which keeps them parallel, and regulates the width of the space to be left for the back. A strip of paper is pasted into the back, the edges of the cloth are laid in, and the boards are passed between a pair of india-rubber rollers, by the pressure of which any air-spaces between the cloth and the millboards are squeezed out. They are then hung up to dry previous to receiving title and ornamentation. The ornamentation on book cases consists of embossing or blind tooling, black or colour printing, and gilding; and the machines in which the work is done are the same in principle. They are powerful presses, worked either by long lever handles or by power with heavy fly-wheels. Blind patterns, or gilded work and titling, are done at one operation, the dies containing the pattern being heated either with steam or gas. In the case of ornaments to be printed in ink, the pattern is first blocked in the blind with a heated die, and subsequently ink-printed in the same press with the die cold.

The gathering, collating, and stitching of the sheets differ in no way from the same processes already described for leather work. Machinery has been adapted for folding, but, for the working of folding-machines, guide points require to be printed on the sheets, as books must be folded by the type and not by the edge of the sheet. A machine of American origin, besides folding 8vo sheets, will cut, fold, and insert the half sheet of a 12mo. This machine, attended by a single girl, is sufficient to fold from 1200 to 1500 sheets in an hour. The folded sheets are sometimes condensed in another American machine called "The Smasher," which is similar in its action to the embossing press. After stitching, books which are to be cased up with uncut edges have their face and tail cut square by means of a trimming-machine. The principle of this machine consists in a revolving circular knife driven with a treadle or handle; a table (containing the gauge, press bar, and rest), upon which the books are placed, glides across the axis of the knife, and the parts requiring cutting off, coming in contact with the revolving knife, are cut away. When the edges are to be gilt they are cut in some of the numerous forms of guillotine cutting-machines. The comonest form of guillotine is a heavy knife fixed in a strong framework, and having a diagonal motion in its descent by which it cuts with a kind of shearing action. In another machine the knife acts with a punching motion, and cuts the three edges in one descent; and there is in use a most ingenious American machine, with a revolving table, in which each edge of the book is in succession drawn in a slanting direction up against a fixed cutter. The edges are gilt as in ordinary binding, but instead of each volume being operated on singly, a number are placed evenly in a lying press and gilt simultaneously.

After trimming or gilding, as the case may be, the backs are glued up, and when dry they are rounded, generally with the hammer. Several machines have been devised to perform this operation, and one patented in 1865 by Messrs Cope and Bradbrook has come into extensive use. In this machine the book is clamped up between a pair of horizontal cheeks on a table which moves backwards and forwards under a heavy roller adjusted in a frame over the table. The pressure of the roller against the back gives the required "round," which can be varied by raising or lowering the pitch of the roller. From the rounding process the volume goes to the backing-machine, by which the joint or groove along the back in which the boards lie is formed. The backing-machine is worked by the hand, and its action is somewhat similar to that of the rounding-machine. The book is seized between a pair of jaws, which only leave about a quarter of an inch projecting above them. The workman brings down a roller on this projecting part of the volume, and its pressure forces the free portion of end sheets over the sides of the jaws, thus forming the joint to receive the boards. With the backing the part of the work done by machinery ends. The backs are next coated with glue, pieces of calico for pasting down are laid on, and the entire back is covered with paper. When dry, the volume is fitted into its cases and "pasted up," and the operations are finished by piling the cased books in a hydraulic press between boards, so as to leave only the backs projecting.

A kind of binding in which the process of sewing is dispensed with, and the backs coated with a rapidly-drying solution of india-rubber, was patented by Mr William Hancock in 1836, and is still used to some extent. The sheets in this binding must either be cut into single leaves or folded as folios, as they all require to be agglutinated by repeated coatings of the india-rubber solution. The india-rubber backing is convenient for volumes of plates, music books, and any volumes made up of large separate sheets.

Although cloth casing is found sufficient for the greater proportion of the literature which now circulates so extensively, books of reference and works in public libraries require the more secure and workmanlike binding accomplished by hand. At the same time, while ornaments stamped from dies may be very pretty and effective, they have no claim to rank as works of art, and for the collections of bibliophiles the hand-tooling of bibliopegic artists is in as great demand and as handsomely remunerated as was the art of the most accomplished binders of the 16th century. (J. PA.)

BOOK-KEEPING.—The object of book-keeping is to exhibit a distinct and correct state of one's affairs, and to enable companies, firms, and individuals in trade, or otherwise occupied, to ascertain at any time the nature and extent of their business, the amount of their profits or available income, or, as the case may be, the extent of their losses.

