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SEPTEMBER, 1914

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The Open Court

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the
Extension of the Religious Parliament Idea

Founded by EDWARD C. HEGELER.



ANCIENT GREEK BOAT SHOWING AN EYE ON THE PROW.
(See pages 549-550.)

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ISIS

REVUE CONSACREE A L'HISTOIRE ET
A L'ORGANISATION DE LA SCIENCE,
PUBLIEE PAR GEORGE SARTON

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JOHN NAPIER OF MERCHISTON.

Frontispiece to The Open Court.

THE OPEN COURT

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and
the Extension of the Religious Parliament Idea.

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JOHN NAPIER AND THE TERCENTENARY OF THE INVENTION OF LOGARITHMS.

BY PHILIP E. B. JOURDAIN.

THREE hundred years ago—in 1614—was published at Edinburgh John Napier's "Description of the Wonderful Canon of Logarithms": *Mirifici Logarithmorum Canonis Descriptio, ejusque usus in utraque Trigonometria; ut etiam in omni Logistica Mathematica, amplissimi, facillimi, et expeditissimi explicatio*. Napier was described on the title-page as "Authore ac Inventore, Joanne Nepero, Barone Merchistonii, etc. Scoto"; and this has given rise to the notions, which are met more particularly in French books, that Napier was that kind of peer known as a "Baron," and that his name should be spelt "Neper." However, John Napier was not a member of the peerage: he was a Scotch "laird"—an unofficial title which corresponds to the English "lord of the manor"—of an ancient and respected family. His eldest son Archibald was the first Lord Napier properly speaking, for Archibald was raised to the peerage in 1627.

With regard to the name, it seems that "Alexander Napare," the first of Merchiston, acquired that estate before the year 1438 from James I, was provost of Edinburgh in 1437, and was otherwise distinguished in that reign. His eldest son, also Alexander, became in his father's lifetime comptroller to James II, and "ran a splendid career under successive monarchs." The origin of these ancestors of John Napier is very uncertain. In the thirteenth and fourteenth centuries, persons of the name of Napier were not uncommon. The Merchiston family cherished a tradition that their name was changed from Lennox to Napier by command of a king of the Scots who

wished to do honor to one of their ancestors, Donald, a son of an Earl of Lennox. This Donald, it is said, had turned the tide of battle when flowing strongly against the king, and had fought so valiantly that the king declared before all the troops that he had "Na Peer." The name is probably of a more domestic origin, and commemorates virtues that are not usually associated with a warrior. On one occasion, John Napier was described, quite seriously it would seem, as "un Gentilhomme Ecassais nomm e Nonpareil"; and one of the commendatory odes prefixed to the *Canon Mirificus* of 1614 ends with the lines:

"Nomine sic Nepar Parili fit et omine Non Par,
Quum non hac habeat Nepar in arte Parem."

It is perhaps of more importance that we do not know the correct spelling of Napier's name, since many forms of the word are found, such as Napeir, Nepair, Nepeir, Napare, Naper, Naipper. It seems that John Napier usually signed his name as "Jhone Neper" or "Jhone Nepair." The form now adopted by the family is comparatively modern.

John Napier was born at Merchiston Castle, near Edinburgh, in 1550, the year in which the Reformation in Scotland may be said to have begun. His father, Sir Archibald Napier, must have been not more than sixteen when he was born. In 1563, John Napier matriculated at St. Salvator's College, St. Andrews, and though his residence there seems to have been comparatively short, the influence of it on his future life was of the most far-reaching character. It was then that he received an impetus to theological studies that formed throughout his life quite as great an attraction as mathematics in any of its branches. He himself tells the story in the address "To the Godly and Christian Reader" prefixed to his first publication *A Plaine Discovery of the Whole Revelation of Saint John*. In that address is the following passage: "Although I have but of late attempted to write this so high a work, for preventing the apparent danger of Papistry arising within this Island; yet in truth it is no few yeers since first I began to pre-cogitate the same: for in my tender yeers and barneage at Saint Androes at the Schools, having on the one part contracted a loving familiarity with a certain Gentleman, etc., a Papist; and on the other part being attentive to the Sermons of that worthy man of God, Master Christopher Goodman, teaching upon the Apocalypse, I was so moved in admiration against the blindness of Papists, that could not most evidently see their seven-hilled-city Rome,

painted out there so lively by Saint John, as the maker of all Spiritual Whoredom, that not only burst I out in continuall reasoning against my said familiar, but also from henceforth I determined with myself (by the assistance of God's spirit) to employ my studie and diligence to search out the remanent mysteries of that holy Book; as to this hour (praised be the Lord) I have been doing, at all such times as I might have occasion."

Napier has been instanced by Mach as one of those who believed that philosophy and science must be founded on theology. "Napier," says Mach,¹ "applied himself to some extremely curious speculations. He wrote an exegetical commentary on the Book of Revelation, with propositions and mathematical demonstrations. Proposition XXVI, for example, maintains that the pope is the Antichrist; proposition XXXVI declares that the locusts are the Turks and Mohammedans; and so forth."

Various references in Napier's mathematical works can only be explained on the assumption that he could not divert his attention from theological studies sufficiently long to enable him to carry out cherished mathematical investigations. Whatever we may think of the ascendancy that James VI acquired over the church in Scotland, Professor Gibson² is inclined to believe that it was James's victory over the Presbyterian party, to which Napier belonged, that compelled Napier to withdraw from the ecclesiastical field and devote himself to his mathematical studies.

A second edition of the *Plaine Discovery*, revised and enlarged, was published in 1611, and the book continued to be republished for several years. It was also translated into many foreign languages.

There were traditions that Napier was in league with the devil, and these traditions might be met with about Edinburgh up to within not very many years ago. Among these traditions is one of a jet-black cock which was his constant companion, and was supposed to be a familiar spirit bound to him in that shape. Mark Napier, in his *Memoirs of John Napier of Merchiston, his Lineage, Life, and Times, with a History of the Invention of Logarithms*, which was published at Edinburgh and London in 1834, took the story of the cock so seriously that he tried to rationalize the tradi-

¹ *The Science of Mechanics*, 3d ed., Chicago and London: The Open Court Publishing Co., 1907, p. 447.

² George A. Gibson, "Napier and the Invention of Logarithms," *Proc. Roy. Phil. Soc. of Glasgow*, 1914, p. 8. To this paper (pp. 3-24), and to the biography, by Dr. J. W. L. Glaisher, of Napier in the *Encyclopædia Britannica* (11th ed. Vol. XIX, pp. 171-175) this article is very largely indebted.

tion by suggesting that Napier played upon the belief in his witchcraft to frighten his servants into confession of misdemeanors.

From the parish of Killearn come other traditions. Adjoining the mill of Gartness are the remains of an old house in which John Napier resided a great part of his time when he was making his calculations. It is reported that the constant noise of the cascade never gave him uneasiness, but that the clack of the mill, which was only occasional, greatly disturbed his thoughts. Therefore, when in deep study, he was sometimes under the necessity of desiring the miller to stop the mill that the train of his ideas might not be interrupted. He used frequently to walk out in his nightgown and cap. This, with some things which to the vulgar appeared rather odd, fixed on him the character of a "warlock." There is evidence that even Napier himself, like other eminent men of that time, was not free from a belief in magic.

After the publication of the *Plaine Discovery*, Napier seems to have occupied himself with the invention of secret instruments of war. These consisted of (1) a mirror for burning the enemies' ships at any distance, (2) a piece of artillery destroying everything round an arc of a circle, and (3) a round metal chariot so constructed that its occupants could move it rapidly and easily, while firing out through small holes in it. Besides this, Napier as the owner of large estates turned his attention to the improvement of agriculture.

But Napier's chief claim to remembrance is the invention of logarithms. It is a remarkable thing that, with one possible exception, there has been no rival claimant to the discovery of logarithms. Let us first consider the few hints that mathematicians had given before Napier's time.

A Frenchman, Nicolas Chuquet, in his work *Le Triparty en la science des nombres* of 1484, seems to have been the first to consider an arithmetical progression 1, 2, 3, 4, and so on, side by side with a geometrical progression which we would now write a , a^2 , a^3 , a^4 , and so on; and to remark that the product of any two numbers of the geometrical progression is a term of the same progression, whose rank is the sum of the ranks of the two factors.³ The same idea also appeared with the German "cossists" and with Michael Stifel in 1544.⁴

The exception referred to above is Joost or Jobst Bürgi (1552-

³ M. Cantor, *Vorlesungen über Geschichte der Mathematik*, Vol. II, 2d ed., Leipsic, 1900, pp. 350-351.

⁴ *Ibid.*, pp. 397, 403, 431-432. Cf. p. 635.

1632 or 1633), an ingenious watchmaker and mechanic. But Napier's *Canon mirificus* was published six years before Bürgi's *Progress Tabulen*; Bürgi's tables are very imperfect compared with Napier's; and there is, according to Gibson, every reason for believing that Napier had formed his conception of logarithms and begun their calculation quite as early as Bürgi—probably much earlier. Moritz Cantor,⁵ however, states that Bürgi's work was probably earlier than Napier's. Still Bürgi's work has not had the slightest influence, so far as can be traced; either on the theoretical or on the practical development of the theory of logarithms.

The *Canon* contains fifty-seven pages of explanatory matter and ninety pages of tables. An English translation of the first part was made by Edward Wright and published in 1616. Napier's treatment is based on the comparison of the velocities of two moving points. Suppose one point P to set out from the point A and to move along the line AX with a uniform velocity V ; then suppose another point Q to set out from B on the line BY , of given length r , at the same time that P sets out from A and also with the velocity V , but to move, not uniformly, but so that its velocity at any point (D) is proportional to the distance DY from the end of the line BY . If, now, C is the point that P has reached when Q , moving in the way described, has reached D , then the number which measures AC is the "logarithm" of the number which measures DY .

Let us try to form some notion of the way in which Napier was led to the invention of these logarithms. Throughout all his life he was more or less busied with devices for making multiplications, divisions, and extractions of the square and cube roots of great numbers capable of being carried out more quickly and easily. One of the first results which he obtained was a method by which the numbers that were to be multiplied, divided, or to have their roots extracted, are replaced by other numbers called "artificial numbers" by means of which all that the numbers first mentioned can do is done far more easily. To replace the name "artificial number" Napier afterwards invented the name "logarithm," which is derived from two Greek words meaning "ratio" and "number." Indeed, he used the idea we have touched upon of the comparison of an arithmetical progression with a geometrical progression. Other more or less well-known devices for shortening calculations were published by Napier in 1617.

It is necessary to emphasize the fact that the invention of

⁵ *Ibid.*, pp. 725-729.

logarithms was made long before the theory of indices began to grow up. It is not a very difficult deduction from this theory, which began with the introduction of our present very convenient notation for indices. At the present time, we say that, if a , x , and m are three numbers such as $a^x = m$, then we call a the "base" and x the "logarithm of m to the base a ", $x = \log_a m$. From this we see at once that the logarithm of the product of numbers is equal to the sum of the logarithms of those numbers, the logarithm of the quotient of two numbers is equal to the logarithm of the numerator diminished by the logarithm of the denominator, the logarithm of a power of a number is equal to the logarithm of that number multiplied by the index, and the logarithm of the n th root of a number is equal to the logarithm of that number divided by n .

However, Napier himself made no explicit use of a base. What is now called the "Napierian base" is the incommensurable number e , but Napier at first implicitly used $1/e$ as base. Bürgi's base was e . The idea of integral indices was only beginning to be known in Napier's day, while those of fractional and negative indices were quite unknown then and for long after.

Napier had the needs of trigonometry primarily in view, and he usually spoke of BY (or r) as the "whole sine" and DY as a "sine." It must be remembered that at that time a sine was a line and not a ratio, as it is with us. In the table which formed the second part of Napier's book, the logarithm of sines and tangents of all angles from 0° to 90° , at intervals of one minute, were given.

Returning to the consideration of Napier's moving points; when Q is at B , the point P is at A , so that the logarithm of the whole sine BY is zero. The logarithms of numbers greater than the whole sine are negative.

Napier then found the rule that, if a is to b as c is to d , then

$$\log a - \log b = \log c - \log d,$$

and hence he easily obtained all the rules required for ordinary calculations.⁶

It used to be a general opinion that there was a "metaphysical objection to the introduction of ideas of motion into geometry." This opinion seems to me to leave out of account the profound logical objections to the conception of motion which were first formulated by Zeno the Eleatic about five hundred years before our era began, and to which no satisfactory answer has been—or indeed

⁶ On Napier's logarithmic work, see also M. Cantor, *op. cit.*, Vol. II, pp. 730-737.

could be—given until within the last thirty-five years. It is certainly worthy of particular remark that the notion of flowing quantities was expressed very clearly indeed in Napier's *Canon*, and Colin Maclaurin⁷ remarked that "the nature and genesis of logarithms is proposed by the inventor in a method similar to that which is applied in this doctrine[fluxions] for explaining the genesis of quantities of all sorts, and is described by him almost in the same terms."

Henry Briggs (1556-1630), reader of geometry at Gresham College, London, and later Savilian professor of geometry at Oxford, welcomed Napier's book with great enthusiasm. In 1615 he wrote to Archbishop Usher: "Napper, lord of Markinston, hath set my head and hands awork with his new and admirable logarithms. I hope to see him this summer, if it please God, for I never saw book which please me better, or made me more wonder." Briggs visited Napier in 1615 and stayed with him a whole month. Indeed, Briggs, we read, was so moved that he could not rest until he had seen the inventor of logarithms. When Briggs actually saw Napier, each, it is reported, beheld the other with admiration and without a word being spoken. At last Briggs said: "My Lord, I have undertaken this long journey purposely to see your person, and to know by what engine of wit or ingenuity you came first to think of this most excellent help unto astronomy, viz., the logarithms; but, my Lord, being by you found out, I wonder nobody else found it out before, when, now being known, it appears to easy."

At this visit, Napier and Briggs discussed certain changes in the system of logarithms. In a letter to Napier before the visit, Briggs had suggested that it would be more convenient, while the logarithm of the whole sine was still taken as zero, to take the logarithm of the tenth part of the sine as a power of 10, and he had actually begun the calculation of tables on his proposed system. Napier agreed that a change was desirable, and stated that he had formerly wished to make a change; but that he had preferred to publish the tables already prepared, as he could not, on account of ill health and for other reasons, undertake the construction of new tables. He proposed, however, a somewhat different system from that suggested by Briggs, namely that zero should be the logarithm, not of the whole sine but of unity, while, as Briggs suggested, the logarithm of the tenth part of the sine should be a power of 10. Briggs at once admitted that Napier's method was decidedly the

⁷ *Treatise of Fluxions*, Vol. I, p. 158. On Napier's idea of flowing quantities, cf. M. Cantor, *op. cit.*, Vol. II, p. 849.

better, and he set about the calculation of tables on the new system, which is essentially the system of logarithms now in use.

In 1616, Briggs again visited Napier and showed him what he had done, and would have paid him a third visit in 1617, had Napier's life been spared. In 1617 Briggs published a small book giving the logarithms of all numbers from 1 to 1000 calculated to 14 places of decimals; and these tables were very greatly extended in his *Arithmetica logarithmica* of 1624. A gap in these tables was filled up by the work of Adrian Vlacq published in 1628. Edmund Gunter published a table of some Briggian or common logarithms of trigonometrical functions in 1620. More extensive tables were published later by Vlacq and Briggs,⁸ and, from that time, mathematical tables began to be very plentiful.

Napier's account of the construction of his tables of 1614 was published posthumously by his son Robert in 1619, though it seems to have been written many years before 1614.

