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OPENING ADDRESS of the PRESIDENT of SECTION F (ECONOMIC SCIENCE and STATISTICS), of the BRITISH ASSOCIATION for the ADVANCEMENT of SCIENCE, at the THIRTY-FOURTH MEETING, at BATH, in September, 1864. By WILLIAM FARR, ESQ., M.D., D.C.L., F.R.S.

GENTLEMEN,—I am deeply sensible of the honour which has been conferred upon me by placing me in this Chair.

In opening your proceedings, I propose to bring rapidly under your notice the state of the science which you have met in this Section to promote as members of the British Association.

Mathematics is the great abstract science which fosters all the rest; and physics, mechanics, chemistry, mineralogy, geology, geography, ethnology, embrace the phenomena of the heavens, the earth, and the three kingdoms of nature. They occupy other Sections.

Man himself is the special study of physiology and of ethnology in two of those Sections; but there they inquire into the functions and parts of the body, or the condition of our race as the foremost of the animal kingdom; while geography describes nations, as it describes mountains and rivers, because they are on the earth's surface.

We have to do with men in States, and in political communities. Statistics is essentially a science of the relations of numbers of men, and its laws are founded on the observation of mankind as they exist in nations now and in past times; but, building on facts that can be measured and expressed in numbers, it is only in civilized communities, and in recent times, that it finds adequate materials. The domain of the past we almost abandon to the geologists or the historians: and we leave the uncivilized world in the possession of our enterprising neighbours the ethnologists; while we yet hope one day to enter this field, and indeed have already made, under established Governments, some conquests among the races in India, in Russia, and in South America.

Man in society possesses property, and all his possessions fall

within our province, for they form an intrinsic part of the State. We have to study, besides the political relations of men to each other, their riches in land, in horses, sheep, and the cattle on a thousand hills, in grain and crops, in precious metals, in minerals, and in merchandise.

Here are found the grounds of two grand divisions of statistics; the first falling under the head of *Population*, and the second under the head of *Property*, which is the subject also of economic science.

Under POPULATION are discussed the races, sexes, ages, marriages, births, deaths, causes of death, the ranks, professions and tenures of each people in a State: from their earnings the values of their life-work is deduced; certain acts are also investigated, such as baptisms, attendances at schools or at churches, votes at elections, crimes, punishments, diseases, and civil actions. Civil and military statistics constitute a capital chapter of this division.

The statistics of PROPERTY are divisible into two chapters: the first treats of the fixed property, including land, mines, forests, manufactories, houses, roads, canals, and rivers; its basis is a map on a scale large enough to exhibit the quantities of every parcel of land and the area of every dwelling-house: the holdings of land, its burthens, and transfers, naturally fall under this head.

Under the second head falls the movable property, including live stock, ships, machines, goods, merchandise, and vendible products of all kinds.

The annual produce of the two classes of property, its transport, its sales, its prices, and its relation to the stock, form the subject of the three sections of agricultural statistics, industrial statistics, and commercial statistics.

The public revenue and expenditure, the financial operations of the public exchequer, of the banks, and of the great companies, offer an extensive field, and are in the domain of financial statistics.

There are other minor divisions, but the object I aim at is to survey rapidly the field of our labours, which, although it is concerned in the facts of public interest to statesmen and political inquirers, and includes the fundamental part of politics, yet does not embrace all the doctrines of that kindred science, which, I may add, has been luminously expounded by Sir George Lewis in the treatise on the "Methods of Observation and Reasoning in Politics;" his greatest work—and to politics what Whewell's book is to the physical sciences—replete with the latest results of European learning, and a solid, hitherto unsurpassed, contribution to political science.

Sir George Lewis was a Fellow of the Statistical Society, and himself a labourer in early life in the field of practical statistics. He was well versed, too, in its philosophy, yet his genius did not lie in the direction of the physical sciences or of the mathematics, which

are the soul of statistics; but, standing on the border land, and on an eminence surveying all the territories, his calm judgment is impartial and commands attention. Noticing the imperfections in the early records of facts and numbers, Sir George Lewis observes:—

“The importance of accurate statistical information as the basis of historical description, as well as of political reasoning, both speculative and practical, cannot be too much insisted on. The attention of modern Governments has been directed to the subject, and it has been understood that a constant registration of social and political facts ought to be kept up, without any immediate practical object; like the observations of the heavenly bodies, temperature, weather, tides, and other natural phenomena, made by the physical philosopher. Facts, unimportant in themselves, become important as units comprised in a complete enumeration; and results are thus obtained, to which mere conjecture, or the loose and vague impressions derived from a partial observation, could not have led. This process is now carried on, with more or less completeness, by all civilized Governments, and the collection of statistical information, not merely for practical but for scientific purposes, is recognized as a legitimate object of public policy. There are now statistical departments in all the principal States of Europe.”*

Here is another element of classification, for the materials of science exist in each State, so in our archives are the statistics of England, Sweden, France, Spain, Italy, Germany, Russia, the United States of America, and some other countries, at least in outline. M. Quételet, one of the founders of this Section of the British Association, is now engaged on a work, of which proofs are on the table, exhibiting the comparative statistics of the population of Europe, on a plan nearly uniform. He submits it to your inspection, and had a great desire to be present here, but is kept away by circumstances over which he has no control. I feel sure that I have your authority to reciprocate the good wishes of this veteran of science. (Applause.) The work had its origin at the International Statistical Congress, which was convened in 1860 by Her Majesty's Government, in London, and was presided over by the late Prince Consort; whose sagacity, we may believe, did not fail him when he proclaimed that the statisticians of his day were laying “the foundation of an edifice, necessarily slow of construction, and requiring, for generations to come, laborious and persevering exertion, intended as it is for the promotion of human happiness, by leading to the discovery of those eternal laws upon which that universal happiness is dependent.” These last words of the good Prince may well cheer us on the way.

