, sowed and set in order by the Supreme Life, understood and interpreted by all who have His life in them” . . . “not power, but *sight* is wanted; not force to wrest the secrets of Creation, but humility and love to nestle into them.”

The CHAIRMAN (Professor E. HULL, LL.D., F.R.S.).—I am sure all will join in the vote of thanks to Dr. Kidd for his paper. (Cheers.)

Professor LIONEL S. BEALE, M.B., F.R.S.—I have listened with great pleasure to Dr. Walter Kidd's excellent paper, and hope I may be allowed to express the wish that ere long a greater number of members of the medical profession may take part in the consideration of this interesting question.

Much has been done of late contrary to the general views which have been very popular, and were advanced many years ago under the name of evolution. We are gradually coming, as it seems to me, into somewhat close quarters—much closer quarters than we have ever reached hitherto. I mean many interested in the question are now considering the actual nature of the earliest changes that really take place in the formation of structure, not only in the highest organisms, but in the lowest simplest living things—and it is remarkable that, in the early stages of development at least, the living matter of the one set cannot be distinguished from that of the other. I am not sure that, in some respects, I cannot go even further than my friend Dr. Kidd. A point which is well worthy of consideration is this:—that although it is generally held, as Dr. Kidd has stated, that plants are nearer to the inorganic kingdom than animals, I think this only partly true, because when we come to study the very early stages of plants—even the lowest of them—and the earliest stages of the higher organisms, even man himself, there is much in common as regards the vital phenomena. The most careful and minute investigation of the actual living matter with the aid of the highest powers of the microscope does not enable us to point out characteristics which would enable us to say—*this will develop into a high and complex organism, and that into a low and simple one*. In the absence of colour, in consistence, and in general appearance they agree. The minute particles of both kinds of living matter may be extremely small, perhaps less than the one hundred thousandth of an inch in diameter. From them a very small amount of solid matter may be obtained. Probably, if the examination were possible, we should find that as much as from 90 to 95 per cent. of water, or more, was present in all living matter during the earliest stages of its development. In the case of the higher organisms the difference of the results of development and growth are not to be explained by *differences in the composition*

of the living matter. When I speak of growth I mean a process very different from that to which Mr. Herbert Spencer applies this term "growth." Growth certainly involves a great deal more than mere accretion or aggregation—the gradual collecting together of minute particles of matter. This aggregation of material particles does not constitute *growth* in the case of living matter. In aggregation and crystallization the addition of new particles is always on the outside of the original mass. The particles are applied layer over layer on what was the external surface. But in all *living growth*, from the lowest to the highest particle of Bioplasm, the new matter *passes from the outside through the external layers, and reaches the central part of the living particle*; and this being far more central than we can see—more central than anyone has yet been able to reach, and perhaps no one ever will see the actual change that takes place in the central part of every particle of living matter or Bioplasm which yields by death, among other matters, a little albuminoid matter, traces of fats and salts with a very large proportion of water. But there is indeed much more to be considered, and I think Dr. Walter Kidd will agree with me in this. It is only during the last few years that chemists and physicists have recognised the influence of *vital action—vitality* in the necessary changes in all living matter. At the last meeting but one I think of the British Association, one of the most distinguished chemists suggested that we wanted "a little more vitality." Well, we want not only a little more but very much more than has hitherto been allowed. This vitality has been ignored by many who have during many years expressed decided views upon questions bearing upon the nature of life.

Allow me to say a few words with regard to the importance of members of the medical profession taking part in the discussion of these great questions; for I venture to think that many of us by our training are well qualified to do so. We have, all of us, had a scientific education, and we have also had practical experience in reference to the vital changes taking place during life at different periods, and under different circumstances. We endeavour to do our utmost to help to keep people alive and well, and indeed the members of both professions—clerical and medical—the followers and teachers of religion—and the followers and teachers of medicine, are surely the very persons to engage in the consideration of great questions which intimately concern all men. Few are so circumstanced as to be able to enter upon all the

scientific details, but many are qualified to offer an opinion upon the broad principles which the writer of the paper has brought under our notice.

Every page that Dr. Walter Kidd has read to us is an epitome of a vast amount of work and thought. Every one of his paragraphs deserves thorough consideration and discussion. All, I am sure, agree with the general views he has expressed.

There is another circumstance that ought to encourage members of the medical profession to study those branches of science which are connected with their work in life and generally to take a scientific view of things. A distinguished member of our profession has been made President of the Royal Society—the highest position which a man can take in Science.

Is it well that scientific questions of this kind should be entirely left to be decided and taught in an authoritative way by the so-called scientist? The whole subject requires discussion.

For my own part I should not think of deviating one hair's-breadth from reason, and appealing to, or being led by, authority. If we cannot give sufficient reasons for accepting views that seem to be opposed to some doctrines of evolution which have been put forward, I think we must consider that we are beaten. Is "*evolution*" an answer to the question concerning the exact changes which take place not only at the earliest period of existence, but in all living matter at every period of existence? No one, from the mechanical or chemical side, has really explained these changes in one single case.

Of course authority must always exercise a temporary influence on public opinion, but I think we might now clearly submit a distinct issue with regard to the so-called mechanical and chemical changes that take place in this minute transparent mass of living stuff. We know that in certain cases movement, heat, light, electricity are all evolved in living things, and we also know that the movements, heat, light, and electricity we obtain from machines we make, are produced under circumstances totally different from those present in living organisms. Just compare the phenomena, as they occur in living things, with the phenomena as they occur in non-living man-made machines as we know them. Contrast any electrical apparatus with the electric organ, the "*apparatus*" of the gymnotus or that of some other species. Is there the faintest resemblance between the moist structures and organs that have all grown from perfectly

structureless, transparent living matter containing much water, and the machines?

The organs and structures of living things cannot be produced without vitality, for they are all the products of the changes in living matter or Bioplasm.

Do not man's capacity and power of making machines and every kind of apparatus depend on his vitality? The same remarks apply to the production of heat and also of light. When shall we find out how to obtain light or electricity from proteids, fat, salts, and much water? We do not know, to this day, how it is that the light is produced in the glow-worm or in fire-flies. All we can find out is a certain arrangement of anatomical elements, a certain structure; but it is not the *structure* that produces electricity and light. When the living stuff, the Bioplasm, dies, the phenomena cease. This Bioplasm is concerned in the production of light as well as in the formation of all structure. What you *kill* is not the structure any more than when a man or animal is *killed*, his nerves, bones, muscles, and other tissues are destroyed. All these have been *formed* by the Bioplasm, and they contrast remarkably in characters and properties with the actual living matter. But living matter is necessary to their action, to their maintenance in a normal state, to their repair in case of injury.

If the living matter is destroyed then everything stops. When we talk of the *physical* action of the muscles and the *physical* action of the nerves, what do we mean? We refer to certain phenomena which we know take place, but which are nevertheless absolutely dependent on the living matter connected with those textures. So that we must know what is taking place in the living matter, and what it has to do with the physical and chemical changes which succeed, before we can hope to give a reasonable explanation of the phenomena. It is the vital action which determines all physical and chemical changes in matter that lives—and it is this which gives rise to the anatomical characters and properties of the several tissues.

But really I must apologise, Mr. Chairman, I shall tire all present if I trouble you longer. Allow me then to conclude by again thanking our friend Dr. Walter Kidd for the extremely lucid manner in which he has treated one of the most difficult and extensive subjects that can be considered by the mind, and I trust the example he has set will be soon followed by other members of our profession. (Applause.)

The CHAIRMAN.—I have listened to this paper with great interest, and it seems to me one of the ablest essays in support of the doctrine of Design in Nature I have ever read. I need scarcely say that in the main I am entirely in accord with Dr. Kidd's arguments and conclusions. I am one of those who think that if the followers of Mr. Herbert Spencer, and others who deny the doctrine of Design, experience difficulty in understanding the reasoning of the teleologist, the latter must have greater difficulty in understanding the reasoning of his opponent; because the teleologist is every day accustomed to observe the relations of cause and effect, of design and designer, in all the ordinary affairs of life; and can point to analogy in the history of the Cosmos which his opponent ignores; or has to try and explain away by invoking the aid of what the author calls "the gods of the evolutionary pantheon," of whose actions, after all, he can know very little, and has to guess very much.

Dr. Kidd has very ably endeavoured to synchronise the process of development of living beings on this earth with the geological changes in the physical phenomena which the science of geology has unfolded to us in recent years. I do not feel able to go quite so far in this direction as the learned author in regard to the adaptation of the physical conditions to the animal and plant life; because I do not believe that ever since early Cambrian or Silurian times, the globe was in a condition in which it could not, at one part of its surface or another, have supported the plants and animals of the present day, including man himself. Generally speaking I quite admit a gradual process of preparedness as time went on, and in my work on *The Coal-fields of Great Britain* (4 Edit. p. 71), I use the argument of design in reference to the storage of the strata with the vast supplies of mineral fuel. It seems to me, however, that the Creator having endowed physical matter with laws, left these laws to work out their own results without special interference with their operation. For example, though we can observe the admirable manner in which the distribution of land and water, or of continent and ocean, acted upon by the sun's heat and directed by the rotation of the earth on its axis, serve to set in motion the great oceanic currents by which the warm waters of the equatorial regions are carried into the arctic and antarctic regions, and thus serve to equalize to a great degree the climates, I am unable to go so far as to say how this general arrangement of continent and ocean has been brought about. But when we come to deal with organised beings,

so vast is the distinction between dead matter and living, I feel that we are justified in inferring, not only the ordinary guidance, but also the frequent extra-ordinary interposition, of Omnipotent Power from the creation of the first living cell to that of man himself. The difference between inert inorganic matter and a living organism is as vast as space itself.

There are several other points in the author's essay which I would like to refer to, but I shall confine myself to one or two. The author has referred to Lord Kelvin's theory stated in his address to this Institute, to account for the quantity of oxygen necessary for the support of the future animal life. The view which appears to me the more probable one is that I have stated in my paper on the question, "How the waters of the ocean became salt" (*Trans. Vic. Inst.*, vol. xxvii), in which I inferred that the primæval atmosphere was largely composed of carbon-dioxide (carbonic acid gas), and that the elimination of the carbon by the agency of plants, notably in the Carboniferous period, would have left free large quantities of oxygen for the future air-breathing inhabitants of the globe.

There is only one other note I wish to make to Sec. 19, where Dr. Kidd refers to the effect of the incoming cold of the glacial epoch in killing off many forms unsuited to withstand its severity, and the creation of *new forms* more fitted for the environment. Undoubtedly many animals were locally killed off in the northern hemisphere by the severity of the glacial climate, but comparatively few were actually exterminated, and no new forms, as far as we know, were subsequently introduced with the possible exception of man himself. There was, however, a general migration of animals to more southerly and warmer clines—for example, from Europe and Asia into Africa, as shown by Dr. Alfred Wallace.

REV. F. A. WALKER, D.D., F.L.S.—There are two or three points upon which I should be glad to have the opinion of the author of this learned paper.

Butterflies and other insects are ranked, in section 17, as occurring at remote epochs.

It would be very interesting to learn if butterflies are preserved in strata, because I have been told that such specimens are very few and far between, naturally in consequence of their fragility and the impossibility of their beautiful delicate hues being preserved throughout the ages. There are two instances mentioned in Mr. Butler's book.

Then again Cole mentions cold as being a destructive factor in the killing of certain species in primæval times. I do not dispute that statement, but I have visited some of the most exposed coasts and I know Iceland round all three sides of the coast, and I can safely state that cold is not *the most* destructive factor in killing insects. It is the utter want of shelter from snow or rain that would cause them, in the transition period, to rot, and we have the testimony of entomologists now to prove that heat is quite as prejudicial to the preservation of life as cold.

There are two or three other points to which I would draw attention. I suppose we are all content to agree that the evolution of to-day can evolve something. Experimentalists can do something in that way by different treatment and different conditions. I know from my own collection how the sizes and tints of different specimens may be varied by their food, and it remains to be seen whether those different tints or markings and lines remain permanent. Feed the caterpillar on dark green leaves and you get a perfect yellow moth. Feed the same caterpillar on light green leaves and you have white and so on. But you must go on season after season, or they will hark back to their original ancestor. On the other hand, look at the evident purpose of design and see what it does for the creature.

Perhaps few of you have seen the *Larentia casiata*, of a delicate soft grey, which is found on the grey slate rocks of the Cambrian coast of the Campbell country in Argyleshire and the lava ditto in the S.W. of Iceland, upon which the perfect insect can lie so concealed from its natural foes on the surface of the boulders that you cannot tell the living insect from the inanimate stone.

When I see these things I note that Providence has adapted the colour of the insect to its natural environment, and then I am prepared to say, "Yes, this is the finger of God."

The CHAIRMAN.—I will now ask Dr. Kidd to reply.

The AUTHOR.—I am very grateful to those who have spoken for their kind agreement with most of the paper.

It would be only presumption in me to refer to anything that Dr. Beale has said. I am most thankful for the interesting suggestions he has made—more especially for that point on the absence of any analogy between the electrical organism of animals, such as the gymnotus, and the electrical machines formed by man. That is a most valuable point, but the subject is far too deep for us to go into to-night.

In regard to Dr. Walker's inquiry, respecting butterflies, I am

not prepared to mention any special case of butterflies being discovered in the Secondary age; but I have read that they have been frequently discovered in the strata of this age.

The CHAIRMAN.—Yes, along with other forms of insect life.

The AUTHOR.—In speaking of certain types in the Secondary Period, I referred, not so much to insects as to the larger vertebrate animals which died out before the varied reptilian *forms* of the Tertiary Period appeared.

It is true that Evolutionists can evolve something, and it is marvellous to read Darwin's book on the domestication of plants and animals, and the extent to which they can go; but the strength of the human mind and will is in this very line of work mostly strikingly shown, and the argument therefrom supports rather than contradicts Design.

The Meeting was then adjourned.

COMMUNICATIONS RECEIVED ON THE FOREGOING PAPER.

Dr. BIDDLE writes:—

This paper is likely to take high rank in the Transactions of the Victoria Institute. It is especially powerful in meeting the Evolutionist challenge—as to there being no structure or instinct in one being that is constituted for the exclusive benefit of another—by producing the vegetable kingdom as an evident intermediary between the mineral and the animal. The Evolutionary Theory, in its “survival of the fittest,” takes almost exclusive note of the destructive faculties of the plants and animals with which it deals, setting against these only the defensive. But it is even more wonderful to observe the law of *mutual benefit* in the animal world, and to find it based upon a no less evident regard for self (not necessarily *selfishness*). Nothing less than consummate design could effect such correlation and co-ordination of distinct and widely differing faculties, originating in species having no common historic origin, as are daily seen. Moreover, if the Origin of Species be an enigma which none but the Theist can logically solve, a still greater is the

Origin of Environment which makes the differentiation of species evolutionally possible. Natural selection accounts for but little. How many things unsought are nevertheless enjoyed! Whence the light and heat of the sun, the air we breathe, the water to quench our thirst? Even the most extreme advocate of the doctrine of evolution will admit that these and many more things had a prior existence to Natural Selection, and formed part of the *preparation* for life. We can in nowise promote the beauty of the sunset-sky, but it meets with a gratified response in the hearts of most of us, and proves that there are correlations utterly beyond the reach of natural selection.

Dr. A. NEVÉ writes:—

It has always seemed to me that the preparation of the environment for the organism, *i.e.*, of the *earth for man*, was a fact more impressive in its teleological aspect than the reverse, *viz.*, the adaptation of man to his surroundings; and that the existence of certain useful materials with properties only becoming available by the application of human intelligence is to be fairly regarded as a preparation for man, and a *prophesy* of man. One special thing I would mention is the various action of drugs. Digitalis acts on the heart, opium on the nervous system. Then again the specific action of quinine on the malarial organism. If it should be shown that these chemical combinations which in relation to ourselves we call medicines, are of primary value to the plant or tree from which we obtain them, I do not see that the force of the teleological argument would be in any way weakened.

Dr. Kidd's paper is so compact that it takes close reading to discover his mention of the coal beds, mineral oils, and many other substances prepared such ages ago for man's use.

Professor LANGHORNE ORCHARD, B.Sc., writes:—

We are much indebted to the able and learned author for this important paper which sets forth the grand Design argument in one of its most striking phases.

This argument has three principal aspects, *viz.*, the argument from:—

1. *Co-existence*—suitability between a creature and its immediate environment at *any one particular time*;

2. *Sequence*—such suitability continued throughout *all* times ;
3. *Inter-relation*—the suitability between the structures and instincts of *all* creatures as related one to another.

Any one of these facts is inconsistent with the doctrine of “chance”; their cumulative cogency is absolutely decisive.

Dr. A. T. SCHOFIELD writes :—

I am much obliged for the copy of Dr. Walter Kidd's paper so kindly sent, and much regret that an engagement on Monday prevents my attending the meeting. I do not think I ever read a more lucid or graphic account of creation from the standpoint taken. There is no doubt that it is too soon yet to decide the nett value of Darwin's work, and that the Design argument gains ground as the pendulum swings over from the unsatisfying creed of the *extreme* evolutionist.

Professor J. H. GLADSTONE, Ph.D., F.R.S., writes :—

I find it difficult to understand Dr. Walter Kidd's position in this controversy. This arises partly, no doubt, from the extreme difficulty of keeping always to the same meaning of the terms employed ; partly also to the fact that he is arguing sometimes against one, and sometimes against another of the various development hypotheses.

Among those who believe in a Divine Creator and Sustainer of the Universe, there are three quite distinct views :—

1. That He makes new things or organisms out of nothing. This idea has no warrant in the sacred Scriptures ; and the progress of science makes it less and less tenable.

2. That He accomplishes His purpose by making the new thing or organism at once out of some material previously existing, but totally different from it. This, of course, is a very common way of procedure among men ; and it is impossible to avoid making use of the language appropriate to it, even when arguing against its application to the Divine procedure.

3. That He forms the new things, whether inanimate or animate, by means of the gradual modification of things already existing. This is development, or evolution.

Dr. Walter Kidd seems to hold this third view generally. Thus he describes very minutely the progressive evolution of the individual from the embryo. He might have continued

his description of the progressive stages of the animal after birth, and would, of course, be willing to apply it equally to plant life. His long and often poetic description of the geological changes which have taken place, shows that he recognises the slow and gradual development of the different kinds of rock or strata. I have no doubt he would admit that the same law of gradual development holds good in astronomical phenomena. It may be traced also in the progress of human inventions. What he does not seem free to admit is the existence of the same manner of procedure in the introduction of the various species of plants and animals. It would almost appear as though, while he can easily conceive of the environment being prepared for the organised beings that were afterwards to be placed in it, he cannot admit of their successive generations being modified through the environment. He seems even to look upon the thousand species of nautilus in the Silurian basin of Bohemia as a sudden outburst of independent creations.

