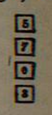
anger. After the return of the Greeks from Troy he is said to have retired to Colophon. According to the story, his death was due to chagrin at being surpassed in a trial of soothsaying skill by one Mopsus. It had long been predicted that he should die whenever he met his superior in divination.

CALCULATING MACHINES. Mathematicians and astronomers have felt in all ages the irksomeness of the labour of making necessary calculations, and this has led to the invention of various devices for shortening it. Some of these, such as the Abacus, Napier's Bones (invented by the father of logarithms), and the modern Sliding Rule, are rather aids to calculation than calculating machines. Pascal is believed to have been the original inventor of a calculating machine; its use was limited to addition, multiplication, &c., of sums of money, and as it required the constant intervention of a human operator the results were subject to the ordinary errors of manipulation. After him came the celebrated Leibnitz, Dr Saunderson, who, blind from his childhood, became professor of mathematics in Cambridge, and others. But all their machines were completely cast into the shade by the wonderful inventions of the late Charles Babbage. He knew well the immense value that absolutely correct tables possess for the astronomer and the navigator, and that a machine which could produce them with speed was a very great desideratum. The first calculating machine he invented he called a difference engine, because it was to calculate tables of numbers by the method of differences. By setting at the outset a few figures the attendant would obtain by a mechanical operation a long series of numbers absolutely correct. The difference engine was not intended to answer special questions, but to calculate and then print numerical tables, such as logarithm tables, tables for the *Nautical Almanac*, &c. An interesting account of some of the errors which are found in what are considered reliable tables is given in a paper by Babbage in the *Memoirs of the Astronomical Society*, 1827.

Every numerical table consists of a series of numbers which continuously increase or diminish. As an example take the squares of the natural numbers, 1, 4, 9, 16, 25, 36, &c. Designate this series by N. If we subtract each term from the one following it we get a new series, 3, 5, 7, 9, &c., which is called the series of first differences; designate this by Δ^1. If in the same way we subtract each term of this series from the succeeding term, we get what is called the series of second differences, every term of which is in this instance 2. Designate this series by Δ^2. As the different series were obtained by subtraction, it is quite evident that by reversing the process we shall obtain the original table. Suppose we are given the first terms of N, Δ^1, and Δ^2, *i.e.*, 1, 3, 2. If we add 3, the first term of Δ^1, to 1, the first term of N, we get 4, the second term of N; and if we add 2, the first term of Δ^2, to 3, the first term of Δ^1, we get 5, the second term of Δ^1; and this added to 4, the second term of N, gives us 9, the third term of N. Similarly we obtain 16 by adding 9, 5, and 2 together, and 25 by adding 16, 7, and 2. Hence, given 1, 3, 2, we can, by a process of additions, obtain the series of square numbers. All numerical tables can be calculated entirely by this method or by repetitions of it.

Table of Square Numbers, N	First Differences, Δ^1	Second Differences, Δ^2
1	3	2
4	5	2
9	7	2
16	9	
25		

The main characteristics of the difference engine, designed and partially constructed by Babbage, are these:— It consisted of several vertical columns of figure-wheels like large "draught men" one above another, to the number of six in each column. The natural numbers from 0 to 9 were cut on the rims of the figure wheels; hence each figure-wheel in a column could represent a digit. Thus the lowest wheel gave the units digit, the second wheel the tens digit. The number 5703 would be represented on the wheels of a column as in the margin. The different columns were to represent the successive series of differences above referred to, and were called the table column, the first difference column, &c.



"The mechanism was so contrived that whatever might be the numbers placed respectively on the figure wheels of each of the different columns, the following succession of operations took place as long as the handle was moved. Whatever number was found upon the column of first differences, would be added to the number found upon the table column. The same first difference remaining upon its own column, the number found upon the column of second differences would be added to that first difference." Similarly for all the other columns. For example, suppose we are calculating the cubes of the natural numbers. At a certain stage of the work we would find 125 shown by the wheels of the table column, 91 by those of the first difference column, 36 by those of the second difference column, and 6 on the lowest wheel of the third difference column. On making a turn of the handle the 91 would be added to the 125, which would then show 216; at the same time 36 would be added to the 91, so that the first difference column would then show 127; moreover 6 would be simultaneously added to the 36, which would thus become 42, and the 6 would remain unaltered. Another turn and we would get 343, 169, 48, 6 on the different columns. Had the engine been completed it would have had columns for six orders of differences, each of twenty places of figures, whilst the first three columns would each have had half a dozen additional figures.