* Vol. i, p. 137.

You will see at once that the observation of the scientific facts with which we are concerned in so many States of the world, has already supplied the materials for sure induction, and placed statistics among those applied sciences which reveal laws, and arm man with power over man and over nature.

In proportion as Governments are organized and intelligent, they cultivate statistics; and it is gratifying to observe that nearly all the States of Europe sent official delegates to the Statistical Congress which met last year at Berlin, under the auspices of the Government of Prussia, and under the able presidency of Dr. Engel.

Spain, which had fallen in arrear, had been put upon her mettle, and in 1857, and again in 1861, took a census, of which many interesting results have just been published: the population was 15,658,531, some millions more than she formerly had credit for, and entitling her, when her finances are upon a sound footing, again to a place among the Powers of Europe.

The Kingdom of Italy was no sooner constituted than its statistics were developed. A census was taken, and we find a population of 22 millions (21,893,171*) in this constitutional State. Over Rome, Venice, Lombardy, Mantua, Trieste, the Tyrol, Ticino, Savoy, Corsica, Malta, and the Kingdom of Italy, a population of 27 millions speaking Italian is diffused. The births, deaths, and marriages are registered, and the principal statistical elements are under observation and inquiry in the Kingdom of Italy, which will henceforward have a voice of weight in the affairs of Europe, and in science. The statistics of Italy are ably displayed in the Statistical Annual, for 1864, of Correnti and Maestri, who have had a large share in the organization of the statistics of the new kingdom.

Russia, until lately, did little for statistical science; and the Emperor Nicholas refused to send a Russian to the first Congress in Brussels, on the alleged ground that his empire had nothing to learn from the science of Europe. Things have since greatly changed, and the Russian Government now fully recognizes the claims not only of her own people, but of science and of Europe, to a faithful account of the population and resources of that empire. M. Von Buschen and Mr. Wilson were sent over by the Imperial Government to observe our proceedings in the last census; and M. Troinski, who was here recently, informed me that measures were under consideration for taking as accurate a census of Russia as circumstances will allow. The births, deaths, and marriages, will also be registered more accurately. We may thus expect a great accession of information from Russian statisticians, respecting an empire emancipating millions of serfs, and passing through changes which the older States of

* Estimated for 1st January, 1863; by the census of 1st January, 1862, the population was 21,776,953; increase 116,218.

Europe traversed in what may be called pre-statistic times. Popular books contain many statements of numbers which are put forth as statistics, but are purely conjectural, or are based upon loose estimates. Among the latter numbers is the alleged population of Russia, which is set down in the "Gotha Almanack" at 74,139,394 souls, neither more nor less—exclusive of the population of Russian America, which belonged to a company whose privileges expired at the end of 1863. How far this is wrong it is difficult to say; there have been partial censuses, but the population of the empire has never been enumerated.

So it is in our Indian Empire, the population of which is cited as 135,571,351. The populations of the North-West Provinces, and of the Madras Presidency, have been counted, but the other numbers are "guesses," for we have not everywhere adopted the "practice of counting." The population is as likely to be several millions more in India as to be millions less, for the maxim of Dr. Johnson is not invariably true, that "when numbers are guessed they are always magnified." It is said that the population of Rome was once estimated by the weight of cobwebs within its precincts; and that Xerxes ascertained the numbers of his host by measuring the ground upon which they stood. How the guesses are made in India we do not precisely know, but it is probable that the population of many of the provinces has been estimated from their area. The enlightened and really beneficent Government of India, which collects 43,000,000*l.* of revenue from the population annually, will no doubt ere long contrive to perform the really arduous task, at least once, for that part of Southern Asia which Russia is about to perform in the North for the barbarous tribes of Siberia, and thus extend the boundaries of official knowledge, enumerate Her Majesty's subjects, and make India by its census an integral part of the empire.

The British Colonies deserve great praise for their statistics. The last census of Canada is elaborate; and Mr. Archer, Mr. Rolleston, and their colleagues in Australia, have placed the statistics of those colonies upon such a footing that we shall be able to trace with extraordinary minuteness the development of the empire in the southern hemisphere.

Of China several State censuses are cited, but I confess that I have less faith in the official returns of 367,632,907 "mouths,"*—the Chinese for *souls*—in China proper—than I have in those of India; in fact, we should be glad to hand them over to the geographers, recommending them, when they give the populations of countries, even in their elementary books, to cite the figures with discrimina-

* See paper by R. M. Martin, in "Addenda to Report on Sanitary State of the Army in India," 8vo. edit., p. 559. A recent return makes the population of the whole empire 415,000,000. ("Gotha Almanack," 1864.)

tion. A due appreciation of the value of published facts is an element in all the sciences.

Statistics is prosecuted to some extent in every State; and in countries where observation is difficult, intelligence scarce, and facts fugitive, figures appear to be so essential that they are invented. I should regret to apply this remark to the census of the Sandwich Islands, which in 1861 had a population of 67,084 natives and 2,716 foreigners, and is declining, according to the census of King Kaméhaméha IV and of his Anglo-Saxon Queen Emma, *née* Miss Rooker. Indeed I would rather adduce the insular census to prove that statistics are journeying round the world, and that the statistics of small States are often interesting, and illustrate general laws.