To those engaged in trade or commercial pursuits book-keeping is absolutely necessary, as by it all transactions should be regulated, and their results exhibited. The more simple the system the better; but care must be taken that the plan adopted is sufficiently comprehensive and explanatory, to satisfy not only the person keeping the books, but those who may have occasion to refer to them; for, however satisfactory it may be to a trader to follow a system which is intelligible to himself alone, circumstances might arise to render the inspection of others necessary, and from their inability to follow out transactions in the books, suspicions would probably be engendered for which there was no real foundation. Hence the necessity for the adoption of certain recognized and approved systems, which, being plain and easily understood, must prove satisfactory to all concerned.

Book-keeping, when conducted upon sound principles, is invaluable; it not only shows the general result of a commercial career, but admits of analysis, by which the success or failure, the value or utter worthlessness of its component parts, or each particular transaction, can be easily ascertained. In a word, on the one hand it promotes order, regularity fair dealing, and honourable enterprise; on the other, it defeats dishonesty, and preserves the integrity of man when dealing with his fellows.

It would be difficult, and perhaps of little importance, to trace the origin of book-keeping. It was certainly known to the ancients (see Pliny, lib. ii. cap. 7); and Cicero seems to have had bill transactions between Rome and Athens when he arranged for his son's education without the necessity of having to remit money (see *Epis. ad Att.* xii. 24; xv. 25), which infers some kind of book-keeping. Kelly, however, who wrote on the subject in 1805, asserts, and it is not disputed, that a friar, named Lucas di Borgo, whose work on algebra was the first to appear in print, was the first to write a treatise upon book-keeping, and this was published at Venice in 1495.

This work was followed by many others, possessing considerable merit, but so complex as to make them useless. After a time the mercantile community became alive to the fact that a practical system would be preferable to the theoretical suggestions of writers who were utterly ignorant of commercial matters; and men, more or less connected with trade, began to write on the subject. The incubus of prolixity, however, still clung to them, conciseness of style seeming an impossibility, and the great fundamental principles of the art were so smothered by rules and explanations—the volumes sometimes containing 500 or 600 pages—that the difficulty was how to apply them; hence the need of still greater simplicity and improvement.

In 1796 Mr E. T. Jones of Bristol devised a plan "for keeping books correctly," breaking the ice with a treatise which is still held in very high estimation. After that a great improvement is visible in the writings of authors on this important subject, as in those of Benjamin Booth (1789), Hamilton (1820), Jones (2d treatise, 1821. 3d treatise, 1831), C. Morrison (1823), W. and R. Chambers, Edinburgh,—the most of them, those of Jones excepted, being elementary works, more particularly adapted to schools, and illustrating the principles of the science by the example of one set of books adapted to foreign trade. In F. H. Carter's *Practical Book-keeping, adapted to Commercial and Judicial Accounting* (3d ed. 1875), which gives a great variety of forms and sets of books, the recognized

systems of book-keeping are practically applied, so as to enable any one, without difficulty, to acquire a thorough knowledge of the science.

The questions to which a satisfactory system of book-keeping gives the trader ready and conclusive answers are such as relate—1. To the extent to which his capital and credit will entitle him to transact business; 2. To the assurance he has that all his obligations are honestly fulfilled; 3. To the ascertainment of the success or failure of his commercial dealings, and the position of his affairs from time to time.

There are three recognized systems of book-keeping, namely, by "single entry," "double entry," and the "mixed method."

I. SINGLE ENTRY.—This system is denoted by its name, transactions being posted singly, or only once, in the ledger. Three books are generally kept—the cash book, day book, and ledger, although the first-named is not essential, the cash entries being passed through the day book. Its only use is to check the balance of cash in hand. In the day book are entered daily all the purchases and sales, whether for cash or credit; and all the credit entries are then transferred to accounts opened in the ledger, that is, all goods sold on credit are charged against the customers, and what are purchased are carried to the credit of parties supplying them. In the same way, when cash is received from a customer for goods sold on credit, it is posted to his account, and the reverse entry is made when a trader pays for the goods he has bought. Thus it will be seen that only personal accounts are entered in the ledger.

To frame a balance sheet, or state of affairs, on this system, the book-keeper brings down the balances due by customers to him, also his stock of goods as valued, and the cash he may have in hand, on the *left-hand side* of the sheet; whilst on the *right-hand side* he enters the balances still due by him for goods supplied, or money lent to him, and the capital, if any, with which he commenced business. The difference between the amounts of the two columns is either profit or loss; if profit, the merchant's capital is increased to that extent, and if loss, then he is so much the poorer.

The following skeleton balance sheet will give a better idea of the working and ultimate results of the system:—

Balance Sheet by Single Entry.