Many of us Christian men of science, on the other hand, recognise that there is a unity of plan, as well as of purpose, running through the works of God. We hold that the Darwinian theory of the survival of the fittest, so far from destroying the idea of a Divine purpose and plan in nature, rather confirms it, and gives us a welcome insight into the way in which this has been carried out throughout the ages, not as a series of fortuitous events, but as the result of an orderly law.

FURTHER REPLY BY THE AUTHOR.

A few words may be said in reply to certain points raised by the written remarks of members.

Professor Gladstone has somewhat narrowed down, more than I

intended in my paper, the question of Design to that of the creation or evolution of organisms. My main contention on this occasion was the broad proof of Design of Nature which arises from considering the planet, on which we find ourselves, and the inhabitants thereof, as being mutually adapted. I did not hesitate to argue that if one sees plan and purpose in preparation of the environments, one must also see it in the production of organisms to occupy those environments, that this necessarily involves something opposed to any "mechanical" theory as to the *production, development or creation* of organisms, and that indeed it involves design in their production. My desire was mainly to combat such a theory of the production of the plants and animals of the world as is seen in the development of a mammal from a microscopic cell through its natural, orderly, preordained stages, till adult life is reached. The development of the individual provides an analogy for the supposed development of organisms in general of a kind so loose and indeed so inaccurate, as to be hardly admissible for even a diagrammatic exposition.

The argument from artificial selection among plants and animals goes strongly to support Design in its broad aspect, if used at all, as a vast experimental proof of the powers of *mind, plan and purpose*, when organized matter is provided. It does not, as far as it goes, support the creation-hypothesis, nor is it needed for that position. *Modification* of species no one attempts to deny, in the face of the vast evidence arising from the cultivation and domestication of plants and animals. The *origin* of these by natural selection is a different matter altogether.

Dr. Gladstone refers to my arguing at one time against one, and at another time against another of the various evolutionary theories. My desire was only to support the theory of Design in the production of organisms so that the "mechanical" theory so-called should be put out of court. An excellent illustration of what one means by this "mechanical" theory is given by Darwin in the *Origin of Species* where he speaks of the *selecting* effect of the force of gravity upon a series of rocks, stones, and pebbles of all sizes falling down a steep slope, in which event they would be sorted at the bottom according to their various sizes and other qualities. It is exactly such a haphazard selection as this to which I venture to object, as being in any way responsible for the

production of new species of organisms with their myriad adaptations to the needs of their lives.

This remark sufficiently answers the question I have heard asked as to the meaning of a "mechanical" theory of the origin of organisms.

ORDINARY MEETING.*

REV. F. A. WALKER, D.D., F.L.S., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following Elections took place :—

ASSOCIATES :—W. Mackworth, Esq., London ; E. Tydeman, Esq., M.A., India.

CORRESPONDING MEMBER :—Professor Weidemann, Bonn, Germany.

The following paper was then read by the Rev. F. A. Walker, D.D., the author being in the United States :—

THE STAR WORSHIPPERS OF MESOPOTAMIA. By the Rev. SAMUEL M. ZWEMER, F.R.G.S.

IN the towns along the lower Euphrates and Tigris, especially at Amara, Sook es Shiokh, Busrah and Mohanmerah, there dwell an interesting people variously known as Sabæans, Nasoreans, or St. John Christians. They call themselves Mandæe (مَنْدَائِي), Mandæans, and although only numbering four or five thousand they have always been and remain entirely distinct from the Jews, Moslems and Christians, among whom they have dwelt for centuries. Their origin is yet lost in obscurity, although it is traced, by those few scholars who have studied the subject, through the maze of their religion to ancient Babylonia and Chaldea. It seems to me that in this remnant of a race and religion we have still an example of the oldest form of idolatry, *i.e.*, star worship, and that many of their mysterious customs would throw a side-light upon the cult of ancient Babylonia. It is partly to stimulate such study that the following paper

* 4th April, 1898.

was prepared. Mandæism is not only of deep interest as "the only existing religion compounded of Christian, heathen and Jewish elements" [Kessler] but it affords another proof of the early spread of religious ideas in the East, and the Babylonian origin of much that is supposed to be Alexandrian Gnosticism in a semi-Christian, semi-pagan garb.

In the English Bible the name *Sabeans* is perplexing, and although used of three different tribes or peoples, none of these are any way related to the present Mandæans unless those mentioned in Job. Sabeans is also the term used in the Koran, and there it undoubtedly applies to them and affords proof that at the time when Islam arose their numbers and settlements were far from unimportant. The Koran recognizes them as distinct from idolaters, and places them with Jews and Christians as people of the book (اهل الكتاب): Surah ii. 59. "Surely those who believe and those who judaize and Christians and Sabeans, whoever believeth in God and the last day and doth that which is right they shall have their reward with their Lord, no fear on them, neither shall they grieve"; and so again Surah 22, 17. "The true believers and those who Judaize and the Sabeans (الصَّابِئِينَ), and the Christians and the Magians and the idolaters. God shall judge between them." Compare also v, 73, etc. From these passages it is evident that the so-called Sabeans could not have been, as some allege, a minor Christian sect or identical with the Hemero-baptists.

According to Gesenius, Sabeans should be *Tsabians* from *tsaboth* (צְבֹוֹת) the host of heaven, *i.e.*, the supposed objects of their worship. Nöldeke and others say it comes from a root *subba* سَبَّ to wash, baptise, and refers to the manner of their worship. And Gibbon is perhaps correct when, on the authority of Pocock, Hettinger, and D'Herbelot, he states the origin of their other name thus: "A slight infusion of the gospel had transformed the last remnant of the Chaldean polytheists into the Christians of St. John at Bussora." Of the names which they themselves adopt—Mandæe and Nāsorāye we will speak later. Suffice it here to say that, although giving special honour to John the Baptist, *they can in no sense be called Christians.*

Isolated by a creed, cult and language of their own, they love their isolation and do not intermarry with strangers nor accept a proselyte to their faith. Nearly all of them follow

one of three trades. They raise the finest dairy produce of Mesopotamia; they build a peculiar kind of light canoe called *Mashhoof*, and for the rest, all of them are silver-smiths. No traveller should visit their villages without carrying away specimens of their beautiful inlaid-work, black metal on silver and gold. A peaceful people they are, industrious, though mostly poor and seldom affording trouble to their Turkish rulers. Both men and women have a remarkably fine physique; tall, of dark complexion, good features, and with long black beards, some of the men are typical patriarchs, even as we imagine Abraham appeared when he left their present country for Haran. On ordinary days their dress does not distinguish them from Moslems or Jews, but on feast days they wear only white. Their women go about unveiled and have a more masculine cast of features than Moslem women; they are also rather taller.

The two great things however that distinguish the Sabeans are their language and their religion. Both are remarkable. The former because of its long preservation among a dying people, and the latter as the most remarkable example of religious syncretism.

Naturally the bazaar-talk of all the river-country is Arabic; all Sabeans speak it and a goodly proportion read and write it; but beside this they have a household language of their own, the language of their sacred books, which is called Mandäitic. So closely related to Syriac that it might almost be called a dialect, it yet has an alphabet and grammar of its own, and their writing and speech is not fully intelligible to the Syriac-speaking Christians from Mosul. Wright says that their alphabet characters most resemble the Nabathean and their language that of the Babylonian Talmud. The only grammars of the language are the *Sketch of a Sabean Grammar* by Captain Prideaux and the accurate and elaborate *Mandäische Grammatik* of the indefatigable scholar Nöldeke. One great drawback of the latter however is that the *Hebrew* character is used throughout and not the Mandäitic. Accompanying is a table of the alphabet with its Hebrew and Arabic equivalents; also a few brief sentences and the days of the week to show the construction of the language and its close similarity to the Arabic. One peculiarity is the naming of the letters with the *ā* vowel and not as in other Semitic languages by special names: alif, bay, jeem, dal, etc. The oldest manuscripts of the Mandäitic date from the sixteenth century, and are in European

THE MANDAÏTIC ALPHABET.

(Adapted and corrected from Nöldeke.)

NAME.	CHARACTER.	VALUE.	HEBREW EQUIVALENT.	ARABIC EQUIVALENT.
āh	◦ 𐤀 𐤁	ā	א	آ
bā	𐤂 𐤃	b	ב	ب
gā	𐤄 𐤅	g	ג	ج
dā	𐤆 𐤇	d	ד	د
hā	𐤈 𐤉	h	ה	ه
wā	𐤊 𐤋	w	ו	و
zā	𐤌 𐤍	z	ז	ز
hā	𐤎 𐤏	hh	ח	ح
ṭā	𐤐 𐤑 𐤒	t	ט	ط
yā	𐤓 𐤔	y (i)	י	ي
kā	𐤕 𐤖	k	כ	ك
lā	𐤗 𐤘	l	ל	ل
mā	𐤙 𐤚	m	מ	م
nā	𐤛 𐤜	n	נ	ن
ṣa	𐤝 𐤞	ṣ	ס	س
'ā	𐤟 𐤠	ā (guttural)	ע	ع
pā	𐤡 𐤢	p, f	פ	پ
tsā	𐤣 𐤤 𐤥	ts	צ	س
qā	𐤦 𐤧	q	ק	ق
rā	𐤨 𐤩	r	ר	ر
shā	𐤪 𐤫	sh	ש	ش
tā	𐤬 𐤭	t	ת	ت
eddoā	𐤮 𐤯	sign of relative pronoun.	⌋(?)	⌋

Specimens of MANDAÏIC CURSIVE-SCRIPT with transliteration and translation.

ⲁⲥⲱⲟⲩ ⲁⲃⲓⲗⲁⲕ	=	Āssooḏa hāvilak	=	peace be to you.
ⲕⲉⲧⲕⲩⲙ ⲥⲏⲱⲉⲉ	=	kethkūm shawee	=	how much is it ?
ⲁⲛⲁ ⲗⲓⲃⲃⲁ ⲕⲁⲃⲉⲗⲁⲕ	=	ana libba kabeelak	=	I love you much.
ⲕⲁⲥⲃⲁⲱⲉ ⲁⲃⲓⲱⲏⲁⲥ	=	kasbah we dahwah	=	silver and gold.
ⲏⲟⲑⲥⲏⲃⲁ ⲗⲁⲃⲃⲁ	=	hofshaba rabba	=	great day (Sunday).
ⲁⲧⲗⲁⲛ ⲏⲟⲑⲥⲏⲃⲁ	=	atran hofshaba	=	Monday.
" ⲁⲕⲗⲁⲧⲏ	=	aklatha	"	= Tuesday.
" ⲁⲗⲃⲁ	=	arba	"	= Wednesday.
" ⲏⲁⲙⲥⲏⲃⲁ	=	hamsha	"	= Thursday.
" ⲥⲏⲱⲧⲏ	=	shitta	"	= Friday.
" ⲥⲏⲱⲱⲏⲁⲥ	=	shuvah	"	= Saturday.

Libraries (Paris and Oxford). But the golden period of their literature, that is, the time when their religious books received their final and present form was, according to Nöldeke, from 650–900 A.D. At present only the few among them can read or write their language, although all can speak it, and from religious motives they refuse to teach those outside of their faith even the first lesson, except secretly.

And so it was that although meeting Sabeans for the past four years and being their guest on frequent journeys up and down the rivers, I found no satisfactory answer to the question what their real faith and cult were. The popular story that they turn to the North Star when they pray and “baptise” every Sunday was all that Moslems or Christians could tell. Books of travel on this region gave fragmentary, conflicting and often grossly erroneous statements. According to some accounts they were idolaters, others classed them with Christians. An anonymous article which appeared in the London *Standard*, and which was entitled, “A prayer meeting of the Star Worshippers,” curiously gave me the key to open the lock of their silence. Whoever wrote it must have been perfectly acquainted with their religious ceremonies or be one of themselves, for when I translated it to a company of Sabeans at Amara they were dumbfounded! Knowing that I knew *something* made it easy for them to tell me more. But let me first quote a portion of this account by way of introduction to what follows.

“Toward midnight the Star Worshippers, men and women, come slowly down to the river side. Each enters the tiny wattled hut [built of palm-branches] by the southern wall, disrobes and bathes in the circular reservoir. . . . On emerging from the water each robes him or herself in the *rasta*, that is the ceremonial garment, all white, crosses to the open space in front of the door of the tabernacle, and seats himself upon the ground, saluting those present with the customary, *Sood Havilakh*, ‘blessing be upon thee,’ and receiving the usual reply, *Assootah de hai havilakh*, ‘blessing of the Living One be upon thee.’ The sacred book, *Sidra Rabba*, is laid upon the altar folded back where the liturgy of the living is divided from the ritual of the dead. The high priest takes one of the two live pigeons handed to him, extends his hands to the polar star, upon which he fixes his eyes, and lets the bird fly, calling aloud: ‘*Bshmo d’hai rabba mshabba zivo kadmayah Elaha Edmen Nafhi Eprah.*’ ‘In

the name of the Living One, blessed be primitive light, the ancient light, Divinity self-created.' [Then] . . . the reading being in progress, they prepare the *Peto Elayat*, or high mystery, as they term their communion. One kindles a charcoal-fire in the earthenware stove by the side of the altar and the other grinds small some of the barley brought by the deacon. He then expresses some oil from the sesame seed, and mixing the barley-meal and oil, prepares a mass of dough which he kneads and separates into small cakes the size of a two-shilling piece. These are quickly thrust into the oven and baked. The fourth deacon now takes the pigeon left in the cage, cuts its throat quickly with a very sharp knife, taking care that no blood is lost. The little cakes are then brought to him by his colleagues, and, still holding the dying pigeon he strains its neck over them in such a way that four small drops fall on each to form a cross. Amid the continued reading of the liturgy the cakes are carried around to the worshippers by the priests, who themselves pop them directly into the mouths of the members with the words, 'Marked be thou with the mark of the Living One.' The four deacons inside the *Mishkna* [مِسْكِنَة] walk round to the rear of the altar and dig a little hole in which the body of the dead pigeon is then buried."

What a mosaic of ceremonies and what a mixed cult in this one river-bank service! Every minute particular of it is correctly described, I am told, by the Sabeans of Amara, and yet they themselves do not furnish the clue to the maze of their cult.

Here one sees Judaism, Islam, and Christianity, as it were, engrafted on one old Chaldean trunk. Gnosticism, star worship, baptisms, love feast, sacrifice, ornithomancy, and what not else in one confusion. The pigeon sacrifice closely corresponds with that of the Mosaic law concerning the cleansing of a leper and his belongings, Leviticus xiv, 4-7, 49-53, and is perhaps borrowed from that source. But how anti-Judaistic is the partaking of blood and the star worship! (cf. Job xxxi, 26-28.) The cross of blood seems a Christian element, as does also the communion of bread, but this again is in discord with all that precedes from a New Testament standpoint. Yet a complete system of dogma lies behind all this curious cult, and one can never understand the latter until he knows the former. *Sabeanism is*

a book religion; and it has such a mass of sacred literature that few have ever had the patience to examine even a part of it. In the collection the *Sidra Rabba*, or Great Book, holds the first place. The copy I examined (but could not read) one day, contains over five hundred large quarto pages of text divided into two parts, a "right" (Ar. *بِئَمِين*) and a "left hand" (Ar. *شَمَال*) testament; because of the manner in which they are bound together, *i.e.*, each begins at one of the two ends of the book, so to speak, and when one reads the "right," the "left" testament is upside-down. The other name for the Great Book is *Ginza*, Treasure (Arabic *كَنْز*). It is from this treasure-house that we chiefly gather the elements of their cosmogony and mythology.*

First of all things was Pera Rabba *ܡܢܗܘܢܐ* the great Abyss. With him "Shining ether" and the Spirit of Glory (*Mana Rabba*) form a primal triad, similar to the Gnostic and ancient Accadian triads. Kessler even goes so far as to say *that it is the same*. From *Mana Rabba* who is the king of light, emanates *Yardana Rabba*, the great Jordan. (This is an element of Gnosticism) *Mana Rabba* called into being the first of the æons, Primal Life, or *Hayye kadema*. (Arabic *الحيوت القديم*). This is really the chief deity of the Sabeans, and all their prayers begin by invoking him. From him again proceed secondary emanations, *Yushamim* (*i.e.*, Jah of heaven) and *Manda Hayye*, messenger of life. This latter is the mediator of their system, and from him all those that accept his mediation are called, *Mandæe*. *Yushamim* was punished for attempting to raise himself above Primal Light, and now rules the world of inferior light. *Manda* still "rests in the bosom of Primal light" (*cf.*

* The first printed and translated edition of the *Sidra Rabba* was by Math. Norberg (Copenhagen 1815-16), but it is said to be so defective that it is quite useless critically; Petermann reproduced the Paris MSS. in two volumes at Leipsic 1867. Besides the *Sidra Rabba* there are: *Sidra d'Yaheya* or Book of St. John, also called *Drasche d'Malek* (discourse of the King); The *Divan*; The *Sidra Neshmata*, or book of souls; and last, but not least, the books of the zodiac called *Asfar Malwashee*. Except for the small portion of the *Sidra Rabba* found in Brandt's recently published *Mandäische Schriften* (1895) all of the above still await critical study and editing.

John i, 18), and had a series of incarnations beginning with Abel (Hibil) and ending with John the Baptist! Besides all these there is yet a third life called 'Ateeka (Arabic عتيق ancient?) who created the bodies of Adam and Eve, but could not give them spirit or make them stand upright.— To pause here for a moment. If the Babylonian trinity or triad has its counterpart in the Mandæen *Pera*, *Ayar* and *Mana Rabba*, then *Manda Hayye* is clearly nothing but the old Babylonian Marduk (Merodach), first-born, mediator and redeemer. *Hibil*, the first incarnation of Manda, also has a contest with darkness in the underworld even as Marduk with the dragon Tiamat.