	Table Column.	First Difference Column.	Second Difference Column.	Third Difference Column.
	1 2 5	 9 1	 3 6	 6
After one Turn ...	2 1 6	1 2 7	 4 2	 6
After two Turns...	3 4 3	1 6 9	 4 8	 6

It was about 1822 that Babbage having constructed a small model of his engine sent an account of it to Sir Humphrey Davy, then president of the Royal Society of London. Government heard of the invention, and, having received from the Royal Society a favourable report on the merits and utility of the engine, advanced money towards its construction. Sums of money were at irregular intervals voted for this purpose; but so great were the difficulties to be overcome, so entirely new even were many of the tools necessary, so much time was occupied in testing the value of each proposed contrivance, that in 1834 only a portion was completed. The construction of the machine here stopped, although the Royal Society had again, in 1829, reported most favourably on the engine as regards its practicability, immense utility, and the progress it had made. The Government had already advanced £17,000 (over and above what Babbage had spent, besides giving his personal superintendence without any remuneration), and they saw no definite limit to the amount it would cost; and Babbage had a delicacy in pressing for the completion of the difference engine, as he had recently designed a new machine, the analytical engine, which, if completed, would entirely supersede it. The portion completed is in King's College, London.

It will be noticed that the use of the difference engine was limited to the working of such problems as can be solved by successive additions or subtractions. The analytical engine, on the other hand, was designed to *work out* any problem that the superintendent knew *how* to solve. It consists of two parts, each of a number of vertical columns of figure wheels, similar to those of the difference engine; on the one set called the "variables," which we shall designate by V_1, V_2, &c., the numbers of the special problem or formula are placed; the other set is called the "mill," and performs the required operations of multiplication, division, addition, or subtraction. Its working was directed by means of two sets of cards—"operation" cards, which instructed the mill whether to multiply, divide, add, or subtract, and "variable" cards, which indicated to the mill the particular columns, *i.e.*, numbers on which it was to perform this operation. An example will make this clear. Suppose we wish to solve the equations

$$ax + by = c,$$
$$dx + fy = g.$$

On the wheels of V_1, the first column of the variables, the number a is placed, b on V_2, c on V_3, and so on. Six columns in all are required for this. It is evident that $x = \dfrac{fc - bg}{fa - bd}$. Hence, to get x, we require the products of f and c, b and g, &c. To get these the superintendent intimates to the mill by means of an "operation" card that a multiplication is to be performed, then points out by a "variable" card what are the two numbers, *i.e.*, the two columns to be multiplied, and on what column the result is to be placed. In the first case the columns indicated would be V_5, V_3, and V_7 respectively. By another operation card and another variable card, the mill would then be instructed to multiply the numbers on V_2 and V_6, and to place the result on V_8. Similarly ca and bd would be obtained on V_9 and V_{10}. The superintendent would then instruct the mill to subtract the number on V_8 from that on V_7, to place the result $(fc - bg)$ on V_{11}, and similarly, $fa - bd$ would be placed on V_{12}. By a new operation card the mill would now be put into a "dividing" state, and a variable card would tell it that V_{11} was to be divided by V_{12}, and the result given on V_{13}. This would be the value of x. Similarly for y. The number of cards can be greatly diminished. Thus, for the four multiplications one card would suffice. The cards are of pasteboard (say) and have holes punched in them,—a "multiplication" card having a certain number of holes bored in it and arranged in a particular way, a "division" card a different arrangement of holes, &c. The cards are so placed in the machine that certain levers drop through these holes, while others are unaffected, and the machinery in connection with the levers is put out of gear or not as is desired. In this way the mill is put into a condition in which it multiplies (say) the numbers indicated to it. The variable cards act in a similar manner. When an operation card and a variable card are given to the engine, the numbers on the assigned columns are transferred to the mill, the operation is performed, and the numbers and the result are placed on the proper columns. The series of cards used for any one problem would enable the machine to solve any other similar problem. Babbage says of the engine, "The analytical engine is therefore a machine of the most general nature. Whatever formula it is required to develop, the law of its development must be communicated to it by two sets of cards. When these have been placed the engine is special for that particular formula. The numerical constants must then be put on the wheels, and on setting the engine in motion it will calculate and print the numerical results of that formula." In the construction of this engine he overcame one of the greatest difficulties in such an instrument, that of effecting the carrying of tens. The engine was designed so as to foresee these carriages, and act upon that foresight, and thus a great reduction of the time necessary to make a given calculation was at once obtained by effecting all carriages simultaneously instead of in succession. He says of it, "The analytical engine will contain—1°, apparatus for printing on paper, one, or if required, two copies of its results; 2°, means for producing a stereotype mould of the table or results it computes. The engine would compute all the tables it would itself require. It would have the power of expressing every number to fifty places of figures." It would multiply two numbers of fifty figures each, and print the result in one minute. Its construction was never begun, but Babbage left complete plans of every part of it.

In the *Edinburgh Review* for July 1834 appeared an account of the principles of Babbage's difference engine. Herr George Scheutz, a printer at Stockholm, read it, and shortly afterwards he and his son Edward set about constructing a calculating machine. By 1843 they produced one capable of calculating series with terms of five figures, with three orders of differences, also of five figures each, and of printing its results. Provided with a certificate to this effect from the Royal Swedish Academy of Sciences, they endeavoured unsuccessfully to get orders for their machine. In 1853, with the aid of grants from the Swedish Government, the Messrs Scheutz finished a second machine which was exhibited in England, and at the Paris exhibition of 1855. It eventually went to America. It was about the size of a small square pianoforte. It could calculate series with four orders of differences each of fifteen figures. It printed the results to eight figures, the last of which was capable of an automatic correction where necessary for those omitted. "It could calculate and stereotype without a chance of error two and a half pages of figures in the same time that a skilful compositor would take to set up the types for one single page."