Assets.	£	s.	d.	*Liabilities.*	£	s.	d.
To Sundry Customers for Goods sold, per List	216	10	0	By sundry Tradesmen for Goods supplied, per List	184	7	8
,, Goods in Stock, per Inventory and Valuation	314	9	6	,, Capital put into the Business	300	0	0
,, Cash in hand	3	4	9		484	7	8
				,, Profit on Business to date	49	16	7
	534	4	3		534	4	3

It will be observed that as the assets exceed the liabilities (including capital) by £49, 16s. 7d., that sum, being profit, must be added to capital; if, in the next or following years, any loss should emerge, as a matter of course such deficiency must be deducted from the trader's capital. The advantages of single entry are simplicity and easy adaptation to small retail trades, as the ledger contains only outstanding debts due to or by the trader. The disadvantage is in the difficulty of ascertaining the profits or losses on various goods, or on the several departments of a business.

II. DOUBLE ENTRY.—It is now universally admitted that this system is the best adapted for heavy, responsible, or speculative trades, for foreign trade especially, and for extensive mercantile concerns. As its name implies, it so far differs from the system already described, that every transaction must be recorded doubly in the ledger, that is to say, accounts must be opened in that book, to which all entries in the subsidiary books, after being journalized, are twice carried, to the debit of one account and the credit of another. To illustrate this, let us assume that a merchant speculates in cotton, and purchases so many bales from John Bevan and Co. upon credit; he debits "Cotton account," and credits "John Bevan and Co." He does not pay for it in cash, but gives his bill at three months for the amount; John Bevan and Co. are debited with the bill, and "Bills Payable" are credited. He then sells the whole lot of cotton for cash to Cairns, Brown, and Co., debiting "Cash" and crediting "Cotton account." Lastly, he retires or pays the bill granted to John Bevan and Co., debits "Bills Payable," and credits "Cash." We will now put all these transactions into a "journal," posting therefrom to a "ledger," and so illustrate book-keeping by double entry.

Dates.	JOURNAL.	Dr. £	s.	d.	Cr. £	s.	d.
1875. June 4	Cotton Account	2349	0	0			
,,	To John Bevan and Co., Charleston	..			2349	0	0
	For Bales, @ , *ex* "Mary Jane."						
June 6	John Bevan and Co	2349	0	0			
,,	To Bills Payable	..			2349	0	0
	For our acceptance, No. 136, @ 3m/., due 6/9 Sept., at County Bank.						
June 17	Cash Account	3200	0	0			
,,	To Cotton Account				3200	0	0
	For Bales, @ , sold to Cairns, Brown, and Co., Manchester.						
Sept. 9	Bills Payable	2349	0	0			
,,	To Cash	...			2349	0	0
	For Bill, No. 136, retired at County Bank.						
Sept. 30	Cotton Account	851	0	0			
,,	To Profit and Loss Account	...			851	0	0
	For Profit on Cotton, *ex* "Mary Jane."						
		11,098	0	0	11,098	0	0

LEDGER ACCOUNTS.

Dr.	COTTON ACCOUNT.					Cr.
1875.		£ s. d.	1875.		£ s. d.
June 4	To J. Bevan and Co., for Bales, *ex* "Mary Jane"	2349 0 0	June 17	By Cash for Bales, sold to Cairns, Brown, and Co.	3200 0 0
Sept. 30	,, Profit and Loss, for gain	851 0 0			
		3200 0 0			

Dr.	JOHN BEVAN AND CO., Charleston.				Cr.
1875.		£ s. d.	1875.		£ s. d.
June 6	To Bills payable, No. 136, due 6/9 Sept., County Bank	2349 0 0	June 4	By Cotton, per "Mary Jane," Bales, @	2349 0 0

Dr.	BILLS PAYABLE.				Cr.
1875.		£ s. d.	1875.		£ s. d.
Sept. 9	To Cash, No. 136. retired	2349 0 0	June 6	By John Bevan and Co., No. 136, due 6/9 Sept., County Bank	2349 0 0

Dr.	CASH ACCOUNT.				Cr.
1875.		£ s. d.	1875.		£ s. d.
June 17	To Cotton Account, Cairns, Brown, and Co.	3200 0 0	Sept. 9	By Bills payable, No. 136, retired at County Bank	2349 0 0
			,, 30	Balance	851 0 0
					3200 0 0

Dr.	PROFIT AND LOSS.				Cr.
			1875.		£ s. d.
			Sept. 30	By Gain on Cotton, *ex* "Mary Jane"	851 0 0

Dr.	BALANCE SHEET, 30th September, 1875.				Cr.
		£ s. d.			£ s. d.
	To Cash in hand	851 0 0		By P. and L.	851 0 0

It may be alleged that there are many unnecessary entries, involving too much trouble and waste of time, in bringing out the above results; but upon examination of the several accounts the great simplicity and utility of double entry is evident. For instance, "Cotton" account shows the actual result of the speculation per "Mary Jane;" "John Bevan and Co.'s" account exhibits the whole transaction with them, and how it was settled; "Bills Payable" account at once shows that the cotton bill is retired or paid; and "Cash" account declares a balance of £851 in cashier's hands, being the actual profit on the cotton, as further shown in "Profit and Loss" account.