The Sabean underworld has its score of rulers, among others these rank first: *Zartay*, *Zartanay*, *Hag*, *Mag*, *Gaf*, *Gafan*, *Anatan* and *Kin*, with hells and vestibules in plenteous confusion. *Hibil* descends here, and from the fourth vestibule he carries away the female devil *Ruha* (روح) the daughter of *Kin*. This *Ruha*, Kessler affirms, is really an anti-Christian parody of the Holy Spirit, but from conversation with the Sabeans I cannot believe this to be true. By her own son *Ur* (نور) *Ruha* becomes the mother of all the *planets* and signs of the zodiac. These are the source and controllers of all evil in the world *and must therefore be propitiated*. But the sky and fixed stars are pure and clear, the abode of Light. The central sun is the Polar Star, with jewelled crown standing before the door of Abathūr, or "father of the splendours" (from עתר = to be rich). These "splendours," æons, or primary manifestations of deity, are said to number three hundred and sixty (which is only a Semitic way of expressing many), with names borrowed from the Parsee angelology (Zoroastrianism). The Mandæans consider all the Old Testament saints except Abel and Seth false prophets (Gnosticism).* True religion was professed by the ancient Egyptians, who, they say, were their ancestors. Another false prophet was *Yishu Mashiha* (Jesus Christ), who was in fact an incarnation of the planet Mercury. John the Baptist, *Yahya*, appeared forty-two years before Christ and was really an incarnation

* See the history of Gnostic teaching, especially that of the Ophites and Sethians. All the evil characters in the Old Testament, with Cain at their head, were set forth as spiritual heroes. Judas Iscariot was represented as alone knowing the truth. Only I find no large account of the serpent in the Sabean system; this may be otherwise accounted for.

of *Manda*, as was Hibil. He baptised at Jordan, and by mistake (!) also administered the rite to Jesus.

About 200 A.D. they say there came into the world sixty thousand saints from Pharaoh's host and took the place of the Mandæans who had been extirpated. Is not this a possible allusion to the spread of the Gnostic heresy and its coalescence with the then Sabean community? They say their high priest then had his residence at Damascus. That is, their centre of religion was right between Alexandria and Antioch, the two schools of Gnosticism.

Mohammed, in their system, was the last false prophet, but he was divinely kept from harming them, and they flourished to such an extent that at the time of the Abbassides they had four hundred places of worship in Babylonia.

The Mandæan priesthood has three grades; *tarmida* (تلاميذ) disciple; *shkanda* or deacons; and the *Ganzivra* or high priest; literally the keeper of the *Ginza* or Great Book. The late *ganzivra* was Sheikh Yahya, a man of parts and well-versed in their literature, who long lived at Sook es Shiookh. Their present head or high priest is called Sheikh Sahn and is now imprisoned at Busrah on charge of fomenting the late rebellion of the Arab tribes near Koorna at the junction of the Tigris and Euphrates.

The Sabeans observe six great feasts besides their weekly Sabbath (Sunday). One of the feasts celebrates the victory of Abel in the world of darkness, another the drowning of Pharaoh's army, but the chief feast is one of baptism. On it, observed in the summer, and called *Pantsha*, all Sabeans are baptised by sprinkling three times a day for five days; this is compulsory. The Sunday baptisms of immersion in running water are, however, largely voluntary and therefore meritorious: these latter correspond to the Moslem laws of purifications and take place after touching a dead body, the birth of a child, marriage ceremony, etc.

The moral code of the Sabeans is that of the Old Testament in nearly every particular.

Polygamy is allowed and even recommended in the *Sidra Rabba*, but not often indulged in. They do not circumcise, and have no holy places or churches except those built for a feast night at the river side, and removed the next morning. The story that they go on pilgrimage to Haran and visit the Pyramids as the tomb of Seth (see Sale's *Koran*, "Introduction") is, I believe, a myth. They are friendly to Christians of all sects, and love to give the impression that because

they honour the Baptist they are more closely related to us than are the Jews and Moslems. Of course they deny that they do not accept Jesus as a true Prophet, as they do all those other articles of their belief, which they deem wisest or safest to keep concealed.

It remains to add a note regarding the supposed origin of their name *Nasoreans*. According to Petermann they themselves give this title only to those of their number who are distinguished for character or knowledge. It doubtless is connected with the Arabic نصارى and comes perchance like it from Ναζωραῖοι, the early half-Christian sect of Syria.

So that all our investigations end as we began, by finding that the Sabeans "worship that which they know not," and profess a creed whose origin is hidden from them and whose elements, gathered from the four corners of the earth, are as diverse as they are incongruous. And who is able after all to classify these elements or among so much heterogeneous *débris* dig down to the original foundations of the structure? If we could, would we not, as in so many other cases, come back to Babylonia and the monuments?

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Votes of thanks having been accorded to the author and to the reader of the paper:—

Dr. T. CHAPLIN said:—It would be interesting to know if there is any connection between these Nazarenes and the Nusairiyeh or Anseiriyeh, a well-known tribe living in the northern part of the Lebanon range, who have almost the same name as the people on the banks of the Euphrates and Tigris, and who seem to have in their religion some Pagan, some Christian, and some Mohammedan elements. These people are said to be half Christian and half Moslem. They seem to have been originally *pagans*, and when Christianity first spread in that part of the world, they became impressed, to a certain extent, with its doctrines, but they never fully embraced it. Living in these remote mountains they retained pagan ideas and adopted Christian ceremonies, and on Mohammedanism spreading accepted certain Mohammedan practices, and so continued without any definite religious belief. It is interesting to note that authorities regard their language as being of Syriac origin, a natural supposition considering that many of their words have undoubtedly a Syrian source. They come from well-known Chaldaic and Syrian roots, *e.g.*, their chief priest or leader, said to be the guardian or preserver of their sacred books, is called the "Genizeh" or "treasure," a well-known Hebrew word. I may mention that oriental Jews have a great aversion to destroying any of their worn-out writings, and to avoid the sin of so doing deposit such in a chamber called a "Genizeh" or treasure house. I also notice the word *Sidra Rabba* which is Syriac: then the names of the days of the week are almost exactly the same as in Arabic, and, to some extent, in Hebrew. I would also refer to the origin of the word Nasorean; this word as given in the Arabic ("Nazârah") is exactly the word used in Arabic countries for Christians. It means Nazarenes—people who come from Nazareth or who are followers of Jesus the "Nazarene." I hope the author may be persuaded to continue his researches amongst the interesting people he has described, searching for accurate information respecting their antecedents.

A discussion of a conversational character ensued, during which the value of the evidence collected by Dr. Zwemer, and the unique opportunities afforded him of observing and studying these particular star worshippers and their cult during the many years he had resided among them, was specially remarked upon.

The discussion was then adjourned.

REMARKS ON THE FOREGOING PAPER.

Colonel C. R. CONDER, R.E., D.C.L., writes :—

The Star Worshippers of Mesopotamia.—Mr. Zwemer's paper on this curious sect is very interesting, and there can be little doubt that the star worship points to early Semitic paganism, though the details suggest that it may have come indirectly through the Masdean system of Persia. The Mendaïtes or Sabians resemble several other strange sects of Syria and Persia, such as the Druzes, for instance, but their system does not recognize Islam as fully as do the Druzes, Ismailiyeh and Anseiriyeh (whose name is also connected with that of the Nazarenes by some); and it is fairly clear that it is descended from the Syrian Gnosticism of the second century A.D., to which the Druzes also owe much. The Mendaïte language and alphabet are Aramean, and somewhat distantly related to the speech and script of the Nestorians. Naturally the Nabathean alphabet is related. The Nabathean "Book of Agriculture," now, I believe, only known through the Arabic translation of Kuthami, contains a curious myth of the death of Tammuz; and the Sabians are said to have preserved the rite of mourning for Tammuz down to the tenth century A.D., though ignorant of its meaning (see Baring Gould's *Curious Myths of the Middle Ages*, pp. 278-283, and Maimonides *More Nebushim*, iii, 29). The beliefs of the Sabians or Mendaïtes have been compared with the teaching of the Gnostic Carpocrates, containing a strong Mazdean (*i.e.*, Zoroastrian) element. They were also akin in their teaching to the Elkesaites of the third century—an Essene Gnostic sect accepting Elxai as a prophet, as did also the Ebionites of Bashan (Hippol ix, 13; Epiphanius xix, 2-5). Elxai accepted the Jewish system of sacrifice, and regarded Christ as a reincarnation of Adam. The Elkesaïte Eucharist consisted of bread, salt and water. The spread of Gnosticism to the mouth of the Euphrates, and into Arabia, appears to have been due to the followers of Beryllus, to the Ebionites, and to the Nazarenes of Bashan in the second century A.D. (Epiphanius, *Hæres*, i, 40; iii, 75-79).

Having carefully studied Capt. Prideaux's *Sketch of Sabean Grammar*, I venture to remark that it has nothing to do with the Sabians. It is the language of the Sabean Arabs of Yemen, about 200 B.C., written in quite a different character—usually called

Himyaritic. As regards the "Two Testaments" (eighth page of paper), they would probably represent two degrees of initiation, one upsetting the other—as among Druzes. I should suppose that *Yardana Rabba* means "Great Emanation" not "Great Jordan." The idea that Jehovah was an inferior deity (Demiurge) recalls the Gnosticism of Syria. The incarnation of Abel in St. John Baptist recalls Druze teaching. I have never been able to find any evidence of *triads* among the Babylonians, though some modern scholars have read them into the texts. Marduk was not, properly speaking, a Mediator, and certainly not a Redeemer in the Christian sense of the term. The Dualism of the Sabians is of Mazdean origin, and their allegories recall those of Basilides and Valentinus. Probably, like the Druzes, they claim relationship with Christianity when speaking to Christians, and would equally claim affinity to Islam, and to Judaism, if speaking to Moslems or to Jews.

It would be very interesting to get a full translation of their books, and to know whether—like Druzes, etc.—they have degrees of initiation, as the adoration of the pole star may be only the exoteric teaching for the vulgar, concealing an esoteric teaching of initiates, as in other cases. The *Hayye Kadema* of Sabians ("Ancient of Days") seems, as among Gnostics, to have been connected with the *Zervan Akarene* or "boundless time" of Mazdeans, and the *Ain* or "nothingness" of the Cabbalists. All these curious systems among Christians, Jews, and Moslems, appear to be based on the principle that knowledge was for the few, and that the creed taught to the ignorant should conceal a scepticism only revealed to more advanced disciples, while it should also amalgamate the dogmas of all sects—Jewish, Christian, Moslem, etc.—so as to attract many, and strengthen the leaders, who really cared nothing for any form of religion. This is known to have been the case among Gnostics, Druzes, and others, and might in the end prove true of the Sabians, if the "Two Testaments" of the *Sidra Rabba* could be translated. But to penetrate beyond the exoteric teaching might be as difficult as it was among the Druzes until 1860, when their books were obtained by De Sacy.

THIRTY-SECOND ANNUAL GENERAL MEETING.

(HELD AT THE HOUSE OF THE SOCIETY OF ARTS.)

Monday, July 18th, 1898.

[To obviate the delay in publishing the Annual Addresses, the proceedings of the thirty-second Annual Meeting are inserted here.]

The President,

Sir GEORGE GABRIEL STOKES, Bart., LL.D., Sc.D., F.R.S.,
IN THE CHAIR.

Captain FRANCIS PETRIE, F.G.S., &c., Hon. Sec., read the following Report:—

Progress of the Institute.

1. In presenting the THIRTY-SECOND ANNUAL REPORT, the Council is glad to be able to state that the position of the Victoria Institute has been maintained, although the Institute has felt those adverse influences which have been so widespread.

2. The Institute has not only maintained its character for doing important and sound work, but specially has it attracted marked support for its investigations, from leading men in the scientific world, who have not as yet formally joined its ranks. It is widely acknowledged that what has been accomplished has been of much value in the interest of Religion as well as of Science.

The tendency of its work has been to bring about a truer appreciation of the results of scientific inquiry, and those results have been to demonstrate that there is an absence of opposition between Science and Religion.

3. The Institute, for years so carefully built up by wise counsels, and found so useful in the defence of Truth,—especially in cases where the great truths revealed in Holy Scripture have been questioned by any on scientific grounds—claims heartiest support. The formation of a Society for such a purpose is not the work of a day, and it is one which should not want for the loyalty of a single Member.

4. In order that every advantage may be derived from the labours of those now furthering its objects, and that the efficiency of the Institute may not only be maintained but augmented, the Council is anxious that the importance of adding to the number of its supporters should be a subject present to the mind of each Member and Associate, both at home and abroad, and to this end asks their co-operation.

5. The following is the new list of the President and Council:—

President.

Sir George Gabriel Stokes, Bart., LL.D., Sc.D., F.R.S.

Vice-Presidents.

The Rt. Hon. Earl Halsbury, P.C., F.R.S., The Lord High Chancellor.
The Ven. R. Thornton, D.D., *Archdeacon of Middlesex*.
Sir H. Barkly, G.C.M.G., K.C.B., F.R.S.
Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S.
W. Forsyth, Esq., Q.C., LL.D.
Alexander McArthur, Esq., J.P., D.L.
W. H. Hadleston, Esq., M.A., F.R.S.

Trustees.

D. Howard, Esq., D.L., F.C.S.
Rev. Preb. H. Wace, D.D.

Hon. Auditors.—J. Allen, Esq.; Colonel T. A. Le Mesurier.

Council.

Hon. Treas.—Professor E. Hull, LL.D., F.R.S.

Hon. Sec.—Capt. F. W. H. Petrie, F.G.S.

E. J. Morshead, Esq., H.M.C.S. (*For. Cor.*)

William Vanner, Esq., F.R.M.S.

His Honor Judge Waddy, Q.C.

Rev. J. H. Riggs, D.D.

H. Cadman Jones, Esq., M.A.

Rev. W. Arthur.

Rev. J. Angus, M.A., D.D.

*D. Howard, Esq., D.L., F.C.S.

Professor H. A. Nicholson, M.D., F.R.S.

Rev. F. W. Tremlett, D.D., D.C.L., Ph.D.

Sir C. A. Gordon, M.D., K.C.B. Q.H.P.

His Excellency Dr. R. H. Gunning, F.R.S.E.

*Rev. Preb. H. Wace, D.D.

Rev. Chancellor J. J. Lias, M.A.

*Gen. G. S. Hallowes.

Rev. A. I. McCaul, M.A.

Capt. Creak, R.N., F.R.S.

Rev. F. A. Walker, D.D., F.L.S.

T. Chaplin, Esq., M.D.

Rev. Canon Girdlestone, M.A.

T. G. Finches, Esq. (Brit. Mus.).

The Ven. Archdeacon Sinclair, M.A.

Gerard Smith, Esq., M.R.C.S.

Commander G. P. Heath, R.N.

Rev. Canon Tristram, M.A., D.D., LL.D.,

F.R.S.

Rev. G. F. Whidborne, M.A., F.G.S., F.R.G.S.

The Council regret to announce the decease of the following supporters of the Institute:—

A. J. Arnold, Esq., A.; F. L. Barker, Esq., A.; J. Bateman, Esq., F.R.S., M.; Rev. D. A. Beaufort, M.A., F.M.; J. T. Bent, Esq., F.R.G.S., C.M.; Rev. Professor C. D. Bradlee, D.D., A.; Rev. R. N. Buckmaster, B.A., A.; A. J. Carden, Esq., A.; Rev. S. B. Charlesworth, M.A. M.; Rev. M. J. Cramer, M.A., D.D., A.; R. Crewdson, Esq., M.; Rev. President R. J. Dabney, D.D., LL.D., M.; Rev. H. H. Dugmore, A.; Rev. P. Frost, D.Sc., F.R.S., M.; Mrs. L. Geldart, A.; Captain H. Hall, A.; H. Hartshorne, M.A., M.D., LL.D., A.; Rev. Canon H. King, M.A., A.; D. Larnach, Esq., A.; Colonel McClurg, M.D., A.; Rev. S. M. Mayhew, A.; Rev. Stanley Mitchell, A.; The Rt. Hon. Lord W. C. Plunket, D.D., Archbishop of Dublin, M.; Rev. Principal E. Parker, D.D., M.; J. H. Phillips,

Esq., *A.* ; Rev. P. Prescott, M.A., *M.* ; Peter Robertson, Esq., *F.M.* ; A. E. Tomlinson, Esq., B.A., *A.* ; Rev. Bolton Waller, *A.* ; C. H. Wilmot, Esq., C.E., *A.*

F.M. Foundation Member.

A. Associate.

6. The following is a statement of the changes which have occurred:—

	Life		Annual	
	Members.	Associates.	Members.	Associates.
Numbers on June 2, 1897	.... 61	50	369	884
Deduct Deaths ....	.... —	—	10	20
„ Retirements ....	.... —	—	4	15
			— 14	— 35
			355	849
Joined to July 12, 1898 ....	.... —	1	10	33
	61	51	365	882
	112		1247	
Total ....	....	....	1359	

Finance.

7. The Treasurer's Balance-sheet for the year ending December 31, 1897, duly audited, shows total receipts £1,114 15s. 1d.; expenditure £1,022 0s. 7d.; leaving a balance creditor of £92 14s. 6d., after the payment of all liabilities excepting the last printing and binding account. The amount invested in 2½ per Cent. Consols is £1,365 18s. 9d.

• *Special.*—The Council desires to urge the very great importance of all subscriptions being remitted during the first half of the year (Bye-law III, 3). Adherence to the rule on this point would remove a serious difficulty in the management of the Institute. Forms for the payment of the subscriptions through a banker are kindly used by a large number of Members and Associates, and may be had at the office.

MEETINGS.

The meetings of the Institute have been well attended.

The subjects* taken up during the session have been:—

MONDAY, DECEMBER 6, 1897.—“Tithe-giving amongst Ancient Nations,” by HENRY LANSDELL, D.D., M.V.I., M.R.A.S., F.R.G.S.

The author urged that the prevalence of tithe-giving among the nations, even of Antiquity, pointed to a remote time when the

* See this volume, xxxi.

ancestors of those nations lived together, and so derived the custom from a common source.

MONDAY, JANUARY 3, 1898.—A Lecture, on "Past Civilizations," by the Rev. J. TUCKWELL.

In which he reviewed the life and customs of early nations so far as research has as yet made them known.

MONDAY, JANUARY 17.—"Another possible cause of the Glacial Epoch." By Professor E. Hull, LL.D., F.R.S.

The author described new researches as to the origin of the Glacial Epoch, referred to the successive elevations and depressions of the ocean bed and the American Continent, and the influence of the Gulf Stream, on the north-west coasts of Europe. Professor Rupert Jones, F.R.S., Professors Gresley, Warren Upham, of the United States, and Cavaliere W. P. Jervis, head of the Royal Italian Museum of Turin, and others, contributed to the discussion.

MONDAY, FEBRUARY 7.—"Literature in Egypt in the time of Moses." By Professor FRADENBURGH, D.D., Ph.D., LL.D.