A new machine by the Messrs Scheutz was constructed about 1860 by Messrs Donkin for the Registrar-General for the sum of £1200. It has been used in the calculation of some of the tables in the *English Life Table*, published in 1864. Dr Farr says of it, "The machine has been extensively tried, and it has upon the whole answered every expectation. But it is a delicate instrument, and requires considerable skill in the manipulation. It approaches infallibility in certain respects; but it is not infallible, except in very skilful hands. The weakest point is the printing apparatus, and that admits of evident improvement."

M. Staffel and M. Thomas (de Colmar) have invented machines which can perform addition, subtraction, multiplication, division, and extraction of the square root. M. Thomas's machine is extensively used.

Sir William Thomson has recently invented an instrument (no description of which has yet been printed) which is able to solve any linear differential equation with variable coefficients.

Professor Tait has also invented the principle of a machine, which, if constructed, will integrate any linear differential equation of the second order with variable coefficients.

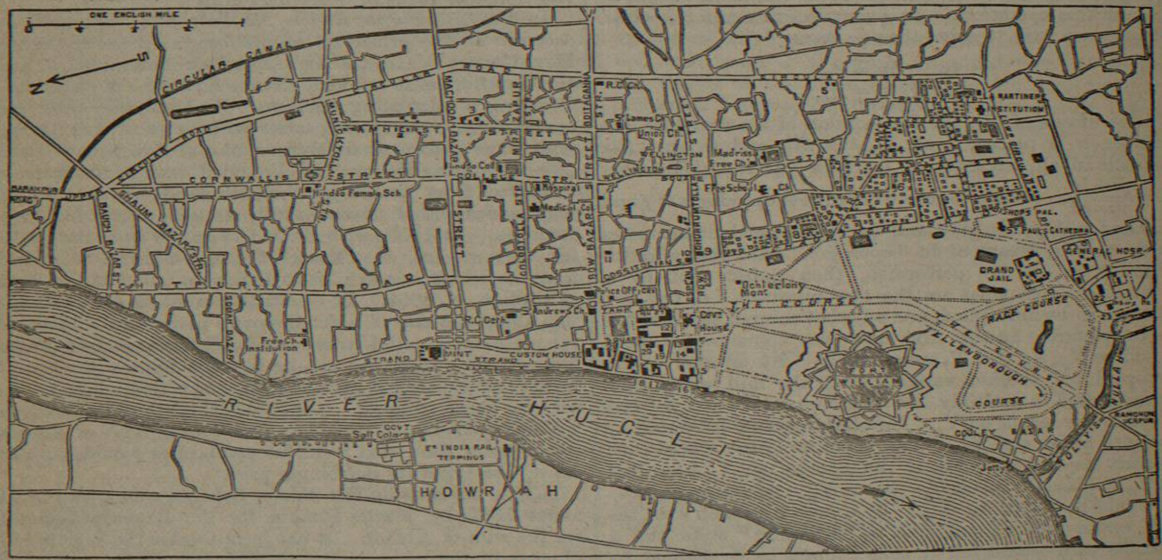
See the article "Calculating Machines" in Walford's *Insurance Cyclopædia*, where many references will be found, and a translation of General Menambrea's article on Babbage's Analytical Engine in Taylor's *Scientific Memoirs*, vol. iii. (P. S. L.)

CALCULUS. See DIFFERENTIAL AND INTEGRAL CALCULUS.

CALCUTTA, the capital of India, and seat of the Supreme Government, is situated on the east bank of the Húglí River, in latitude 22° 33′ 47″ N. and longitude 88° 23′ 34″ E. It lies about 80 miles from the seaboard, and receives the accumulated produce which the two great river systems of the Ganges and the Brahmaputra collect throughout the provinces of Bengal and Assam. From a cluster of mud villages at the close of the 17th century, it has advanced with a rapid growth to a densely inhabited metropolis, which, with its four suburbs, contains a population of 892,429 souls. The central portion, which forms the Calcutta municipality, has a population returned in 1872 at 447,601. In the same year its maritime trade amounted to 52½ millions sterling, of which the exports formed 31¾ millions, and the imports 20¾, showing an excess of exports over imports of 11 millions sterling.

The history of Calcutta practically dates from the year 1686. In 1596 it had obtained a brief entry as a rent-paying village in the survey of Bengal executed by command of the Emperor Akbar. But it was not till 90 years later that it emerged into history. In 1686 the English merchants at Húglí, finding themselves compelled to quit their factory in consequence of a rupture with the Mughul authorities, retreated about 26 miles down the river to Sutánatí, a village on the banks of the Húglí, now within the boundaries of Calcutta. Their new settlement soon extended itself along the river bank to the then village of Calcutta, and by degrees the cluster of neighbouring hamlets grew into the present town. In 1689–90 the Bengal servants of the East India Company determined to make it their headquarters. In 1696 they built the original Fort William, and in 1700 they formally purchased the three villages of Sutánatí, Calcutta, and Gobíndpur from Prince Azim, son of the Emperor Aurungzebe.