An infinity of examples might be given, but the above will be a sufficient illustration. A brief outline, however, of the principal books required in this system may be introduced.

1. The CASH BOOK.—In this most important book every cash transaction must be entered of its proper date, and under its distinctive ledger heading, so as to give facility in journalizing; any balance thereon must be cash in hand, and should agree with the balance on "Cash account" in the ledger.

2. The DAY or WASTE BOOK.—This book records the daily transactions of every description in the rough, which, when properly arranged and classified, are written into the journal, and posted from thence to the ledgers.

3. The JOURNAL.—This may be called the mainspring of the system, and is sometimes called the "*posting medium*," as in it every transaction of the business is properly recorded before being again distributed into the ledger. There are several forms of journal, but the simplest and best is that of which a specimen has been given, with the addition of a column for the insertion of ledger folios when posted. It will be observed that the debit entries are in one column and the credit entries in another; if, therefore, the summations of these agree, and the entries therein embraced are correctly posted to the debit and credit of accounts in the ledger, the double entry is correct, and the books of the concern, no matter how multitudinous the entries may be, must come to a true balance.

The LEDGERS.—These are important books, as they are the final recipients of every transaction of the concern, branched out or distributed into certain heads or accounts which tell their own history; and if unbalanced, must exhibit a difference either in favour of the business as an "Asset," or against it as a "Liability." The usual plan is to have only one ledger, embracing every account, but in large concerns there are debit and credit ledgers, and generally a private ledger, which is accessible to partners only.

The advantages of double entry are many—(1.) Unless the debit balances exactly correspond with the credits the books are wrong, and the error must be discovered by comparison; (2.) The discovery of such errors is more easily accomplished than in any other system; (3.) Accounts can be readily analyzed; and (4.) The profit or loss on distinct transactions can be ascertained without difficulty. The disadvantages are—(1.) More manual labour required in transcribing the journal and posting therefrom than in other systems; and (2.) There is not the same privacy, as profits and losses can be seen at a glance by any one having access to the ledger. Nevertheless, no other system as yet devised can at all compare with that by double entry.

III. MIXED METHOD.—This system is now extensively adopted by such companies and firms as begrudge the time expended in journalizing, and are of opinion that double entry is too elaborate, when the same results can be arrived at by a more direct and less laborious plan. There is this identity, however, between the systems, that every transaction must be recorded somewhere, and eventually twice posted, as in double entry, but without the medium of a journal; moreover, the entries are fewer, summations and not specific items being posted, and what would be the daily labour under one system is reserved under this for a monthly or perhaps longer period. There are only three books required for this system to which we need draw attention, and in doing so we will point out in what respect they differ from those kept in single and double entries.

1. CASH BOOK.—Every entry is posted from this book, but not all to the ledger as in double entry—"Charges" being posted to the day book. It is not journalized, and is in itself a ledger, as it contains the bank account, and reports its own cash balance. On the other hand, it is unlike the "Cash" of single entry, because every entry is posted somewhere, whereas by the latter system only personal accounts are carried to the ledger.

2. DAY BOOK.—This book also exhibits a marked difference between the journal of double entry and the day book of single entry. The journal is simply a posting medium, and when its use is served is almost valueless. The single entry day book, on the other hand, is only a posting medium to a certain extent, as it does not embrace all transactions; but in this system the day book unites the characteristics of journal and ledger, and also becomes in itself a profit and loss account, as by deducting the amount of charges from the amount of the business fees (say for solicitors' books) the profit on said business is shown.

3. The LEDGERS.—These books also lose their completeness under the mixed method. It has already been shown that in double entry every amount must appear in the ledger, and in single entry that only personal accounts are posted in it. By this system not only are all personal accounts included, but those applicable to "Capital," to "Banks," "Bills," &c.; whilst, on the other hand, such accounts as "Profit and Loss," "Charges," and "Cash" are excluded.