The author gave a full description of the results of recent researches in showing the high state of the Arts and Sciences in ancient Egypt at that time, and how that country was a recognized centre of learning to surrounding nations; [thus seeming specially to justify the expression in holy writ, "learned in all the wisdom of the Egyptians."] Colonel Conder, D.C.L., Mr. T. G. Pinches, of the British Museum, and others, took part in the discussion that ensued.

MONDAY, FEBRUARY 21.—"Plan and Purpose in Nature." By W. KIDD, Esq., M.D. With additional arguments by Professors Lionel S. Beale, M.D., F.R.S., J. H. Gladstone, Ph.D., F.R.S., and others.

A paper criticising the various current objections to the argument from Design, and illustrating the force of that argument from some of the more recent scientific researches. Many took part in considering this subject.

MONDAY, MARCH 7.—"The Sphinx: Its Purpose." By General A. B. TULLOCH, C.B., C.M.G.

I. General Tulloch, in a brief lecture, described the results of some interesting explorations carried out in the neighbourhood of the Sphinx, which throw light upon its purpose.

II. Some remarks on "The Harmony of Science and Faith," by the President, were read as a lecture.

Sir Charles Gordon, K.C.B., Dr. Walker, Professor Hull, F.R.S., and others took part in the discussion that ensued.

MONDAY, MARCH 21.—A Lecture on "The Two Babylonian Versions of the Story of the Flood." By THEO. G. PINCHES, Esq., M.R.A.S.

The author gave the results of his critical examination of the text on the fragment of the tablet lately discovered by Dr. Scheil, showed the importance of the indications it gave as to its date, and the references given by the two versions in our possession to the well known story of the Flood. He held that there was a common origin for these versions.

MONDAY, APRIL 4.—"The Star Worshippers of Mesopotamia." By the Rev. S. M. ZWEMER, M.A. Notes by Colonel CONDER, R.E., D.C.L., and others.

The author described this tribe, in whose neighbourhood he had

recently spent many years, as having a religion composed of Christian, Heathen, and Jewish elements. Dr. Chaplin, the Revs. Dr. Mathews and Dr. Walker, travellers in the East, and others took part in the discussion.

MONDAY, APRIL 18.—A Lecture on "The Design of the Human Foot." By GERARD SMITH, Esq., M.R.C.S.

The author showed how the human foot offers a valuable example of a limb formed for its work (as opposed to the contention that the human body is an imperfect result of the action of environment), he described its mechanical arrangement as unique, and "ministering to the unique human physical advantage,—that of the *perfect erect posture*."

MONDAY, MAY 2.—"Further investigations regarding the submerged terraces and river valleys off the British Isles." By Professor E. HULL, LL.D., F.R.S. (See vol. xxx, p. 305.)

The author described his recent investigations in regard to these, and the evidence they appeared to afford of stupendous physical changes in the past. Professors Etheridge, F.R.S., Rupert Jones, F.R.S., and others welcomed the paper as a valuable contribution to our geological knowledge, and as affording fresh matter to be taught in geological text books.

MONDAY, MAY 16.—"The Philosophy of Education." By A. T. SCHOFIELD, Esq., M.D. (*Publication unavoidably delayed*.)

The author described the results of a long study of the method of educating the young, and the formation of their character, and referred to points which seemed to be far too much lost sight of in the present day to the injury of the race.

MONDAY, JULY 18. *The Annual Meeting*. Address "On the Perception of Colour." By the President, Sir G. G. STOKES, Bart., F.R.S.

Publications.

The Queen having in past years added the whole of the Transactions of the Institute to Her own library, the last volume, with a complete list of all the Members and Associates supporting the Institute named in Her Majesty's honour, was specially submitted. Her Majesty commanded that her thanks might be expressed for the same.

The thirtieth volume of the *Journal of Transactions* is now in the press. It contains the subjects brought before meetings of the Institute and discussed, together with the communications received from Members in the country and abroad, who have added to the value of the discussions by sending in communications on the subjects considered.*

* Among the subjects in the xxxth volume "the history of Manikka Vacagar, the Indian Sage," is well worthy of consideration, not only in India but nearer home, where it has become fashionable amongst some to speak with high approval of—and even to adopt—Buddhist views. The warnings of Manikka convey both a lesson and a reproof to those who, having *the Light*, seek instead a darkness which even he so desired to dispel.

The careful correction of the papers, discussions, and communications, by their respective authors, is at times a cause of delay in the publication of the Journal containing them, but the result is to give the Volume of Transactions the character of a finished work.

Not many years ago the issue of the Annual Volume was considered to complete the work of the Institute, but of late the wish to make further use of the matter it contains has had valuable results:—

First, Members and Associates at home, in India, and elsewhere, make use of the papers in the Journal as lectures, or as the basis of such, in their several localities, often corresponding with the Institute in regard to the preparation of such lectures.

Secondly—Some Members and Associates secure the translation and circulation of portions of the Journal in the various countries in which they reside. Such translations have been made in many countries of Europe, South America, and India; and now from China the importance of securing translations has been strongly urged.

Thirdly—Some home, foreign, and colonial public libraries and institutions are regular purchasers of the Journal, and Members and Associates have sought to encourage this practice in their respective localities. The need of so doing has been pointed out by many Members, since it is by no means unusual, especially in the Colonies, to find in public libraries books arguing that Science and Revelation are at variance. The Journal of the Institute has been spoken of as specially suited as a corrective to such erroneous views. In India and elsewhere some have obtained the Journal or copies of the People's Edition, and placed them in local reading rooms for the use of English-speaking natives and others.

The Special Fund.

This fund (to which both Members and non-Members can contribute) has been founded to advance the influence of the Institute, and to forward the circulation of

The People's Edition.

This consists of twelve papers—written by men of eminence in such a style that they may be comprehended by all—reprinted from the *Journal of Transactions*. The Edition was started by some members in the year 1873, and first attracted attention in other quarters to the importance

and need of works of the kind. The pamphlets often contain the objections and criticisms brought forward in discussing the subjects, as many home and foreign correspondents have urged the value of including these. They are published in neat covers, and are sold at a nominal price (sixpence), and single copies are supplied *gratuitously* or at cost price, at the office, to all individual lecturers against infidelity, including those of the London City Mission, the Christian Evidence Society, and similar bodies.

The Gunning Fund.

This fund was founded by His Excellency Robert Halliday Gunning, M.D., LL.D., F.R.S.E., &c. It consists of a capital sum of £500, the interest on which is used in furthering the work of the Institute. It is hoped that this fund may be increased by other benefactions.

China and India.

The Institute has lately had a most pressing call from China, urging the usefulness of its transactions there, and has communicated with a large circle throughout China and Japan. (The Archdeacon of Shanghai—an old Member—speaking of the requirements of China, says, “I have turned to the Transactions of this Society as a treasure of untold importance.”)

In consequence of letters from South India, similar steps have just been taken there. The cost of such work falls on the “Special Fund,” which it is imperatively necessary should be increased to enable the Institute to carry forward this much-needed and most useful work.

Conclusion.

In conclusion the Council desires to express its thankfulness for the success thus far of the Institute. But each year shows more fully that according as the body of the Members in England is numerous and powerful to accomplish the objects in view, so will its influence and strength be encouraged abroad. Its system is one in which the Members may be centres of influence in their respective neighbourhoods—in the words of our motto—“*Ad majorem Dei gloriam.*”

Signed on behalf of the Council,

G. G. STOKES, *President.*

[Letters expressing regret at not being able to be present at this meeting were received from several, especially the Right Hon. the Lord Chancellor, who had arranged to move the vote of thanks "to the author of the Address, and those who had read papers and communications during the session," but was detained at the House of Lords, having to preside at an important debate then proceeding.]

Sir CHARLES GORDON, K.C.B.—The resolution I have the honour to propose is one that requires neither explanation nor comment. It is "That the Report be received and that the thanks of the Members and Associates be presented to the Council, Hon. Officers, and Auditors for their efficient conduct of the business of the Victoria Institute during the year."

ALEXANDER MCARTHUR, Esq., D.L., J.P.—The time at our disposal this evening is short; and as we are all anxious to hear the President's Address, I will simply say that I have great pleasure in seconding this resolution.

[The resolution was then put to the Meeting and carried *nem. con.*]

The Ven. R. THORNTON, D.D., V.P. (Archdeacon of Middlesex).—Mr. President, Ladies and Gentlemen: I feel very thankful that the work of the Council has been so kindly received by you. I am sure the Council, of which I fear I am almost an unworking member, deserve your most sincere thanks, because they have been very diligent indeed in transacting the affairs of the Institute, which under our excellent President and our active and valuable Hon. Secretary (Captain F. Petrie), has really attained a rank amongst scientific societies which is by no means to be despised.

I feel the greater interest in this Society, being one of its earliest members.* I am extremely obliged to you for the way in which you have received the vote of thanks to the Council, and I can assure you, on behalf of the Council, that we shall continue to do our work, with undiminished vigour and with extreme gratitude to you for your kind vote. (Applause.)

The President then delivered the following address:—

* The Ven. Archdeacon Thornton, Vice-President, and Captain Francis Petrie, the Hon. Secretary, are the only members now living of the original Committee which drew up the Institute's charter in 1865.

ON THE PERCEPTION OF COLOUR. By SIR GEORGE
GABRIEL STOKES, Bart., M.A., D.C.L., LL.D., F.R.S., *The
President.*

ON a former occasion I expressed the opinion that in furtherance of the objects of the Victoria Institute, it would be a useful thing from time to time to take stock, as it were, of what is known in particular branches of science; with the view of assisting the general public in discriminating between well-established scientific theories and hypotheses still on their trial, or it may be mere conjectures, going far ahead of actual evidence. At the Annual Meeting in 1895 I introduced the subject of the luminiferous ether, a medium so mysterious in its nature, and yet one through the intervention of which some effects are brought about which have received a thoroughly satisfactory explanation. In the following year I brought forward the subject of the perception of light, a subject about which we know far less than about the nature and laws of light objectively considered; I mean than about such subjects as interference, diffraction, polarisation, &c., in the study of which the eye is used merely as an instrument of research, and may in certain cases be replaced by a photographic plate or some other appliance. Even when the subject was limited to the perception of light it was still much too extensive to be gone into in the Annual Address, and the branch I propose to notice to-day was dismissed in very few words. I said (page 20),* “We do not see light merely as light, but we see a great variety of colour. We can distinguish one light from another light by its colour, and not by its intensity only. It would take me a great deal too long to give you any idea of what is known (which after all is not much) as to the way in which that is effected.”

To bring such a subject before the Institute seems ill to accord with the proposal I mentioned to “take stock” of what is known in some particular department. Still, little

* *Transactions*, vol. xxix.

as we really know relating to the perception of colour, something has been done experimentally, partly in the way of establishing certain laws as to the direct perception of colour, partly in the way of investigating other perceptions which may guide us by analogy towards forming some conception of the requirements which are demanded in our bodily organisation in order to the perception of colour. The subject lies on the border-land between physics and physiology, or indeed more properly belongs to the latter, though physical considerations relating to the nature of light largely come in. I have no claim whatsoever to be a physiologist, and in consequence felt some hesitation in venturing to bring before this meeting the subject I have named. Still, I have read something even on the physiological side bearing on the question, and so far as my knowledge extends, it seems to me that there is one theory which appears to have by far the greatest probabilities in its favour. That is the one known as the Young-Helmholtz theory.

It is now universally admitted that light consists of vibrations, somewhat in the manner in which sound is produced by vibrations in the air; and in the early days of the study of the theory of undulations in light, very great assistance was obtained from what was known of the analogous phenomenon of sound. But while there is a good deal in the theories of light and of sound that is common to the two, still there are some wide differences; and we must not lean too strongly on the analogy of light to sound in our attempt to explain the phenomena of light, and more especially in our endeavour to explain, so far as any explanation can be given at all, the manner in which the objective state of things (vibrations) is perceived by our senses. We must not lean too strongly on the analogy of sound lest we should be led into error. One great point of difference is the nature of the vibrating medium in the two cases. In the one case there are vibrations of the air—a substance which we can weigh and examine chemically and so forth—and in the other case we have vibrations of the mysterious medium, which we believe to exist between us and the remotest fixed star, to which we have given the name of luminiferous ether. Now when sound acts upon our bodies there are certain portions of the structure of our bodies which are thrown into vibration, and which vibrate sympathetically with the vibrations of the air, such, for example,

as the tympanum of the ear. It is not apparently essential to the perception of sound that the tympanum should be thrown into vibration, for if we press a watch against our skull and stop our ears, we hear the ticking. In that case the skull is no doubt thrown into vibration; and whether it be the tympanum or the skull which acts on the nerves of hearing, they are apparently in that manner excited, and they carry a certain stimulus, which passes along them into the brain, which somehow or other becomes to us the means of our sensation of sound.

Now we must not go too far here in our analogy of light with sound. We have no reason to believe—but quite the contrary—that when light falls on the body or any portion of the body (when it falls, for example, on the eye) a portion of the structure of our bodies is thrown into vibrations which synchronise with the vibrations in light which fall upon us. I do not say that there is nothing in our bodily organism which receives vibration—what I said was that we have no reason to suppose that any part of *the structure* of our body is thrown into vibrations in the manner of the tympanum of the ear when sound is heard. What is thrown into vibration, what is disturbed, as we have reason to believe, when light falls upon the eyes is, in the first instance, some of the ultimate molecules of which, we have reason to believe, matter consists. These differ from a structure as the individual bricks in a heap differ from a house.

Now it may be (I do not say it is, because we know very little about it) that it is bound up with this difference, that we have in the case of sound one phenomenon which has absolutely no counterpart in light. If two musical notes are sounded together, if there is a simple ratio between the times of vibration we experience a pleasing sensation which we call harmony; if, for example, the frequencies are as two to three we have a perfect fifth, and so forth. Now we have nothing in light answering to the sensation of harmony in sound. People talk it may be of colours harmonising with one another, but that is merely a metaphorical form of expression. In sound harmony is a pleasing sensation, and when an assortment of colour pleases us, we sometimes say that the colours are harmonious, using the word in a purely metaphorical sense. But there is actually no phenomenon known in light answering to the sensation of harmony in sound. How then do different lights affect us when they are put together? I am not at present speculating

on the manner in which our bodily organisms are affected. I am not now speaking of physiology, but in the first instance of pure observation and experiment.

We know that by allowing two lights of different colours to mix together, we get a sensation of some other colour differing in general from the two. In certain cases it may be we actually get the sensation of white, in which case the colours are what is called complementary. The study of the effect of mixing colours together was, at first, somewhat impeded by confusing two different things, the colour obtained by mixing together two coloured pigments, and the colour resulting from mixing together the colours which the two pigments exhibit when taken separately. It is probable that even still some misapprehension arising from this source exists in the minds of those who have not studied the subject. The difference is now, however, well known, and there are methods known whereby coloured lights may be mixed together, and whereby we may study the sensations which these mixtures produce, which it would take too long now for me to go into. That subject has been very well worked out by the late Professor Maxwell, who has written some very elaborate papers, giving the results of experiments on the effect of the superposition of lights of different colours. It has long been supposed that in light there is in some sense a kind of triplicity, as if there were three kinds of light which give us all the sensations of colour by mixing them together. This triplicity might be either what I will call objective or subjective. We know that lights of different refrangibility are capable of being separated, forming a spectrum, and as we observe the spectrum we have gradations of colour, red, yellow, and so on, until we get up to the violet. Now, some have speculated on the possibility of there being an objective quality of light, answering, I will say, to redness or greenness or blueness or whatever trio of colours we may take. Sir David Brewster imagined that there was such an objective triplicity, and that really light from a given part of the spectrum, though it cannot be decomposed by the prism, was nevertheless compound, and that there were three kinds of light there coexisting in different proportions, the difference of the proportions varying according to the part of the spectrum we are considering. He supposed that though light of any particular refrangibility could no longer be separated by the prism,

nevertheless three kinds of light, capable separately of exciting three different sensations of colour, there co-existed, and were capable of having their proportions altered by passing through suitable absorbing media, so that the filtered light might affect the eye with a different sensation of colour from the original.

It has been shown, however, that this was a mistake, and he appears to have been led into the error by being deceived by the illusion due to contrast. So far as we know, there is absolutely nothing objectively in light answering to redness as such, or yellowness as such, or blueness as such, although of course at one part of the spectrum there is redness predominant, and so with the other parts.

Dr. Young believed that there were, so to speak, three primary sensations of colour, and that those sensations were called up simultaneously when any colour was presented to us—simultaneously, but in different proportions according to the nature of that colour. Even the colours of the spectrum, which are the purest colours that one can get, are, on his theory, supposed to give rise to three primary sensations of colour which are co-existent, but in different proportions according to the place in the spectrum.

The sensations which Dr. Young supposed to be the primary ones were red, green, and violet. Perhaps it may not be quite right to speak of those as the primary sensations, but you may take them at any rate as three standards of colour, and perhaps they are the best to take as standards, because by their mixtures we can the most nearly reproduce all other colours, of which we have an infinite number of hues. That view was taken up and extended or rendered in some respects more precise by Helmholtz, and so the theory is now known as the Young-Helmholtz theory.

Now, as I said, some very elaborate experiments were made by the late Professor Maxwell in regard to our sensations on the mixing together of different kinds of light, and the result of his experiments showed that not merely qualitatively, but quantitatively, one may express any colour in terms of three colours taken as standards.

Suppose we take three colours as standards, and call them X , Y , Z , each supposed to be referred to a unit of its own kind, and suppose that a , b , and c are numerical co-efficients, which may be positive or negative. Then any colour whatsoever (C) as regards its effect upon our eyes—not by any means as regards its physical properties,

but merely as regards the colour sensation which it produces—may be expressed by the equation—

$$C = a x + b y + c z,$$

where “=” means matches in colour and intensity; “+” means superposed on; and “-” (in case any of the co-efficients should be negative), means that the term must be transferred to the other side of the equation. Mathematicians will understand that, but I will not go further into it. That equation represents the direct result of observation; and moreover different persons arrive at results as to the mixture of colours very nearly agreeing with one another, if we except persons belonging to the somewhat rare, but by no means uncommon class, called “colour-blind.” But I will not go into the subject of colour blindness, it would take me too far from the subject I have to bring before you, and therefore I will content myself by merely mentioning it.

Now it would be a natural extension of this law, which has been so carefully verified by Maxwell, and I may mention, by others also, to assume that if you could get at the supposed three primary sensations of colour, pure by themselves, the same law would apply to the mixture of those one with another. In this manner the subject of the effect of mixing colour may be rendered very clear in a general sort of way by means of what is called the triangle of colours, but that would take me a little too much into mathematics, very simple as those are, and I just refer to it in passing.