The site thus chosen had an excellent anchorage, and was defended by the river from the Marhattás, who harried the districts on the other side. A fort, subsequently rebuilt on the Vauban principle, and a moat,



Ground-Plan of Calcutta.

1. Almshouses.
2. Leper Asylum.
3. Church Mission.
4. Catholic College.
5. Baptist Chapel and Mission.
6. St Thomas R.C. Church.
7. Asiatic Society.
8. Small Cause Court.
9. Church (R.C.) of the Sacred Heart.
10. Mosque.
11. Baptist Chapel.
12. Home Department.
13. Treasury.
14. Town Hall.
15. Supreme Court
16. Bank of Bengal.
17. Stationery Office.
18. Metcalf Hall.
19. St John s Church
20. Foreign Department.
21. New Post Office.
22. Sudder Dewanny Adulut.
23. Government Iron Bridge Yard.

designed to form a semicircle round the town, and to be connected at both ends with the river, but which was never completed, combined with the natural position of Calcutta to render it one of the safest places for trade in India during the expiring struggles of the Mughul empire. It grew up without any fixed plan, and with little regard to the sanitary arrangements required for a town. Some parts of it lie below water mark on the Húglí, and its low level throughout rendered its drainage a most difficult problem. Until far on in the last century, the jungle and paddy fields closely hemmed in the European mansions with a circle of malaria; the vast plain (*maidán*), with its gardens and promenades, where the fashion of Calcutta now displays itself every evening, was then a swamp during three months of each year; the spacious quadrangle known as Wellington Square was built upon a filthy creek. A legend relates how one-fourth of the European inhabitants perished in twelve months, and during seventy years the mortality was so great that the name of Calcutta, derived from the village of Kálighát, was identified by mariners with Golgotha, the place of a skull.

The chief event in the history of Calcutta is the sack of the town and the capture of Fort William in 1756, by Suráj-ud-Daulá, the Nawáb of Bengal. The majority of the English officials took ship and fled to the mouth of the Húglí River. The Europeans who remained were compelled, after a short resistance, to surrender themselves to the mercies of the young prince. The prisoners, numbering 146 persons, were driven at the point of the sword into the guard-room, a chamber scarcely 20 feet square, with but two small windows. Next morning only 23 were taken out alive, among them Mr Holwell, the annalist of the "Black Hole." This event took place on June 20, 1756. The Mahometans retained possession of Calcutta for about seven months, and during this brief period the name of the town was changed in official documents to Alinagar. In January 1757 the expedition despatched from Madras, under the command of Admiral Watson and Colonel Clive, regained possession of the city. They found many of the houses of the English residents demolished, and others damaged by fire. The old church of St John's lay in ruins. The native portion of the town had also suffered much. Everything of value had been swept away, except the merchandise of the Company within the fort, which had been reserved for the Nawáb. The battle of Plassey was fought on June 23d, 1757, exactly twelve months after the capture of Calcutta. Mir Jáfar, the nominee of the English, was created Nawáb of Bengal, and by the treaty which raised him to this position he agreed to make restitution to the Calcutta merchants for their losses. The English received £500,000, the Hindus and Mahometans £200,000, and the Armenians £70,000. By another clause in this treaty the Company was permitted to establish a mint, the visible sign in India of territorial sovereignty, and the first coin, still bearing the name of the Delhi emperor, was issued on August 19th, 1757. The restitution money was divided among the sufferers by a committee of the most respectable inhabitants. Commerce rapidly revived, and the ruined city was rebuilt. Modern Calcutta dates from 1757. The old fort was abandoned, and its site devoted to the Customs House and other Government offices. A new fort, the present Fort William, was commenced by Clive, a short distance lower down the River Húglí. It was not finished till 1773, and is said to have cost two millions sterling. At this time also the *maidán*, the park of Calcutta, was formed; and the salubrity of its position induced the European inhabitants gradually to shift their dwellings eastward, and to occupy what is now the Chauringhi (Chowringhee) quarter.

From this time the history of Calcutta presents a smooth narrative of advancing prosperity. No outbreak of civil war nor any episode of disaster has disturbed its progress, nor have the calamities of the climate ever done mischief which could not be easily repaired. A great park (*maidán*), intersected by roads, and ornamented by a garden, stretches along the river bank. The fort rises from it on its western side, the stately mansions of Chauringhi with Government House, the high court, and other public offices, line its eastern and northern flank. Beyond the European quarter lie the densely populated clusters of huts or "villages" which compose the native city and suburbs. Several fine squares, with large reservoirs and gardens, adorn the city, and broad well-metalled streets connect its various extremities.