It would be out of place here to dwell on the many intricacies of this subject, or on the difficulties which are constantly presenting themselves even to the most practical men. With a thorough knowledge of the art, however, and that patience and perseverance so essential to the calling of a book-keeper, the gravest impediments are overcome, and everything becomes simple and plain. Our sole object having been to show the utility of book-keeping as a science, and the peculiar features of existing systems with their advantages and disadvantages, it is unnecessary to enter more minutely into details by describing subsidiary books or forms of accounts, as these are only so many materials out of which the fabric of book-keeping is erected, and can be seen in any counting-house or mercantile establishment where regular systems are adopted. (F. H. C.)

BOOLE, GEORGE, one of the most original logicians and mathematicians whom England has produced, was born in Lincoln on the 2d of November 1815. His father was a tradesman of limited means, but of studious character and active mind. Being especially interested in mathematical science the father gave his son early instruction in the rudiments of the science he was so greatly to advance; but it is remarkable that the extraordinary mathematical powers of George Boole did not manifest themselves in early life. The classical languages formed at first the favourite subject of his studies. Not until the age of seventeen years did he attack the higher mathematics, and his progress was much retarded by the want of efficient help.

When about sixteen years of age he became assistant-master in a private school at Doncaster, and he maintained himself to the end of his life in one grade or other of the scholastic profession. Few distinguished men, indeed, have had a less eventful life. Almost the only changes which can be called events are his successful establishment of a school at Lincoln, its removal to Waddington, his appointment in 1849 as professor of mathematics in the Queen's College at Cork, and his marriage in 1855 to Miss Mary Everest.

To the public Boole was known only as the author of numerous abstruse papers on mathematical topics, and of three or four distinct publications which have become standard works. His earliest published paper was one upon the "Theory of Analytical Transformations," printed in the *Cambridge Mathematical Journal* for 1839, and it led to a friendship between Boole and D. F. Gregory, the editor of the journal, which lasted until the premature death of the latter in 1844. A long list of Boole's memoirs and detached papers, both on logical and mathematical topics, will be found in the *Catalogue of Scientific Memoirs* published by the Royal Society, and in the supplementary volume on *Differential Equations*, edited by Mr Todhunter. To the *Cambridge Mathematical Journal* and its successor, the *Cambridge and Dublin Mathematical Journal*, Boole contributed in all twenty-two articles. In the third and fourth series of the *Philosophical Magazine* will be found sixteen papers. The Royal Society printed six important memoirs in the *Philosophical Transactions*, and a few other memoirs are to be found in the *Transactions of the Royal Society of Edinburgh* and of the *Royal Irish Academy*, in the *Bulletin de l'Académie de St Pétersbourg* for 1862 (under the name G. Boldt, vol. iv. pp. 198–215), and in *Crelle's Journal*. To these lists should be added a paper on the mathematical basis of logic, published in the *Mechanic's Magazine* for 1848. The works of Boole are thus contained in about fifty scattered articles and a few separate publications.

Only two systematic treatises on mathematical subjects were completed by Boole during his lifetime. The well-known *Treatise on Differential Equations* appeared in 1859, and was followed, the next year, by a *Treatise on the Calculus of Finite Differences*, designed to serve as a sequel to the former work. These treatises have become the standard text-books on the important branches of mathematics in question, and Boole, in composing them, seems to have combined elementary exposition with the profound investigation of the philosophy of the subject in a manner hardly admitting of improvement. To a certain extent these works embody the more important discoveries of their author. In the 16th and 17th chapters of the *Differential Equations* we find, for instance, a lucid account of the general symbolic method, the bold and skilful employment of which led to Boole's chief discoveries, and of a general method in analysis, originally described in his famous memoir printed in the *Philosophical Transactions* for 1844. Boole was one of the most eminent of those who perceived that the symbols of operation could be separated from those of quantity and treated as distinct objects of calculation. His principal characteristic was perfect confidence in any result obtained by the treatment of symbols in accordance with their primary laws and conditions, and an almost unrivalled skill and power in tracing out these results.

During the last few years of his life Boole was constantly engaged in extending his researches with the object of producing a second edition of his *Differential Equations* much more complete than the first edition; and part of his last vacation was spent in arduous study in the libraries of the Royal Society and the British Museum for the purpose of acquiring a complete knowledge of the less accessible original memoirs on the subject. It must be always a matter of regret that this new edition was never completed. Even the manuscripts left at his death were so incomplete that Mr Todhunter, into whose hands they were put, found it impossible to use them in the publication of a second edition of the original treatise, and wisely printed them, in 1865, in a supplementary volume.