It is pleasant to reflect that charges which have been brought against Napier of jealousy of Briggs are unfounded. Both Napier and Briggs were united by a very warm friendship for each other. Other unfounded reports are that Napier's devotion to mathematics was due to old age and the gout, and that his mathematical pursuits led him to dissipate his means.

Besides the invention of logarithms and other methods for shortening calculations, to Napier are due certain rules in spherical trigonometry and the technically important introduction of the decimal point in arithmetic.

The portrait of John Napier that is reproduced as a frontispiece to this number is from a steel engraving prefixed to Mark Napier's *Memoirs of John Napier*. This engraving is a partial copy of an authentic portrait of Napier which belongs to the College of Edinburgh. It was presented by Margaret, Baroness Napier in her own right, and there is no doubt of its genuineness. It bears the shield of arms and the initials of Napier with a date 1616 and his age. The name of the painter is unknown.

⁸ On the logarithmic work of Briggs and others, see Cantor, *op. cit.*, pp. 738-748.

GOETHE AND SCHOPENHAUER ON MATHEMATICS.

BY ARNOLD EMCH.

IS it a mere accidental coincidence that Goethe and Schopenhauer in some of their writings should both express themselves more or less adversely towards mathematics and mathematical methods in the study of natural phenomena?

The fact that Schopenhauer in 1813, when twenty-five years of age, went to Weimar and became acquainted with Goethe, under whose powerful influence he wrote a memoir *Ueber Sehen und die Farben* (published in 1816), would warrant the conclusion that their opinions on various scientific topics were a result of rather penetrating mutual discussions.

It is a proof for the universality of their intellects that they dared to enter into a discussion on the merits of a science of which both had only a very rudimentary knowledge. There is a kernel of truth in some of their statements, while others are dilettantic and still others erroneous or at least warped.

As is well known, Goethe was deeply interested in problems of natural philosophy during his later life, and his fundamental discoveries justly entitle him to be classed as a pioneer of Darwinism. That Goethe was fully aware of his handicap in attacking certain scientific problems appears from the following extract from "Mathematics and its Abuse"¹: "Considering my inclinations and conditions I had to appropriate to myself very early the right to investigate, to conceive nature in her simplest, most hidden origins as well as in her most revealed, most conspicuous creations also without the aid of mathematics. . . . I was accused of being an opponent, an enemy of mathematics in general, although nobody can appreciate it more highly than I, as it accomplishes exactly those things which I was prevented from realizing."

¹ *Naturwissenschaftliche Schriften*, 2d part, Vol. II, p. 78, Weimar, 1893.

Further on, however, when the thought turns again upon mathematics and mathematicians, we find this curious statement:² "It is a wrong conception to think that a phenomenon could be explained by calculus or words" and "mathematicians are like Frenchmen; if one speaks to them they translate it into their own language, and then it will be very soon something entirely different." On page 138 when writing about natural science in general, Goethe expresses his idea of the mathematician as he ought to be in the following striking manner: "The mathematician is perfect only in so far as he is a perfect man, as he feels the beauty of truth; only then does he become thorough, penetrating, pure, clear, graceful and even elegant. All this is necessary to become like Lagrange."

What particular individual he had in mind when he wrote: "There are pedants who are at the same time thieves, and these are by far the worst," is not revealed. It is a partial consolation for the modern scientists, however, to find that Goethe already had to contend with such types.

It is extremely interesting that Goethe should quote d'Alembert as an authority on mathematics. We see here the influence of the encyclopedists upon European thought of that great period. There probably never lived a more brilliant and influential circle of philosophers and scientists that shaped the destiny of nations. Diderot and d'Alembert as co-editors of the great *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers*, Helvetius in his famous work *De l'esprit*, Voltaire by his piercing satire and Rousseau by his educational philosophy, La Mettrie as the author of *L'homme machine*³ and Holbach in his *Système de la nature*, were all teaching that a new time had arrived.

With the exception of Kant, the great intellectual giant at Königsberg, Germany had during that whole period no philosophers and scientists of her own to boast of. From 1741 to 1766 it was the Swiss Euler and from 1766 to 1787 Lagrange, who gave lustre to the Academy at Berlin. Others, like the poet-scientist Haller, as appears from the dedication⁴ of *L'homme machine*, were intellectually not even a match with such men as La Mettrie. Towards the end of the eighteenth and the beginning of the nineteenth century Gauss began his epoch-making discoveries and thereby placed Gêr-

² *Loc. cit.* p. 98.

³ English translation by Gertrude C. Bussey, published by the Open Court Publishing Co.

⁴ This is not included in the above-mentioned English edition, but may be found in *The Open Court* of July, 1913, p. 427.

many in mathematics on a level with France, where men like d'Alembert, Lagrange, Monge, Laplace, Legendre and Fourier had won international reputation.

Gauss, however, never published anything for a general scientific public on his early meditations on the nature of mathematical reasoning and in particular on what we call now non-Euclidean geometry, so that naturally Goethe, even in his old age, was not able to learn anything about the new views in the science of space.

The passage of d'Alembert to which Goethe refers may be found in the famous *Discours préliminaire de l'encyclopédie*:⁵

"As regards mathematical sciences, which constitute the second of the limits of which we have spoken, their nature and their number must not startle us. What are most of the axioms of which geometry is so proud, if not the expression of the same simple idea by two different signs or words? The man who says that *two times two is four*, does he know more than somebody that contents himself by saying *two times two is two times two*? The ideas of the whole, the part, of greater and less, properly speaking, are they not the same simple and individual idea; since one cannot have one of them without the others presenting themselves all at the same time? As some philosophers have observed we owe many errors to the abuse of words; it is perhaps to the same abuse that we owe the axioms."

This is as far as Goethe quotes, so that without the rest of d'Alembert's argument one might look upon the latter as a rather one-sided critic. From d'Alembert's achievements as a mathematician and those portions of his *Discours* that treat of the various divisions of mathematics it is plain what great intrinsic value he placed upon mathematics and the mathematical spirit in scientific investigations in general. When he speaks of the abuse of words he simply states those truths which later his famous compatriot Poincaré, on various occasions, advanced against some claims of the modern logisticians.

Concerning logic d'Alembert has the following to say:⁶ "It is the reduction to an art of the manner in which knowledge is gained and in which we communicate reciprocally our own thoughts to each other. It teaches to arrange ideas in the most natural order and to link them by the most direct chain of thoughts, to resolve those that contain too large a number of simpler ideas, to look at them from all sides, in order to present them to others in a form

⁵ *Œuvres de D'Alembert*, Vol. I, pp. 30-32, Paris 1821.

⁶ *Loc. cit.*, pp. 33-34.

in which they can be easily grasped. It is in this that this science of reasoning consists and which is justly considered as the key to all our knowledge. One must not believe, however, that it occupies the first place in the realm of invention. The art of reasoning is a gift presented by nature of her own accord to good intellects (*bons esprits*); and it may be said that the books which treat of logic are hardly of any use except to those who can get along without them.⁷ Those that are familiar with Poincaré's style might easily mistake the last humorous remark as one of his famous sallies.

In this connection it is interesting to see what a modern writer, Mr. H. C. Brown, thinks about "the problem of method in mathematics and philosophy." He writes:⁸ "The fact which seems to have been neglected by mathematicians is that the proof of consistency, by demanding an exhibition of something already known, puts a check on the "free creation" theory of mathematical systems and places them logically on a level with the concepts of all other sciences which all aim at hypothetico-deductive procedure.—A merely deductive mathematics would be of as little value as a 'freely created' philosophy.—All sciences must turn upon some existence, and a science which turns to a merely imagined world is dream-play."

D'Alembert returns with great detail to a discussion of the principles of the various branches of human knowledge and of scientific methods in his *Essai sur les élémens de philosophie*.⁹ For the mathematicians and philosophers that make a study of the foundations of science, chapters fourteen to twenty are of particular interest. On pp. 278-280, for instance, we find a very clever discussion of the difficulties that arise in connection with the parallel-axiom. The "Elements" were published in 1759, at a time when hardly anybody thought of a critical examination of Euclid's Elements.¹⁰

Schopenhauer's remarks on mathematical questions were on the whole less personal than Goethe's. From his principal work *Die Welt als Wille und Vorstellung*,¹¹ whose first volume appeared in 1819 (a second edition increased by a second volume did not appear till 1844) we translate the following lines on Euclid's method:

⁷ See a recent article by J. Charpentier: "Diderot et la science de son temps," in *La Revue du Mois*, Vol. 8, pp. 537-552 (Nov. 1913).

⁸ *Essays Philosophical and Psychological*, p. 427.

⁹ *Loc. cit.*, pp. 115-348.

¹⁰ *La geometria del compasso* by Mascheroni appeared in 1797 in Pavia.

¹¹ *Werke*, Vol. I, p. 75 (Leipsic, F. A. Brockhaus, 1901).

“It is true in mathematics, according to Euclid’s treatment, that the axioms are the only undemonstrable premises, and all demonstrations are successively subordinated to them. This treatment, however, is not essential, and, indeed, every theorem begins with a new construction in space which in itself is independent of the preceding ones and which in reality can be recognized also in entire independence of them, in itself, by pure intuition of space, in which in reality also the most complicated construction is immediately as evident as the axiom itself.”

This remarkable statement interpreted by an inventive geometrician or intuitionist of the present day would of course not stand serious criticism. How, for instance, should Steiner’s famous solution of Malfatti’s problem to construct three circles each tangent to the other two and to two sides of the triangle, or the Steinerian problem of closure in connection with cubics and quartics be obvious even to the most acute geometrician? From a more general standpoint the only reasonable meaning which may be placed on Schopenhauer’s idea is that an intrinsic geometric truth is independent of any particular set of axioms.

Schopenhauer denies the creative power of logistic geometry when he says “that intuition is the first source of evidence and that the immediate and intermediate relations derived from it are the only absolute truth, furthermore that the shortest path to truth is always the surest and that the transmission through concepts is subject to many illusions. . . . We demand the reduction of every logical proof to one of an intuitional nature; Euclid’s mathematics, however, makes great efforts to cast off wantonly its intuitional evidence everywhere near at hand, in order to substitute in place of it a logical proof. We must find that this is as if somebody would cut his legs off in order to go on crutches. . . . That what Euclid proves is true we have to acknowledge through the principle of contradiction; but we do not learn the reason why it is true. We experience therefore almost the same unpleasant sensation that is caused by a sleight-of-hand performance, and, indeed, most of Euclid’s proofs singularly resemble such tricks. The truth almost always appears through the back door, since it results by accident from some minor condition. An apagogical proof often closes one door after another and leaves open only one through which to pass. According to our opinion, therefore, Euclid’s method in mathematics appears as a very brilliant perversity (*Verkehrtheit*).”

Schopenhauer maintains that the reason for the Euclidean system could be traced back to the prevailing philosophic system

of that time. The Eleatics were the first to discover the difference, and frequently the contradiction, between the things observed and the same things thought of. The sophists and skeptics drew attention to illusions, i. e., to the deception of the senses. It was recognized that intuition through the senses was not always reliable. For this reason they came to the conclusion that only logical reasoning could establish truth. Plato and Pyrrhon, on the other hand, showed by examples how definitions and conclusions in agreement with the laws of logic were likewise apt to mislead and to produce sophisms which were much more difficult to solve than deceptions of the senses. Rationalism in opposition to empiricism however became the dominant philosophy, and, according to Schopenhauer, it is under its influence that Euclid wrote his "Elements," in which he felt compelled to regard only the axioms as based upon intuitional evidence (*φανόμενον*) while the remainder follows from conclusions (*νοούμενον*). In a highly refined form the controversy which separated the Greeks is still present. As Carus¹² says: "In philosophy we have the old contrast between the empiricist and transcendentalist." Concerning the origin or the starting-point of mathematical system the same author remarks "that the data of mathematics are not without their premises; they are not, as the Germans say, *voraussetzungslos*, and though mathematics is built up from nothing, the mathematician does not start with nothing. He uses mental implements and it is they that give character to his science."¹³

Schopenhauer's conception of the domain that should be characteristic of mathematics is that the existence of a mathematical truth should be equivalent with the reason for it. It would of course be a tremendous advantage if this equivalence could always be established in the most simple manner by pure intuition, even when conceived in a higher sense. This method followed by the inventive mathematician as conceived by Poincaré is of a superior type and has presumably led to the greatest mathematical discoveries. The process of coordination with other branches and of rigorous analysis of the elements that constitute the truth is subsequently a problem of the mathematical logician. In a noted lecture¹⁴ on humanistic education and exact science Poincaré said:

¹² *The Foundations of Mathematics, a Contribution to the Philosophy of Geometry*, p. 36. Chicago, Open Court Publishing Co., 1908.

¹³ See also the valuable and clearly written article "De la méthode dans les sciences" by E. Picard in *De la science*, pp. 1-30, Paris, 1909.

¹⁴ Delivered at the annual session of the *Verein der Freunde des humanistischen Gymnasiums* in Vienna, May 22, 1912.

“Before he [the mathematician] demonstrates he must invent. But nobody has ever invented anything by pure deduction. Pure logic cannot create anything; there is only one way to discovery, namely induction; for the mathematician as well as for the physicist. Induction, however, presupposes the art of divination and the ability to select; we must be satisfied with intuition and not wait for certitude. To do this, however, requires a refined intellect (*esprit de finesse*). For this reason there are two kinds of mathematicians. There are some that possess the mathematical spirit only; they may be valuable laborers who pursue successfully the paths laid out for them. We need people of this kind, we need many of them. But beside these more common mathematicians there are some that possess the *esprit de finesse*, they are the truly creative intellects.”

It is true that the famous example for the evidence of the Pythagorean theorem shows the limited mathematical knowledge of Schopenhauer, or else he would have known that “evident” proofs of the general theorem are numerous. That Schopenhauer, in spite of some valuable critical remarks on mathematical methods did not understand the true meaning of Euclid’s method and much less the *raison d’être* of non-Euclidean geometry¹⁵ appears from the following characteristic passage:

“In the famous controversy over the theory of parallel lines and in the perennial attempts to prove the 11th axiom, the Euclidean method of demonstration has born from its own fold its most appropriate parody and caricature. . . . This scruple of consciousness reminds me of Schiller’s question of law:

‘Jahre lang schon bedien’ ich mich meiner Nase zum Riechen;
Hab ich denn wirklich an sie auch ein erweisliches Recht?’

[Years upon years I’ve been using my nose for the purpose of smelling.
Now I must question myself: Have I a right to its use?]¹⁶

“I am surprised that the eighth axiom: ‘Figures that can be made coincident are equal,’ should not be attacked. For, to coincide is either a mere tautology or else something of an entirely empirical

¹⁵ Lobatschewsky’s epoch-making work on parallels appeared between 1829 and 1840. (English translation by George Bruce Halsted under the title *Geometrical Researches on the Theory of Parallels*). *The Science Absolute of Space* by Bolyai, equally important, was published in 1826 (English translation by Dr. Halsted). *Die geometrischen Constructionen, ausgeführt mittels der geraden Linie und eines festen Kreises*, by Steiner, appeared in 1833.

¹⁶ See Carus, *Goethe and Schiller’s Xenions*.

character which does not belong to pure intuition. It presupposes movement of figures. In space, however, only matter is movable."

In *Parerga und Paralipomena*¹⁷ Schopenhauer, discussing optical questions, strikes a personal note when he writes: "On the polarization of light the Frenchmen have nothing but nonsensical theories on undulations and homogeneous light, besides computations which are not based upon anything. They are constantly in a haste to measure and to calculate; they consider this as the main thing, and their slogan is *le calcul! le calcul!* But I say, *Où le calcul commence, l'intelligence des phénomènes cesse*: he who has only numbers in his head cannot find the trace of the connective cause."