Up to 1707, when Calcutta was first declared a presidency, it had been dependent upon the older English settlement at Madras. From 1707 to 1773 the presidencies were maintained on a footing of equality; but in the latter year the Act of Parliament was passed, which provided that the presidency of Bengal should exercise a control over the other possessions of the Company; that the chief of that presidency should be styled Governor-General; and that a supreme court of judicature should be established at Calcutta. In the previous year, 1772, Warren Hastings had taken under the immediate management of the Company's servants the general administration of Bengal, which had hitherto been left in the hands of the old Mahometan officials, and had removed the treasury from Murshidábád to Calcutta. The latter town thus became the capital of Bengal, and the seat of the Supreme Government in India. In 1834 the Governor-General of Bengal was created Governor-General of India, and was permitted to appoint a Deputy-Governor to manage the affairs of Lower Bengal during his occasional absence. It was not until 1854 that a separate head was appointed for Bengal, who, under the style of Lieutenant-Governor, exercises the same powers in civil matters as those vested in the Governors in Council of Madras or Bombay, although subject to closer supervision by the Supreme Government. Calcutta is thus at present the seat both of the Supreme and the Local Government, each with an independent set of offices. Government House, the official residence of the Governor-General of India, or Viceroy, is a magnificent pile of buildings to the north of the fort and the *maidán*, built by Lord Wellesley in 1804. The official residence of the Lieutenant-Governor of Bengal is a house called Belvedere, in Alipur, the southern suburb of Calcutta. Proposals have been made from time to time to remove the seat of the Supreme Government from Calcutta. Its unhealthiness, especially in the rainy season, its remoteness from the centre of Hindustán, and its distance from England, have each been animadverted upon. These disadvantages of Calcutta have now, however, been almost entirely removed, or their consequences have been mitigated, by the conquests of science and modern engineering. The railway and the telegraph have brought the Viceroy at Calcutta into close contact with every corner of India; while an ample water supply, improved drainage, and other sanitary reforms, have rendered Calcutta the healthiest city in the East,—healthier, indeed, than some of the great European towns. English civilization has thus enabled Calcutta to remain the political capital of India. The same agency still secures the city in her monopoly of the sea-borne trade of Bengal. The River Húglí has long ceased to be the main channel of the Ganges; but Calcutta alone of all the successive river capitals of Bengal has overcome the difficulties incident to its position as a deltaic centre of commerce. Strenuous efforts of engineering are required to keep open the "Nadiyá Rivers," namely, the three off-shoots of the Ganges which combine to form the Húglí. Still greater watchfulness and more extensive operations are demanded by the Húglí itself below Calcutta, to save it from the fate of other deltaic streams, and prevent it from gradually silting up. In 1853 the deterioration of the Húglí channel led to a proposal to found an auxiliary port to Calcutta on the Matlah, another mouth of the Ganges. A committee, then appointed to inquire into the subject, reported that "the River Húglí was deteriorating gradually and progressively." At that time "science had done nothing to aid in facilities for navigation," but since then everything has been done which the foresight of modern knowledge could suggest, or the power of modern capital could achieve. Observations on the condition of the river are taken almost hourly, gigantic steam dredgers are continually at work, and the shifting of the shoals is carefully recorded. By these means the port of Calcutta has been kept open for ships of the largest tonnage, and now seems to have out-lived the danger which threatened it.

Statistics.—Calcutta may, in one sense, be said to extend across the Húglí, and to include Howrah on the western side of the river, as well as the three separate municipalities on the eastern bank, known as the suburbs of Calcutta, the north suburban town, and the south suburban town. The total *population* of the area thus defined was returned by the census of 1872 at 892,429 souls. Calcutta proper, or the central portion, which lies, roughly speaking, between the old Marhatta ditch and the Húglí, is governed by a distinct municipality. In 1752 Mr Holwell estimated the number of houses within its limits at 51,132, and the inhabitants at 409,056 persons; but both these estimates were probably much too high; in 1822 the number of inhabitants was returned at 179,917; in 1831 at 187,081; in 1850 at 361,369; and in 1866 at 377,924. In 1872 a regular census was taken under the conduct of the municipality. The results present features of doubtful accuracy. They were as follows:—Area, 8 square miles; number of houses, 38,864; population,—Hindus, 291,194; Mahometans, 133,131; Buddhists, 869; Christians, 21,356; "other" denominations not separately classified, 1051;