Now what supposition can we make physically as to these three supposed primary sensations of colour? What laws must any theory obey that we may make, respecting the manner in which those sensations are produced? Set aside for a moment the existence of colour at all, and think only of light. We know that we see separately a vast amount of independent objects in the field of view. There is a very wonderful structure in the retina of the eye, corresponding with that capacity we have of distinguishing one point in the field of view from another. In the back of the retina there is a most remarkable structure, in which the nerves or nerve-fibres which are concerned in vision end, which is called the bacillary layer. It consists of very peculiar bodies of two different forms in most eyes—in the human eye, for instance—which are

denominated rods and cones. The number of these in the eye is enormous. I have here a drawing* giving the facts to which I am now pointing in regard to the retina. You look on the eye from behind so that you see the ends of those rods and cones. Those rods and cones are richly provided with excessively delicate minute nerve fibres, and there is little doubt that somehow or other the ends or end portions of those nerve fibres are excited by the influence of light, and convey the stimulus on through the set of nerves lining the retina further in front, where they are crossed by the light without being affected thereby, and at last unite in a bundle forming the optic nerve, and pass into the brain.

Now it has been found that in the central part of the retina of the human eye, where vision is most acute, and where there are cones only, without rods, the distance between consecutive cones is about $\cdot 003$ of a millimetre—an excessively small quantity—and we can easily calculate independently the approximate distance on the retina of the images of two visible points which can just be seen as two, supposing, of course, that, in the first instance, we have determined experimentally the angular distance of those visible points. It turns out that the distance of the images corresponds very closely indeed with the distance apart of the cones in the bacillary layer of the retina, so that apparently the stimulation of one of those gives us the perception of a single point in the field of view, the apparent position of which varies with the position in the retina of the particular cone on which the image falls. If we view a star we have the sensation of a point of white light in a particular direction. If we hold a red or green or blue glass before the eye, we have the sensation of a point of red or green or blue light in the same direction. On the theory of three primary colour sensations, whatever those may be, we must infer that the stimulation of the same cone is capable of giving rise to all three of the primary colour sensations, but that the difference of colour sensation does not entail a difference of apparent direction. Can we form any idea as to how these conditions may be fulfilled?

Dr. Young's idea was that there are three kinds of nerve

* Referring to one of the plates in a paper by Max Schultze in the 2nd volume of the *Archiv für Microscopische Anatomie*.

fibres which, if excited separately, would give rise to the three supposed primary colour sensations respectively, but which usually are excited together. Microscopic examination shows that the same cone or rod is provided, not with a single nerve fibre, but with a whole set of nerve fibres. Therefore we cannot say *a priori* but that it may really be true that there are different nerve fibres appropriated to the different supposed colour sensations; and we have to explain, if we can, two things in order to account for what we observe. We have to explain for one thing—if we can explain it—how it is that the nerve fibres of these three sets respectively are affected in different proportions by the same incident light, according to the nature of that light; so that if light be taken from the red end of the spectrum, those fibres which give rise to the sensation of red (supposed provisionally to be one of the primaries) are the most affected, though the others may be affected to a less degree, and so in other cases. We must seek in the distal ends of the nerves, or in some apparatus connected with them, for something enabling differentiation of stimulation to take place. I do not mean to say that that has been explained yet. It is not, however, incomprehensible that it is a thing which may hereafter be explained. At present we can only form certain conjectures regarding it.

Then there is another thing concerned with these three primary sensations of colour, viz., that these three classes of nerves being affected, some sort of stimulus appears to be propagated along the nerves to the sensorium, and there gives rise to a sensation differing from one to another of the three classes. How sensation is there produced is a question belonging to that mysterious region in which, so to speak, mind and matter come together, and I do not suppose we shall ever be able to explain how it is that this stimulation of the nerves (if they are stimulated) produces in us these three sensations. But at the other end—the distal end—there may possibly, as I have said, be some chance of our doing something.

Different conjectures might be formed as to how these three sets of nerves might at the distal end be affected in a proportion differing according to the nature of the light. As regards the mode of stimulation, I may mention that the most probable theory seems to be that it is due to the result of a photo-chemical change, possibly it may be in

the molecules of the structure of the nerve itself, but it seems much more probable that it is in something with which that part of the retina is suffused, it may be in the so-called visual purple, which, as experiment shows, is very readily affected by light, changing colour and being ultimately bleached, which indicates a successive formation under the influence of light of different chemical substances. Now it may be that these different chemical substances affect the three classes of nerves differently, and that it is in that way that the differentiation between the stimulation of the different sets is effected at the distal end of the nerve apparatus. If the excitement of the nerves at the distal end is due to substances produced in the photo-chemical action, there must be some difference or other between the three classes of nerves, or between something belonging to them, in order to account for their not being all excited in the same proportion one to another whatever be the nature of the exciting light. It may be that the nerves are differently constituted in some respects; but I do not think it is absolutely necessary to suppose even that. I can conceive that it is possible (it is merely an idea that has occurred to myself, and I hardly venture to throw it out, especially in the presence of Lord Lister, but if I go wrong he will correct me in the end) that if the excitement of these nerve fibres is due to chemical stimulation, produced by products of the action of light on the visual purple or some other substance, and if endosmose comes in as well as photo-chemical action, I can conceive, I say, that without any necessary difference in the structure of the nerves of those three classes, the difference may be made by their position in the outer segments of the rods or cones; by the nerve fibres lying closer to the surface or a little deeper in. The minuteness of the rods and cones is such that any substance which is produced at the outside might very quickly pass in by endosmose, and so sensation might very readily respond to the light as the substance is produced. That, however, is a mere conjecture of my own; but I will ask Lord Lister to tell the members of the Institute it is all nonsense if he thinks it is.

I will now refer to one or two very curious recent experiments, not directly relating to light, but bearing on other sensations, and going to establish, or at any rate to confirm, a law, which if it be true seems to have a very important bearing on the theory of our sensations of colour. My

attention was recently called to some curious experiments by Blix* and Goldschneider.†

In investigating the seat of the perception of heat or cold, they used a small body ending in a surface of very small area slightly warmer or colder (suppose in the first instance warmer) than the skin, and applied it in succession to all points in a selected area of skin, chosen, say, at the back of the hand. It was found that certain points were sensitive to heat, while elsewhere the skin was indifferent. The sensitive points ("heat points" as they may be called), when found, were marked with a particular colour. A similar experiment was then tried with a surface colder than the skin, and a group of sensitive points, "cold points," was thus determined, and marked with a different colour. The marking allowed of the experiments being repeated, it might be, on a different day, so as to make sure of the result. It is particularly to be noted that we have not got a group of points sensitive to a *change* of temperature but two distinct groups, one sensitive to heat but not to cold, the other sensitive to cold but not to heat. Here and there a heat point and a cold point might coincide, or rather lie so close as not to be distinguishable in position.

Similar experiments were tried as to finding out points which were sensitive to pressure, just the gentlest possible touch of a very small body so as not to cover a large area. and a third group of sensitive points, quite distinct from the two former groups, was thus obtained. It appears from these experiments that a different set of nerve fibres is concerned in communicating to the sensorium the sensation of heat from that concerned in communicating a sensation of cold, and a different set again of nerve fibres concerned in the sensation of touch. These nerve fibres seem to be very numerous, and to lie pretty close together in some parts of the body, and in other parts more widely apart. That, therefore, leads us to regard as not incredible the supposition that in the group of fine nerve threads coming from one of the cones or rods of the retina, there might be nerve threads of different kinds that are capable respectively of producing different sensations as to colour. No doubt the microscope

* *Zeitschrift für Biologie*, vol. xx (1884), p. 141, and vol. xxi (1885), p. 145.

† *Archiv für Anatomie und Physiologie Physiologische Abtheilung*. Supplement-Band, 1885, p. 1.

fails to reveal any difference in these different nerves; but why should we expect that it should be capable of revealing anything different? For aught we know to the contrary, the nerve threads of these three classes may be just like one another, and the difference in their function may arise from the difference in the mode of stimulation at the distal end of the nerve apparatus, and from some difference in the way in which they affect the sensorium at the other end. In relation to Goldschneider's experiments, I am told that one of the marked heat points and one of the cold points were selected, and self-vivisection in a small way was performed by punching out little bits of skin, so as to catch the ends of the two kinds of nerves. On examining them under the microscope, no particular difference could be made out. Hence, if we cannot make out any difference in the distal ends of the nerve fibres of the retina, we cannot say that there is therefore no difference.

As I said the subject that I have ventured to bring before you is not only out my line but it is rather speculative. Still, I think it leads us to some interesting contemplations, and one thing I think we cannot fail to be strongly impressed with—viz., the astonishing complexity of this marvellous organ, the eye, and the wonderful proof which (to my own mind at least) it gives of design in its construction.

Addition made while going through the Press.

The question naturally presents itself, if there are three primary sensations of colour, brought about by the stimulation of three sets of nerves respectively, how is it that the sensation of unity of direction is preserved? If, when the image of a star falls in focus on the retina there are three classes of nerve fibres excited, leading, it may be, to different places in the brain, how is it that we see but one white star, instead of three stars showing respectively the three primary colours?

The only answer, as I conceive, that it is possible to make to such a question is to show that the phenomenon is in perfect analogy with what we know by experience in the case of other nerves of sensation. Suppose, for example, that a toe or a finger or an elbow is gently pressed, or else that a small warm body is held against it. The quality of the sensation, be it that of pressure or of warmth, is alike

in all three cases, but the part of the body to which the sensation is referred is in each case the same, whether the sensation be that of pressure or warmth, or as it may be a mixture of the two; and *that*, although in accordance with experiments already referred to, it appears that it is by two different sets of nerve fibres that the sensations of pressure and of warmth respectively are conveyed. While the character of the sensation (be it of pressure or heat) depends very probably on the part of the brain to which the nerves of the three sets lead, the part of the body to which the sensation is referred seems to depend on the position of the distal ends of the nerves.

It would be in full accordance with this to suppose that when the nerve fibres belonging to a particular cone of the retina are stimulated by the rays from a luminous point which are there brought to a focus, while the character of the sensation as to whiteness or colour depends on the proportion in which the three supposed sets of nerve fibres are stimulated, which itself depends on the character of the light, the part of the body to which the sensation is referred is the particular cone in question, the same therefore for all three of the primary colour sensations. Different luminous points are seen in the same order of sequence in which their images lie in the retina. Furthermore, just as in touching in the dark an object with the forefinger we can judge of the position of the object relatively to our body, of whether it lies right or left, up or down, through the knowledge we have of the position of the arm, so in vision we can not only judge by direct sensation of the position of an object relatively to the point we are directly looking at, but also as to the direction of such an object relatively to a point right opposite to the head, through the knowledge we have of the way in which we have willed to turn the eye-balls when the object is in our field of vision.

The contrast between our perceptions of sound and light may be emphasised by saying that while both phenomena objectively considered depend on undulations, in sound we have a direct perception of frequency, but not of direction, while in light we have a direct perception of direction, but not of frequency. This succinct statement requires explanation, without which it might even be supposed to be untrue. It might be said, we have a continuous change of pitch, from the lowest bass to the shrillest sound that we can hear, and we have a continuous change of hue from the

extreme red to the extreme violet of the spectrum; where then is the difference?

The evidence of the difference lies in the total difference of the result of mixture in the two cases. When two notes of different pitch are sounded together we have the sensation of discord or harmony as the case may be, a sensation altogether different from that of a note of intermediate pitch. The two sensations of pitch retain their individuality in the mixture. But when two lights of different refrangibility, exhibiting separately different colours, are mixed, we have the sensation of a single colour; and in many cases, when the places of the two colours in the spectrum are not too far apart, the mixture gives almost exactly the same sensation as an intermediate colour of the spectrum. And the same compound colour may be produced in an infinite number of ways by mixing trios of colours of definite refrangibility.

The Right Hon. LORD KELVIN, G.C.V.O.—We have all listened with great interest to Sir George Stokes' treatment of one of the most difficult subjects in natural philosophy. In using the term "natural philosophy" here, I mean the study that comprehends physics and physiology—and, something beyond both, the mental perceptions and emotions connecting the physical and external with the psychical and nervous processes and with the wonderful sensorium of which we have been hearing Sir George Stokes speak.

The theory of the perception of colour which he has so clearly explained (the Young-Helmholtz theory) is, I believe, now universally accepted by scientific men over the world as absolutely true in respect of explaining the different qualities of colour; and as having a possibility of being also mechanically true in respect of this system of nerve fibres by which a hypothetical explanation of known facts is given. I will say nothing on this subject except to express my own intense interest in it, and my desire to know the truth; but I hope Lord Lister will tell us his view in respect of the triplicity of the nervous system, connected with the retina of the eye, and of the beautiful experiments of which the President has told us in respect to the different

effects on certain fibres by which the sense of pressure, and the sense of heat and cold, are produced.

Now I spoke of scientific men. There are scientific ladies also—and ladies who are not scientific—and I am sure they will all thoroughly sympathise with scientific men in their appreciation of this beautiful theory.

Sir George Stokes told us that every variety of colour may be produced by the mixture of red, green and violet, and in Maxwell's practical work on the subject of which he spoke, white and black are added in the mixture, white to dilute the intensity of the colour; and black to diminish the total light emitted by a body exposed to sunlight.

Now in these times when ladies are so well occupied with important work that they scarcely have time for shopping, it would be a great comfort to them, if when they wanted a beautiful blue ribbon, they could simply write down on a piece of paper 2.5.7.3.4. and put it in an envelope and send it to the shop; or 3.4.0.2.0 a brilliant yellow, no black in it—3 of red, 4 of green, 0 of violet, 2 of white to brighten it up a little and dilute some of the colour. Do not imagine that you will get green by mixing yellow and blue—on the contrary, you get yellow by mixing red and green, as was first taught by Young, enforced by Helmholtz, and splendidly put in practice by Maxwell.

Sir George Stokes spoke of design. Is it conceivable that the luminiferous ether should throw out these effects by chance—that the colours of the butterfly or of a beautiful flower should result from a "fortuitous concurrence of atoms," and having come by a fortuitous concurrence of atoms, they should give pleasure, whatever that may mean, to another fortuitous concurrence of atoms constituting myself, and I should—I don't know how to express it. The atheistic idea is so nonsensical that I do not see how I can put it in words. (Applause.) Surely design does not stop short at the production of outside physical influences but includes giving pleasure in the perception of colour. We cannot go further in such thoughts just now. Surely they bring strong evidence indeed of design, and if the Victoria Institute required proof, I think it needs nothing more than what we have heard to-day from the President, and which we all feel in regard to the beautiful effects of colour. (Applause.)

I beg to propose a cordial vote of thanks to the President for his most interesting lecture, and not only to him but to the eleven

other gentlemen who have contributed the papers during the last session which have been referred to by the Honorary Secretary.

The Right Hon. LORD LISTER, M.B., F.R.C.S., LL.D., P.R.S.—I have very great pleasure in seconding the vote of thanks. We learn from the Report that various gentlemen have given what no doubt were exceedingly valuable communications in the course of the session, and it would be our desire that the best thanks of the Society should be given to those gentlemen. But we have all of us had the opportunity of listening to this most beautiful discourse.

Sir George Stokes has appealed to me as to whether I should regard the special hypothesis that he has put forward with regard to the means of the perception of different kinds of colour as heterodox physiology. So far as I am able to judge, merely by listening to his words, there do not occur to me any symptoms of heterodoxy in that hypothesis.

Of one thing I think we may be sure—that the different sensations we experience do not depend on difference of structure of the individual nerve fibres; but that certain nerve fibres being called into action by certain stimuli, the result as regards our sensations depends on the part of the sensorium with which each nerve fibre is connected.

I do not think it is necessary for me at this late hour to detain you with further words, but only to express my own gratification at having been permitted to listen to this discourse, and to second the vote of thanks for it. (Applause.)

LORD KELVIN, G.C.V.O., then put the resolution to the Meeting and it was carried unanimously.

The PRESIDENT.—Speaking for myself I should say, as President, it is my duty to acknowledge the vote of thanks which has been passed to all those who have contributed to the business of the Institute by reading or sending papers to be read during the session. For myself I feel very strongly the kind way in which a very imperfect attempt to bring a difficult and little known subject before the Meeting has been received.

I am glad to see that I have not been charged by Lord Lister with being altogether heterodox.

The Meeting was then adjourned.

ORDINARY MEETING.*

SIR CHARLES A. GORDON, K.C.B, Q.H.P., IN THE CHAIR.

The Minutes of the last Meeting were read and the following elections took place :—

MEMBER :—Professor J. Zimmerman, M.A., D.D., United States.

ASSOCIATES :—Rev. T. B. Angell, D.D., United States ; D. Harlowe, Esq., United States.

The following paper was read by the Author :—

ON THE SUB-OCEANIC TERRACES AND RIVER VALLEYS OFF THE COAST OF WESTERN EUROPE. By Professor EDWARD HULL, LL.D., F.R.S., F.G.S. (Late Director of the Geological Survey of Ireland.) (With three Plates.)

PART I. INTRODUCTORY.

IT has been recognised for many years past that the British Isles and adjoining parts of the European continent rise from a submarine platform—generally known as “the 100-fathom platform”—and that this terminates along a declivity more or less steep, descending into very deep water forming the abyssal region of the Atlantic. As far back as 1849, the late Mr. Godwin-Austen described the limits and composition of this platform over its western area off the coast of the British Isles, and showed that it was covered by shingle containing littoral shells, sometimes entire, including *Patella vulgata*, *Turbo*, *Littorina*, etc., far out to sea and at depths of 80 to 100 fathoms ; arriving at the conclusion that they at one time formed successive margins of the Atlantic during a period of upheaval, or before the present submergence. Such shingle beaches are well

* 17th April, 1899. The importance of full consideration by the scientific world of the points brought out in Dr. Hull's paper, has been held to require its early insertion in the Journal.

represented at the Little Sole Bank and the Nymph Bank in lat. 49° N. and long. 10° E.*

In 1853 the late Sir H. T. de la Beche in his *Geological Observer* shows by a map the expanse of the area within the 100-fathom line, which if raised to the level of the sea, as he believed it had been, would represent to the eye little else than a vast plain; and he adds, "if we extend the area to the 200-fathom line it would not be much increased owing to the steep descent of the slope."† This able exponent of geological phenomena indicates also the process of formation of this but very gently sloping shelf, by attributing it to the eroding effects of wave action, and the distributing power of the tides during a period of gradual submergence. The existence of this remarkable platform—established by these early observers—has since been recognised by several writers,‡ and its extension southwards along the coasts of France, Spain and Portugal is thoroughly established. But the real physical base of the declivity forming the margin of the British-Continental shelf has not been indicated by these authors, nor the fact that the shelf is intersected by river channels reaching down to its very base at depths varying from 6,000 to 9,000 feet below the level of the ocean, as I hope to show by means of the soundings on the Admiralty charts of the British Isles and Western Europe. Nor is this at all surprising, seeing that the existence of such physical features at such great depths demands the admission of stupendous changes in the regions here contemplated as regards elevation and depression, such as naturalists might well hesitate to accept unless demonstrated by evidence of the most convincing kind. And, for myself, I fully admit that had it not been for the clear demonstration by several American geologists, but especially by that of the Professor J. W. Spencer, that the bed of the ocean along its western margin has been worn into terraces traversed by old river

* "The Valley of the English Channel," *Quart. Journ. Geol. Soc.*, vol. vi (1849). Prestwich concurs in this view, *Geology*, vol. i, p. 118.