Here again we see that Schopenhauer, like Goethe, did not appreciate at all what the French mathematical physicists had done. But how, without hardly any mathematical knowledge, could they expect to understand the Frenchmen? Nothing could show better than the foregoing statement the scientific limitations of the otherwise towering intellect of Schopenhauer. Of the real difficulties that lie at the foundation of mathematics neither Goethe nor Schopenhauer had a true conception. They were not able to anticipate even a possibility of the tremendous progress that has since been made and had been made during Schopenhauer's lifetime.

But considered from a modern standpoint their often ill-tempered remarks appear as interesting flash-lights of a great historic period.

¹⁷ *Loc. cit.*, Vol. II, p. 128.

THE ADVENTURES OF AN x .

BY I. M. BROWN.

Chapter I.

TO think that I of all the five vowels and twenty-one consonants, should have been the one destined to meet with such adventures! I, who of all letters was the quietest and least desirous of attracting attention! I, to have been sent, into that bewildering land of puzzles, to become the jest and plaything of all men.

You will readily agree with this estimate of my own importance, if you will notice that I alone of all the letters have not yet taken part in these opening words, and only in this phrase will use be made of the last of the twenty-six.

The fact is that I was ruthlessly taken from my own beloved land of Letters, to travel as a stranger in the Country of Mathematics. I will tell you my experiences from the day of my arrival there.

I was greeted by an official guide and he at once asked me where my badge was.

"My badge?" echoed I, "I haven't any."

He turned to a desk at his side and opening a drawer pulled out two black and white badges, one like this $+$ and the other like this $-$. He said I must never go out of doors without one of these badges firmly pinned on in front, and the other one in my pocket ready for when I should need it. I said very stiffly that I was not in the habit of wearing any one's badge, and why should I put on his? He replied that if I did not wear a plus or minus sign I should only be allowed to travel in a very small part of the country, namely that ruled over by Queen Arithmetic, and I had been chosen to try to penetrate much further inland, into the territory of Algebra. He explained further that if possible one always wore the plus badge, for it stood for the nicer of the pairs, add and subtract,

up and down, right and left, receive and owe, pull and push, gain and loss, growing and shrinking. . . and so on.

He gave me a great many directions and much good advice, but I will skip all that and tell you what actually happened.

I fastened on my plus badge and went out to explore. I had gone but a very little way when, hand in hand, two letters like myself swooped down upon me shouting: "Here's another, come along and join hands with us; now our coefficient is three."

I was too bewildered to make any objection and too much out of breath from running with them to ask any questions. Presently one of them spied some more of our kind linked together. Off we went at once and joined them, all taking hands; one of the newcomers said: "Well, now our coefficient is eight." I had noticed that there were five in their group before we three joined it. I soon found that "coefficient" meant the number of letters there were. I think the word has something to do with one's efficiency or strength, just as we talk of the efficiency or strength of an army or of a man-of-war meaning the number of men there are.

Some one called out: "Hallo! there are two with minus badges, let's dodge them."

But we were not quick enough, so the two minus letters seized the last two of our line; all four were *hors de combat* for the rest of that day, and our coefficient was reduced to six.

It was not long before I learned to play this game quite well, so I walked farther into the country to find something new.

Chapter II.

In the next village I met a letter like myself, and he said: "Will you come and live with me?"

"Willingly," said I.

So he took me to a little square mat, where there was just room for us both to sit down. As we stepped on to this mat I noticed that my companion put away his badge and chalked up just outside: " $+x^2$."

"Put away your badge too," said he, "you don't need it when we're living together."

We talked a good deal, seated on our little mat, and consequently we did not notice another x wearing a minus badge approaching. Suddenly with a shout he jumped between us saying:

"I'm here now and you can't get rid of me; so up with the walls and hoist the minus badge."

Like magic the little square mat became a cube-shaped tent and outside hung the minus sign.

"Bad luck," whispered my friend to me, "keep your eye open now for some other x with a minus badge. We can't get on a bit until somehow we can change this wretched minus into a plus; and that we can only do by getting another minus to join us; for then if we put one minus horizontal and the other vertical we'll make a plus: two minuses always make a plus."

Sure enough, soon there came down the road a pair of letters carrying a mat like our first home except that " $-x^2$ " was written on it.

"Here, come here," we all shouted.

And once more our little cube-shaped tent was changed: but what the new shape was I *can't* remember. Then we arranged our minus and that of the newcomers cross-wise and were plus once more. And now our full title was " $+x^5$."

I stayed several days in this little village for I found it very confusing to be always changing the shape and sign of the house, and we had to do this every time any one went in or out.

But after a while it seemed a very simple arrangement and I thought the time had come for me to travel further.

Chapter III.

As I drew near the next village (it was called Simplesness) I noticed that all the inhabitants, numbers and letters alike, were out playing in the fields.

It was a kind of tug-of-war they played. There was a long rope and in it, sometimes in the middle and sometimes at one or other end, were fastened two little wooden rods called, as I found out, "equals."

Well, letters and numbers, higgledy-piggledy, seized hold of the rope: but as some pushed while others pulled, the rope got in a dreadful muddle. Then some one, the umpire I think, suggested that all the letters should go on one side of the little equal rods and all the numbers on the other; and any one who changed over had also to change his work, that is, if he had pulled he now pushed and *vice versa*.

But that didn't seem very much better; so they did as they had done in the first village I visited, they linked up all those with plus badges and then these paired off with the same number of minus ones: and the numbers did the same on their side. Until

at last there were only a few letters with one badge on one side pulling against some number on the other side. Lastly they tried to see what number one letter by himself could just balance. And that was the end of the game.

Chapter IV.

I enjoyed myself so much playing with the people in this village, Simpleness, that I stayed longer than was really necessary, for I had soon become a good player of their favorite game.

The fact is I'd overheard some of them talking about the life in Utility, the town that lay next in my route. And what they said made me nervous. However I was bound to travel that way, so it was no good delaying.

As I was starting forth, one of the villagers came running after me. "You'll be sure to get on all right," said he, "if you only manage to get into the service of one of the experts; whatever happens *avoid all very young employers.*"

I didn't quite know what he meant by "expert," but I thought that probably if I found an expert, he would be kind to me just because his name and mine were so alike.

Well, the streets of Utility were crowded with people who went about asking each other most complicated questions, such as:

"If a Father is three times as old as his son now, when will he be twice his age?" and "If a train had gone half a mile an hour quicker, it would have reached its destination an hour earlier; how fast did it travel?"

And any one who had made up one of these questions rushed out into the street and seized an x and insisted on his working for him.

It was quite easy work if you had a good master; he gave you very simple and straightforward directions, saying for example in a gambling question: "Suppose I lose $\text{£}x$ and then win $\text{£}2$; I find I have as much as I started with; how much did I lose?"

I thought at once how I should have arranged the letters and numbers in the village Simpleness and quickly answered " $\text{£}2$ "; and he was quite pleased.

But, oh dear, the next person who employed me was a girl of about fourteen years! She said vaguely: "Let x equal the weight, how much ought I to buy?" I asked in an injured tone: "But what is x ? is it pounds or ounces or grammes? and what are you going to buy? butter or cheese?"

She sighed and said: "I don't know, tons of coal, I think."

"Well," said I, "is this your order? Let x tons of coal be bought?"

"Yes, that's it; and if I had bought ten tons more I should have had twice as much. Isn't it a dreadfully hard question?"

"No," said I, " $x + 10 = 2x$, therefore $x = 10$."

"Goodness," said she, "it's the first one I've ever got a decent answer to!"

Chapter V.

Once more I set out on my lonely way.

As I approached the walls of a large city, I overtook another traveler, called y . He told me that the city we were nearing was called Together-ton, and he had heard rumors that no letter was allowed to start business by himself, it was necessary to have at least one partner. I was distressed at hearing this, for I knew no one there and I said so. He said he was in the same predicament and suggested that we should become partners. I gratefully agreed and we hired an office and called ourselves "The Simultaneous Solving Society."

We advertised that we would find values for any one who could produce two facts for us to work on. We charged our clients highly, for the work was very trying. In fact, in the first case that I undertook I fainted right away. You see the client came and said: " $3x + 2y = 13$ " and " $2x + 7y = 20$." Then he did something to both these statements, and when I looked round, y was no longer to be seen and my client told me that I was equal to three.

"But," said I, "what has become of my friend y ?"

"That's all right," said he, "now steady"; and he wrote down one of the facts again. Then I had a most dreadful feeling of substitution and knew no more until I heard my client saying: "Thank you, that's sufficient, $x = 3$ and $y = 2$."

It wasn't so bad the second time though, as I knew more or less what to expect.

Chapter VI.

After having made a great success of our Simultaneous Solving Society, I sold my share of the concern to another x ; for I had determined to take a course as a common mechanic in the workshops of the factories.

I felt this would be a wise step, since the next town in my route

was a huge manufacturing center, and I always think it is a very good thing to be able to *do* the work as well as direct it.

Now I found out why the factories are so called: it is because in all the shops the most important tool is one called a "factor." Really it is almost the only instrument the workman is allowed to use. Some of the clumsier men try to struggle in old-fashioned and cumbersome tools which their parents had used before them. But the inspectors are dreadfully angry when they discover that a job has been done with these tools; they say that it never has the same neat appearance as if the proper factors had been used.

After some days of hard work here, for they say that nothing but long practice will make one proficient, the master of the factory gave me a certificate of excellence, and I felt that I was well equipped for my coming sojourn in the town of Quadraticness.

Chapter VII.

The characteristic feature of Quadraticness is the type of the houses. There must always be accommodation for an x^2 , and x , and a number; and the best houses provide for the coefficients of the letters as well.

Each house has two doors, and these are kept shut and locked. When you want to come out you either unlock the door with your factors, or if that fails (sometimes the doors are very stiff) you use a combination lock. This is quite simple to use; but some people were always forgetting the combination and then they could neither let themselves out nor any one else in. The combination is an excellent one, and I never knew it to fail when it was properly used. Of course there were always some careless people who didn't work it steadily and accurately but kept making slips with it; but that was their fault, not the combination's.

Most houses had their doors clearly marked, either both in front, or both at the back, or one in the front and the other in the back. But there were some exceptional cases. Once I applied the combination, and the lock turned easily enough, but there was no real door, only a sham one! I hastily dropped the handle feeling that there were things uncanny behind the closed door and they were better left to the imagination.

Chapter VIII.

My next visit was to *Graphbury*, the large and growing suburb of Quadraticness.

Here everybody, without exception, was very keen on photography; and the houses were crammed with photographs of all descriptions.

I went to one of the best studios and arranged for my portrait to be taken.

First the photographer placed me in front of two perpendicular lines as background, telling me to think of any number. I came out a vertical line! I didn't order many copies!

On my next visit he proposed that I should be taken with my friend y ; it was a favorite pose he said and easy to do well. This time the photograph was a slanting line!

I told the man then, that I couldn't have any more such ridiculous results. I was quite sure none of these graphs (they used the latter half of the word for short) resembled me in the slightest.

So in the next we had a group and we came out a circle. The photographer seeing that I was better pleased this time showed me his price list of arranged groups, saying that if I would choose the style he would do his best to satisfy me.

The price list was as follows:

	<i>s</i>	<i>d</i>
Groups of two letters, using first and second degrees, parabola	1	0
Groups of two letters, using second degree in equal quantities, cir:	1	0
Groups of two letters, using first and second degrees, circle	2	0
ellipse	2	0
hyperbola	2	6
Groups of two letters, using higher degrees, various curves	3	6

I had been told to spare no expense on my tour, so I was taken in every possible group and sent a copy of each to my Headquarters.

Chapter IX.

My next stopping place was in a large mining district. I went to interview the manager of the mines, and he advised me to watch the work for some days without taking any actual part in it.

"There are," he said, "six laws which have to be strictly observed, and although they appear simple enough at first sight, there is generally great difficulty in getting them enforced. And"—here he shrugged his shoulders—"you know the dangers of mining if the laws are not kept."

So I arranged to come the next morning when the work was in full swing and watch the proceedings.

The lift had just gone down when I arrived, and I turned into the little waiting-room. Here on the walls was a large printed copy

of the six laws. I read them carefully, remarking to myself: "What a fuss about nothing! These laws are surely easy enough to enforce."

Then the lift came creaking up.

On my way down, I tried to recollect what the laws were; but I couldn't think of more than two or three, and I began to see that after all they were a little elusive. However on glancing round the lift I saw another copy of them; apparently they find it necessary to put them in every possible place.

When I arrived at the bottom, it seemed pitch dark and I could see nothing save a few brilliant specks of light moving about. But after a moment or two my eyes became accustomed to the gloom, and I was able to distinguish queer little figures, each one carrying a lighted lantern in his cap.

These miners, I must tell you, are a special class of people, surds by name. It takes one a long time to get accustomed to their ways, and even after a fairly long acquaintance one has to deal tactfully with them or they will make good their escape and hide in a most impossible and tangled root. For this is a craze of surds, to escape, and hide under the long branch of some root; for here their lantern becomes invisible and without this guide or index of their power, it is impossible to get any work done.

I must describe this lantern or, as they call it, their index. It is a small tube with an oval-shaped glass top and bottom; on this glass is painted + or -, and some lanterns are made up with the plus at the top and others with minus at the top. Each surd paints his own particular index number after the plus or minus at both ends of his lantern.

A gang, or, as the manager technically said, "an expression," was just being sent out.

First they all ran and hid under the roots which grew on all sides. When they were driven out of these, they had to range themselves on a long ladder, which was placed horizontally. I was watching from a raised gallery and I could read clearly in the top of each one's lantern his index-number.

There were some plus and a fair number of minus ones. The manager gave an order and all those with minus signs dropped like monkeys and hung by their arms on to the rungs of the ladder, and as they dropped, their lanterns turned upside down automatically; and now I saw they all showed plus indices.

"Rearrange," called the manager, and all surds of the same kind collected together and chose one of their number to represent

them all. This one then altered the index in his lantern and took his place either standing on or hanging from the ladder, whichever was necessary to show his plus sign. And all the others of his kind put a nought as their index. The manager explained to me that they were no longer the letters or numbers they had been but were just "ones," and as such made no difference to the product of the work.

Occasionally I noticed one could extract quite easily a surd from the root in which he was hidden, but that was only when the root was one very near the surface and not deep down in the mine. And sometimes, if one knows the trick, one can extricate from one root by threading in another with it; but the new root has to be chosen carefully or it is worse than useless.

Of course there were a great many inspectors in the mine and they went round testing all the appliances. Sometimes they helped with the work and got it done, simply by inspection, in ever so much less time than did the average workman.

I made a long stay in these mines and succeeded in making good friends of the surds. When I said goodbye I promised never to forget them and their ways.

All the same I was glad to get up into the open air again.

Chapter X.

Beyond me rose three mountain ranges, each one sloping gradually up to a higher level.

At first the climbing was easy, but it grew harder and harder. But one was well rewarded for one's trouble, for from time to time one caught glimpses of the far-off Sea of Infinity—away on the ever receding horizon of the Land of Higher Mathematics.

These mountain ranges were called The Progressions and in climbing them one had to provide oneself with certain invaluable means and formal appliances.

In the tableland of which these Progressions formed the approach, there had once been an enormous forest. But three hundred years ago two pioneers of Science had passed this way (though strangely enough they had overlooked the Surd district), and, noticing that the thicket was so dense that one could only work one's way through at a very slow pace, they had reduced it to a neat and orderly pile of logs.

And there these logs still stand in tabular array for any one to use who will.

PHILOLOGY AND THE OCCULT IN ROGER BACON.

BY JOHN S. P. TATLOCK.