grand total, 447,601: total of males of all denominations, 299,857; females, 147,744; average number of persons per house, 11; number of persons per square mile, 53,950. The length of the *roads* in the town is about 120 miles. The present *governing body* was created in accordance with the provisions of Act 6 of 1863 (Bengal Council). It consists of the justices of the peace for Calcutta, with a salaried chairman, who is a member of the civil service. All the members are nominated by the Government, but a deputy chairman is chosen by the justices out of their own body. As the justices are not in any sense representative, the power and responsibility are to a great extent centred in the chairman; but of late years, by means of departmental committees, the co-operation of the ordinary members has been enlisted. Out of about 100 justices who are resident in Calcutta exactly one-half are Europeans. In 1874 the ordinary revenue of the municipality amounted to £240,656, of which £160,000 was raised by rates, and £37,000 by licences. The ordinary expenditure for the same year amounted to £233,374, of which £80,000 was devoted to interest on loans and sinking fund, £32,000 to general expenses, £30,000 to roads, two items of £22,000 to lighting and water supply, and £13,000 to conservancy. Including capital account, receipts, loans, suspense account, and cash balances, the total amount at the disposal of the justices during the year was £433,938. The aggregate expenditure under both revenue and capital account amounted to £382,823. The total loan liabilities of the corporation are £1,466,060, and the total of interest and sinking fund payable yearly is £100,474. The average rate of municipal taxation per head of the population is about 10s. 8d. The most important undertaking under the care of the municipality is the *water supply*. The present system dates from 1865, when the sanction of Government was given to the construction of works which now pour upwards of 6 million gallons a day of filtered water into the city. The source of supply is from the Húglí at Palta, about 16 miles above Calcutta. The works there consist of two large suction pipes, 30 inches in diameter, through which the water is drawn from the river by three engines, each of 50 horse power nominal; the water is then passed into six settling tanks, each 500 feet long by 250 feet wide. Here it is allowed to stand for 36 hours, when it is permitted to run off to the filters, eight in number, the area of each being 200 by 100 feet. After filtration the water is made to flow over a marble platform, where its purity can be observed. It is then conducted to Calcutta by a 42-inch iron main. These works cost £525,432. They were finished in 1870, and connected with pipes laid under 100 miles of streets. The total number of house connections up to December 31, 1874, was 8159. The total quantity of water delivered during that year amounted to 2,524,566,300 gallons, being considerably over the estimated average of 6 million gallons daily, or about 13 gallons per head of the population. The total cost for the same year of the water-supply (inclusive of interest) was £55,547, or about 5d. per 1000 gallons.

The *drainage* works are on an equally effective scale. The main sewers are underground, and for the proper discharge of their contents in the direction of the Salt Lake, a pumping station is maintained at an annual cost of £3000. The system of underground drainage, although not entirely completed, had cost in 1874 a capital sum of £620,000. In 1863, on the constitution of the present municipality, a *health officer* with an adequate establishment was appointed. The practice of throwing corpses into the river has been put down, and the burning *ghâts* and burial-grounds have been placed under supervision. All refuse and night-soil are removed by the municipality, and conveyed by a special railway to the Salt Lake. The town is lighted by a private *gas company*, 2723 gas lamps and 730 oil lamps being paid for at the public expense. The fire brigade consists of 2 steam fire-engines, and 5 hand engines, its annual cost being about £2000. The *police* of Calcutta is under the control of a commissioner, who is also the chairman of the justices. Beneath him there is a deputy-commissioner. The force consists of 4 superintendents, 155 subordinate officers of various grades, 1292 constables, and 6 mounted constables, maintained in 1873 at a cost of £41,227, of which Government contributed one-fourth. Several minor bodies, such as the river police, Government guards, &c., bring the entire strength of the force in the town and on the river to 2313 men. The great majority are natives, the number of European sergeants and constables being only 50.

In 1872–73 the statistics of *education* in Calcutta were as follows:—There were 3 Government colleges, namely, the Presidency College, founded in 1855, and attended by 709 pupils; the Sanskrit College, established in 1824, attended by 26 adult pupils, of whom 17 are Bráhmans; the Calcutta Madrásá or Mahometan College founded in 1781, number of pupils 528. There are also five colleges mainly supported by missionary efforts, aided by Government, and attended by 305 pupils. The total number of schools in Calcutta reported on by the Educational Department is 260, with 19,445 scholars; 157 of them are male schools, teaching 16,155 boys; the remaining 103 are for girls, and teach 3290 pupils. According to a different principle of classification, 36 schools teach English to 9445 boys, 121 teach the vernacular only to 6620 boys, 99 are vernacular schools for girls with 3244 pupils, and 4 are normal schools, instructing 90 male teachers and 46 female. Of the total number of pupils in these schools, 47·7 per cent. are ascertained to be Hindus, 13·5 Christians, 2·6 Musalmáns, and the remaining 36·2 per cent. are of unascertained religions. The total ascertained expenditure was £25,011, of which sum the Government contributed £9160. The Government School of Art was attended in 1872–73 by 94 students, of whom 88 are Hindus, 4 Musalmáns, and 2 Eurasians. Calcutta has also an important school of medicine, or medical college, with a large hospital attached and every facility for a thorough scientific training.

The *medical charities* of Calcutta comprise the Medical College Hospital, just named the General Hospital, the Native or Mayo Hospital, the Municipal Pauper Hospital, and minor dispensaries. Of these the General Hospital is confined almost solely to Europeans. The total amount contributed by Government to these institutions is £30,000. The number of persons treated during the year 1872–73 was 251,039, of whom 20,805 were indoor patients. Of these 64·9 per cent. were men, 16·3 women, and 18·8 children. The rate of mortality in cholera cases was 484·3 for every thousand treated.

Mortuary returns are collected in Calcutta by the police inspectors, and compared with the registers kept by paid clerks of the municipality at the burning *ghâts* and burial-grounds. In 1873 the total number of deaths thus ascertained was 11,557, or 25·82 per thousand. The death rate among the Christians was 31·5, among the Hindus 26·1, and among the Mahometans 24·7. The highest death rate was in January, November, and December, and the lowest in June and July.