† *Geological Observer*, 2 Edit., pp. 91-92.

‡ Amongst these may be mentioned Dr. G. C. Wallich, *The North Atlantic Sea-Bed* (1862), Plate XII, Professor Boyd-Dawkins, *Popular Science Review*, October, 1871; Professor T. Rupert Jones, *Rep. Croydon Microscopic Club*, 1877; Professor J. Geikie, *Address Brit. Assoc.*, 1892, and *Proc. Roy. Geog. Soc.*, Sept., 1892; Professor T. McK. Hughes, *Trans. Victoria Inst.*, 1879; A. J. Jukes-Browne, *Building of the British Isles*, 2 Edit.

channels down to depths of several thousand feet below the present level, it would probably not have occurred to me to ascertain whether similar physical features characterise the bed of the ocean along its eastern margin.*

II. MODE OF DETERMINING SUB-OCEANIC PHYSICAL FEATURES.

—Isobathic lines (or lines of equal depth), drawn on the charts by the aid of soundings, offer a reliable means for determining the physical features of submerged areas in the same way that contours traced by means of levelling, serve for representing those of the land. When the soundings are sufficiently numerous, as is the case on the Admiralty charts off the British coasts, the isobathic lines may be drawn at short intervals of depth, and the form of the sea-bed may be very accurately drawn in section; but off the coasts of Spain and Portugal, as in the case of Vigo Bay, additional soundings are much to be desired in order to enable us to delineate with sufficient accuracy the contours of the oceanic bed. It may, nevertheless, be affirmed that those shown on the Admiralty charts are quite sufficient to enable us to trace out the main features of the ocean floor; and, in some instances when the coast is approached, with all needful minuteness of detail. For the purpose of this investigation I have found the isobaths of 100, 200, 500, 750, 1,000, and 1,500 fathoms, generally sufficient except in a few special cases where additional contours have been drawn. Beyond the 1,500-fathom contour, the gently sloping floor of the abyssal ocean, formed mainly of "Globigerina ooze," spreads away westward. On the British Admiralty charts, the nature of the sea bottom is frequently indicated along with the depth of each sounding.

III. EXTENT OF THE REGION EMBRACED IN THIS PAPER.—

Having already dealt with the tract lying off the British Isles extending from the platform of Rockall round by that of the west coast of Scotland, England and Ireland as far south as the English Channel,† I propose to extend our

* Spencer, "Reconstruction of the Antillæan Continent," *Bull. Geol. Soc. Amer.*, vol. vi; Warren Upham, "Cause of the Glacial Epoch," *Trans. Victoria Inst.*, vol. xxix, p. 121. Several American geologists, including Dr. Walcott, have given their adhesion to Professor Spencer's views.

† "Further investigations regarding the Submerged Terraces and River Valleys bordering the British Isles," *Trans. Victoria Inst.*, vol. xxx, p. 305.

observations round the coast of France and the Bay of Biscay southwards to the entrance of the Straits of Gibraltar embracing a distance of about 1,500 miles along the coast, containing numerous very interesting features, such as we now meet with on the surface of the land, consisting of terraces, escarpments, and river-valleys.

PART II.

I. THE CONTINENTAL PLATFORM.—This gently sloping terrace, stretching seawards from the coasts of France, Spain, and Portugal, is continuous with that on which the British Isles are planted. As far as I can ascertain it was first indicated in Dr. Stieler's Hand Atlas.* Its margin is shown by the 100–200-fathom contour; but there are no indications given there that it is trenched by channels resembling those of rivers on the land. On the Physical Chart of the World of the "Challenger" expedition, the general form of the British-Continental Platform is approximately indicated by the 1,000–2,000-fathom contours, but the scale is too small to show details, and there are no indications of clefts or river-valleys.† The chart of Perthes seems to have been generally followed by subsequent writers. The newest sub-oceanic map is that of Mr. Hudleston, F.R.S., showing the platform—but not the river-valleys.‡

Opposite the coast of France, at Brest, the platform is about 130 miles in breadth, where it enters the Bay of Biscay; and here, owing to the recession of the coast, the breadth reaches over 100 miles, but becomes gradually narrower southwards. Along the north coast of Spain the platform becomes unusually narrow, averaging only from 20 to 30 miles outward from the coast to its margin. Off Cape Finisterre, and west of the coast of Portugal, the breadth varies from 30 to 40 miles and then gradually increases southwards till, off Cape St. Vincent, it appears to widen out and terminate in a succession of terraces;

* Published by Justus Perthes. Gotha, 1872.

† Published 1873–6.

‡ *Geological Magazine*, March, 1899, p. 97.

but the soundings are here insufficient to show clearly the physical structure of the ocean-bed. All along this coast the margin of the platform very nearly coincides with the 200-fathom isobathic line.

(b.) *Composition of the Floor.*—Throughout the tract above described from the English Channel to the entrance of the Straits of Gibraltar, the floor of the platform is composed of fragmental matter, such as gravel, banks and sheets of sand, clay and occasionally boulders of rock. These materials have been carried down into the sea by the rivers or dislodged from the coast-cliffs, and spread over the floor by tidal currents. Though enclosing molluscs and other animal forms, these materials are essentially different from those which are spread over the floor of the abyssal regions of the ocean consisting mainly of calcareous marl; and thus the great declivity along which the platform breaks off seawards becomes the physical line of separation between the essentially oceanic and essentially littoral deposits.

“*Plane of Marine Denudation*”;* and “*Base-level of Erosion.*”†—In the platform above described we have an illustration of the former, and in the cliffs which form its boundary along the coast, we have an illustration of the latter. The platform owes its nearly level surface to the action of the sea during periods of emergence and subsequent gradual submergence. The term “plane of marine denudation” is one applied by the late Sir Andrew Ramsay to describe theoretical plane-surfaces of extensive tracts in Wales and elsewhere, which have been subsequently eroded by river-valleys.‡ The British-Continental Platform is an admirable example of one of these, and is still in course of formation along the “base-level of erosion” of the coast cliffs by means of wave and current-action.

II. THE GREAT DECLIVITY.§—I apply this term as it is, in my view, the only fitting one to describe the abrupt descent along which the Continental Platform breaks off and is connected with the vast plain which forms the floor of the

* Either “plane” or “plain” according as we regard it a mechanical or a physical surface. † Professor Emmons of U.S.A.

‡ *Physical Geology of Great Britain*, 5 Edit. (1878).

§ The term I had originally employed for this feature was “Grand Escarpment,” but in deference to the objections of some geologists I have substituted the above, although “Escarpment” is allowed in this sense in America. Mr. Hudleston calls it “The Sub-oceanic Continental Slope,” *Geological Magazine*, March, 1899.

abyssal regions of the ocean. Measured from Rockall in the north (lat. $57^{\circ} 12' N.$) to Cape St. Vincent it has a length of about 1,500 English miles; but along the coast, about 2,000 miles. Such an oceanic slope if elevated into land would have no parallel in Europe; but, as Professor J. W. Spencer has shown, has its representative in the steep declivity which ranges from Mexico into the United States of America, surmounted by a plateau rising to 8,000 feet above the Gulf of Mexico.* 'The Great Declivity of the eastern Atlantic is diversified by numerous headlands and bays; while it is also deeply cleft to its very base by channels intersecting the platform for long distances; being, in fact, cañons, or fjords, of the rivers which descended into the ocean when under terrestrial conditions; these will be described further on.

As far as I have been able to determine from the soundings the Great Declivity descends in one continuous sweep from its upper margin to its base at a depth of 6,000 to 9,000 feet below the surface of the ocean. In this respect it differs from its representative on the western borders of the Atlantic, where the descent from the American Continental Shelf into the abyssal regions is accomplished by means of two distinct declivities separated by a broad and well defined terrace, known as the "Blake Plateau."† These differences in the form of the continental slopes on opposite sides of the ocean are illustrated by the following general sections (Figs. 1 and 2).

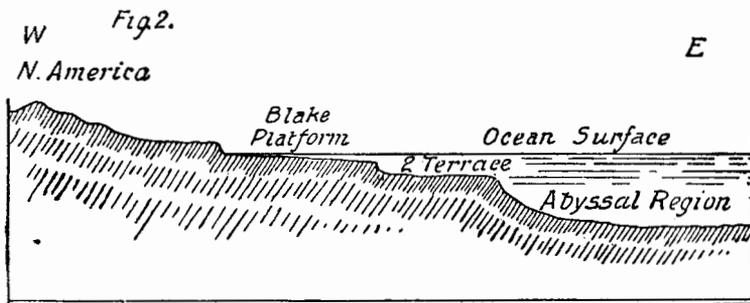
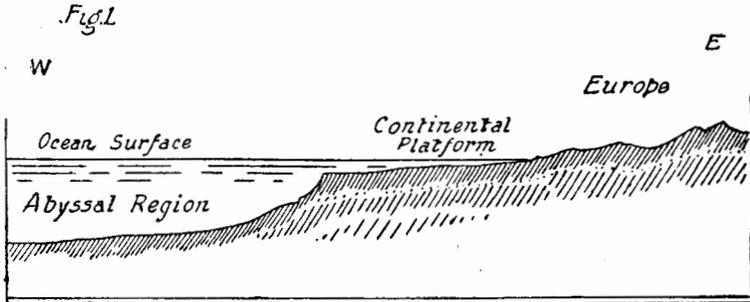
The base of the Declivity, which in the case of the Vidal Bank off the coast of Scotland corresponds with the 1,000-fathom contour, gradually descends in a southerly direction, so that off the Porcupine Bank it appears to touch the 1,500 contour, giving a total descent of 7,800 feet (1,300 fathoms) from the upper margin to its base. With this general descent the Declivity follows the coast of the Bay of Biscay and that of Spain and Portugal to Cape St. Vincent, beyond which points I have not as yet had opportunity to follow it; we cannot doubt, however, that it is represented off the coast of Africa for some distance southwards.

From the base of the Great Declivity at a depth varying between 1,000 to 1,500 fathoms—the floor of the abyssal

* Spencer, "Great Changes of level in Mexico, etc.," *Bull. Geol. Soc. Amer.*, vol. ix (1897); *Trans. Canadian Inst.*, vol. v.

† So-called by Professor L. Agassiz, *Two Cruises of the "Blake."*

ocean stretches gradually away westwards to depths of 2,600 fathoms and upwards. The material of which it is composed is mainly of organic origin. In the Bay of Biscay the depth descends to 3,000 fathoms, and the floor consists of "blue and green mud" varieties of the *Globigerina*-ooze, with percentages of carbonate of lime, ranging from 53 to 75 ;



Figs. 1 and 2. To illustrate the difference of outline between the European Continental Terminal Slope and that of the N. American Continent.

the residue consisting of minute particles of quartz, felspar, augite and volcanic matter.*

III. SLOPES OF THE GREAT DECLIVITY.—Exception has been taken to the views here advanced regarding the nature and origin of the Great Declivity on the ground that the slopes are extremely slight. This view does not appear to be borne out by the results of actual measurement—which

* Report "Challenger" Expedition, p. 48.

show that the slopes from the edge of the Continental Platform to the base are in general quite comparable with those of land escarpments. For the purpose of determining this point I have drawn by means of co-ordinates where the soundings admit, nine sections, and plotted them to a natural scale. In doing so I have only taken those of the outer slopes; but if I had also included the sides of the cañons, or old river-valleys, the results in the direction of steepness would have been much greater. As a general conclusion we may take the average slope at 13° to 14° ; varying from 5° to 36° or even more. The walls of the submerged cañons or river-valleys are, however, often precipitous, sometimes vertical, faces of rock. The following table shows the results of the soundings:—

TABLE SHOWING APPROXIMATE SLOPES OF THE
GREAT DECLIVITY.

No.	Position.	Fathoms in depth.	Distance from edge to foot in miles.	Approximate slope.	Approximate angle of slope.
1	Vidal Bank, Lat. 55° N.	900	10	1 in 10	5 degrees.
2	" " " 54° N.	800	5	1 in 5.5	10 "
3	La Chapelle Bank, " $47^{\circ} 30'$	900	4.5	1 in 4	16 "
4	Bay of Biscay, " $47^{\circ} 20'$	1,000	15	1 in 13	4 "
5	Promontory of Brest, " $48^{\circ} 10'$	1,300	4	1 in 2.6	21 "
	" " " 46° N.	1,200	7	1 in 5	11 "
6	Off C. Penas, " $44^{\circ} 20'$	1,300	5	1 in 3.4	17 "
7	Off C. Ortegual, " $44^{\circ} 5'$	1,300	4.5	1 in 3	18 "
8	Off C. Torinana, " $43^{\circ} 4'$	1,300	2.5	1 in 1.6	36 "
9	Off Oporto, " $41^{\circ} 5'$	1,300	12.5	1 in 8.5	7 "

Off the coast of Spain and Portugal the descent to the 1,000 fathom contour is generally steep and is varied by numerous bays and headlands; but owing to the fewness of the soundings, as for example off Vigo Bay, the features cannot be traced with that degree of detail which is possible in the British and French waters. Off the north coast of Spain the declivity is characterised by several precipices comparable with some amongst the Alps and other mountain chains. Thus off Cape Bidio, there is a descent of about 8,000 feet in four miles; another off Cape Ortegual of about 13,000 feet in the

same distance; a third off Cape Toriñana of about 9,750 feet, where the 200 fathom contour is very nearly over a sounding of 1,825 fathoms. These nearly sheer descents have their counterparts in those which bound the submerged terraces off the coast of North America and the West Indian Islands.*

It is not to be supposed, however, that the descent from the edge of the platform to the base was by any means uniform. The isobathic lines indicate great variations in the amount of slope—with (in some cases) wide terraces intervening between steep, perhaps precipitous, descents. This is what might be expected as the result of wave action along emerging or subsiding land, accompanied by occasional pauses in the movement, and amongst rocks varying in character and hardness.†

Thus off Cape Prior (lat. 44° 10' N. and long. 9° W.) the contours clearly indicate wide terraces ending off in steep descents at the margin of the oceanic floor, and similar features are observable both in the region lying to the north of the grand cañon of the Adour in lat. 44° N. and long. 3° W.—and off Cape St. Vincent. A larger number of soundings are, however, required in order to arrive at a better knowledge of these details.

As far as I have been able to judge from the soundings a complete change in the form of the oceanic floor takes place between Cape St. Vincent and the Straits of Gibraltar. The Grand Declivity appears to widen out, and to give place to a gradual slope descending from the margin of the land to the abyssal regions of the ocean, probably in a succession of steps or terraces.

IV. SUBMERGED RIVER-CHANNELS OR CAÑONS.—It is owing to the existence of river-channels, sometimes traceable up to those now entering the ocean from the land, that we are enabled to arrive at the conclusion that the ocean-bed was formerly, to some extent, a land surface; and it is also by means of these features that we can ascertain the extent of the former emergence. It is only on emergent lands that rivers can wear down their channels; for once they have entered the sea their currents are checked, or

* See map to Professor Spencer's "Reconstruction of the Antillean Continent," *Bull. Geol. Soc. Amer.*, vol. vi, 1895; *Geol. Mag.*, Nov. 1898, Plate, p. 515.

† It must be recollected also, that the effect of wave-action on the subsiding escarpment would have been in the direction of reducing the amount of the original slope which after the maximum emergence may have been much greater than at present.

annihilated, and their erosive action ceases.* Hence if the soundings enable us to trace out channels of rivers descending from comparatively shallow levels to those of great depth, we are driven to the conclusion, however unexpected, that the sea-bed was elevated into land to that extent; and the "base-level of erosion" (or ultimate depth) is shown by the position of the *embouchure* where the channel opens out on the abyssal floor. In the region we are now considering, this depth reaches as far down as the 1,500 fathom contour; in other words, 9,000 feet below the surface; possibly a little over this.

I now proceed to give some account of the principal submerged river-channels themselves, from the north to the south of the region here under consideration, taking in succession those of France, the Bay of Biscay, and the coast of Spain and Portugal.

Having on a former occasion endeavoured to describe the sub-oceanic river-channels to the west of the British Isles as indicated by the Admiralty soundings, it is only necessary for me to refer the reader to the paper in question†; but I propose to make an exception in favour of the "English Channel River" for the reason that it in part belongs to the continental system and should not be omitted from a treatise dealing with submerged continental streams. It is also one of peculiar interest, and its existence has been recognised by Professor Boyd-Dawkins, Mr. Jukes-Browne, and Professor T. Rupert Jones definitely.

(d.) *The English Channel River.*—This channel may be traced at intervals from the Straits of Dover in a nearly straight course to its *embouchure* in long. 8° W. between walls of rock about 4,000 feet in height. After passing through a deep cañon for a distance of 80–90 miles it received the streams draining the south of England and the north of France, including the Seine, Somme and Rance. Between the Devon and Dorset coast on the north, and the Channel Islands on the south, its course is clearly defined on the Admiralty Chart, by the channel marked as "The Hurd Deep," which is traceable for a distance of 70 miles, with a breadth of about four miles, and a maximum depth of 60 fathoms, or 360 feet, below the general floor of the sea-

* It was largely from this consideration that Professor Spencer was able to demonstrate the former great elevations of the American and West-Indian lands and adjoining ocean-bed.

† *Trans. Vict. Inst.*, vol. xxx (1896–7).

bed at that place. Owing to this part of the old channel lying in the line of the present tidal currents where they are very swift (from eight to nine miles per hour), the channel has been kept clear; while above and below, where the shores of the English Channel recede, the silting has nearly obliterated the course of the original stream.*

V. THE SUBMERGED RIVER-CHANNELS OF THE BAY OF BISCAY.—Still more remarkable, than those already described, are the submerged river-channels of the Bay of Biscay. Those of the Loire, Adour, Caneira are the most important; but besides these are several bays, trenching deeply into the Continental Platform which were clearly the embouchures of streams the upper channels of which cannot now be definitely determined from the charts.