ROGER BACON is best known to the modern world for his knowledge, method and speculation in natural science. But this is not all in his work to excite interest or demand explanation. He was not, it is true, a quite encyclopedic writer, nor, writing extensively and with enormous haste, was he methodical, even for a medieval. But he had something to say of many subjects which do not fall within the field of physical science or of philosophy (in our sense), and to ignore them would leave an inadequate idea of his grasp and his originality.

Most of these may be reviewed in a word, though on some of them he wrote voluminously. On such subjects as geography, botany, music and medicine he had little to say that was original or significant, though much that was practical and showed his strong interest in the good of humanity, as in what he says of the prolongation of human life. He wrote on comparative religion, naturally not in a well-informed or unprejudiced way;—on Buddhism, Mohammedanism, Judaism, Christianity and other faiths. But two subjects may be singled out for especial mention, in one of which he was most modern, in the other most unmodern. His attitude to philology and the study of language is one of the matters most to his credit; and to understand the reason for his attitude toward astrology and magic is essential to a fair view of him.

Bacon insists with emphatic iteration on the importance of an accurate and full knowledge of the languages in which the wisdom of the past has come down to us. The four languages of which he urges the especial study are Greek, Hebrew, Arabic and Chaldee. He gives us to understand that he knew some Arabic and Chaldee, and he certainly knew the others. An incomplete Greek grammar by him is still in manuscript in Oxford; in several of his other

works he records and explains the Greek and Hebrew alphabets, showing some power of phonetic analysis in doing so, and he knew enough of the grammar and vocabulary of Greek to correct the Latin Vulgate. He knew something of the sound-changes that have occurred in both Greek and Latin. The pronunciation of Greek which he gives is a fairly accurate representation of the contemporary pronunciation, which he had probably learned from some of the Greeks who had been brought to England by Robert Grosseteste, bishop of Lincoln. He uses his knowledge to reprove some of the jaunty etymologizing common in his day, which often reminds one of Voltaire's gibe against etymology as the science in which the vowels count for nothing and the consonants for very little; he especially rebukes the practise of deriving Latin words from Hebrew and Hebrew from Latin, a practise which can be found in old-fashioned dictionaries to the present day. He gives a long and fairly accurate list of Latin words derived from the Greek, consisting of terms for general ideas, and ecclesiastical terms. He exalts very high the importance of an accurate knowledge of language, discoursing on it four or five times. In his *Opus majus*, next after his introduction on philosophy comes his discussion of language,—the basis of knowledge, as ethics and religion are its culmination; of five things essential to knowledge both divine and human, grammar is first. Many persons among the Latins he says can speak Greek, Hebrew and Arabic, but not five know their grammar. These languages are important chiefly because little that is valuable for the theologian or philosopher was written originally in Latin. While learned works ought to be read in the original languages, the western world will be mainly dependent on Latin translations, which no one can make well without close knowledge of the subjects involved and also of the two languages. Yet of those who in the last thousand years or so had made translations from Greek to Latin, only Grosseteste had known science well, and only Boethius had had a due knowledge of the two languages. Bacon complains bitterly of wrong translations in the Vulgate Bible, due partly, he says, to St. Jerome's mistakes and partly to his desire not to make too many changes from the older Latin version in use in his day. Bacon did not share the view of the Council of Trent and of Pope Pius X. as to the ultimate authority of the Vulgate. He also complains of the bad translations of Aristotle current then, which came through the Arabic and also through one or two other languages; made by men ignorant of the subject-matter and not too familiar with the languages. Since so much

of the scientific knowledge and philosophical method of his day was based on Aristotle, he was certainly moderate in demanding accurate versions of him.

Here as elsewhere, in the reasons he gives for his opinions, we cannot forget that he was a medieval. After all, he frequently harks back to mysticism. He sees a glorious tribute to the dignity of philology in the fact that St. Jerome had his teeth filed or moved (*aptari*) that he might the better pronounce certain oriental sibilants. A study of astronomy will help us, he points out, to ascertain the date of Noah's flood and the precise ages of the patriarchs. But if at times he gives reasons which do not appeal to us, if sometimes he gives what we might call the Devil's reasons for doing God's work, this was partly because his intellect usually lagged a little behind his intuition; and partly because with unexpected tact he was adapting himself to his pontifical patron. In regard to his motives, Bacon fluctuated between the medieval and the modern. The fundamental division of things in the middle ages was into the good and the bad; in our day, into the true and the false. The middle ages were an even more utilitarian epoch than the present; they do not look so to us, because they had a different idea from ours as to what is useful. Bacon was medieval enough to hold in the field of consciousness the belief that the true is for the sake of the good. But no one who has read his works can doubt that new truth for its own sake inspired his sub-consciousness and stirred his heart.

In spite of the scientific spirit which Bacon shows in regard to language, there may have been a little mysticism as well,—a little sense of the mystical power of words. This sense is one of the fundamentals in his view as to the reality of magic. For this we shall not condemn unheard as a mere superstitious dreamer an official of a religious system whose most august daily task was to work a stupendous miracle by the five little words "*Hoc est enim corpus meum.*" Yet there is a paradox in seeing the twentieth-century scientific world uniting to honor the memory of a man who was not only a stout defender of magic and astrology, but in whom until rather recently the moderns saw mainly a magician, and at whose feats when he was impersonated on the Elizabethan stage the groundlings craned their necks. Yet, to make the paradox more complete, it must be said that Bacon's attitude to the occult, to magic and astrology, was a consequence of his scientific spirit.

To realize this fully, at least a sketch of background is necessary. Bacon, like almost every one else who ever lived, was a man

of his age; not in regard to certain matters on which he meditated long, but in regard to most of his fundamental view of the world and that part of his mental equipment which he had not time to scrutinize. This is the case with even the most revolutionary thinkers, who may share the most narrow prejudices of their neighbors about social customs or the like. But, more than this, Bacon in his years of discretion had joined the Franciscan order, and ends his greatest work with a long and eloquent tribute to the Sacrament of the Altar. The study to which, next after necromancy, he was most hostile was the Roman law, because it undermined a theocratic system of society. He was a faithful Catholic, and the main reason he urges for the advancement of learning is that it will spread the power of the Christian faith.

Now to the medieval the universe was a closed universe, in which everything had a discoverable use and meaning; it was all-pervaded with spirit, and even with spirits, good and bad. Of man the most important part was spirit, constantly acted on by subtle spiritual influences from outside. His daily life was full of acts and words meant to produce an effect quite incommensurate with their surface meaning. The line between religion and magic has always been found hard to draw; what is religion to the believer often seems magic to the unbeliever. More accurately, religion seeks to gain benefits from the unseen by submission and persuasion, magic by cunning and force. But the two are not incompatible; man might placate the almighty and the benevolent unseen, and outwit or force the subordinate and mischievous or impersonal powers. The impulse which is expressed in magic is almost as deep-seated as that of religion; a late Roman writer makes merry over atheists who would not do the most trifling thing (such as bathe) without ascertaining in what part of the zodiac the moon was. But in the middle ages all good men were believers. There were atheists and scoffers; but they were men whose crimes made them prefer a godless universe and annihilation after death to a good God and his just condemnation. Now the Bible in which good and wise men believed taught the reality of magic; men read of the witch of Endor and the sentence of the Mosaic law, "Thou shalt not suffer a witch to live"; and it taught the reality and power of evil spirits. As to astrology, that was not vouched for by the Bible. But it came to Europe from the east, the source of all wisdom; it came in an imposing system, always so impressive to humble-minded people, as the medievals were; it could point to amazing fulfilments of its prophecies; it seemed *a priori* probable.

For an argument that convinced some of the ablest men of the middle ages was this: on earth there is nothing useless, there is no use in the stars unless they influence the earth, hence the truth of astrology.

A year or two ago the writer had occasion for another purpose to collect the views on astrology and magic of a dozen representative writers of the thirteenth and fourteenth centuries, writers both literary and philosophical. Not one of them denied the influence of the planets, and the only one who showed scepticism was Petrarch. As to judicial astrology, the attempt to learn of the future in detail from the heavens, the general opinion was that this could be done, though not with such definiteness as to set at naught the prerogatives of divine providence and human free-will; but it was generally regarded as more or less impious, not a very logical conclusion. Magic was less often mentioned; partly because of its greater remoteness from ordinary life, partly because it was a more grave matter. It is not true, however, that before the days of the witchcraft manias the ordinary practice of magic involved any very serious danger from the civil or canon law. "White" or "natural" magic, the use of images and charms, seems to have been condemned by nobody, to have been generally recognized as useful, and to have been a more or less regular part of the practice of medicine, especially in the fourteenth century; "black" magic or necromancy, involving the use of blood, sacrifices, incantations, suffumigations, and invocations of demons, was always condemned as impious, but not generally as useless. The word "superstitious," constantly applied to it, had not at all the coloring of intellectual superciliousness which it has now; it meant something not so much despicable as shocking; St. Thomas Aquinas defines *superstitio*, which he applies to magic, as worship directed to a wrong object or in a wrong manner. On the whole, people were not sure just how much there was in these occult arts; any voice which declared there was nothing in them trembled a little, they were regarded with hostility, suspicion, and fear, and men were glad, like children, to hide their faces in Mother Church's vesture. On the whole the medieval attitude was not one of disbelief but of disapproval.

Bacon's position as to all this is quite clear. Good, indifferent, or evil constellations (which means arrangements of the planets) *incline* to good, indifferent, or evil effects on earth; which may be frustrated by man's free-will, divine grace, or the devil. Therefore, he says, all good astrological authorities agree that their forecasts

are not certain, but depend on the divine will, a view not condemned by the early saints. The body, health, and states of mind are strongly affected by the planets; therefore moral acts may be predicted, but not with certainty. Accordingly, the wise man in his actions will heed celestial influences. As to magic, he wrote a work (mentioned by Bale) *Contra necromanticos*. Their art, he says elsewhere, is cursed and unphilosophical, consisting partly of forbidden though effective traffic with demons, and partly of fraud. In reading his account of their fraudulent hocus-pocus, one might imagine himself reading an exposure of a modern charlatan; he inveighs against their use of confederates' help, of darkness, of ingenious hidden instruments, of legerdemain, of meaningless characters, silly songs, and irrational prayers. So far he is at one with St. Thomas Aquinas himself. But while the only magic which the Angelic Doctor approves is useless, Bacon holds that natural magic is righteous and useful, *ad opera miranda*, do good and repress evil. Accordingly, charms and images, which contain, as in storage-batteries, some of the power of what they represent, the human mind and the God-made heavenly bodies, should be used to the utmost. The enemies of Christendom may and do use them to our damage, and he begs the pope that Holy Church may not lack the same power in defense.

Bacon's repute in modern times as a magician is mainly due to the fact that it was his works on the occult which were spread abroad in the sixteenth and seventeenth centuries by astrologers and others, proud, perhaps, to find approval for their arts from one who had earned in the schools the title of Admirable Doctor. His repute in his own day as a dabbler in magic is usually ascribed to his general pushing of inquiry and experiment into little-known fields of science. It may well be questioned, though, if it was not rather due to the clear-cut and the approving attitude he took in regard to astrology and natural magic, in contrast to the usual attitude, which was vague or timid, or both. Now what I affirm is that Bacon's position showed mental courage and a scientific spirit. If he did not throw overboard this whole occult lore as intellectual rubbish—and it is too much to expect a thirteenth-century Franciscan to do that—he did the next best thing. If the planets show how events tend, if charms and images are potent for good, why should man not use their help for his own good ends? St. Thomas Aquinas, of the rival order of Dominicans, another wonderful clear-headed man in an age of muddy-mindedness, here was less clear-headed than the Franciscan. He talks of a tacit

compact with demons in the inscriptions on the images used in natural magic, and maintains that demons sometimes help astrologers in their predictions. But if the worker has no desire and leaves no room for diabolical aid, where is the logic of St. Thomas's position? The real reason for it was that these beliefs seemed to impugn the supremacy of God and the freedom of man. But Dante, one of St. Thomas's most faithful disciples, avoids the difficulty by holding that stellar influence is merely one of the channels through which divine providence acts. In regard to the occult, St. Thomas and his like followed their intuition rather than their reason. The fact that we now know their intuition to have been right will not prevent a scientific mind from justifying Bacon for this time fearlessly following his reason.

So Bacon's attitude toward the occult, though one of his mistakes, is really no reflection on his scientific spirit, but was due to the action of it on his more fundamental beliefs—accepted on authority, it is true. It was this scientific spirit, rather than any of its specific products, which is the significant thing about his career, especially coming when it did. It is hard to show much direct consequence of anything that he wrote, though Columbus's voyage in 1492 was partly inspired by what he had read from Bacon on geography, another of Bacon's mistakes, in reality. The significant thing is that Bacon marks an almost dramatic stage in the relations between the church and the world, between traditional wisdom and scientific knowledge.

Bacon lived in the high tide of the western European medieval system, which, on all sides but the legal, means of the medieval church. His century saw the highest development of medieval art, poetry, philosophy; it saw the high social activity of the church in the work of the friars; it saw Innocent III interdicting England, and the Latins ruling in Constantinople. In Bacon the human intellect brought its highest and finest activity, and laid the rich oblation of gold and frankincense at the church's feet; and she turned away. So far as we know, Clement IV never read, he certainly neglected, the lore which the poor friar, with almost pathetic eagerness at having gained such august encouragement, in earnest haste had written out for him three or four times on different scales, to fit the large or small leisure the pope might have for reading. The church was right, from her point of view; she felt instinctively there was nothing there for her; perhaps she even felt there was danger for her. So here the paths of the human mind divide. The intention of the Catholic church to embrace and

govern all human activity, which in the thirteenth century she seemed in a fair way to attain, she defeated herself. She made here the great refusal. In spite of her continued hold on politics, in spite of such work as that of the Jesuits on astronomy in the nineteenth century, she has cast out science and independent critical learning. In later days, when we think of science and the church, we are reminded of what Bunyan says of the two giants, Pope and Pagan, living in caves in the Valley of the Shadow of Death: "Pagan has been dead many a day; and as for the other, though he be yet alive, he is, by reason of age, and also of the many shrewd brushes that he met with in his younger days, grown so crazy and stiff in his joints, that he can now do little more than sit in his cave's mouth, grinning at pilgrims as they go by, and biting his nails because he cannot come at them." He issues now and then a syllabus of errors, denouncing modern thought and its creations as the works of Satan, to which the modern world replies in such a poem as Carducci's *Hymn to Satan*. But toward subversive thought within her own gate the church takes no longer the attitude of indifference which she took to Bacon, as the modernists can testify, the spiritual descendents of Bacon. They have been trying to do for her what he tried to do, an utterly hopeless and impossible thing. She recognizes clearly now what she recognized obscurely then, that her mission is wholly different, and that if the world will not follow her she must not follow the world. The most thorough man of science cannot but admire the most remarkable institution which ever existed on this planet for sticking to her guns as no other institution ever did.

But we must believe the future to be mainly with what Bacon introduced to the modern world. He was not chiefly a discoverer, but he realized the infinite possibilities of mind working with nature. When he faintly foresaw such modern creations as steamships, it was not due to knowledge but to faith in nature and man. He had faith in the future because he was intellectually humble, and esteemed intellectual conceit a chief fount of error; he did not account himself and his world to have attained. He had a strong sense of the unity and rationality of the universe, such as we are coming to on a larger scale and on a higher plane. When we see that one of the last of the schoolmen was one of the first of the scientists, we see vividly how continuous has been the imposing hierarchy of learning.

NOTE ON BOUSSET, DEUSSEN, GARBE, ET AL.

BY WILLIAM BENJAMIN SMITH.