The mean temperature of Calcutta is about 79° Fahr. The highest temperature recorded during the last 18 years is 106° in the shade, and the lowest 52°·7. The extreme range is therefore a little over 53°, while the mean temperatures of December and May, the coldest and hottest months, are 68°·5 and 85° respectively. The average rainfall during 36 years has been 66 inches,—the highest rainfall on record being 93·31 inches in 1871, and the lowest 43·61 inches in 1837. By far the greater part of the rain falls between the months of June and October.

Like the rest of the seaboard of the Bay of Bengal, Calcutta is exposed to periodical cyclones, which do much mischief. The greatest pressure of the wind registered is 50 ℔ to the square foot. In the storms of 1864 and 1867 the anemometer was blown away. A great loss of life and property was caused along the Húglí by the storm of October 5th 1864. In Calcutta and its suburbs 49 persons were killed, and 16 wounded, 102 brick houses were destroyed, and 563 severely damaged; 40,698 tiled and straw huts were levelled with the ground. The destruction of shipping in the port of Calcutta appears greatly to have exceeded that on record in any previous storm. Out of 195 vessels only 23 remained uninjured, and 31, with an aggregate tonnage of 27,653 tons, were totally wrecked. On November 2, 1867, the force of the wind was not less violent, but there was no storm wave, and consequently the amount of damage done was much less.

THE PORT OF CALCUTTA, extending 10 miles along the Húglí, with an average width of working channel of 250 yards, and with moorings for 169 vessels, is under the management of a body of 9 European gentlemen styled "Commissioners for making Improvements in the Port of Calcutta." This body was constituted in 1870, and has since that date received considerable additions to its powers. In 1871 they were appointed "Bridge Commissioners," to take charge of the floating bridge over the Húglí, and to work it when completed. This bridge, finished in 1874, now supplies a permanent connection between Calcutta and the railway terminus on the Howrah side of the river. It is constructed on pontoons, and affords a continuous roadway for foot passengers and vehicles. The traffic returns for 41 weeks in 1875 were £7593; the cost of the bridge has been £220,000. The main duty of the Port Commissioners has hitherto consisted in providing accommodation, by jetties and warehouses, for the shipping and native boats, which carry on the great and increasing trade of Calcutta.

In the year 1873–74 the income of the commissioners from all sources was £114,709, and the expenditure £78,260. The total amount of capital expended up to that year was £580,339, including a debt of £400,123. The number of vessels arriving and departing in 1861–62 was 1793, with an aggregate tonnage of 1,337,632 tons; in 1873–74, the number of vessels was 1927, tonnage 2,437,447. The number of steamers, and especially of steamers passing through the Suez Canal, is greatly on the increase.

The growth of the commerce of Calcutta may be seen from the following figures:—In 1820–21 the total value of the exports and imports, including treasure, was £10,454,910; in 1830–31, £8,756,382; in 1840–41, £15,202,697; in 1850–51, £18,754,025; in 1860–61, £31,794,671; in 1870–71, £49,316,738. The value of the customs duties (including salt) was in 1820–21, £151,817; 1830–31, £121,321; 1840–41, £495,515; 1850–51, £1,038,365; 1860–61, £2,270,654; 1870–71, £3,548,926. Cotton goods first became an important article of import in 1824; oil seeds were first exported in 1835; the exports of jute on a large scale date from 1860, those of tea from 1864. Among the chief articles of import in 1870–71 were—apparel, value £186,767; beer, £140,859; coal, £109,185; cotton manufactured, £11,624,712; machinery, £194,198; metals, £1,311,547; railway materials, £710,357; salt, £652,632; spices, £150,150; spirits, £162,635; wine, £214,191; wood, £156,903; woollen manufactures, £347,116; treasure, £2,255,244. Government shipments, £981,557; total value of imports, £21,198,478. Among the chief articles of export in 1870–71 were—cotton raw, £2,020,159; cotton manufactured, £811,825; dyeing materials, £153,113; grain and pulse, £2,630,451; hides and skins, £1,573,655; indigo, £2,285,202; jute, £2,585,390; jute manufactured, £664,898; lac, £194,576; metals, £215,920; opium, £5,490,395; saltpetre, £440,133; seeds, £2,921,117; silk, £1,508,801; silk manufactured, £244,076; spices, £215,018; sugar, £674,149; tea, £1,117,712; tobacco, £152,716; woollen manufactures, £136,052; bullion and treasure, £1,021,638; Government treasure, £228,534; total value, of exports, £28,118,260.