It is evident too that the statistics of Bath, for instance, which has 52,528 inhabitants, are at least as instructive as the statistics of Hesse Homburgh, which has a population of only 26,817; while those of the 444,873 people of Somerset, the county in which we meet, are not a whit less interesting than those of any of twenty-four kingdoms and principalities in Germany, which fill the pages of that useful publication the "Gotha Almanack."

Wherever there is local Government we look for local statistics; as they afford means of information which enlightened municipal councillors can always turn to account. We may well believe that, as Adam Smith boasted he had converted some of the merchants of Glasgow to his doctrines before he had promulgated them to the world, his spirit lingers among their descendants, for the statistics of that city have long held an honourable place on our rolls. The statistics of Glasgow are—as indeed are those of any city—of universal interest, when they are collected and discussed by such a statist as the late Dr. Strang, a truthful observer, a thoughtful writer, and an excellent man. In the name of our Section I venture to say that we shall be very glad if the Mayors—with the prosperity of Glasgow before them—and all the town councils in England, Bath leading, will at once appoint competent officers to elaborate their statistics.

As well as Governments and municipal bodies, England has always at work in the field of science richly gifted independent men, like Buckle and Darwin, who devote their lives to science, either as observers or as reasoners; and as an example of what an individual can do, I will cite Dr. Heysham, who twice enumerated from house to house the population of Carlisle, abstracted the ages from the burial registers, and published the results in a judicious form. The volume, Mr. Milne—as he informed me—found by chance on a book-stall; whereupon he opened a correspondence with Dr. Heysham, constructed the Carlisle Life Table, and deduced a general law of mortality which served through many years as the basis for thousands

of transactions, and for the valuation of millions of property. The names of the two men, the statistical observer and the statistical reasoner, will remain for ever engraved upon our annals.

It is evident that statistics may be investigated in every English parish; and I know no fairer field than local statistics offer to a liberal and ingenuous mind. Some subjects can be more impartially investigated by private gentlemen than by men in office; and a specimen of this is a paper by Mr. Norman, which is a model of style and statistical logic, proving the fact which at first appeared paradoxical, that, large as the taxation is, the people of England pay less in proportion to their means, and get more work for their money than the people of any other country.* Again, the remarkable work before you of M. Guerry, on the comparative crime of England and France, embodies the labours of the life of one of the most ingenious private statisticians in Europe.†

The Statistical Society of London has done so much, by its papers and its Journal, in the eyes of Europe for science, that a similar society has recently been founded in Paris, and publishes an excellent Journal, to which M. Legoyt and others contribute; the necessary complement to the well known "Journal des Economistes." The Dublin and the Manchester Societies remind us by their useful labours of the utility of Statistical Societies in our great cities.

I admit that the country has a right to look to the Government for the census, for registration returns, for commercial statistics, for agricultural statistics, for industrial statistics, and for financial statistics: as the collection, analysis, and promulgation of facts of universal interest is one of the Queen's most useful prerogatives. Formerly little or nothing of the kind was done; but by referring to the annual reports which emanate now from the public offices—you will see that this great duty is kept in view. The reports of the War Office and the Admiralty; those of the Board of Trade, of the Customs, the Inland Revenue, the Post Office, and of the Registrars-General of England, Scotland, and Ireland, of the Poor Law Board, and of the Emigration Commissioners, of the Privy Council Officer of Health, of the Education, Factory, and Mine Inspectors; the judicial statistics, criminal and civil, the Consuls' Reports which the Foreign Office now publishes, show that the Civil Service is everywhere anxious to do its duty. And I shall perhaps be pardoned for reminding you, that men in the Civil Service are among the great names of our science, from Petty, King, and Davenant, to Deacon Hume, Porter, McCulloch, John Mill, and, to cite no more contem-

* "On the Pressure of Taxation in this and other Countries." By George Warde Norman, Esq.

† "Statistique Morale de l'Angleterre comparée avec la Statistique Morale de la France." Par M. A. M. Guerry, Correspondant de l'Institut, &c., &c. 1864.

poraries, Adam Smith himself. The Civil Service of the present day is quite in a position to sustain the statistical reputation of England in the face of Europe. What it wants is a better co-ordination of the work; which might, as was recommended by the Congress, be accomplished by a board at which the principal offices should be represented.

We venture in this Section to call the attention of Mr. Milner Gibson to the organization of a central authority "to direct," in the words of the late Prince Consort, "all the great statistical operations." Such a body has been recently created in many of the States of Europe.

Another matter this Association may very properly urge on the same minister. We ought, from agricultural statistics, to know approximately in October the produce of the harvest in Europe as well as in America, and the state of the live stock to supply the markets. The season has been extraordinary; what have been its effects upon the crops? Unfortunately the Government has nothing to tell us. English agricultural statistics are a complete blank. Yet no one seriously doubts the utility of this question of the supply of food, to town and country, to rich and poor, to farmers and merchants; it will enter largely into the commercial combinations of the next twelve months, and is one of the elements affecting the circulation.

The Registrar-General of Ireland procures the returns for that division of the United Kingdom; and the produce of the last harvest of Australia is known: it is in some parts, if my memory serves, half the average crop; an unpleasant result, which may influence the gold supply, but will partially be mitigated by timely provisions to meet a loss the extent of which is already known.