Profound and important as were Boole's discoveries in pure mathematics, his writings on logic may be considered as still more original. With the exception of De Morgan, he was probably the first English mathematician since the time of Wallis who had also written upon logic; and his wholly novel views of logical method were due to the same profound confidence in symbolic reasoning to which he had successfully trusted in mathematical investigation. From the preface to his *Mathematical Analysis of Logic*, printed as a separate tract in 1847, we learn that speculations concerning a calculus of reasoning had at different times occupied Boole's thoughts, but it was not till the spring of 1847 that a memorable logical controversy led him to put his ideas into a definite form. Boole afterwards regarded this pamphlet as a hasty and imperfect exposition of his

logical system, and he desired that his much larger work, *An Investigation of the Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities*, published in 1854, should alone be considered as containing a mature statement of his views. Nevertheless, there is a charm of originality about his earlier logical work which no competent reader can fail to appreciate, and the introduction gives striking evidence of his profound views and wide reading.

It is not easy to give in a few words a correct notion of Boole's logical system, and only those who are conversant with the principles of symbolical reasoning can exactly apprehend his position. He did not regard logic as a branch of mathematics, as the title of his earlier pamphlet might be taken to imply, but he pointed out such a deep analogy between the symbols of algebra and those which can be made, in his opinion, to represent logical forms and syllogisms, that we can hardly help saying that logic is mathematics restricted to the two quantities, 0 and 1. By unity Boole denoted the universe of thinkable objects; literal symbols, such as x, y, z, v, u, &c., were used with the elective meaning attaching to common adjectives and substantives. Thus, if x = horned, and y = sheep, then the successive acts of election represented by x and y, if performed on unity, give the whole of the class *horned sheep*. Boole showed that elective symbols of this kind obey the same primary laws of combination as algebraical symbols, whence it followed that they could be added, subtracted, multiplied, and even divided, almost exactly in the same manner as numbers. Thus, $1 - x$ would represent the operation of selecting all things in the world except *horned things*, that is, *all not horned things*, and $(1 - x)(1 - y)$ would give us *all things neither horned nor sheep*. By the use of such symbols propositions could be reduced to the form of equations, and the syllogistic conclusion from two premises was obtained by eliminating the middle term according to ordinary algebraic rules.

Still more original and remarkable, however, was that part of his system, fully stated in his *Laws of Thought*, which formed a general symbolic method of logical inference. Given any propositions involving any number of terms, Boole showed how, by the purely symbolic treatment of the premises, to draw any conclusion logically contained in those premises. The second part of the *Laws of Thought* contained a corresponding attempt to discover a general method in probabilities, which should enable us from the given probabilities of any system of events to determine the consequent probability of any other event logically connected with the given events. Soon after its publication this method was the subject of a controversy in the *Philosophical Magazine*; but it cannot be said that the exact value of this part of his works has ever been clearly ascertained.

It is often supposed that mathematicians are deficient in judgment and knowledge of other matters. In Boole this was not the case; for though he published little except the mathematical and logical works already mentioned, his acquaintance with general literature was wide and deep. Dante was his favourite poet, and he preferred the *Paradiso* to the *Inferno*. The metaphysics of Aristotle, the ethics of Spinoza, the philosophical works of Cicero, and many less celebrated works of a kindred character, were also frequent subjects of study. His reflections upon scientific, philosophical, and religious questions are to be mainly gathered from four addresses upon *The Genius of Sir Isaac Newton, The Right Use of Leisure, The Claims of Science*, and *The Social Aspect of Intellectual Culture*, which he delivered and printed at different times.

The personal character of Boole inspired all his friends with the deepest esteem. He was marked by the modesty of true genius, and his life was given to the single-minded pursuit of truth. Though he received a royal medal for his memoir of 1844, and the honorary degree of LL.D. from the University of Dublin, it may be said that he neither sought nor received the ordinary rewards to which his discoveries would entitle him.

On the 8th of December 1864, in the full vigour of his intellectual powers, Boole died of an attack of fever, ending in suffusion on the lungs. An excellent sketch of his life and works, by the Rev. R. Harley, F.R.S., to which the present writer is indebted for many particulars, is to be found in the *British Quarterly Review* for July 1866, No. 87. (W. S. J.)

BOOM, a town of Belgium, in the province of Antwerp, and 12 miles S. of that city, at the junction of the Brussels Canal with the River Rupel. It is an active industrial town, possessing tanneries, salt-works, starch-factories, breweries, and brick and tile works, and carries on a considerable trade. Population of the commune, 10,064.