The internal trade of Calcutta is conducted partly by railway, and partly by water traffic. There is no railway station within the limits of the municipality, but three separate railways have their terminus in the immediate neighbourhood. The East Indian Railway, whose terminus is across the river at Howrah, brings down the produce of the North-Western Provinces and Behar, and connects Calcutta with the general railway system of the Peninsula. The Eastern Bengal Railway and the South-Eastern Railway have their terminus at Siáldah, an eastern suburb of Calcutta. The former is an important line running across the Delta to the junction of the Ganges and Brahmaputra at Goalandá. The latter is a short railway, intended to connect the metropolis with Port Canning, in the Sundarbans. The three chief lines of water traffic are—(1), the Calcutta canals, a chain of channels and rivers passing round and through the Sundarbans, open at all seasons of the year, and affording the main line of communication with the Ganges and the Brahmaputra; (2), the Nadiyá rivers, three in number, which branch off in a more directly southern course from the Ganges, above its junction with the Brahmaputra, and ultimately become the Húglí—these are with difficulty navigable during the dry season; (3), the Midnapur and Hijili canals, leading south towards Orissa. (W. W. H.)

CALDANI, LEOPOLD MARCO ANTONIO (1725–1813), a distinguished Italian anatomist and physician, was born at Bologna in 1725. After holding various minor appointments, he was chosen assistant to the celebrated anatomist Morgagni at Padua; but disgusted with the envy which his distinguished position drew upon him, he removed to Venice. Soon after, however, he was appointed to the professorship of the theory of medicine, with the promise of being elected to succeed Morgagni, who was then old and infirm. In 1772 he published his *Elements of Pathology*, and soon afterwards the *Elements of Physiology*. In the same year he took possession of the chair of anatomy, vacant by the death of Morgagni, and endeavoured, though without success, to found an anatomical museum. At the age of seventy-six, though threatened with blindness, he published, with the assistance of his nephew, a valuable series of anatomical plates. He died in 1813, at the age of eighty-eight.

CALDER, SIR ROBERT (1745–1815), Baronet, was born at Elgin, in Scotland, July 2, 1745 (O. S.) He belonged to a very ancient family of Morayshire, and was the second son of Sir Thomas Calder of Muirton. He was educated at the grammar school of Elgin, and at the age of fourteen entered the British navy as midshipman. In 1766 he was serving as lieutenant of the "Essex," under captain the Honourable George Faulkner, in the West Indies. Promotion came slowly, and it was not till 1782 that he attained the rank of post-captain. He acquitted himself honourably in the various services to which he was called, but for a long time had no opportunity of distinguishing himself. In 1796 he was named captain of the fleet by Sir John Jervis, and took part in the great battle off Cape St Vincent (February 14, 1797). He was selected as bearer of the despatches announcing the victory, and on that occasion was knighted by George III. He also received the thanks of parliament, and in the following year was created a baronet. In 1799 he became rear-admiral; and in 1801 he was despatched with a small squadron in pursuit of a French force, under Admiral Gantheaume, conveying supplies to the French in Egypt. In this pursuit he was not successful, and returning home at the peace, he struck his flag. When the war again broke out he was recalled to service, was promoted vice-admiral in 1804, and was employed in the following year in the blockade of the ports of Ferrol and Coruña, in which (amongst other ports) ships were preparing for the invasion of England by Napoleon I. He held his position with a force greatly inferior to that of the enemy, and refused to be enticed out to sea. On its becoming known that the first movement directed by Napoleon was the raising of the blockade of Ferrol, Rear-admiral Stirling was ordered to join Sir R. Calder and cruise with him to intercept the fleets of France and Spain on their passage to Brest. The approach of the enemy was concealed by a fog; but on July 22, 1805, their fleet came in sight. It still outnumbered the British force; but Sir Robert entered into action. After a combat of four hours, during which he captured two Spanish ships, he gave orders to discontinue the action. He offered battle again on the two following days, but the challenge was not accepted. The French admiral, Villeneuve, however, did not pursue his voyage, but took refuge in Ferrol. In the judgment of Napoleon, his scheme of invasion was baffled by this day's action; but much indignation was felt in England at the failure of Calder to win a complete victory. He was, nevertheless, again sent out in August, and prevented Villeneuve from effecting a junction with the French fleet at Brest. In consequence of the strong feeling against him at home he demanded a court-martial. This was held on the 23d of December, and resulted in a severe reprimand of the vice-admiral for not having done his utmost to renew the engagement, at the same time acquitting him both of cowardice and disaffection. False expectations had been raised in England by the mutilation of his despatches, and of this he indignantly complained in his defence. The tide of feeling, however, turned again; and in 1815, by way of public testimony to his services, and of acquittal of the charge made against him, he was appointed commander of Portsmouth. He died at Holt, near Bishop's Waltham, in Hampshire, August 31, 1818.

CALDERON DE LA BARCA, PEDRO (1600–1681), the most eminent representative of the Spanish national drama, was born in Madrid, January 17, 1600. His prosperous life was undistinguished by striking incidents. He received his education at Salamanca, and after having been, as would seem, for some years a retainer or dependant of various noblemen, in 1625 entered the army, where it is hinted that he did not distinguish himself. He had begun to write for the stage in 1622, and in 1636 he was summoned to court, and soon became habitually employed as a writer of court spectacles by King Philip IV., a munificent patron of authors and artists. He was also made a knight of Santiago, and saw some further military service in Cata