Mr. Hunt has just published a return of the mines of every kind; and of the mineral produce of the kingdom. It is alike creditable to him, to Sir Roderick Murchison, and to the mining proprietors, who voluntarily supplied the information. Some of them are not far from us, and will perhaps communicate the results to the Section.

I now come to our tools and our methods. Foremost in importance is the question of statistical units. The Legislature has just passed a measure authorizing the use of the metric weights and measures in England; and the report of a Committee of the Association on the subject will be presented to the Association by Mr. Heywood. In the first stage of statistics we count; but this no longer suffices, and we have to weigh and measure.

Upon the choice of units of weights and measures our progress in no slight degree depends. Now, one weight will not serve all purposes. Coal, for instance, cannot be sold by the ounce, it is sold

by the ton; sugar by the hundredweight; tea by the pound; gold by the ounce; while opium is administered in grains. If the hundredweight consisted of one hundred pounds, the ton of ten hundreds, the ounce of the tenth of a pound, and all the units required in every trade were so related to each other that we could say tens, hundreds, thousands, and so on, as we do in common numeration, all the compound rules which fill our books of arithmetic, and puzzle children, would be got rid of. So with regard to measures and money—let all the units increase by tens, and all goes “merry as a marriage bell.” One set of rules will apply to the weights, measures, and moneys of all trades and of all nations which use the Arabic figures. With regard to money, we cannot do better than adhere to the sovereign for statistical purposes: it is of gold, which is becoming everywhere the standard of value, is the largest unit in use, and is admirably suited to measure large quantities. The florin, and new farthings or mils, of which 100 would make a florin, $1,000 = 1\text{L.}$, are all the moneys of account required. The penny would be 4 farthings, the shilling 50, and no change in the coinage is required. The Chancellor of the Exchequer will, let us hope, inaugurate this reform, which would be an immense boon to all classes that have anything to do with bills, accounts, and statistics.

We might decimalize our old weights and measures, but the several ranks of units would not fit well into each other; the change would give a great deal of trouble, and there is no chance that other nations would adopt it, for this simple reason, that the first nations have had for years the admirable metrical system in use. Our merchants deal with these nations largely, and if we adopt the meter, Russia, America, and our colonies will adopt it. If England wills it, the whole civilized world will have one system of weights, measures, and money, as it has one system of decimal arithmetic. This system annihilates those ugly pages of Colenso, the compound rules; so through it, in the words of the highest authority, Professor Barlow, “a child may learn everything necessary for entering into the common concerns of the world in a month as well and better than in a year under our complicated system.”*

A Metric Act will be an emancipation act for children, and will give them time for higher studies in mathematics. The compound rules of arithmetic, English orthography, and Latin verses, are the tasks for which the school-boy is oftenest punished; and they are the opprobrium of the age. Unlike the truths of science, they can only be flogged into the brains of English boys. Statists should at once make the pound sterling and the metric weights and measures their units.

* “Mathematical Dictionary.”

In the English market gold and silver are sold by the ounce coffee, tea, tobacco, spices, indigo, silk, cotton, and leather by the pound; meat by the stone; sugar, butter, rice, by the hundred-weight; coal, iron, copper, tin, lead, palm oil, logwood, hemp, flax, by the ton; wool by the pack. For statistical purposes it is convenient to take one unit, the metric ton = a cubic meter of water, and nearly equal to the English ton, to express the imports and exports, and the quantities of all articles sold by weight. This would facilitate comparison. The quantities sold by volume, such as wheat, fish, oil, wine, and spirits, might also be expressed by one unit—the metric tun, the bulk of water weighing a metric ton. The qualities and prices of some articles, such as wheat and spirits, are regulated by the weight of equal bulks, or by the specific gravity, which is easily expressed as it is the weight of a metric *tun* of the stuff, when a metric *ton* is taken for unity. Cloth, linen, calico, and silk, are sold by linear units, which are exceedingly objectionable, and should be converted into square units for statistical purposes.

In mechanics a unit of this kind is used; a pound weight raised a foot is called a unit of work, and 33,000 such units of work in a minute, form the further unit—Watt's *horse-power*. The unit of work may be called a double unit, inasmuch as it involves two elements—weight (*pound*) and space (*foot*), while the horse-power takes in time (*minute*), and is a treble unit. The French use a similar element thus compounded: the horse-power is 75 *kilograms* raised a *meter* in a *second*. Remark that two of the elements of this unit are intangible. Chemistry furnishes examples of compound units in its binary and ternary atoms. In statistics, double and triple units are in use; thus when I say the rate of mortality in a regiment is 2 per cent. per annum, I employ the double unit, a year of life. The years of life are found by multiplying the time in years into the mean numbers living. The strength of a regiment is 1,000, and the average deaths are 20 in a-year, 5 in a quarter, so the mortality is as above stated; but if the men die at the rate of 20 in a quarter, you have 20 deaths to 250 years of life, and the mortality is 8 per cent.

These compound units are the sources of frequent fallacies; thus if the population is compared with the deaths in a quarter, a week, a day, or any short interval of time, the apparent mortality is reduced to any extent. In reckoning interest and profit-rates, 1*l.* under investment a-year is the double unit; if the dividend on 100*l.* is 2*l.* half-yearly, the rate of profit is 4*l.* a-year.

The rate of profit is found by dividing (1) the profits by (2) the capital multiplied into (3) the *time*.