(a.) *The Loire*.—In the case of the Loire, the Continental Platform is so broad, about 100 miles, and the river-channels have been apparently so much silted up, that there is difficulty in tracing the connection of the cañon, which, from its position may be supposed to have belonged to this stream, with the Loire itself. Indications of a channel may be observed, from the soundings, S. of Belle Île, and again at a distance of 50 to 60 miles further W. in long. $4^{\circ} 10' W.$; and from this point to long. $5^{\circ} 30' W.$; lat. $47^{\circ} 10' N.$, where the cañon is fully developed, the channel may be traced continuously by the depression in the soundings below the general floor of the Platform. Here it takes the form of a double cañon (see Plates I and III), with which it passes down to the abyssal floor at a depth of about 1,500 fathoms. This bifurcation of the channel on reaching the edge of the oceanic slope is not uncommon in the case of several of the larger river-channels such as those of the Adour and Tagus.

(b.) *The Gironde*.—A well-defined bay pointing N.E. breaks through the Great Declivity in long. $2^{\circ} 40' W.$; and lat. $44^{\circ} 55' N.$, which I have inferentially connected with the above-named river, distant about 70 miles; but the soundings are not sufficiently numerous to enable us to follow the connecting channel across the wide expanse of the Platform. As this large river must have entered the ocean somewhere about this position, the inference seems justifiable.

* "The Hurd Deep" was so called by Captain Martin White, who sounded over it, after the hydrographer of the day, Captain Hurd, *anno* 1810, as I am informed by Admiral Sir William Wharton, F.R.S. (4th May, 1898).

(c.) *The Adour*.—Of all the sub-oceanic river channels to be met with along the coast of Western Europe, none are so strikingly developed as that of the Adour. This fine river has its sources amongst the highest valleys of the central Pyrenees and enters the ocean at the base of this range near Bayonne. It is unique in this respect, that its submerged channel is continuous with the existing stream from its present mouth to its ancient embouchure at a distance of about 100 miles from the coast of France, and the channel is recognised on the Admiralty chart for some distance from the shore under the name of “La Fosse de Cap Breton.”* This channel reaches a depth of 175 fathoms (1,050 feet) at a distance of five or six miles from the shore, and 117 fathoms (702 feet) below the surface of the Platform. At 15 miles from the same point, another channel joins that of the Adour on the south side, and from this point it rapidly deepens, assuming the form and features of a grand cañon, bounded by steep, sometimes precipitous, walls of rock from 4,000 to 6,000 feet in height, and ultimately opening out on to the floor of the ocean at a depth of about 1,000 fathoms (or 9,000 feet).

A few miles above the embouchure the channel bifurcates (Plate I), the two arms embracing a tract (once doubtless an island) of shallower ground; but the arms ultimately converge on the floor of the abyssal ocean. Between the cañon of the Adour and the coast of Spain to the south, the continental shelf is remarkably narrow, ranging in breadth from 6 to 20 miles, and is indented by several short but deep bays or ravines along which, we may well believe, streams descended from the northern slopes of the western Pyrenees in a succession of rapids and cascades, of which the Rio de Bilbao was doubtless one of the most important. Several branching cañons with their existing streams on the mainland are clearly defined by the contours as shown in Plate I. At the period when all these features were sub-aerial, and when the Atlantic waters washed the base of the Grand Declivity, the scenery of the cañon of the Adour must have resembled in no small degree that of the

* M. Elisée Reclus abandons the attempt to explain the origin of this remarkable “gulf” when he says:—

“But how can we explain that singular gulf which extends immediately in front of Cape Breton on the Coast of Landes? Ought we to attribute its formation to the meeting of the tides, which takes place in the channel of the Gulf of Gascony? This is a question which it is not yet possible to decide.”—*The Ocean*, Section I., p. 7. The author claims to have solved the problem which Reclus relegates to the future!

minor cañons of Western America, with the addition of a mountain range, probably snow-clad from foot to summit, in the background, and a great ocean stretching away indefinitely along the front. No scenery at all comparable, except perhaps in western Norway, is now to be found in the European area.

Were there no other sub-oceanic channels throughout the whole region here under review than that of the Adour it would of itself be sufficient to demonstrate its own fluvatile origin and that of all the others here described. For what are the characteristics of a river-valley draining a plateau and adjoining regions? They are: first, a continuous deepening of the bed of the channel in the direction of the outlet; second, continuous widening of the channel in the same direction; third, a winding course; fourth, lateral tributaries descending on one or other of the sides to join the main stream. All these characterise the sub-oceanic channel of the Adour. On the other hand, they are not characteristic of seismic fissures, or of fissures formed by faults or any other process with which we are acquainted on the land surface. We are familiar with valleys with similar characteristics, but waterless, entering the great valley of the Nile or the shores of the Red Sea, or traversing the region of Arabia Petraea and Southern Palestine, where rainfall is either absent or only intermittent; but we do not hesitate to recognise in them the channels of former streams and rivers, though they are now dry; and not less certain is the nature of these sub-oceanic channels now covered by the waters of the Atlantic, such as those of the Loire, Adour, Douro, and Tagus. No other theory than that here advanced will, I venture to hold, serve to explain their origin and presence under the waters of the ocean.

VI. THE SUBMERGED RIVER-CHANNELS OFF THE COAST OF SPAIN AND PORTUGAL.—The western submerged escarpment off the shore of Spain and Portugal is characterised by several remarkable river-channels and cañons, of which the most important are those of the rivers Caneira, Arosa, Lima, Douro, Mondego, and the Tagus; besides these there is a grand cañon to the north and west of Cape Carvorino (lat. 39° 30' N.) which may have been the combined channel of two or three now unimportant streams; we shall consider these in their order of succession from north to south. (Plate II.)

(a.) *The Caneira*.—A short, but well defined cañon indents the Great Declivity in long. 5° 40' W. opposite Cape Penas.

In a distance of about 20 miles, it descends from the plain of the Continental Shelf at 200 fathoms to a depth of 1,380 fathoms, having made a bend westwards about half-way down from the apex to the embouchure. The direction of this indentation points towards the mouth of the river Caneira, though the soundings are insufficient to indicate the connecting channel.

(b.) *The Arosa*.—This stream probably formed a junction with the river Lerezo Veda before entering the head of the deep and wide cañon which descends from the Continental Platform at the 200-fathom line and opens out on the deep ocean at about the 1,000-fathom line, after a course of 35 miles in long. $9^{\circ} 45' W.$ and lat. $42^{\circ} 35' N.$ The form of the contours indicate the occurrence of wide platforms bounded by cliffs on either side of the cañon,

(c.) *The Lima*.—The platform along this part of the coast being narrow, the head of this cañon (long. $9^{\circ} 5' W.$) approaches to within 20 miles of the mouth of the Lima at Vianna. At its upper part the cañon is narrow, and descends within a distance of 10 miles to a depth of 1,137 fathoms (6,822 feet) below the surface of the ocean; or 5,622 feet below that of the margin of the platform; absence of soundings prevent any attempt to connect the cañon with the river itself across the platform, but there can be little doubt of the continuity of the channel.

(d.) *The Douro*.—The decisive bend inwards of the 200-fathom contour for a distance of 8 or 10 miles opposite the mouth of this river leaves no doubt that we are here in the presence of its submerged channel, and the curves of the 100 and 50-fathom contours enable us to trace the channel across the platform to a distance of only 14 miles from the mouth of the river itself below Oporto. Owing, however, to the absence of soundings in the deeper portions of the sub-oceanic bay, the exact form of this part of the channel cannot be determined, but sufficient remain to show that the river formerly entered the outer ocean through a wide bay and rapid descent at a depth of about 1,500 fathoms.*

* The fewness of the soundings in some parts of the ocean-bed off the coasts of Spain and Portugal makes the attempt to restore the old river channels the more difficult. I have been favoured by H.S.H. the Prince of Monaco with the tabulated results of a large number of soundings made during the years 1885-1888 and 1891-1896 during cruises in the "Hiron-delle" and "Princess Alice" off these coasts, but I have not yet found time to protract them on to the charts (1899).

(e.) *The Mondego*.—(Plate III.) At a distance of about 35 miles from the coast of Portugal at Palleiros de Mira (lat. $40^{\circ} 30'$ N., long. $9^{\circ} 25'$ W.) there occurs a short, narrow, but remarkably deep, cañon, cutting for a few miles into the Continental Platform and bounded on either side by precipices of rock from 6,000 to 7,000 feet in height as if seen from the base. The bottom of this cañon, indicated by the sounding, "1170" fathoms, is only about 8 miles from its apex: so that the fall must have been at the rate of 752 feet per mile, suggesting a series of grand waterfalls, or cascades, rivalling some of the finest now in existence. This cañon is presumably that of the river Mondego, towards the mouth of which it appears to point; but owing to the insufficiency of the soundings over the platform at this place the connection cannot be established. It is possible, however, that this cañon may have also received the waters of the river Vouga which enters the ocean at Barra Nova and has numerous tributaries. Over the area of the platform, there may have been a junction of this stream with the Mondego, the channel of which is now silted up, and thus the indication of a vast mass of water formerly descending through the cañon, which its profundity suggests, may be explained.

(f.) *Cañon off Cape Carvoeiro*.—A profound and well-defined cañon indents the Great Declivity off the coast of Portugal near Cape Carvoeiro, in lat. $39^{\circ} 30'$ N., but which is remarkable for the fact that it does not appear to be directly connected with any important river now descending from the adjoining lands. The apex of the cañon is about 10 miles from the coast at Point Nazareth; and several minor streams, of which the largest is the Vieira, probably united over the surface of the platform to form a sufficient body of water to erode the channel we are now considering. From its apex at the 100-fathom line to its embouchure at a depth of 1,500 fathoms, the length of the cañon is 25 miles, and along its southern margin it was hemmed in by precipices of rock several thousand feet in total depth. The most precipitous part is just to the north of Burling Island where there is a nearly sheer descent of about 5,000 feet. In Plate III, I have drawn sections across this cañon at three successive intervals from the higher to the lower levels.

(g.) *The Grand Cañon of the Tagus*.—(Plates II and III.) No doubt can be thrown on the identity of the submerged channel of the chief river of the Peninsula as its apex is directly in front of the mouth of this river at a distance of only

five or six miles immediately south of Cape Razon. Like several of the cañons of the larger rivers already described—that of the Tagus is characterised by a double outlet, forming in plan a Delta. After descending from its apex for a distance of 35 miles in a westerly direction, and to a depth of 600 fathoms, the channel divides; one branch, which is the deeper, continuing very much in the same direction; the other, sweeping round in a semicircle to the north-west, and ultimately entering the deep ocean at a distance of about 15 miles from the mouth of the former channel. There is thus enclosed a large isolated tract—the highest part of which rises to within 66 fathoms of the present surface of the ocean. Towards the mouths of these channels the waters of the old Tagus must have entered the ocean in a series of cascades with a total descent of over 5,000 feet within a distance of about six or seven miles;* and considering the vast volume of water brought down by the Tagus at the present day, such a series of falls must have been grand in the extreme, because to the present volume of water must be added that of the Platform itself.

Other submerged channels of minor importance might be referred to, but the above will probably be considered sufficient to give some idea of the magnitude and grandeur of the features now lost to view beneath the waters of the ocean—but happily capable of being “summoned from the vasty deep” and idealized by means of the sounding line!

VII. ISOLATED ROCKS AND SEA-STACKS.—Amongst the physical features by which the Great Declivity was diversified the most conspicuous were probably the isolated rocks and sea-stacks which rose from the ocean floor. One of these occurs about 36 miles off Cape Razo in the submerged valley of the Tagus, rising from 500 fathoms of water with the summit 110 fathoms; its height was therefore 2,340 feet. (Plate III.)

PART III.

I. GEOLOGICAL AGE AND MODE OF FORMATION OF THE SUBMERGED PHYSICAL FEATURES.—The fact that the submerged river-valleys are in most cases merely prolongations of those of the adjoining lands is a sufficient indication that the physical features above described are geologically of

* The soundings show a descent from 600 to 1,200 or 1,300 fathoms.

modern age; in other words not earlier than the Middle Tertiary period. It is generally recognised that the physical features of the British Isles and Western Europe received their more definitive form and outline during the Mio-Pliocene stages; in the Alps, in post-Miocene times.* Though the general depression and partial submergence of the existing lands in the Cretaceous period gave place to considerable elevation accompanied by denudation at the commencement of the Eocene period—it was not till after the succeeding Miocene stage that the present sculpturing of the features of the land was fully developed; this process was continued into the Pliocene and post-Pliocene times. It was *then* that the hills, valleys, and river-channels assumed the definite forms and arrangement, which they retain at the present day, and it was, consequently, during this long-continued period that the submerged physical features—the escarpments and river-channels—continuous with those of the land, received their definite outline and direction. This observation applies especially to the south and east of England where the more recent geological formations are to be found.

This view is in harmony with those arrived at by the American observers of these phenomena along the eastern coasts of America and the Antilles. Nor must the biological evidence of recent continuity all round the submerged platform, be overlooked. The flora of the south and west of Ireland gives evidence of a former connection with that of Spain and the south of Europe, as was long since pointed out by the late Professor Edward Forbes, while the identity of the fauna and flora of Iceland with that of Scotland, points to a similar land connection in very recent times, notwithstanding the depression of 550 fathoms (3,300 feet), by which the connecting platform is traversed; as shown by the “Challenger” soundings.† The uprise in recent times of the bed of the North Atlantic to an extent of over 3,000 feet, is absolutely proved on biological grounds. Dr. Wallace includes Iceland in his Palæarctic Region, which embraces the British Isles and North Western Europe.

* See sections across the Alps in various positions by Professors Albert Heim, Carl Schmidt and H. Schardt in *Livret-Guide Géologique, dans Le Jura et Les Alps de la Suisse*, Lausanne (1894).

† “Physical Chart of the world,” “Challenger” Report, 1873-6; also, Hudleston, “Eastern Margin of the North Atlantic Basin,” *Geological Magazine*, March, 1899 (Plate).

It now only remains for me to endeavour to explain the process by which, as we may conjecture, the physical features under the waters of the Atlantic were developed.

II. MODE OF FORMATION OF THE SUB-OCEANIC FEATURES.—It need scarcely be observed that there is extreme difficulty in the endeavour to sketch out the *modus operandi* according to which the physical features here described were produced. To begin with, we are ignorant, to a great extent, of the form and conditions of the oceanic bed at the commencement of the Tertiary period. During the Cretaceous period there was wide prevalence of oceanic conditions and great depression of the land. With the introduction of the Tertiary period, elevation of the land commenced, becoming accentuated throughout the Mio-Pliocene periods, and probably attaining its maximum result at the commencement of the Pleistocene or Glacial epoch.* The initial effect of the emergence on a surface gradually sloping down from the emergent lands to the abyssal regions of the ocean, would be the formation of "a plane of marine denudation," to use the phrase of the late Sir Andrew Ramsay. This gradually sloping plane, levelled and eroded by wave-action during the process of emergence, is now represented by, though not continuous with, the British and Continental Platform. Ultimately, when the elevation of the sea-bed attained its maximum, and a prolonged pause occurred, wave-action came into full play, cutting back the emergent lands along "the base-level of erosion," a process continued during subsequent subsidence and submergence down to the present day.

Meanwhile the rivers draining the land areas, both present and past, were at work in wearing down their channels through the Continental Platform; channels which, as we have seen, are still traceable by aid of the soundings down to the very base of the Grand Declivity. I regard the long lapse of the earliest glacial period, that of intensest cold and of severest glacial conditions, as that during which both wave-action along the base of the Declivity, and river-erosion over the Platform, were most effective. It was only a

* The researches of the Swiss and German geologists Heim, Baltzer, Schardt, Renevier and others, show that in the Alps and Jura the most stupendous terrestrial movements occurred after the close of the Miocene period, that is during the Pliocene; as Miocene beds, both lacustrine and marine, have been flexured, folded, and uplifted several thousand feet amongst these regions.

question of time; and who that has studied the phenomena of the "Great Ice Age" can doubt that the time was sufficiently prolonged?

2. The process of subsidence, greatest in the middle glacial submergence of these islands, was probably more rapid than that of emergence, though this is open to question. At the present time the ocean waters are still extending their range along the coasts of the British Isles and of Western Europe. *Si monumentum quaeris, circumspice.* The south and east coasts of England attest the rapidity of the process.

3. *Nature of the rocks under the floor of the ocean.*—On this point we can only fall back on conjecture, as the sounding apparatus only brings up specimens of the soft superficial deposits, such as sand, clay, or marl, though a general idea of the nature of the solid floor may be gathered from that of the adjoining lands. Dr. J. Joly, F.R.S., has recently invented an apparatus in the form of an electrically driven drill, by means of which cores of solid rock may be hollowed out of the ocean-bed and be drawn to the surface.*

III. CONCLUDING OBSERVATIONS.—Having on a former occasion pointed out how a great uprise of the ocean-bed and adjoining lands on both sides of the Atlantic must have affected the climatic conditions of these regions to the extent of bringing about glacial conditions in these Isles,† I do not propose to re-open the subject here, further than to observe that we have in this uprise a simple and palpable cause of the general lowering of temperature which took place during the Pleistocene Epoch, and brought about glacial conditions in the northern hemisphere. The prevalence of Arctic conditions brought about by elevation would, it must be remembered, be further accentuated by the uprise of the Antillean continent, as demonstrated by Professor J. W. Spencer, owing to which the Gulf Stream would have been unable to enter the Gulf of Mexico, and would have passed into the North Atlantic with a temperature much lower than at the present day; I have estimated this decrease at 12° Fahr. Such an explanation is in harmony with Lyellian principles, which find in the relative distribution of land and sea the causes which have governed conditions of climate in past time.

* *Scient. Proc. Roy. Dublin Soc.*, vol. viii, p. 509.

† "Another possible cause of the Glacial Epoch," *Trans. Vict. Inst.*, 1898.

EXPLANATION OF PLATES.

PLATE I.