IN *The Monist* of July, 1914, Professor Deussen maintains that the story of the resurrection of Jesus implies a "pious fraud," but "such a little one," it would seem, as need involve no serious moral blemish (while in somewhat similar tone Mr. Kampmeier apologizes for Jesus as not so very bad after all). The only interest, but a lively one, attaching to Deussen's judgment is purely psychologic: how could such an idea obtain a moment's lodgment in any mind even fairly *au courant* with New Testament criticism?—a question much easier to ask than to answer.

However, it is important to note that the resurrection-discussion takes a long stride forward in the new and weighty *Kyrios Christos* of Professor Bousset, which in essential agreement with the essay on "Anastasis" in *Der vorchristliche Jesus* (see "The Critical Trilemma," *Monist*, July, 1914) refers "God hath raised up Jesus" *not* to any resuscitation or raising from the dead, but to the *Erhöhung*, the exaltation, the establishment of the "Messiah-Son-of-Man," "a preexistent, heavenly, supramundane, spiritual being," at the right hand of the majesty on high. "The belief in the exaltation of Jesus as Son-of-Man was not the consequence but much rather the presupposition of the appearances of Jesus." Bousset explicitly rejects "the empty grave" as any part of the earlier tradition. "It may therefore still be proved that the women at the empty grave did not belong to the elder evangelic account of the end of the life of Jesus" (p. 79). "The belief in the exaltation of the Son-of-Man took the more concrete form, that he had risen on the third day bodily from the grave" (p. 79). Only one more such step of giant is needed to reach the position already maintained in the article on "Anastasis"—a step that can not be many years delayed.

In the same number of *The Monist* Garbe rests the historicity

on the prediction of the parousia: "Verily I say unto you, There be some here of them that stand by, which shall in no wise taste of death, till they see the kingdom of God come with power" (Mark ix. 1); "Ye shall not have gone through the cities of Israel, till the Son-of-Man be come" (Matt. x. 23); "There be some of them that stand here, which shall in no wise taste of death, till they see the Son-of-Man coming in his kingdom" (Matt. xvi. 28); "There be some of them that stand here, which shall in no wise taste of death, till they see the Kingdom of God" (Luke ix. 27). Quoting Schopenhauer, Garbe holds with Reimarus that unless these "predictions" had been actually uttered (by Jesus) they would never have held their place in the Gospels, since they were "conspicuously not fulfilled." Surely the force of naïveté can no further go. Garbe need not wonder that sauer historicists rely so little on these passages. Schopenhauer speaks of "the glorious return of the Lord," and Garbe quotes with approval. But the reader sees that the scriptures cited say naught of any "return," but only of the "coming" of the kingdom of the Son-of-Man. The notion of "return" is not present; it is the "liberal" contribution of our authors.

Now it is at best merely amusing to talk of the Gospels as sacredly preserving an unfulfilled prediction, just in awe of it as a prediction uttered by Jesus. Who does so should take lessons in old Christian history. If the "prediction" had given offense, it would have been changed without a moment's hesitation. This point has already been sufficiently discussed in *Ecce Deus* (pp. 185-189). Schopenhauer, Garbe, and the rest have totally misunderstood the "coming," the parousia, the presence, in construing it as a "return." The reference is to the wide-spread preaching of the kingdom, the community of God-worshippers, to the proclamation and general acceptance of the Jesus-cult, to the victorious crusade for monotheism, against idolatry. To speak of Jesus as actually uttering such words and of the bewildered church as actually cherishing them, is to imitate the wife of Job (ii. 10). Wellhausen himself declares that "Mark ix. 1 is an additament to viii. 38, externally marked off by 'and he said' and also internally distinguished"—it is not Jesus but a much later Christian consciousness that speaks. Again, of Matt. x. 23 the same great historicist says: "The Son-of-Man is in the meaning of the concipient, not Jesus" (p. 49).

Garbe, Deussen, and their kind should read such critical works as *Kyrios Christos* and especially Norden's *Agnostos Theos*, to learn how they have misconceived "the problem of Jesus"¹ and the

protochristian monotheistic propaganda. They remind one of sophomores who would solve the general algebraic equation of fifth or sixth degree without regarding Abel. It is idle to reason with these, who have no proper conception of the problem. The best one can do is to say, "Well here is an equation of fifth degree, whose roots I know; now find them by your method, and then I'll hear you." When Deussen and Garbe solve one of the least of the real difficulties of the critical situation, then let them ask our attention.

Until then, let hem sneer as they will: let them rage and imagine a vain thing; let them muzzle the press and employ varieties of argument in vogue only among such as know no better. Meantime the dawn creeps down the mountains. He who notes carefully the tone of the best European criticism can no more doubt the steady revolution in progress than watching the vibrations of a Foucault pendulum he could doubt the rotation of the earth.

¹ *Le Problème de Jésus*, by Charles Guignebert, of the Sorbonne—an able, learned, fair-minded book, just published, which scoffers especially would do well to read.

THE LOTUS GOSPEL.

BY THE EDITOR.

BEFORE me lies a book in two volumes entitled *World Healers, or The Lotus Gospel and its Bôdhisattvas compared with Early Christianity*,¹ written by E. A. Gordon, with an introductory letter by A. H. Sayce, of Queen's College, Oxford. It is brimful of interesting material on comparative religion, and the gospel it preaches is a kind of combination of Christianity with Buddhism. The author's idea is expressed in the Preface as follows: "That modern Christianity would be deepened and spiritualized beyond conception by coming into contact with the teachings of the venerable Mahayana and their expression in the wondrous art treasures of the Far East, there is very little doubt."

Professor Sayce in his letter thus adds his approval: "You seem to me to have proved what an intimate relation there is between Buddhism and early Christianity."

While the data here collected are not treated with the critical reserve and accuracy needed for such an undertaking, we have found in these two volumes much that is of general interest and we will reproduce from their pages a number of illustrations with the necessary explanations.

We find on page 192 the Mahayana, the great vessel of salvation, pictured as a ship in the center of which Buddha stands. From his fingers his thoughts stream forth represented as a number of people in a kneeling posture seeking salvation. The eastern ships have eyes painted on their prow, and in this the eye is plainly visible in front. Flowers rain down, and even the waters are covered with lotus blossoms.

Mrs. Gordon is struck with the similarity between Buddhist and Christian nuns. Not only is the rosary very similar but the head dress is practically the same, and she reproduces a picture of

¹ Published by Eugene L. Morice, of Cecil Court, Charing Cross Road, London, and also in China and Japan.

Chujo-hime, the "Lotus Princess," who in the year 763 entered the order and retired from the world (because, as the story goes, she



THE BUDDHIST SHIP OF SALVATION BOUND FOR PARADISE.

was "the victim of a cruel stepmother's tyranny") and was considered an incarnation of Quan Yin. She is still remembered,

for we read: "Each spring, on May 14, the reception of the young princess-nun into paradise is commemorated in a wonderful mystery procession which enacts 'The Coming of Amida with Twenty-five



CHUJO-HIME, THE LOTUS PRINCESS.

Bosatusus' and the whole company of 'heavenly men, women, and children' to compensate this little nun who—in her mortal life—was so grievously afflicted."

Another Japanese princess who has become dear to the Japanese Buddhists is the Empress Asuka-himé, of whom Mrs. Gordon says:

"About the year 735, the Empress Asuka-himé made votive images and vowed to receive, bathe, and cleanse 1000 sick folks if Yakushi [Buddha] would heal her own disease, which is variously described as consumption, blindness, or leprosy. By his grace, her prayer was granted, and so the temple 'Yakushi-ji' was erected in thanksgiving at Nara. It is said that 999 patients arrived, but that for a long time no others came.

"At length a wretched outcast, so terribly defaced and deformed that he was hardly human, craved admission into the hospice, which was readily granted. He then said that Amida had appeared to him in vision, assuring him of cure if only the empress could be persuaded to suck the poison from the putrefying sores which covered him from head to foot, and filled the atmosphere with awful corruption.

"The empress naturally recoiled from this extreme act of self-abnegation (which, however, was divinely destined to develop her own character and ensure her spiritual perfection), so the leper turned sadly away.

"Then it flashed across Her Majesty that *this* was the thousandth patient for whom she had so long and anxiously prayed, and now, alas! rejected. So, having him recalled, she confessed her hesitancy and repugnance and, enjoining silence, she put her lips to the foul wounds, '*for Buddha's sake.*' Instantly the leper, bidding Her Majesty, also, '*tell no man who he was,*' (Luke v. 14), vanished in the most radiant glory, filling the air with fragrance.

"This is one of the many lovely stories which Japanese mothers tell their children. When visiting the spot, I heard that a hospital is about to be raised there by the Imperial University of Kyoto in commemoration of this event.

"The name bestowed upon Asuka-himé after death was Komyo Kogo, 'Empress of Light,' for, as a 'Fruit of the Light,' she had caused copies of the *King Komyo-kyo*, or 'Luminous-Golden-Light-sûtra,' to be made in simple language and distributed throughout Japan. One such the writer saw at Koya-san in the empress's own handwriting.

"With the Emperor Shomu's help, she founded a monastery and nunnery in every province and built dispensaries, where medicines were freely given to the sick (paid for out of the house-taxes), also asylums for the indigent poor, and orphanages.

“This empress’s simplicity of heart is revealed in her poem :

“If I pluck these flowers to offer them to Buddha,
The touch of my hand will defile them;
Therefore, growing in the fields as they stand
I offer these wind-blown blossoms
To the Buddha of Past, Present, and To Come!”



EMPERESS KOMYO KOGO GREETED BY THE CHILDREN IN PARADISE.

“Our illustration depicts Asuka-himé entering the Land of Light [Paradise]—welcomed by the children who have become *hotoké* [sainted].”

Mrs. Gordon discusses the development of Buddha statues as they varied in size. In the eighth century the first colossal statue (160 feet in height, with a face 16 feet long) was cast. Since it



THE AMITABHA OF KAMAKURA.

Erected A. D. 1252. From a Japanese Painting.

has twice suffered from fire it cannot compare with the Kamakura Amitabha (erected by the Lady Itano in 1252) whose majestic calm, exquisite tenderness and beautiful smile seem the embodiment of divine love. We here offer for comparison a photograph of this

great statue side by side with a reproduction of a painting by a Japanese artist.

Mrs. Gordon adds: "The colossal size of the images arises,



THE AMITABHA OF KAMAKURA.

From a photograph.

doubtless, from the desire to magnify the perfections of one whose 'lips are full of grace and truth' and who is 'fairer than the children

of men'—'the infinite heart of Buddha, who has not a small heart as we have!'"

Our author takes great interest in the Nestorian tablet at



THE NESTORIAN MONUMENT SURROUNDED BY BUDDHIST MONKS.

Sian-Fu, and has taken a photograph of the venerable monument of Chinese Christianity, surrounded by Buddhist monks who point out terms used on the stone which are common to both faiths, Christianity and Buddhism.

WHO WAS THE BIBLICAL ARIOCH OF THE DAYS OF ABRAHAM?

BY EDGAR J. BANKS.

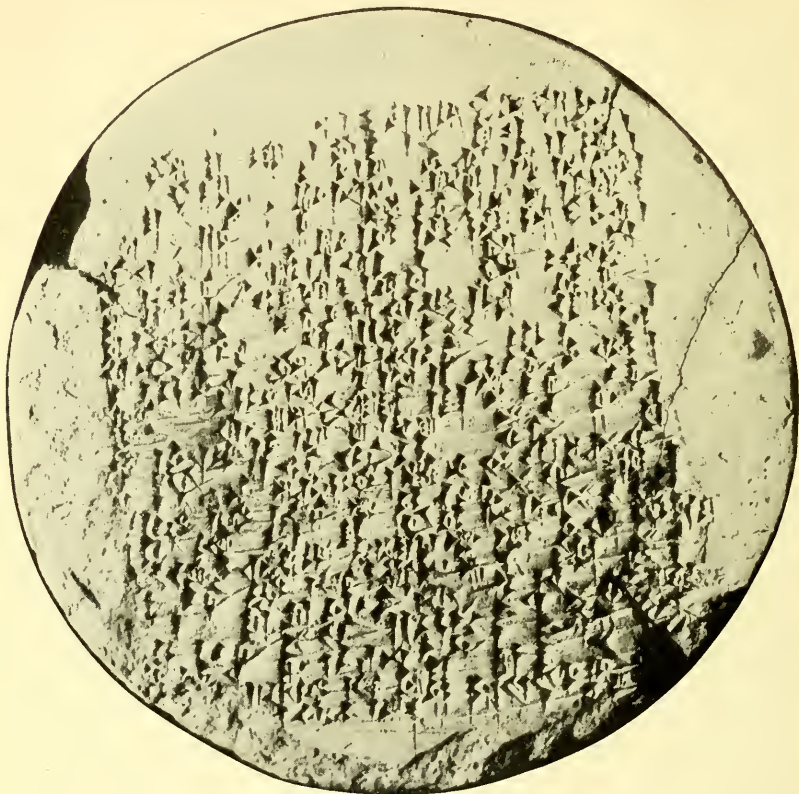
AMRAPHEL, Arioch, Chedorlaomer and Tidal are the names of four kings who invaded Palestine in the days of Abraham, so we are told in Genesis xiv. 2. To learn who those kings were, if they really existed, or were the creation of ancient legend, has long been a riddle which Orientalists have set themselves to solve. Excavations in the ruins of the Babylonian cities have revealed inscriptions which have thrown some light upon the subject. Amraphel was undoubtedly the illustrious Hammurabi, King of Babylon. The King of Ellasar, contemporary with Hammurabi, was Rin-Sin or Warad-Sin, whom the Sumerians of Babylonia called Eri-aku. He was probably the Arioch of the Bible. Chedorlaomer, King of Elam, is supposed to have been the father of Eri-aku, and possibly Tidal was a king of Kurdistan.

Recently in the South Babylonian mound of Senkereh, as Ellasar or Larsa is now called, Arabs discovered a large cone among the ruins of the Ishtar temple. The head of the cone, greatly enlarged to six inches in diameter, is covered with a long Sumerian inscription of fifty lines in an almost perfect state of preservation. The greater part of the cone itself has been broken away, but enough remains to show that the inscription was repeated upon it.

It was the custom of the kings of Babylonia, whenever they restored an ancient temple, to bury in the temple walls the record of their work, that men of the distant future, when the temple should again fall to ruins, might read it. Sometimes the inscription was engraved upon the stone socket of the door post; more frequently it was written on large clay cylinders such as have come from Nebuchadnezzar, but Eri-aku left his record upon the head of a cone, so that when thrust into the wall, the inscription re-

mained visible and might be read. The form of the cone may possibly have had some connection with the nature of the rites employed in the Ishtar worship.

Seldom are these building records of great historical value. They begin by telling who the royal author of the inscription was, and with words of extravagant praise. Then follows an account of the building operations, and at last is a prayer to the deity of



THE INSCRIBED CONE OF ARIOCH.

the temple for the welfare of the king. Such is the inscription upon the cone of Arioch, yet coming, as it does, from an almost unknown Bible king, it is of unusual interest, and makes clearer one of the most obscure and most important historical passages of early Bible history. Its translation is as follows:

“To Ishtar, the exalted lady of splendor, the priestess of hosts, the first-born daughter of the god Sin, his lady!

"I am Uru-aku (Arioch), the favorite prince of Nippur, the restorer of the city of Ur, the governor of the cities Girsu and Shirpurla, who is revered in the temple Ebabbar. (I am) king of Larsa; King of Sumer and Akkad; the beloved lord of the harvest; he who accomplishes the divine commands; who restores the temples of the gods; who built a colossal statue of her ladyship, who restored prosperity to her devastated city, who faithfully built its walls; who truly caused the wide-spread land to be thickly populated; the noble of heart, the warrior who turns the enemy back; to whom Ea has given a wide understanding for conducting the work of the city.