Inattention to this principle is the source of some of the common fallacies on the income tax. Thus if two persons are taxed equitably

on their property, they are taxed in proportion to its amount and to the time it is under the protection of the State: if A pays 1*l.* on 1,000*l.* in a-year, B is not fairly treated if he is made to pay 1*l.* every three months. The sophist assures B that he pays at the same rate as A, keeping out of view the fact that the taxable unit is compounded of value and time. Income is an indication, but not a measure, of property, and if A has a sum under investment in one way, he may have to pay at the rate of 6*d.*, while B with the same amount of property may now have to pay 10, 20, 30 sixpences as his quota of the year's taxation. A life income of 1,000*l.* a-year on men of 20 and upwards, at 5 per cent., is on an average worth 11,712*l.*; while at the same interest, the same income in perpetuity is worth 20,000*l.* The owners of two properties taxed upon the same unit of value, pay 11,712*l.* and 20,000*l.* as their quota of the year's tax; under an income tax the same premium is exacted from properties of totally different values.

The first step in every statistical inquiry is to determine the value of the units to be employed, be they single, double, or multiple. Thus if you find that the mines of a country yield 5,000 tons of copper ore, while the mines of another yield 10,000, these are only preliminary units; the final statistical unit is the ton of copper ore. So of all the minerals the ton of metal is the final unit. The heating power of coal is the element of value, and as it can be measured, it should supply the final unit.

In the statistics of products it is necessary to take time and space into the final units of value; thus, coal at the pit's mouth is worth say 5*s.* a ton, and at this price 40,000,000 tons are worth 10,000,000*l.*; but the consumer pays 1*os.*, 2*os.*, 3*os.*, 4*os.* a ton for this coal, and its cost in consumption may be 40,000,000*l.* This comprises the profit of the coal merchant, the interest of capital, the coal dues, and the cost of transport, which varies with the supply of horses, roads, canals, railways. Our exports and imports differ in value in the home and foreign market. The value of products should be determined at every stage; thus we should follow wheat from the market till it becomes (1) flour, and (2) bread, and take care that in all these cases the units are so like in all their aspects as to admit of comparison. It does not follow that two countries which have the same numbers of cattle are equally rich in that kind of stock; the herds of cattle may differ in size, in age, in their amounts of produce of milk, butter, and meat—in the quality of all their products. Horses differ still more in excellence. In Smithfield sheep are not bought by the head, but by the stone; the offal is sunk, and the price varies from 6*d.* to 8*d.* per pound in inferior and prime sheep. The butcher gets at, and the statist uses, the pound of saleable meat as the final unit. All the elements which

the statist wants here are taken into account in the *value* of stock and of its produce; with this he gets comparable units in every climate. Again, take land: land measures vary. Statists gain a step by employing as their unit a hectar, or a square of 100 meters to the side; it is a large acre, of which our present acre is four-tenths. The United Kingdom contains (31,367,507) thirty-one million hectars of land, rather more than a hectar to each person. This is the proportion of land to people in a populous country; and the hectar is a convenient unit of area. England has 15, Scotland 8, and Ireland 8 million hectars of land; the population being 20 millions in England, 3 millions in Scotland, and 6 in Ireland. The proportions in ten—are England 7, Ireland 2, Scotland 1; on areas related as 2, 1 and 1. Ireland has still twice the population of Scotland. Italy has 26, Prussia 29, Spain 51, France 63, Austria 64 million hectars.

We come to States of a very different magnitude; the United States of America hold 440, Turkey 474, Russia in Europe 544 million hectars. Including the whole of their subject territories, the United States possess 730, England has 1,145, and Russia 2,133 million hectars. We do not accept this unit in statistics as the final unit of land. Land is rich, poor, or waste,—cultivated or uncultivated; and a hectar in the centre of London, in the vale of Gloucestershire, on the banks of the Lena in Siberia, in Melbourne, and in the middle of Australia, is a very different thing. All the chief elements that we need are summed up in the mean *value of a hectar*; and in the usual divisions of hectars into arable, meadow, pasture, forest, water, waste. The value of the land of the United States certainly exceeds that of the Russian Empire; in the absence of agricultural statistics, we do not know the value of our land, but the value of the fixed property of the Isles of England exceeds the value of the fixed property in either the Russian or American dominions.* The *value of a hectar* is the final land unit.

As all the mechanical forces are expressible in units of weight, so the values of land, of all property, of all products, are expressible in units of gold; and we may either measure those values, and express them in tons, or in any pieces of equal weight of that metal. We take the sovereign for the statistical unit of value, because it is in use; for the same reason as engineers take horse-power as the unit of work.

What are we to say to the human unit? Here also distinctions have to be drawn. As hectars differ, so does the average man of different states. Besides the divisions incidental to sex and age, the work of different races of men varies in quantity; a navy, a

* The true value of real estates and personal property in the States was extended at the census of 1860 to 3,232,000,000*l.*, taking $\$5$ to 1*l.*

Siberian peasant, a Hindoo, a Negro, a Chinaman, an Esquimaux, do very different quantities of work in the year.

The mechanical force of a country is the sum of the working forces of its population, with its steam-engines, horses, winds, waters, which can all be measured by the engineer's unit of work. Adam Smith proposed to employ a unit of labour as the unit of value. The wages of men express the value of their labour in gold, and from the mean value of these earnings at different ages of life, the economic value of a man is calculated by taking the interest of money and the contingencies of his life into account. At the age of 25, the present value of the future earnings of an English agricultural labourer, after deducting the cost of necessary maintenance, is 246l.* The value of the mean worktime of artisans, artists, and professional men, varies indefinitely; and as it is evident that the human units differ, so the difference can be appreciated by the value of their works. Nations differ in their intellect as well as in their moral faculties; and the expression of these forces of the soul, whether we look at scientific achievements or vulgar errors, at virtues or crimes, is one of the difficult problems in statistics. It is by the correct appreciation of units—of the things signified by figures—that the statist is distinguished from the empiric who throws heaps of tables in our faces, and asserts that he can prove anything by figures.