These plates are taken by photographic process from the Admiralty charts—on which I have drawn the isobathic lines of 200, 500, 1,000 and 1,200 fathoms—the first and last of which nearly coincide with the upper edge and base of the Great Declivity (or Escarpment) which separates the Continental Platform from the abyssal region of the ocean. It will be observed how the Declivity is deeply trenched by valleys or “cañons” running for greater or less distances into the Continental Platform—which has a breadth of about 150 miles along the north-east coast of the bay. Through this Platform, the deep submerged channels of the Loire, the Gironde, and the Adour, may be traced by means of the soundings for greater or less distances; that of the Adour through its whole extent of 100 miles.* Along the north coast of Spain, the Platform is very narrow; but is deeply trenched by river valleys which can, with much certainty, be connected with existing streams descending from the Cantabrian High lands; amongst these the cañon of the Caneira is the most distinct; but there are others on a smaller scale entering the Channel of the Adour.

PLATE II.

In Plate II, the Platform is continued, and breaks off generally along the 200 fathom contour—which is trenched by numerous channels which can, with more or less certainty, be connected with the existing streams of the mainland of Spain and Portugal. The cañons of the Lima, Douro, the Mondego and the Tagus are clearly traceable; but there are several well-defined and very deep cañons which trench the Great Declivity and the Platform, but which cannot be very clearly referred to existing streams; one of these I have called “the Grand Cañon” in lat. 39° 30' traceable for 40 miles, and bounded by precipitous cliffs about 5,000 feet in height on the south side. Another short, but very deep cañon occurs in lat. 40° 30' bounded by precipitous cliffs of about equal height with that of the Grand Cañon—which open out on the abyssal region of the ocean at the foot of the Great Declivity.

The submerged valley of the Tagus, with its remarkable Double Cañon, is admirably defined by the soundings, and can be clearly traced from its ancient *embouchure* up to within about ten miles of the mouth of the existing river, where the channel becomes choked up by sand and silt. It has an entire traceable length of 50 miles by one channel, and of 60 miles by the other. The Continental Platform along this coast has an average breadth of about 35 miles.

* A plan of the sub-oceanic channel of the Adour on the scale of the Admiralty chart is published in the *Geographical Journal*, March, 1899. The small figures on the maps and sections are fathoms—but unfortunately they are in most cases too minute to be legible.

Sections of Sub-oceanic Cañons and Valleys.

Double Cañon of R. Loire

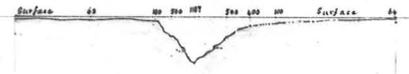


400 Fms. = 2000 feet.

*Cañon of the R. Mondego, Spain.
At about 40 miles off C. Mondego.*



*Cañon of R. Lima, Spain
Off Coast of Vienna*

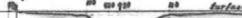


Cañons of the R. Adour

*N: 1.
About 18 miles off C. Breton
Cape Niquera*



*N: 2.
At 57 miles from Coast
Lagutia*



*N: 3.
About 82 miles from Shore
Lagutia Point
Cape Niquera*



44° N. Lat.

Sections across Cañon off C. Carvorino

*N: 1.
From C. Paniche, Portugal*



*N: 2
About 25 miles off S. Martin*



*N: 3.
About 20 miles off C. Carvorino*



Sections across the Cañon of the R. Jaqu

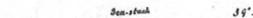
*N: 1.
About 16 miles from River Mouth*



*N: 2.
About 28 miles off C. Rago*



*N: 3.
About 36 miles off Cape Rago*



Horizontal Scale



Vertical Scale



PLATE III.

Little need be said in explanation of Plate III, except that the horizontal and vertical scales are unequal, the latter being (for obvious reasons) exaggerated; but as the soundings are given in fathoms, and may be read by aid of a lens—the determination of the form can be made in each case. These cross sections bring out in a marked manner the forms of the ancient river channels or cañons as they trench deep into the gently sloping plain of the Continental Platform.

DISCUSSION.

The CHAIRMAN (Sir C. GORDON, K.C.B.).—Like myself, all must have followed the author's arguments with great interest and desire to join in according him a vote of thanks. (Cheers.)

Professor ETHERIDGE, F.R.S.—I need hardly say that I am pleased to hear this paper by Dr. Hull, but it is one *not* easily discussed. Its statements are not even easily questioned; few are aware of the amount of labour involved in tracing and determining these great depths, and the involved results placed in that form, for popular exhibition and with scientific description. Few are aware of the labour and patience required to examine and plot out over the Admiralty sheets and the soundings which occur by thousands along our shores and over the deep sea bottom, both British and Continental, then estimating the varying depths to the old and now submerged condition of the river channels ranging from Cape Finistere to near Gibraltar or the entrance to the Mediterranean. These river channels and the "continental platforms" from which the numerous rivers take their rise were discussed by Professor Hull, and compared with the remarkable researches carried on along the eastern side of North and South America as far as the Mexican Gulf, and so ably discussed in his paper read before this Society in 1898 (see p. 141). It would be difficult to name or point out along the extended French and Spanish coast-line any special point of more interest than another, but the case of the remarkable River Adour, north of the Pyrenees, with its deep cañon, is one of many described by Dr. Hull, illustrating the great depression and physical condition of the submarine area some 8,000 or 9,000 feet deep. These great river courses and changes are not depicted as they should be either on our

British or Continental atlases, hence the value of Dr. Hull's researches, thus making his papers read before the Society of such marked value. I need only mention the old and depressed river-beds of the Shannon on the west coast of Ireland and the Seine in the north of France, amongst others, traceable through dredging and sounding as far as the 100-fathom level, or from 150 to 200 miles from the present coast-line. The sections illustrating the depths to the sea-floor given in this paper, and those in the previous paper on the northern British coast-line, are of the greatest value to physical geography, and should be continued to the south-western extremity of Africa, or from where Dr. Hull left off at the mouths of the Adour and its cañon. It must have struck many others present, the difficulty in following the delicate lines of the sections over the sunken areas shown on the transparency; one good coloured section (which few are more able to do than Professor Hull) would have more clearly illustrated the entire series of the interesting sections, stretching far out from the foreshore to the greatest depth he has depicted; and his present paper being more complicated in construction than in his earlier paper from the Shetlands to Cape Ushant, the contour lines are both more numerous and crowded, and therefore difficult to follow.

We yet want these great facts depicted in our physical atlases, which would more clearly illustrate the value of our Admiralty charts, the reading, meaning, and use of which, with their thousands of soundings or registered depths would lead to the still more profound researches and illustrate the physical history of the submerged—but not *lost*—lands which in some future period may again appear under new and increased grandeur.

General McMAHON, F.R.S.—I have had great pleasure in listening to Professor Hull's paper, and I think geologists and physical geographers ought to feel much indebted to him for calling their attention to a subject that hitherto has been much neglected. Professor Hull's paper deals with the Continental Platform and the Great Depression.

As regards the course of rivers on the Continental Platform I think that Professor Hull has proved his case, and I have not seen or heard any valid objections to his conclusions. But when we come to the courses of the rivers in the Great Depression I think the evidence is very much weaker. I think that perhaps the soundings are hardly sufficient to enable us to say that the

depressions marked on Professor Hull's map are the courses of old rivers.

Professor Hull's theory involves the supposition that parts now buried 9,000 feet under the sea must have been dry land and must have continued dry land for a very long period indeed, for deep and wide river valleys are not the creation of a day. It indicates the existence of elevated land during long ages, and it would be more convincing if Professor Hull would give us geological evidence to show that such long-sustained elevation of the area concerned occurred before the present depression took place.

Then another even greater difficulty occurs to my mind. The difficulty is entirely in reference to the river courses in the great depressions.

Professor HULL.—Do you mean across the Great Declivity?

General McMAHON.—Yes. My difficulty is that our rivers have always been, and are still, bringing down enormous volumes of mud with them, and we know that when this comes in contact with salt water, by a sort of quasi-chemical action the mud is precipitated; and the precipitated mud is carried by the currents that sweep up and down our coasts under the influence of the tides and wind until it finds a resting place in some depression. The difficulty that occurs to my mind is how could river valleys have remained for so long a period and not have been filled up by silt, for the effect generally of silt is to fill up and to level every depression? Perhaps Professor Hull can remove this difficulty as he has given so much attention to the subject.

The AUTHOR.—I have to express my great pleasure that my friend Professor Etheridge was able to be present this evening, and I am gratified that he indicates his general assent and approval of my views.

I must say that I am afraid that I have neither time nor opportunity to spend in making large coloured diagram maps of these features. I should be most happy, if any one would undertake to do so, to give him any assistance in my power; but it is quite impossible for me to undertake it.

I think these Admiralty charts are on a sufficiently large scale to show very correctly the sub-oceanic physical features, and with the paper itself will be published these charts taken by a photographic process from the Admiralty charts themselves. I think they are pretty good generally, and when anyone reads the paper with the assistance of these maps he will probably have no difficulty in

following the course of these contour lines. The plan of the Adour is the most remarkable of all these river channels from the fact of its running for 100 miles from the very shores of the present coast out into the abysmal ocean. That is shown on a pretty large scale, in fact the same scale as the Admiralty chart.

I am very glad that General McMahan goes so far with me as to admit that these channels can be traced across the Continental Platform. But I do not see how we can stop there unless he refuses to admit that the Continental Platform was elevated to the base of the Great Declivity, as I certainly hold most strongly—you cannot stop at 500 fathoms, or 700 fathoms, or 1,000 fathoms. You must go down to the very base of the declivity in order to restore the former relations of land and sea, and these channels in many cases—certainly in the case of the Adour, the Loire and the Tagus—are most clearly traceable by means of the contour lines down to the very base of the escarpment showing the lowest point at which the ocean washed the coasts of the ancient shore.

Then as regards the time;—I can hardly put any reasonable limit to the time of the Great Ice Age. That was the period, no doubt, of the greatest elevation, for the greatest cold was produced then; and if I am right in assuming that cold was produced by the elevation of the land then it would be at the time of the highest elevation. The results of the Great Ice Age, both in Europe and other countries, are so remarkable that the lapse of time must have been very great, probably quite sufficient to enable the rivers to cut down their channels to the base of the declivity. Then General McMahan says, “Why are not the channels filled up?” I am sorry to say that to a great extent they are filled up by silt spread over the floor. If it were not for that, I believe every one of these river valleys could be traced from its present *embouchure* to its emergence on the floor of the abyssal ocean.

Perhaps I may be allowed to read an interesting note from Dr. Nansen. I sent him a report of my lecture on this subject which appears in the *Geographical Journal*, and he says, “Dear Prof. Hull, accept my most hearty thanks for your kindness in sending me your interesting paper on the sub-oceanic terraces and river valleys off the coast of Western Europe, which I have read carefully, and appreciate very much. Yours very sincerely, (Signed) NANSEN, April, 1899.”

The Meeting then terminated.

REMARKS ON THE FOREGOING PAPER.

Professor T. MCK. HUGHES, F.R.S., writes:—

I wish I could be with you on Monday to take part in the discussion upon my friend Professor Hull's paper. I am very glad to see that he is carrying on his researches into the great movements of the crust of the earth which, as I believe, are the chief cause of climatal change, and the principal factors in all our calculations as to the time required to build up the visible crust of the earth, and also for all our speculations as to the succession of events throughout geologic time in any area. I should like to ask the author one question, and that is whether he thinks there is sufficient evidence to refer the movements to any system in respect of surface direction and whether there is any reason to believe that the surface direction has been distinctly different or approximately the same in successive periods after a reversal of the vertical direction of movement.*

I am especially interested in the bearing of the results recorded by Professor Hull upon the question of the causes of locally recurring Ice ages, which I would refer almost entirely to geographical and not to astronomical causes.

Il Cavaliere W. P. JERVIS, F.G.S., Keeper of the Royal Italian Industrial Museum at Turin, writes:—

This second paper by Professor Hull presents like interest to his former one. Both alike open up the way to a vast field of research in geology (and as the basis of great future discoveries therein), physical geography, and in relation to the distribution of land and marine fauna of Upper Tertiary and recent times. Such is the multitude of deductions to be drawn from the subject that there is no lack of matter for the cautious study of many different minds. The real fear is that any should be carried away to form rash generalizations, which are the sunken rocks against which too many strike now-a-days, in their precipitate deductions in similar recondite subjects.

Lest I myself should transgress this precaution I submit a few somewhat bold considerations, in the hope that they may be

* I fear that I do not see my way to answer Professor Hughes's question without more consideration than I could give at this moment.—
E. H.

examined by the members of the Victoria Institute, to see whether they can bear scrutiny, for I consider that they all relate to the subject of the paper.

Characteristics of the Upper Tertiary coast-line of Western Europe.— It is essential to place before one the sheets of the Topographical Atlas of France and the large scale charts of the Atlantic sea-board, including the latter relating to the coast southward to Cape St. Vincent; also the best maps of the north of Spain and the west of Portugal. By the aid of such documents we find that the tract of ocean lying within the bathometrical curve of 200 fathoms pretty well indicates the probable former existence of mere hills, which, previous to their denudation, appear to have been analogous to those still emerged, and like them, of Tertiary origin, along the west coast of France. Within the whole area of the Continental Platform the west coast of France is fringed by a gently sloping sea-bed to the very upper margin of the Grand Declivity. The prolonged action of the currents and waves has here planed away all the pre-existing eminences, filling up all the valleys, with the exception of some traces of those of the principal rivers.

Along the Spanish coast the bathometrical curve of 200 fathoms in the Bay of Biscay, precisely as we might have anticipated, approaches very near to the shore, skirting, as it does, the Cantabrian mountains. The important gaps and indents in the direction of the old coast-line are exactly what are met with in steep mountainous regions, whose base is washed by the sea, and the flanks of which are furrowed by short impetuous torrents.

At the period of greatest emersion the Cantabrian mountains must have been a most important chain, and from the fact of their being but a prolongation of the Pyrenees, and lying in the same axis with them, we might be authorised to consider them as having all belonged to the Pyrenees.

Professor Hull, having described the great European Continental Declivity, all along the eastern shores of the Atlantic, from Rockall to Cape St. Vincent, and summarised the researches of American geologists, who have shown the existence of two escarpments along the western shores of the North Atlantic, from the Gulf of Mexico northwards, all along the sea-board of the United States, it seems quite permissible to infer that *the whole bed of the ocean* included between those shores must have participated in *like manner* in the subsidence. In those days the greatest depth of the North Atlantic Ocean must rarely have exceeded 2,000 fathoms.

There is a most interesting collateral illustration to corroborate the statement that during a period of emergence, the surface of the ocean washed the base of the Great Declivity. Thus, the present course of the Jordan lies below the actual level of the Red Sea. Even the lake of Galilee lies 653 feet below the sea level, and the Jordan, on entering the Dead Sea, which is 1,292 feet below the level of the Mediterranean, finds no outlet. But there is sufficient indication in the line of valleys extending southward, bounded by the precipitous rocks of Mount Seir, that at one time the Jordan discharged itself into the Red Sea, south of Mount Sinai, its former cañon (I use the word cañon, in deference to the author; but greatly object to a superfluous foreign name), now submarine, constituting the Gulf of Akaba. Geologically speaking, I should consider this to be the submerged estuary of the Jordan.

The North Atlantic Ocean cannot be classed among the volcanic regions of the globe, nor does it appear that the *uniform submersion* of its coasts has the very remotest connection with volcanic phenomena. On the other hand, the existence of the magnificent gorge or cañon, along the lower course of the Tagus, now submarine, seems to be confirmed by the fact that, during the earthquake of Lisbon, in 1755, the lower part of the city and quays, forming the frontage of the river, were engulfed in a moment, and that no traces of them were ever found since then. They seem to have been precipitated to the bottom of the cañon. Indeed to such instantaneous circumstance—if accepted as justifiable—I would attribute the telluric commotion which, if not the immediate cause of the Lisbon earthquake, certainly would have imparted to it that intensity which gives it a terrific and tragic precedence over all the earthquakes which have devastated Europe. Full well do I anticipate that I am facing the jeers of hosts of believers in far different causes for the Lisbon earthquake, but Professor Hull has proved to a nicety, that the existence of the great cañon of the Tagus defies contradiction, and perhaps my explanation may be considered as true by many.

Most remarkable is the uniform existence of a steep submarine escarpment, some 1,500 miles long, and of about 800 fathoms in depth, which feature is quite unknown in the northern hemisphere, as far as regards emerged ground. Of course the reader could *never suppose that Professor Hull intended to show that it presented that gentle and regularly curved outline which is somewhat diagrammatically shown even in the most accurate charts*, for the excellent reason that soundings of upwards of 200 fathoms

are evidently taken at relatively distant intervals, such being amply sufficient for all practical purposes. Were the same minuteness of detail to be expended in mapping the Great Declivity as is needed for topographical surveys, based on contour lines, we should doubtless learn that the ancient, now submerged, coast-line also presented a well marked curvilinear irregular outline similar to such as those with which we are familiar.

It is not easy to assign, or understand, the determining cause of this great change of level of the North Atlantic Ocean, but it is quite illogical to suppose that such cause, of whatever nature it might have been, should have acted in the same direction all over the globe.

We might attribute the change to the *submergence* of a vast region of the Northern Hemisphere. If so, as I should conceive to be plausible, it is reasonable to conceive the simultaneous *emergence* elsewhere of a region of somewhat comparable extent—probably in the Southern Hemisphere. This problem may be elucidated during the course of next century, especially during the Antarctic polar expeditions.

We might also conceive that in consequence of a regular, slow, progressive change in the axis of rotation of our globe—were that theory to be admitted as tenable—the region under consideration was once situated nearer the then tropical zone, and far nearer the former equator than at present. Need I remind the members that the equatorial diameter of the globe, or any other diameter supposed to be drawn within the tropics, greatly exceeds in length any drawn in higher latitudes, and that it is about 20 miles in excess of the axis of rotation, that is to say the polar diameter?

As a *general rule* the most lofty mountains in the world are situated between the equator and 36° , lesser eminences are met with as high as 43° ; Mont Blanc is 46° . This I attribute to centrifugal force. If so, similar results would have been produced in correlation to the axis of rotation, whatever it might have been at the given period. A submergence of 1,000 fathoms having been established as a certainty, it only remains to add that the great regularity of the submerged tract bespeaks the absolutely logical conclusion that it must been the *result of an enormously long, slow action, excluding all notion of paroxysms or other disturbances.*

NOTE.

A valued member, Mr. H. P. Malet, contests the idea of the upheaval of the earth's surface, and quotes, as expressing his views, Dr. J. W. Gregory's statement that "the plan of the earth may be attributed to the continual foundering of the earth's external shell owing to the unceasing shrinkages of its internal mass." Yet, as Professor Hull points out, in reply, no one has expounded more clearly than Sir C. Lyell, that the contraction of the crust—due to internal "shrinkage"—necessarily gives rise to upheaval of the crust at various places. Perhaps Mr. Malet will permit some remarks on this subject, kindly contributed by him, to be considered in the coming session.—ED.