"For Ishtar, the merciful lady, he (Arioch) filled with more light than before, as it was in former times, her house of splendor, the awe-inspiring dwelling of her joyous heart. He enlarged her shrine for the future. He built it for her abode. He reared high its summit. He made it lofty like a mountain.

"May Ishtar, my Lady, look kindly upon these brilliant deeds! May she grant me as a gift an abundance of years, a firmly established throne, the overthrow of those who rebel!"

MARTYRS' MILK.

(MIRACULUM: LAC PRO SANGUINE.)

BY PHILLIPS BARRY.

AMONG the legends of the early church, it is recorded of certain martyrs that when they were tortured or slain with the sword their wounds would shed milk, sometimes with blood. With a study of this miracle, as found in texts from the fourth century on together with certain related aspects of the martyr-cult, the following essay will deal. At the outset the documents may be put in evidence.

1. St. Paul (Coptic text, c. 375): "Und als man ihn am zweiten Tybi enthauptete, gieng aus ihm Milch hervor."¹

2. St. Romanus (Prudentius, c. 404):

"Vix haec profatus pusionem praecipit
sublime tollant. . . .

tenerumque duris ictibus tergum secent,
plus unde lactis quam cruoris defluat."²

3. St. Sophia (Syriac text, fifth century): "And when the breasts of the maiden had been cut off. . . .the places from which they had been cut off flowed with milk instead of with blood."³

4. St. Pantaleon (Coptic text, c. 400-600): "Then all his body became white like snow, and instead of blood, milk issued."⁴

5. St. George (Coptic text, c. 400-600): "And they took off his holy head, and there came forth water and milk."⁵

6. St. Anub (Coptic text, c. 400-600): "A headsman came. . . . and severed his neck,—blood and milk issued therefrom."⁶

¹ O. v. Lemm, "Koptische Apokryphe Apostelakten," *Bull. de l'Acad. Imp. . . . de St. Petersbourg*, XXXV, p. 308-9.

² *Pristephanon*, X, 695ff.

³ A. S. Lewis, *Select Narratives of Holy Women*, p. 174.

⁴ F. Rossi, *Memorie della R. Acad. dei Lincei*, Ser. 5, 1893, pp. 1-136. This citation on p. 120.

⁵ E. A. W. Budge, *St. George of Cappadocia*, "The Martyrdom of St. George," p. 235.

⁶ I. Balestri and H. Hyvernat, *Scriptores Coptici*, Ser. 3, Vol. I, p. 240.

7. St. Epime (Coptic text, c. 400-600): "...they cut off his blessed head. Blood and milk flowed from his body."⁷

8. St. Isaac (Coptic text, c. 400-600): "...they... cut off his holy head... And there came forth blood and milk."⁸

9. St. Sarapamon (Coptic text, c. 400-600): "When Orion the guardsman cut off his head, water and milk flowed."⁹

10. St. Godeleva (1078): "Quo fiebat ut sacer sanguis qui poenae violentia in guttur confluxerat, in aquam de ore profusus, coagulatus in lapidem album, instar calcis induratus sit."¹⁰

Of the above texts, the Coptic Martyrdom of St. Paul, in a fourth century papyrus,¹¹ contains the earliest record of the miracle. Macarius Magnes, (c. 370) attests the story as current of St. Paul;¹² it is found also in the Greek, Latin, Arabic and Ethiopic texts of the Martyrdom,—of which the Greek, from a manuscript of the ninth century, (than which none is earlier) may be cited.

“ὡς δὲ ἀπεινάξεν αὐτοῦ ὁ σπεκουλάτωρ τὴν κεφαλὴν, γάλα ἐπύτισεν εἰς τοὺς χιτῶνας τοῦ στρατιώτου.”¹³

The martyr-cult, a tribute of the church to latent polytheism, early reached in Egypt a high development. Shenute, bishop of Atripe (333-451), saw in it a menace of social demoralization, even the decay of the church itself;¹⁴ he denounced the worship of dead men's bones,¹⁵ pious frauds, the toll of caves and old ruins, attested by relic-mongers' false revelations.¹⁶ Then the dream oracles and healing cults were revived.¹⁷ In the traditions of the saints, lived on the mythology and folk-lore of the old gods. Ser-

⁷ *Ibid.*, p. 154.

⁸ E. A. W. Budge, "The Martyrdom of St. Isaac of Tiphre," *Trans. Soc. Bib. Arch.*, IX, p. 89.

⁹ H. Hyvernat, *Les Actes des Martyres de l'Égypte*, p. 330.

¹⁰ *Acta Sanct.*, 6 Jul., II, p. 431, "Vita S. Godelevae," 77.

¹¹ O. v. Lemm, *loc. cit.*, p. 237.

¹² "ὁ μὲν γὰρ τῆς κεφαλῆς τμηθεὶς, αἵματι καὶ γάλακτι τὸν ὄφιν εἰς λιχνηίαν ὡσπερ ἐδελέασεν." (*Apocriticus*, IV, 14, p. 182, Blondel.)

¹³ R. A. Lipsius and M. Bonnet, *Acta Apostolorum Apocrypha*, I, 115.

¹⁴ G. Zoega, *Catalogus Codicum Coptiorum*, p. 421: "Sermo de ecclesiis omni tempore et omni die frequentandis in timore Dei."

¹⁵ *Ibid.*, p. 424 (Title of a sermon by Shenute): "Exegesis annexa iis quae diximus et scripsimus de iis qui venerantur ossa mortuorum vano nomine eas appellantes ossa martyrum."

¹⁶ *Ibid.*, p. 424: "Sunt qui ajunt martyres apparuerunt nobis et dixerunt quod ossa sua certo loco condita essent, quos deprehendi et convicti de errore suo. Nonnulli dum aedes demoliuntur vel lapides caedunt, si inierint edificiorum subterraneorum formas et capsulas, ajunt quod martyres sunt. Anne in capsis sepeliverunt homines praeter eos qui martyrium sustinuerunt?" (Extract from a sermon by Shenute.)

¹⁷ *Ibid.*, p. 424 (Shenute): "Loquitur... de aegrotis qui somnum capiunt in locis martyrum, quo salutem recipiant, aut somnio moneantur."

vice in the interest of the martyrs.—building of shrines, writing of memorials, was a work of supererogation.¹⁸ And, in spite of abuses, drinking and merrymaking, gambling, lewdness and brawling, rife among the crowds at the shrines, the cult endured,—since it made more easy, the transition from the old faith to the new.¹⁹

Contemporaneous with the development of the martyr-cult was the rise of another by-product of ecclesiastical evolution, the hagiographic romance. Of this literary genre, Egypt, the land of the folk-tale,²⁰ has left us the best examples in the Coptic writings. Its development was intimately connected with the history of the church. In the pre-Constantinian period of local or general persecution, the saints were witness of the psychic impetus of Christianity,—their records, relatively free from mythology, forming a logical supplement to the apostolic tradition.²¹ With the triumph of the church, however, when the witness of the martyrs was no longer a vital issue, the absorption of pagan elements followed. The memorials of the martyrs, the heroes of the church,²² were historical novels, wherein fancy ran light footed, if history feared to tread. In Egypt the hagiographic romance circulated early,—witness the mute testimony of papyri of the fifth century lately found at Oxyrhynchus, with portions of the memorials of St. Paphnute and of St. Christina, written in vulgar Greek.²³ Of the extant Coptic texts, those in Sahidic were written between 400 and

¹⁸ E. O. Winstedt, *Coptic Texts relating to St. Theodore*, "Apa Chamoul," p. 206: "And those that shall write my martyrdom tear up the copy of their sins."

¹⁹ G. Zoega, *loc. cit.*, p. 423: "Si quis cum dulci miscuerit quod omni felle amarius est, num biberes o homo? Adire loca martyrum, ut ores, legas, psallas, sanctifices te, et sumas eucharistiam in timore Dei, bonum est. At ibi concinere, edere, bibere, ludere, magis adhuc fornicari, homicidia committere per ebrietatem. . . iniquitas est." (Shenute.)

²⁰ J. Leipoldt, *Geschichte der koptischen Litteratur*, p. 142: "Die Lust am Fabulieren ist ihnen sozusagen angeboren,—das beweisen die Märchenbücher, die uns aus den Jahrtausenden vor Christus erhalten sind."

²¹ A. Harnack, "Martyrer- und Heilungsakten," *Sitzber. der kön. Preuss. Akad.*, 1910, 117: "Wie sich der Märtyrer benommen hat. . . sein Christus-bekenntnis, endlich was Christus an ihm manifestiert hat, das war der Gegenstand des höchsten Interesses, denn es gehörte auf dasselbe Niveau, auf welchem das neue Testament stand."

²² Augustine, *De Civ. Dei*, X, 21: "Hos. . . nostros heroes vocaremus. . . quod daemones. . . vincerent."

²³ *Pubblicazioni della Societa Italiana per la Ricerca dei Papiri Greci e Latini in Egitto*, Vol. I, Nos. 26, 27. A Coptic text of the martyrdom of St. Paphnute must have preceded the Greek text of the Oxyrhynchus papyrus, since in the papyrus the martyr is called "Απα Παπνούριος, in which "Απα is Coptic *apa*, the generic word for a saint or holy man. As far as it goes, the text of the papyrus corresponds exactly with the text of the Bohairic "Martyrdom of St. Paphnute."

600 A. D.,²⁴ those in Boheric are mostly translations from Sahidic.²⁵ From linguistic evidence, however, comes the proof that this type of literature, the successor of the native folk-tale, goes back in Egypt to the fourth century.

A time-honored punishment for slaves or criminals was by the rack, or "wooden horse" (Greek ξύλον, Latin *equuleus*). Eusebius and Prudentius testify of its use against the Christians.²⁶ In Coptic hagiographs, torture by the rack, (*hermetarion*, Sah.; *ermetarion*, Boh..) is a commonplace,²⁷ the victims being women as well as men. This word *hermetarion* was a local word in Egypt, according to St. Athanasius who wrote in the year 357, current during the period of Arian atrocities in the Thebaid.

“ἀλλὰ νῦν οἱ θαυμαστοὶ Ἀρειανοὶ, οἱ καὶ ἡμᾶς διαβάλλοντες. . . ταύτας γυμνώσαντες ἐποίησαν ἐπὶ τῶν καλουμένων ἐρμηταρίων κρεμασθῆναι, . . . οὐδὲ γὰρ οὐδὲ ἐν τοῖς γενομένοις διωγμοῖς τοιοῦτον ἠκούσθη πραχθέν. . . μόνοις γὰρ αἰρετικοῖς οἰκεῖον. . . πλημμελεῖν κατὰ τῶν ἀγίων. . . παρθένων.”²⁸

Writing at white heat, he denies that Christian women were thus tortured by the imperial governors. In the Coptic Martyrdom of St. Justus, however, the scene of which is laid in the time of Diocletian, a girl-child is racked by Arianus, governor of the Thebaid.²⁹ History knows no such person: the governor under Diocletian was Clodius Culcianus, as attested by a papyrus of the year 303,³⁰ also by Eusebius,³¹ and one Coptic Martyrdom of St.

²⁴ J. Leipoldt, *Geschichte der koptischen Litteratur*, p. 156: "Die mönchische Litteratur der saïdischen Mundart war noch vor der persischen (619) und arabischen Eroberung (641), auf einem toten Punkte angekommen."

²⁵ *Ibid.*, p. 144, footnote 3: "Die bohairischen Martyrien sind grösstenteils aus den saïdischen übersetzt."

²⁶ Eusebius, VIII, 10: "οἱ μὲν γὰρ ὀπίσω τῷ χεῖρε δεθέντες, περὶ τὸ ξύλον ἐξηρτῶντο, καὶ μαργάνοις τισὶ διετίνοντο πᾶν μέλος."

Prudentius, *Peristephanon*, X, 108-9.

"Incensus his Asclepiades iusserat
Eviscerandum corpus eculco."

²⁷ In these texts, the rack is one of the first tortures used,—at the instigation of the governor, when the martyrs' obstinacy or evasive replies have enraged him. See E. O. Winstedt, *Coptic Texts relating to St. Theodore*, "Apa Chamoul," p. 201. "And the governor was wroth, and he bade them hang him to the rack (*ἐρμητάριον*)."

²⁸ Athanasius, *Apologia ad Constantium*, Migne, P. G., XXV, col. 640.

²⁹ E. O. Winstedt, *Coptic Texts relating to St. Theodore*, p. 218: "He made them place her upon the rack (*hermetarion*), and scrape her till her ribs flowed with blood."

³⁰ *The Oxyrhynchus Papyri*, Vol. I, 132-3: "Κλωδίωι Κουρκιάνωι τῶι. . . ἐπάρχωι Αἰγύπτου."

³¹ Eusebius, *Hist. Eccl.*, IX, 11.

Theodore.³² By these data, the writing of hagiographic romances by the Copts is attested for a period when the memory of Arian atrocities was yet fresh. In the name of the unhistorical Arianus, the hated Arians are gibbeted.³³ The word *hermetarion*, etymologically a corruption of Latin *armentarium*, as actually stated in an early Greco-Latin gloss,

armentarium ξυλον ερμηταριον³⁴

is derived from the neuter form of the nickname Armentarius, borne by the emperor Galerius Maximianus.³⁵ As Greek ἀρμεντάριον it is found in the Acts of SS. Ciryus and Julitta.³⁶

σχετλιάσαντος δὲ ἐπὶ τοῦτο τοῦ δικαστοῦ, κελεύει ἀρμενταρίω ἀναρτηθεῖσαν εὐτόνωσ ξέεσθαι.

Evidence of Egyptian influence is further to be found in the fund of miraculous stories which swell the hagiographic tradition. For the purpose of the present essay may be considered a remarkable and widespread belief, namely, the restoration to life of dead men and animals by reassembling their scattered members. In its oldest form, an incident in the myth of Osiris, it is found in the Pyramid Texts, according to which the deceased king, identified with Osiris, was reanimated by the magical symbolism of dismemberment and integration. In witness whereof are the following documents.

1. Teti (c. 2600 B. C.)³⁷: "Nephthys has collected for thee all thy members, in her name, 'Our Lady the Assembler.'"

2. Teti³⁸: "Hail, hail, rise thou, Teti! Thou hast grasped thy head, thou has brought thy bones, thou hast collected thy members."

³² E. O. Winstedt, *loc. cit.*, p. 162. Culcianus appears in other Coptic stories.

³³ Yet such are the vicissitudes of sainthood! Arianus himself entered later into the cycle of conscience-stricken persecutors, as a professing Christian and martyr. (F. Rossi, *Memorie della R. Accad. dei Lincei*, Ser. V, 1893, a Coptic text of the martyrdom of St. Arianus.) His body, thrown into the sea, is brought back by a dolphin, perhaps a reminiscence of the classic legend of Arion.

³⁴ *C. G. L.*, II, 25, 31. *Cod. Par.*, 7651, of the ninth century.

³⁵ Aur. Vict., *De Caes.*, XXXIX, (c. 360): "Galerium Maximianum, cui cognomen Armentario erat. . . ." Cf. also, *ibid.* XL.

Pseudo-Aurelius, *Epit.* XL (written c. 400): "Galerius autem. . . ortus parentibus agrariis, pastor armentorum, unde ei cognomen Armentario fuit."

³⁶ *Analecta Bollandiana*, I, 198. "Acta Graeca Sincera SS. Ciryi et Julittae." This document is cited exactly by Theodore of Iconium, (c. 1005) and must be earlier than 551, since it appears in the *index expurgatorius* of the Gelasian Decree, which Dobschütz assigns to the period 518-551.

³⁷ K. Sethe, *Die altägyptischen Pyramidentexte*, 616.

³⁸ *Ibid.*, 654.