After observation, discrimination of units, and expression of their numbers in figures, come the exposition of facts in tables or diagrams, and the determination of their relations by mathematical analysis. Logarithms facilitate the calculation of ratios; and the calculus of probabilities enables the statist from the past to predict the future within determinable limits of error. Prediction is a function of this, as it is of all the sciences. The exposition of doctrines, and the use of them in argument, to induce men to follow a course of action, is an important part of statistics; and as it is connected with politics, has been carried to a high pitch of excellence in England. Several of the pieces of Burke, some extant speeches of Pitt, and in recent times the speeches of Huskisson, of Peel, and of the Chancellor of the Exchequer, as well as articles in the newspapers and reviews of the higher class, offer examples of this order of eloquence.

Statistics admit of many practical applications, and this naturally commends the study to the minds of Englishmen. I will mention an example. In the first place, as we have had a minister, we have had statistics of trade, and from the time of Davenant until the present day, when the Statistical Department is presided over by Mr. Fonblanque, the statistics of trade have formed the basis of a large field of economical reasoning. They guided Huskisson, Peel, Graham, and

* *Statistical Journal*, vol. xvi, p. 43.

Gladstone in legislation, by showing the exact effects of rates of duty on the revenue, and on the property of the country. Yes, the statistics of Deacon Hume, of Porter, of Tooke, of Newmarch, of Wilson, of McCulloch, and of our blue books, have accelerated the march of free trade, and banished protection from the shores of England. Statistics, pursuing her through the world, are demonstrating her disastrous influences in every land. Figures show, year after year, that every country which isolates itself from mankind by prohibition, no matter what may be the natural riches of its soil and climate, withers under the influences of protective tariffs. The people out of the open air of competition grow idle and weak. The imports of 1861, in England, were of the value of 217 millions sterling, and the exports of 160 millions, including 35 millions of foreign and colonial merchandise; the revenue was 70,600,000*l.*, and exceeded the expenditure. What do the statistics of Austria show us? Why in 1861-62, her total imports were 22 millions sterling, her exports 34 millions; her revenue 40 millions, her expenditure 51 millions; and as a consequence her debt is accumulating in geometric progression; her credit is low, and her paper is depreciated. This magnificent empire, of 36 millions of the finest races of Europe, with minerals in the Carpathians, Bohemia, and the Alps, with 64 million hectares of land stretching over the rich plains on the Upper Elbe and the Danube, is thus crippled, by a good Emperor and a patriotic Chamber, on the speculation that certain manufactures will prosper ultimately in Austria if they are nursed and encouraged at the expense of the nation for some indefinite time.

France has been drawn towards free trade by statistics; her exports are 123 millions sterling in value; and by the development of her resources, she does not yet falter under an annual expenditure of 83 millions sterling.

Spain again, which has broken the chains of the Inquisition, is still in the fetters of protection, that is, still makes her people pay dear for goods to satisfy their wants; her imports are of the value of only 15 millions sterling, her revenue is only 20 millions, and she is unable to pay her debts, so that she is without the legitimate credit which a nation containing many men of the nicest honour can justly claim.

The United States' statistics offer the saddest illustration of the effects of levying protective duties; their imports (1860-61) were 67 millions sterling; their revenue was 10 millions in 1861-62, exclusive of loans, and their expenditure, it is said, was 114 millions; and higher rates of import duties on the class of articles manufactured in New England will necessarily reduce the amount of revenue. The present war was kindled by combustible materials, of which protective duties form no insignificant item.

The statistical argument in favour of free trade is accumulating: it gains fresh force in every table, and will in the end lead all nations to exchange their products freely.

Another thing statistics does; it enables Governments to count the cost of war, and to weigh its results against its expenses.

There can be no doubt that statistics, by disclosing the laws of life and reproduction, tends to improve the health and moral condition of the people; to point out the causes of disease; and to prove so plainly the utility of sanitary measures, that the people become willing to pay the expenses. In England the Registrar-General has, during twenty-seven years, shown how much the public health is deteriorated by destructive causes; so in our towns they are in the course of removal; the Registrar-General of Scotland and Dr. Stark have lately done the same there, and in the present year the Registrar-General of Ireland and Dr. Burke, following Sir William Wilde, have entered the field. Our army has been invigorated by statistics; and the Commission over which Lord Herbert first, and after his death, Lord Stanley so ably presided, has proposed to endow India with the sanitary institutions of England. Under the eminent man who now governs India, the English race, which has hitherto languished in that paradise, will, we may hope, taste the fruits of the tree of life, and perpetuate itself in the tropics among the natives who also descended from the original Aryan stock.