BOOMERANG, a missile instrument of the Australian aborigines, in the use of which they are very dexterous. It consists of a piece of hard wood, with the curve of a parabola, and is about 2 feet long, $2\frac{1}{2}$ inches broad, $\frac{1}{3}$ inch thick, and rounded at the extremities. One side is flat, the other is rounded, and it is brought to a bluntish edge. It is discharged with the hand by one end, the convex edge being forward and the flat side upwards. After advancing some distance, and ascending slowly in the air with a quick rotatory motion, it begins to retrograde, and finally falls to the ground behind the thrower. A weapon of similar form, but wanting the return flight, has been found in use among savage tribes both in India and Africa. A very full comparative account of the boomerang is contained in Colonel A. H. Lane Fox's lecture on "Primitive Warfare" (*Jour. of the Royal United Service Institution*, vol. xii. No. 51).

BOOTH, Barton, an English tragedian, descended from an ancient family in Lancashire, was born in 1681. He was educated at Westminster school under the celebrated Dr Busby, and his success in the Latin plays, customarily performed there by the scholars, gave him an inclination for the stage. He was intended for the church; but at seventeen years of age he ran away from school, and after some vicissitudes obtained employment in a theatrical company in Dublin. His first appearance was hailed with applause; and he continued to improve daily. After two successful campaigns in Ireland he returned to his native country, having first reconciled himself to his friends. Betterton, to whom he had an introduction, received him with great cordiality, and gave him all the assistance in his power. His success at London was complete, and he established his reputation as only second to his great instructor. He was indebted to a happy coincidence of merit and chance for the celebrity which he at length attained in the character of Cato. The Whigs, in favour of whose principles Addison's tragedy had been written, thought it their duty to support it strongly; while the Tories, at every passage susceptible of a popular turn, were no less vehement in their approbation, and at the close the actor was presented by Lord Bolingbroke with a purse of fifty guineas, "as a slight acknowledgment of his honest opposition to a perpetual dictator, and his dying so bravely in the cause of duty." Booth was twice married,—first to a daughter of Sir William Barkham, Bart., and afterwards to Miss Hester Santlow, an actress of great merit. During the twenty years of his management the theatre was in the greatest credit; and his death, which happened on the 10th of May 1733, contributed not a little to its decline. Booth was a man of excellent character, and greatly esteemed for his amiability and goodness of heart

(See *Memoirs of the Life of Barton Booth*, 1733; Cibber, *Lives and Characters of the most Eminent Actors*, &c., pt. i., 1753.)

BOOTHIA FELIX, a peninsula of British North America, between lat. 69° and 72° N., and long. 92° and 97° W. It was discovered by Captain (afterwards Sir James) Ross, in 1830, and was named after Sir Felix Booth, who had fitted out the expedition. It forms the western side of the gulf of the same name into which Prince Regent's Inlet leads from Baffin's Bay. From the American shore it is almost separated by lakes and inlets; and a narrow channel known as Bellot Strait intervenes between it and North Somerset Island, which was discovered by Sir E. Parry in 1819. The peninsula is not only interesting for its connection with the Franklin expedition and the Franklin search, but is of scientific importance from the north magnetic pole having been first distinctly localized there by Ross.

BOPP, Francis, glottologist, was born at Mainz on the Rhine, September 14, 1791. In consequence of the political troubles of that time, his parents removed to Aschaffenburg, in Bavaria, where Francis received a liberal education at the Lyceum. It was here that his attention was drawn to the languages and literature of the East by the eloquent lectures of Carl J. Windischmann, who, with Creuzer, Görres, and the brothers Schlegel, was full of enthusiasm for Indian wisdom and philosophy. And further, Fr. Schlegel's book, *Ueber die Sprache und Weisheit der Inder* (Heidelberg, 1808), which was just then exerting a powerful influence on the minds of German philosophers and historians, could not fail to stimulate also Bopp's interest in the sacred language of the Hindus. He was, however, too strictly trained in grammatical and philological studies, and too eager for the scientific analysis of language, to allow the clearness of his judgment to be warped by the romantic and speculative predilections of Windischmann and Fr. Schlegel. In 1812 he went to Paris at the expense of the Bavarian Government, with a view to devote himself vigorously to the study of Sanskrit. There he enjoyed the society of such eminent men as Chézy, S. de Sacy, Langlès, and, above all, Al. Hamilton, who had acquired, when in India, a respectable acquaintance with Sanskrit, and had brought out, conjointly with Langlès, a descriptive catalogue of the Sanskrit manuscripts of the Imperial library. At that library Bopp had access not only to the rich collection of Sanskrit manuscripts, most of which had been brought from India by Father Pons early in the 18th century, but also to the Sanskrit books which had up to that time issued from the Calcutta and Serampore presses.