3. Teti³⁹: "Thou hast bound thy head to thy bones, thou hast bound thy bones to thy head."

4. Pepi I (c. 2575 B. C.)⁴⁰: "Pepi has united his bones, he has gathered his members."

5. Pepi I⁴¹: "Hail, Pepi! Thou hast brought thy bones, thou hast received thy head before Seb."

6. Pepi I⁴²: "She gives thee thy head, she unites thee thy bones, she joins thy members, she puts thy heart in thy body."

7. Pepi II (c. 2475 B. C.)⁴³: "Isis offers thy libation, Nephthys has made thee pure,—thy two sisters mighty and great, collecting thy flesh, joining thy members."

This belief, native for thirty centuries to Egypt, passed into popular Christianity, Christ and the Angels taking the places of Horus and Nephthys.

1. St. Lacaron: "Sumpsit membra beati, invicem compegit ea, suscitavitque eum iterum."⁴⁴

2. St. Anub: "Tunc Archangelus Michael, deorsum de caelo venit, Suriele et Raphaelae cum eo ambulantes. Apprehenderunt membra corporis eius, ea invicem coniunxerunt, et exsufflarunt in faciem iusti, qui surrexit incorruptus."⁴⁵

3. St. George: "When he had finished his prayer, and had said 'Amen,' they threw him on the wheel, and . . . immediately his body was broken into ten pieces. . . . And the dragon of the abyss (i. e., Dadianus) commanded them to throw his bones. . . . into a dry pit . . . Michael went down into the pit, and put together the holy body of St. George. . . . and the Lord breathed upon his face and filled him again with life, and He embraced him."⁴⁶

Likewise the reanimation of dead animals, the earliest legend of which appears in the Westcar Papyrus (c. 2000 B. C.),⁴⁷ is an incident in the hagiographs.

³⁹ *Ibid.*, 572.

⁴⁰ *Ibid.*, 980.

⁴¹ *Ibid.*, 840.

⁴² *Ibid.*, 835.

⁴³ *Ibid.*, 1981.

⁴⁴ I. Balestri and H. Hyvernat, *Scriptores Coptici*, Ser. 3, Vol. I, p. 14.

⁴⁵ *Ibid.*, p. 221.

⁴⁶ E. A. W. Budge, *St. George of Cappadocia*, "The Martyrdom of St. George," p. 212.

⁴⁷ W. M. Flinders Petrie, *Egyptian Tales*, p. 28: "And his majesty said, 'Is it true, that which men say, that thou canst restore the head which is smitten off?' And Dedi replied, 'Truly I know that, O King, (life, wealth and health) my Lord!' And his majesty said, 'Let one bring me a prisoner who is in prison, that his punishment may be fulfilled.' And Dedi said, 'Let it not be a man, O King, my Lord,—behold, we do not even thus to our cattle.'

St. Lacaron: "Cum haec dixisset B. Apa Lacaron, calceamentum quod erat in pede praesidis, factus est sicut vitulus, coram praeside et universa turba."⁴⁸

In the tradition of the Latin church the myth of dismemberment and magical restoration is of frequent record. The following documents will illustrate the forms in which it is found.

1. St. Patrick: "Ailill's wife went to the hill on which they were biding and said, 'Swine have devoured our son, O Ailill!' saith she, 'through their brutishness.' And Ailill said to Patrick: 'I will believe, if thou bringest my son to life again for me.' Patrick ordered the bones of the son to be gathered together, and directed a Culdee of his household, namely, Malach the Briton. . . . 'I will not tempt the Lord,' saith Malach. . . . Thereafter Patrick ordered the bishop Ibar and Ailbe to bring the boy to life, and he besought the Lord along with them. The boy was brought back to life after this, through Patrick's prayer."⁴⁹

2. St. Kiaran: "In illa hora videns pius puer lupum miserum et macerum et esurientem ad se venientem, famulus Dei dixit ei, 'vade miser, et commede illum vitulum.'" Et devoravit eum. . . . Sanctus Kiaranus. . . ossa eius in sinum suum collegit, et reddiens deposuit ea ante vaccam plorantem. Et statim divina pietate propter sanctitatem pueri vitulus coram omnibus surrexit."⁵⁰

3. St. Winifred: "Then tooke Benoe the heade, and sett it agayne to the bodie, and covered it with his mantel, and went to his masse. And beholde when he had sounged and preachte to the people much of the mayden, he sayd, God would not that she should be deade. . . . Wherefore he bad manie men and weomen to pray to God to rayse her agayne to lyfe, and so he did. And when she sate up, with her hande she wipte away the dust from her face that was thereon, and spake to them whole and sounde as she was before."⁵¹

This legend of St. Winifred is of interest for the reason that it is doubtless but a reminiscence of an incident in the martyrdom of

And a duck was brought to him and its head was cut off. And the duck was laid on the west side of the hall, and its head on the east side of the hall. And Dedi spake his magic speech. And the duck fluttered along the ground, and its head came likewise, and when it had come part to part, the duck stood and quacked." (The same miracle is wrought on a goose and an ox.)

⁴⁸ I. Balestri and H. Hyvernat, *Scriptores Coptici*, Ser. 3, Vol. I, p. 16. Cf. "Acta Apocrypha SS. Ciryaci et Iulittae," *Acta Sancti.*, 16 June, III, 31.

⁴⁹ W. Stokes, *Tripartite Life of St. Patrick*, p. 198.

⁵⁰ "Vita S. Ciarani de Cluain," v. Plummer, *Vitae Sanctorum Hiberniae*, Vol. I, p. 202. The hagiography is doubtless the origin of a similar story in the Edda. See B. Thorpe, *Northern Mythology*, I, p. 57.

⁵¹ *Anal. Boll.*, VI, 308, "The Lyfe of St. Wenefreide" (c. 1401).

St. George. "They rose up together, and joined the head of the saint to his body and it united with it, as if it had never been severed at all."⁵²

Of all hagiographs, the miraculous history of St. George has had an influence second to none. One disguised version of it passes as the biography of St. Catherine, another as the history of St. Martina. Both of these texts retain the incident of the milk-shedding wounds.

1. St. Catherine: "ἀντὶ τοῦ αἵματος γάλα ἔρυσεν ἐπὶ τῆς γῆς."⁵³

2. St. Martina: "Inciso autem corpore eius, emanabat lac pro sanguine."⁵⁴

Such transference of legends of different saints is not unusual, —the most notable instance, however, is to be observed in the case of St. Aemilianus, patron of Treri in Umbria, the legend of St. Aemilianus being nothing less than the legend of St. Pantaleon taken over bodily.⁵⁵

To return to the main subject of our essay. The incident of the milk-shedding wounds appears besides in a number of hagiographs, the same being here put in evidence.⁵⁶

⁵² E. A. W. Budge, *St. George of Cappadocia*, "The Encomium by St. Theodosius," p. 237. Cf. Pyr. 572.

⁵³ J. Viteau, *Passions des Saints Ecaterine, Pierre d'Alexandrie*, etc., p. 23.

⁵⁴ *Acta Sanct.*, 1 Jan., I, 13.

⁵⁵ Of St. Aemilianus two closely related accounts are given in the *Acta Sanctorum*, viz., 28 Jan., II, 833, from F. Ferrari, who claimed to have read the Acts of St. Aemilianus at Spoleto, and 8 Feb., II, 158, a Latin version of an Italian life by one Iacobillus, who cited biographies of St. Aemilianus, published at Treri, 1592, 1593, but these could not be found by Bolland. That the legend is but the legend of St. Pantaleon, with the name, locality, and a few minor details changed, the following parallel summaries of the two will declare:

I. St. Pantaleon,

1. Accused before Maximian by the doctors' guild.
2. Offers test: heals a paralytic in the name of Christ.
3. Tortured: rack, fire, lead, thrown in sea with millstone, to beasts, by wheel which kills 500 men.
4. Bound to olive: neck grows hard, headsman's sword-like wax.
5. Decapitated: wounds shed milk, olive-tree fruits.

II. St. Aemilianus,

1. Accused before Maximian by the priests of Æsculapius.
2. Offers test: heals a paralytic in the name of Christ.
3. Tortured: rack, fire, lead, thrown into the river Clitumnus with a millstone, to beasts, by wheel which kills 500 men.
4. Bound to olive: headsman's sword like wax.
5. Decapitated: wounds shed milk, olive-tree fruits.

The account of the miracle of the milk-shedding wounds: "Ex cuius corpore lac pro sanguine fluxisse arboresque flores et fructus emisisse ferunt." (*Acta Sanct.*, 28 Jan., II, 833.)

⁵⁶ St. Maeruan of Tallaght had blood of a pale color, due to ascetic habits. See S. Baring Gould, *The Lives of the British Saints*, III, 454.

1. St. Acacius:⁵⁷

“τραχήλον Ἀκάκιος ἐκτμηθεὶς ξίφει,
Ψυχῆς τὸ λευκὸν μηνύων βλύζει γάλα.”

2. St. Antiochus:⁵⁸

“Ἀντίοχος . . . ἰατρὸς τὴν τεχνὴν . . . ἀπετμήθη τὴν κεφαλὴν, καὶ ἔρρου-
σεν ἐκ τοῦ τραχήλου αὐτοῦ σὺν αἵματι γάλα.”

3. St. Blasius:⁵⁹

“Videbant autem milites illi quod pro sanguine lac carnes earum
stillabant.”

4. SS. Cantiani:⁶⁰

“Ecce sanguis eorum, tamquam lac, omnibus videntibus ap-
paruit.”

5. St. Christina:⁶¹

“Iulianus ira commotus, iussit mamillas eius abscindere. Chris-
tina dixit,— . . . vide quia pro sanguine lac . . . defluxit.”

6. St. Cyprilla:⁶²

“Vulneribus sanguis, e papillis vero lac instar fluminis de-
fluxerit.”

7. St. Euppsychius:⁶³

“Nam loco sanguinis, dum caput eius abscinderetur, effluxit
lac et aqua.”

8. St. Mennigus:⁶⁴

“E vestigio igitur articulos ad usque metacarpion resecant, qui
pro sanguine lacteum liquorem profudere.”

9. St. Pompeius:⁶⁵

“ὡς ζῶν πρόβατον, Πομπήιμ, τοῦ Κυρίου,
χεῖς ἀμελχθεὶς ἀχένα ξίφει γάλα.”

10. St. Quintinus:⁶⁶

“At illi abstracto gladio caput eius amputaverunt, et sanguis
statim de collo eius candidus tamquam nix.”

⁵⁷ *Acta Sanct.*, 28 July, VI, 547.

⁵⁸ “Synaxarium Basilianum,” July 15. See *Acta Sant.*, Jul., I, 693.

⁵⁹ *Acta Sanct.*, 3 Feb., I, 338.

⁶⁰ B. Mombritius, *Sanctuarium*, I, 279, 51.

⁶¹ *Acta Sanct.*, 24 July, V, 528.

⁶² *Acta Sanct.*, 5 July, II, 224 (from the Greek).

⁶³ *Acta Sanct.*, 9 April, I, 823 (from the hymns of Joseph the Hymnograph). See also *Acta Sanct.*, 7 Sept., III, 6: “καὶ αὐτίκα ἀντὶ αἵματος γάλα καὶ ὕδωρ ἔγγνε” (from a Constantinople Synaxary). These two legends are different versions of the same story, perhaps colored by the legend of St. George.

⁶⁴ *Acta Sanct.*, 15 Mar., II, 391 (ex recuso Sanctorum Viridario Mattaei Raderi).

⁶⁵ *Acta Sanct.*, 5 Apr. I, 399. From Maximus of Cythera.

⁶⁶ B. Mombritius, *Sanctuarium*, II, 427, 38.

11. St. Secundina:⁶⁷

"Illud etiam mirabile contigisse fertur, quod pro sanguine ex eius corpore lacero lac profluxit."

12. SS. Victor and Corona:⁶⁸

"Itaque sicut iussum fuerat, decollatus est, et de colli eius vulnere lac et sanguis profluxit."

Of these the legend of St. Christina circulated in Egypt during the fifth century.⁶⁹ In connection with the cult of St. Pantaleon, the patron saint of physicians, particular importance was attached to the characteristic miracle of his legend.⁷⁰ A vessel said to contain the identical blood and milk of his martyrdom existed in the ninth century.⁷¹ A thirteenth century document makes of this vessel a curious "war barometer," in which the milk and blood, separated by gravity, exchanged positions every year, save that during a year of war the blood remained uppermost.⁷²

In the Coptic "Martyrdom of St. Isaac" the hagiographer records miracles of healing by the blood and milk which flowed from the martyr's wounds:⁷³ "Now when the blind and the lame, and the deaf and the dumb had taken of that same blood and milk which came forth from the body of the blessed man, and laid it

⁶⁷ F. Ferrari, "Catalogus Sanctorum," in *Acta Sanct.*, Jan. 1, 997.

⁶⁸ *Analecta Bollandiana*, II, 299. St. Victor was martyred at Kome in Egypt; the whole story bears evidence of Egyptian origin.

⁶⁹ See p. 4. The text of the Bollandist account is close to that of the Oxyrhynchus papyrus.

⁷⁰ Verses for the office on St. Pantaleon's day:

"γαλατόμικτον Μάρτυς αἶμα σῆς κάρας,
δι' ἣν ὑδατόμικτον ὁ Χριστὸς χέει,
φάσγανον ἐβδομάτηι εἶλαχ' εἰκαδι Πανταλεήμων."

⁷¹ "Synaxarium Basilianum," in *Acta Sanct.*, July I, p. 697: "Καὶ ἀποτμηθεὶς τὴν κεφαλὴν, ἔρρουσεν αἶμα καὶ γάλα, ὅπερ μέχρι τῆς σήμερον φαινόμενον παρέχει τοῖς προσερχομένοις πᾶσι πιστοῖς ἰάματα."

⁷² *Acta Sanct.*, July VI, 421, "Miracula S. Pantaleonis," 2: "In eadem namque urbe sanguis huius gloriosi martyris Christi in ampulla perlucida, magnae, ut dignum est, venerationi habetur,—discolor, id est, candidus et rubicundus, . . . partim candidum lac, partim rubicundus sanguis. Servant haec duo mirabiliter iussas a Domino suae positionis annuas vicissitudines ita videlicet, ut si praecedente anno, rubicundus superius parebat, anni sequentis initio descendat et superius appareat candidum lac, descensurum nihilominus anno redeunte, ut superne fulgeat pretiosa sanguinis gloriosi purpura. Fere nunquam haec alternatio cessat. . . . Semel tantum nostra memoria, regnante Michaele imperatore, qui nuper decessit, cessasse perhibetur haec descensionis alternatio, ut vice sua non descenderet sanguis, sed permaneret superior anno toto sequente, ut fuerat anno praecedente. Fuit autem annus idem totus praeliorum sanguine cruentus."

⁷³ E. A. W. Budge, "The Martyrdom of St. Isaac of Tiphre," *Trans. Soc. Bib. Arch.*, IX, 89.

upon their diseased members, behold, they were healed immediately."

Of St. Pantaleon also, similar miracles of healing are reported.⁷⁴ Now in Egypt, the land of medical lore and the home of methods in therapeutics that dominated the practice of medicine down to comparatively recent times,⁷⁵ it was early taught that human milk had curative powers. In the Ebers Papyrus, the "milk of a woman who had borne a male child," is indicated for treatment of sore eyes.⁷⁶ This recipe passed into the Latin hagiographic tradition.

1. St. Remigius:⁷⁷ "Scias cum ablactaveris puerum Remigium, de lacte tuo perunges oculos meos, et recipiam lumen. . . . Et ablactatus, . . . lacte matris oculos sui vatis. . . . perungens, lumen illi gratia divina restituit."