Statistics, it must be confessed, has done little for mankind yet, in comparison with its vast powers. Innumerable social problems are still unsolved, and politics, which Alembert justly pronounced, in the "Cyclopædia," "perhaps the most difficult of all the sciences," is every day making fresh demands on statistics. Take the Balance of Power. How are political powers to be measured, and how is the statesman to construct his parallelogram of forces? In past times France, the Emperor, and England were the principal powers; and the problem had then the complications of the three bodies in mechanics, but England, France, and Austria have now Prussia and Russia by their sides, to say nothing of Turkey; Spain is rising again, and the Italian sword is asserting its place; the two States of America disjoined, will be two of the great powers of the world, with which Europe will have to reckon. Italy was comminuted into small States; it is now one power. And latterly Germany—still in two great masses, and a multitude of fragments, which have been as dust in the balance—coalescing, has planted herself on the neck of the Baltic in the face of Russia and Sweden, England and France looking on. Here is a mass of 72,000,000 men, with its due proportion of needle-rifles, and a navy, not yet formidable. It has nearly, but not quite, twice the population of France

(37,386,313) with her rectified frontier; against which Denmark, with only 2,605,024 people, or, excluding German Holsteiners, two millions, dared gallantly to defend her frontiers; but which the Emperor of the French did not deem it prudent to encounter for the sake of an old ally of France in the company of England, with the coveted Rhine—that German river—before his armies.

This population of the German States is split up (our statistics show) into 36 million Austrians, 18 million Prussians, and 18 million Germans comminuted in cities and principalities—but scarcely powers. And if it has France on the west flank it has Russia, with what may be taken at 66 million people, on the eastern frontier, not very distant from Berlin and Vienna. Germany has also unfriendly races within its limits—Poles, Hungarians, and Italians who divide Austria from the sea. Between Germany and Russia lies Poland, in pieces and ashes, but still exhaling her indestructible soul in one flame to heaven. The fine Scandinavian race has fallen back behind the Baltic, before the masses of Russia and Germany, and stands at bay, looking towards England. In the south is looming, we are reminded, the possible coalition of the Latin races in face of the descendants of those Germans who broke the power of the Roman empire. Over the Atlantic, 8 millions were added to the population of the United States in ten years; and at the same rate of increase, the people on the ample territories will amount to 42 millions in six years, to 56 millions in sixteen years' time. Our colonies are increasing at as fast a rate, and repose secure in peace under the sceptre of the Queen. How are all these bodies to be balanced? How is the power of each State to be measured?

The first step in the solution of the problem of equilibrium is naturally the determination of the population, and of the value of the wealth or credit which nerves the sinews of war. When this is done for each State, the unit to get at is the precise worth of the fighting man and officer; the numbers of such units in service and in reserve; the arms, fortresses, and ships. It was enough not long ago to count the ships of the line, frigates, and other vessels; for when the naval historian had told, in addition to the number of ships and men, the number of guns at Aboukir or Trafalgar, his readers were satisfied. The unit of naval force is now by no means so simple; it is compounded of the velocity of the ship and its resisting power—as well as of the weight, velocity, and destructive force of its shot and shells. Strategic position, administration, fertility of military genius, are all elements of power to be taken into account. What minister knows at this hour the military force in war of his own State with any degree of accuracy? or can weigh the force of other States in his balance? What means has he of judging

of the number of possible adverse or favourable combinations? As the number of States increases, the possible combinations increase more rapidly. Thus take England, France, or Austria, and there are only three possible combinations of two against one; throw in Russia and Prussia, and the possible combinations are ten of three powers against two, and five of four powers against one; and one, two, or three may be neutral while the rest are at war. England, France, Prussia, Austria, Russia, Italy, Spain, Turkey, the Federals, and Confederates, constitute ten States of 293 millions; that is 29·3 millions to each on an average; and ten combinations can be formed of nine against one, 210 of four against six; in all 511 war combinations. Then if we introduce the element of neutrality, the combinations are still further multiplied; and there remains the separate probability of each alliance. After all the resources of statistics are exhausted, enough is left to task the intellect of the most sagacious minister. We are beyond the age of Government by instinct; and the political questions of the day in England demand new light from science. In the decision of the course to pursue in all the questions of the balance of power—of peace and war—the country has the wisdom of experienced ministers like Lord Palmerston and Lord Derby to rely upon; but the Queen's Ministers know the difficulties of the problem, and will appreciate the value of the facts which they require from statistics—and which the Houses of Parliament require—to aid them in deciding questions of international policy. In steering the vessel of the State over the ocean our captains cannot now entirely rely upon their stars; they must consult their "Nautical Almanack."

Besides the problem of equilibrium, there remain others of equal difficulty. Aristotle, Comte, and other thoughtful theorists, looked with favour on the organization of mankind in small States. But while small States often exhibit great intellectual activity, and in Judea, Greece, Italy, Switzerland, Holland, Frankfort, Weimar, Würtemberg, and elsewhere, have nurtured men of transcendent genius—they exist now by sufferance; they exert little direct influence on the political affairs of mankind. Property is less secure in these dominions than it is in large States; and their defence is more difficult, and in proportion much more expensive. Thus, to say nothing of smaller States, Bavaria, to keep the same army in the field as Prussia, must draw four times as deeply on the resources of her people. Sweet are the charms of small Courts and local Government; yet the people of small States are, as in Italy, yielding by degrees to the soft compulsion of powerful neighbours; and the great continental powers, as their population increases, evince a passion for the sea, to which the small States upon the coasts may not for ever offer an effectual barrier. Still a valiant nation in

hearty cohesion, feeble in aggression, cannot be subjugated by a nation of four or perhaps ten times its magnitude; as was seen in the cases of Greece and Persia, of Prussia under Frederick—who with 5 millions of people fought 100 millions—in Austria and Switzerland, Spain and the Netherlands, England and America. The population of England was about 10,530,000, and that of the whites in the States 2,614,000, holding half a million slaves, in the war when the colonists resisted brave British armies, until the intervention of France and other European powers closed the unavailing contest.