The first fruit of his four years' study in Paris appeared at Frankfort-on-the-Main in 1816, under the title *Ueber das Conjugationssystem der Sanskritsprache in Vergleichung mit jenem der Griechischen, Lateinischen, Persischen, und Germanischen Sprache*, and it was accompanied with a preface from the pen of Windischmann, bearing date 16th May of that year. In this first book, Bopp entered at once on the path on which the philological researches of his whole subsequent life were concentrated. It was not that he wished to prove the common parentage of Sanskrit with Persian, Greek, Latin, and German, for that had long been established; but his object was to trace the common origin of their grammatical forms, of their inflexions from composition,—a task which had never been attempted. By a historical analysis of those forms, as applied to the verb, he furnished the first trustworthy materials for a history of the languages compared.

After a brief sojourn in Germany, Bopp came to London, where he made the acquaintance of Wilkins and Colebrooke, and became the friend of Wilhelm von Humboldt, then Prussian ambassador at the court of St James's, to whom he gave instruction in Sanskrit. He brought out, in the *Annals of Oriental Literature* (London, 1820, pp. 1–65), an essay entitled "Analytical Comparison of the Sanskrit, Greek, Latin, and Teutonic Languages," in which he extended to all parts of the grammar what he had done in his first book for the verb alone. He had previously published a critical edition, with a Latin translation and notes, of the story of *Nala and Damayantî* (London, 1819), the most beautiful episode of the Mahâbhârata, which he had with genial tact culled from the tangled labyrinth of that gigantic epic. Other episodes of the Mahâbhârata—*Indralokâgamanam*, and three others, Berlin, 1824; *Diluvium*, and three others, Berlin, 1829; and a new edition of *Nala*, Berlin, 1832—followed in due course, all of which, with A. W. Schlegel's edition of the *Bhagavadgîtâ*, 1823, proved excellent aids in initiating the early student into the reading of Sanskrit texts. On the publication, in Calcutta, of the whole Mahâbhârata, Bopp discontinued editing Sanskrit texts, and confined himself thenceforth exclusively to grammatical investigations.

After a short residence at Göttingen, Bopp was, on the recommendation of W. von Humboldt, appointed to the chair of Sanskrit and comparative grammar at Berlin in 1821, and was elected member of the Royal Prussian Academy in the following year, both which posts he held up to his death, Oct. 23, 1867. In his quality as Sanskrit professor he brought out, in 1827, his *Ausführliches Lehrgebäude der Sanskrita-Sprache*, on which he had been engaged since 1821. A new edition, in Latin, was commenced in the following year, and completed in 1832. A shorter grammar (*Kritische Grammatik der Sanskrita-Sprache in kürzerer Fassung*) has run through three editions (Berlin, 1834, 1845, 1863). At the same time he compiled a Sanskrit and Latin glossary (1830) in which, more especially in the second and third editions (1847 and 1867), account has also been taken of the cognate languages. His chief activity, however, centred on the elaboration of his *Comparative Grammar*, which appeared in six parts at considerable intervals (Berlin, 1833, 1835, 1842, 1847, 1849, 1852; 1511 pages in small 4to), under the title *Vergleichende Grammatik des Sanskrit, Zend, Griechischen, Lateinischen, Litthauischen, Altslavischen, Gothischen, und Deutschen*. How carefully this work was matured may be gathered from the series of monographs printed in the *Transactions of the Berlin Academy* (1824 to 1831), by which it was preceded. They bear the general title, *Vergleichende Zergliederung des Sanskrits und der mit ihm verwandten Sprachen*. Two other essays (on the "Numerals," 1835) followed the publication of the first part of the *Comparative Grammar*. The Old-Slavonian began to take its stand among the languages compared from the second part onwards. At the instance of the earl of Ellesmere (then Lord Francis Egerton) the work was translated into English by Mr E. B. Eastwick (3 vols., 1845; second edition, 1854). A second German edition, thoroughly revised (3 vols., 1856–1861), comprised also the Old-Armenian. From this edition an excellent French translation was made by Professor Michel Bréal, which came out in 5 vols. in 1866, *ff*. A third German edition has been published since the author's death, in 1871, *ff*.

The task which Bopp endeavoured to carry out in his *Comparative Grammar* was threefold,—to give a description of the original grammatical structure of the languages as deduced from their intercomparison, to trace their phonetic laws, and to investigate the origin of their grammatical forms. The first and second points were subservient to the third. As Bopp's researches were based on the best available sources, and incorporated every new item of information that came to light, so they continued to widen and deepen in their progress. Witness his monographs on the vowel system in the Teutonic languages (1836), on the Celtic