2. St. Mochoemog:⁷⁸ "Non poteris sanitatem oculorum invenire tuorum, nisi oculos et faciem tuam laveris lacte uberum uxoris Beoani artificis, quae enim nunquam peperit, sed dono Dei sanctum habet in utero conceptum. . . . Lavans igitur lacte uberum B. Nessae sanctus, uxoris Beoani artificis, oculos suos, ibi illico lumen recepit suum."

In the hagiography, also, a belief is current that water⁷⁹ in which a saint has washed was a veritable panacea.⁸⁰ A typical instance is recorded in the Arabic Gospel of the Infancy:⁸¹ "Postero die eadem mulier aquam odoratam sumpsit ut Dominum Jesum lavaret, quo loto aquam illam qua id fecerat recepit, eiusque partem

⁷⁴ See note 71.

⁷⁵ G. Ebers, "Wie Altägyptisches in die europäische Volksmedizin gelangte," *Zeitschrift für ägypt. Sprache*, XXXIII, 18: "Hier kam es nur darauf an, zu zeigen, dass sich Altägyptisches in der mittelalterlichen Medizin findet, und dass es über Salerno nach Mitteleuropa kam. Zu den Salernitanischen Meistern war es theils durch Griechen, die ihre Schriften damit bereichert hatten, grösstentheils aber durch Uebersetzungen altägyptischer medicinischer Texte ins Koptische und vielleicht auch ins Griechische gelangt, die die Araber schon früh in ihre Sprache übertrugen."

⁷⁶ G. Ebers, *loc. cit.*, XXXVIII, 10, footnote.

⁷⁷ *Acta Sanct.*, I Oct., I, 135.

⁷⁸ C. Plummer, *Vitae Sanctorum Hiberniae*, II, p. 165.

⁷⁹ In the martyrdom of St. George, the magician Athanasius washes his face in one of the philtres he offers St. George. See E. A. W. Budge, *St. George of Cappadocia*, "The Martyrdom of St. George," p. 210.

⁸⁰ E. Amelineau (*Annales du Musée Guimet*) *Vie de St. Jean Kolobos*, p. 338. In the *Acta Sanctorum* the cases run into hundreds,—water in which a saint's clothes or relics had been washed; even water in which a saint had washed a leper's sores had the same virtue.

⁸¹ C. Tischendorf, *Evangelia Apocrypha*, p. 188, sect. XVII. Compare also sect. XXVIII. In sect. XXXI, a dying child is restored to health by being placed in the bed of Jesus.

in puellam ibi habitantem, cuius corpus lepra album erat, effudit, illamque ea lavit, quo facto, puella statim a lepra purgatus est." Of this belief, likewise, the earliest intimation is in the Pyramid Texts⁸² (Pepi II, 2475 B. C.): "A bowl of cool water before the door of this Neferkare,—every god washes his face in it! Thou washest thy hands, Osiris, thou washest thy hands, Neferkare, thou renewest thyself!"

Still another legend of which Egyptian origin is traceable, and which passed into the hagiography, may be noticed in passing: namely, the effect of martyr's milk and blood on plant life. The earliest record is in the *Tale of the Two Brothers*,⁸³ in which the blood of the slain Bata, falling on a door-post, transforms it into a persea-tree.⁸⁴ In the Coptic Martyrdom of St. Pantaleon, it is recorded that when milk and blood flowed from his wound, "the olive-tree to which he was bound, became loaded with fruit."⁸⁵ A Greek text has a similar story of St. Therapon of Said:⁸⁶

“ἀπλώθεις καταξέεται ράβδοις τὰς σάρκας, καὶ πιανθείσα ἡ γῆ τῶι αἵματι αὐτοῦ φυτὸν βαλάνου ἀνέδωκε μεγιστὸν λίαν, ὃ μέχρι τῆς σημέρον δείκνυται ἀίφυλλον ὃν πᾶσαν νόσον καὶ πᾶσαν μαλακίαν ἰώμενον.”

It remains now to trace the possible origin of the legend that the wounds of martyrs shed milk for blood, and the significance of this belief for the development of the idea of sainthood.⁸⁷ As has been pointed out, the earliest record is in the Coptic Martyrdom of St. Paul,⁸⁸ that it is a bit of the marvel-lore of Egypt is at least probable. Yet as legends of this sort do not originate out of nothing, it must not be thought impossible to discover a historical background for any story, however far removed into the realm of the fantastic. In the case of the miracles of levitation by solar rays and resuscitation by reassembling a dismembered body, the etiology resolves itself into a case of literalization of types of religious symbolism. In the present instance, the miracle had its

⁸² K. Sethe. *Die altägyptischen Pyramidentexte*, 2068.

⁸³ From a papyrus of Seti II (19th Dynasty).

⁸⁴ *Records of the Past*, Vol. II, "Egyptian Texts," p. 150.

⁸⁵ F. Rossi, *loc. cit.* (see note 4).

⁸⁶ *Acta Sanct.*, 27 May, VI, 680.

⁸⁷ Sainthood in general was an extension of the martyr-cult. It conveyed with it the connotation of a type of life in which the experiences of the senses and the reason no longer constituted valid criteria for the truth. See my article "Saints and Sainthood," *The Open Court*, Jan. 1914, pp. 46-57.

⁸⁸ This fact is not rendered less significant by the evidence that Greek was the original language: the Copts never were mere translators, but embellished as well. No assurance is forthcoming that our ninth century Greek text represents the original.

origin in certain physiological theories filtered down through the minds of ignorant monks whose ideas were dominated by *die Lust zu fabulieren*.

The medical writers, from Hippocrates to Galen, who drew at least some of their information from Egyptian sources,⁸⁹ held to a view of the intimate connection between blood and milk. According to Galen,⁹⁰ "Milk is developed from blood, undergoing a very slight change in the lactiferous glands." Hippocrates also believed in the existence of an abnormal condition, manifested in the secretion of milk by a *nullipara*.⁹¹ Such a tradition obviously preceded the accounts of the several instances in which the mutilated breasts of a virgin were said to have yielded milk.⁹²

It is but a little longer step to suppose a condition in which the blood of a man might be suddenly changed to milk, as in the case of St. Paul and others. That such a condition was believed to be obtainable in the case of male animals through magic, is attested by a passage in the life of St. Columba relative to milk obtained by magic from a bull.⁹³ "(maleficus) a sancto iussus, de bove masculino qui prope erat lac arte diabolica expressit. . . Vir itaque beatus, vas, ut videbatur, tale plenum lacte, sibi ocus dari poposcit. . . et continuo lacteus ille color in naturam versus est propriam, id est, in sanguinem."⁹⁴

* * *

The results of the foregoing investigation may now be summed up as follows:

1. The tradition that milk instead of blood flowed from the wounds of St. Paul and other martyrs, appears first in a Coptic text which goes back to the fourth century.

2. The martyr-cult, as Shenute testifies, became important in

⁸⁹ G. Ebers, "Wie Altägyptisches in die europäische Volksmedizin gelangte," *Zeit. für ägypt. Sprache*, XXXIII, 1.

⁹⁰ Galen, XV, p. 394 (ed. Kuhn): "ἐξ αἵματος δὲ καὶ ἡ τοῦ γάλακτος, ὡς εἶπον, γένεσις ἀλιγίστην μεταβολὴν ἐν μαστοῖς προσλαβόντος."

⁹¹ Hippocrates, III, 744 (ed. Kuhn): "ἦν γύνη μὴ κύουσα, μηδὲ τεκοῦσα, γάλα ἔχθη. . ."

⁹² Cf. St. Christina, St. Cyprilla, St. Sophia. The story of St. Sophia has been rewritten by Hrotsvitha, ("Sapientia," *Pat. Lat.*, CXXXVII, 1054): "*Fidēs: Inviolatum pectus vulnerasti, se me non laesisti; En pro fonte sanguinis fons erumpit lactis.*"

From the hagiography, the belief in maidens' milk passed into the popular tradition of Europe.

⁹³ *Acta Sanct.*, 9 Jun. II, 217. Written by Adamnanus Scotus, c. 704.

⁹⁴ Cf. *Acta Sanct.*, 8 May, II, 336 ("Miracula S. Petri Tarent.," 6) for a story of a cow that gave blood for milk till the animal was turned over to the monks.

Egypt during the fourth and fifth centuries, being one of the most significant expressions of popular Christianity.

3. The Egyptian type of hagiographic romance dates soon after the Arian atrocities in the Thebaid (c. 350) as shown by the use in Coptic of the word *hermetarion*, the word current among the Arians as the name of the rack, and also by the references to the torture of women by the unhistorical Roman governor, Arianus (i. e., Arian).

4. Egyptian stories entered into the hagiographic tradition,—witness the legend of the resuscitation by reassembling the parts of a dead body.

5. The origin of the miracle of martyrs' milk is to be traced to medical theories (perhaps Egyptian) of the development of milk from blood.

MISCELLANEOUS.

BOOK REVIEWS AND NOTES.

A HISTORY OF JAPANESE MATHEMATICS. By *David Eugene Smith* and *Yoshio Mikami*. Chicago: The Open Court Publishing Company, 1914. 8vo. pp. v, 288. Price \$3.00 net.

Not many years ago the typical English attitude towards foreign philosophies of life and customs of life was of the crudest simplicity—the philosophy was heathen and the customs were uncivilized. The doubt whether “civilized” is or is not a laudatory epithet: and the conviction that the doctrine of life which has produced the east and west ends of London, for instance, cannot belong to the last stage of human progress has profoundly modified this attitude.

The marvelous capacity of adopting western ideas which the Japanese have shown has produced very humanly, though not perhaps very logically, a profound respect for the native civilization of Japan. But the evidences of this civilization are disappearing fast, partly like the flora of St. Helena, under the competition with methods developed under conditions of greater stress, partly from such fortuitous circumstances as the frequency with which books and manuscripts have disappeared in the flames to which the wooden dwellings of old Japan are so liable. Thus Smith and Mikami are sure of appreciative readers of their well timed effort to record a very characteristic development of the Japanese genius.

In considering the relative progress of European and Japanese mathematics there are two topics in which the Japanese made greater progress than the West. First comes the idea of a negative number. This appears in the second century B. C. and was probably even more ancient (p. 48) and is embodied in the use of red (+) and black (—) pieces on the *sangi* board or abacus. It is not too much to say that the educational mathematics of the West has not yet gained so firm a grasp of the use of the negative number as the Japanese had in the seventeenth century. The second important advantage gained by the Japanese was the method (equivalent to Horner's method) for the solution of numerical equations. The *sangi* or *soroban*, the abacus which the Japanese still employ, gave useful aid. The question whether the abacus in elementary education may not prepare us for the day when a calculating machine will cost less than a bicycle is an open one. The Japanese at present keep to the *soroban*, with such a reason in mind.

The conspicuous deficiency in the earlier Japanese mathematics seems to have been in formal geometry. This too is a feature of pedagogic interest.

Have the violent opponents of systematic or formal geometry in this country always taken a wide and far reaching view of the position? Several geometrical problems involving arithmetical results of great complexity, were dealt with and the numerical value of π received much attention.

The same tendency towards keeping back methods while disclosing results which has been so injurious to the progress of western mathematics operated in Japan, and it is not at all clear by what methods the very accurate values of π were obtained.

For instance an ingenious rule was as follows. Start with any fraction (e. g., $\frac{3}{1}$). If it is less than π add 4 to the numerator and 1 to the denominator. If it is greater than it add 3 to the numerator and 1 to the denominator. Continuing this progress a series of fractions are obtained ultimately approaching π , though of course any one is not necessarily better than its immediate predecessors.

The series of fractions

$$\frac{3}{1}, \frac{7}{2}, \frac{19}{3}, \frac{13}{4}, \frac{16}{5}, \frac{19}{6}, \frac{22}{7}, \frac{25}{8}, \frac{29}{9},$$

may be shown by successive horizontal and vertical steps and the movements zig zag across the line whose slope is π . The method obviously presupposes a knowledge of the value of π .

It is known that, despite all difficulties and prohibitions, some intercourse with Europe took place during the seventeenth century, but opinions have differed as to the amount of mathematical knowledge, if any, which reached Japan from the West. The authors have collected the available materials for forming an opinion, but in their judgment the question requires closer investigation. The authors' final summary of the place of Japanese mathematics in general history of human thought is that "the mathematics of Japan was exquisite rather than grand." "When we think of Descartes's *La Géométrie*, of Desargues's *Brouillon Projet*, of the work of Newton and Leibniz on the calculus, . . . we do not find work of this kind in Japan. But in execution the work was exquisite in a way which is unknown in the West. For patience, for the everlasting taking of pains, for ingenuity in untangling minute knots and thousands of them, the problem-solving of the Japanese has never been equaled."

The authors have conferred a real service on all mathematics by the loving care with which they have set out the story of mathematics in Japan.

C. S. JACKSON.

CHINESE AND SUMERIAN. By C. J. Ball, M. A., D. Litt. London: Oxford University Press, 1913. Pp. 151. Price 2 pounds 2 shillings net.

Prof. C. J. Ball, Assyriologist in the University of Oxford, England, has summed up his labors on the connection between the Chinese and the Sumerian languages in an elaborate book containing plates and comparative collections of words which go very far in establishing the common origin of both systems of writing. The theory of a connection was proposed many years ago, first by A. Terrien de Lacouperie, but the proposition of the latter was not sufficiently supported by facts and may be characterized as a bold guess, whereas Professor Ball's theory is well grounded, and we do not see how any one in the face of the diligent comparisons of Sumerian and Chinese characters, can

entertain any further doubt. A mere glance through the sign-list in which the old forms of Chinese characters (called *ku wên*) are compared with Sumerian congeners or prototypes is convincing and henceforth we may regard the theory as established.

The connection between Sumerian and Chinese being proven, it becomes probable that the ancient Chinese civilization started in prehistoric times from the ancient Sumerian in lower Mesopotamia, the same root from which western culture has sprung. A tribe of Sumerians must have left their home in the valley of the Euphrates and Tigris, and must have wandered east into the fertile fields of China, where they settled and developed a culture of their own. The cause of the emigration may have been the intrusion of the Semites, who gradually adopted the Sumerian civilization and crowded out the original inhabitants as it appears in a peaceful competition, presumably by outnumbering them and adopting their religion, as well as their mode of living.

Professor Ball's investigations will lay the basis for further research in the line of comparative studies of the prehistoric ages, and the interconnection of the several branches of human civilization. The volume before us is large quarto, and considering the difficulty of presenting the tables in a sign list the price of two guineas is not too high.

CLEAR GRIT. A Collection of Lectures, Addresses and Poems by *Robert Collyer*. Edited by *John Haynes Holmes*. Boston: American Unitarian Association, 1913. Pp. 328. Price \$1.50 net.

This collection contains a few lectures which were delivered to many thousands of people from the public lyceum platforms throughout the country, and a number of more informal addresses given to Dr. Collyer's own congregation on various Sunday evenings. Their subjects are largely of general human and literary interest: Cathedrals, Westminster Abbey, Martineau, The Pilgrims, The Human George Washington, The Human Heart of Martin Luther, Robert Burns, Charles Lamb: Genius and Humor, Hawthorne, Whitier, Thoreau and the like. There are only half a dozen poems included. One of these is a hymn written for the dedication of the new Unity Church in Chicago after the great fire of 1871. The first and last stanzas are as follows:

"O Lord our God, when storm and flame
Hurled homes and temples into dust,
We gathered here to bless thy name,
And on our ruin wrote our trust.

"Thy tender pity met our pain,
Thy love has raised us from the dust;
We meet to bless thee, Lord, again,
And in our temple sing our trust."

The volume is accompanied by a beautiful portrait of Dr. Collyer as frontispiece.

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