In spoiling Poland three great powers participated; and Hungary in the war of 1848 was only recovered by Austria with the aid of Russia. Each of the great powers of Europe has fought—and is able to defend its existence for a time against—Europe in coalition, so long as the hearts of the people are loyal.

The solution of the problem—can 19 Free States conquer 15 Slave States—can 19 millions of people subjugate 8 millions of freemen holding 4 million slaves?—might have prevented a desolating war. And statistics supplies but one solution.

The census was taken in the United States in 1790, eleven years before the first English census; and the last report by Mr. Kennedy is one of the fullest of which statistics can boast. From this it appears that the 697,897 slaves of 1790 had multiplied so rapidly, that they amounted to 3,953,760 in 1860; and this increase proves that the physical condition of the slaves and their health are, as the Southerners tell us, good in a warm climate. They cannot possibly, in the aggregate, like the blacks in Cuba, be worked to death by the masters of English blood, and their conduct during the war confirms this inference. The present Southerners did not, as Sir George Lewis remarks of the Greeks, invent slavery; they inherited it under their laws, and are in the same uneasy situation as masters would be here, who had paid their servants wages for life in advance. With the growth of population, the equitable abolition of slavery in America, like the abolition of serfdom in Europe, is only a question of time, to be worked out in peace as the prosperity of the South increases; yet the institution of slavery is so much at variance with the principles of liberty and of the American constitution, that its speedy extinction was a sacred aspiration in the north, and was shared in England. The passionate war, which has a tragic interest, has shown that though the British race has undergone changes, such as Sir Charles Lyell pointed out, it has lost none of its valour, none of its endurance and none of its military genius in America since the days of Washington. It is rather exposed to the reproach Hume addressed to England, of fighting on uselessly in stubborn anger, when the object of the war is attained, or is unattainable,

than to that of imitating the new fashion set by the Emperor of the French in the Crimea and Lombardy.

As the war proclaims the power of two nations, Kennedy's ample statistics fill us with astonishment at their achievements in all the arts of life; and if Frederick in Prussia, and Peter in Russia, are justly, for founding two great powers, called Great, that title cannot be withheld from the two nations sprung from the men whom England sent over the waves of the Atlantic.

In Bath Abbey—I am reminded—lie quietly the ashes of Malthus, one of the fathers of statistics, and one of the founders of this Section of the Association at Cambridge. In his celebrated work he deduced from all the information then extant respecting the populations of the earth, the well known law that population increases in geometrical progression. The first philosophic naturalist of his age assures us that this law rules in every species of plant and animal; and that he derived from Malthus the conception of the struggle for existence, which, with the tendency to variations of form and natural selection always operating in favour of the best, through the millions of ages which our President unrolled before us last night, wrought those miracles of organization which we now regard with wonder and awe.

Malthus did not, however, sufficiently advert to one great characteristic of man, which distinguishes him from all his fellow creatures. The lion and the eagle prey upon the fawn and the lamb, but do not breed them; and even the busy bee only gathers honey from flowers existing. Man, by his industry, creates flowers, fruit, grain, and all products; his science places the forces of nature in his hands; his powers of transport give him the use of the lands of all climates; and hence subsistence has increased during the present century in a more rapid geometrical progression than the numbers of the people in England. Hence her numerous cities, her full ports, and her cultivated fields; hence the States of America, hence Canada and its sister provinces, hence the colony of the Cape, Australasia, and our Indian empire. If, like the power of Imperial Rome, whose ruined temples lie under our feet in the streets of Bath—England should ever decline and pass away—she will not have existed in vain; she will leave eternal traces of her life in the life of mankind; and our dry fossil figures, read by the Macaulay of a later age, will reveal the works—in America, in Australia, and India—of a great nation. But hitherto no signs of decay are visible; our population is to-day in its youth; it has proportionably more young men in it than any other people in Europe; who in no respect, take them in the ranks of the Volunteers or in the Sections of the British Association, need fear a comparison with their contemporaries: the English race—the

greatest of the nationalities — amidst all the coalescing nations, yields all the signs of being able to hold her own for ages to come.
Yes—

Thou shalt be the mighty one yet!
Thine the liberty, thine the glory, thine the deeds to be celebrated,
Thine the myriad-rolling ocean, light and shadow illimitable,
Thine the lands of lasting summer, many blossoming Paradises,
Thine the North thine the South and thine the battle-thunder of God.*

Let us, gentlemen, work hard in that humble field allotted to us ; and by doing our duty endeavour to make the statistics of our day worthy of the country in which we live. Above all, let us never forget at our meetings how much we are indebted to the men no more among us, who have made us heirs of their labours, and to whom we are bound by natural piety. Among those names this year to be especially remembered is that of Sir Alexander Tulloch, K.C.B. He was a Fellow of the Statistical Society, to whose Journal he contributed valuable papers ; with Henry Marshall and Dr. Balfour he laboured successfully in army statistics ; he organized the pensioners ; his ability in administration induced the Government to send him with Sir John McNeil to the Crimea, where he rendered essential service to his country, helped to save the army, and afterwards endured a persecution which he merited only by honesty and endured with brave constancy. M. Villermé in France is a great name gone ; we may place it after that of M. Quételet. His contributions to statistics are clear, truthful, and practical. Like the Earl of Shaftesbury, he strove to do good to workmen by judicious regulations. In Germany Dr. Casper, a most amiable and excellent physician, has left works which are often cited in England. Let us strive, gentlemen, to continue the labours which these men began, and to imitate their virtuous love of statistical truth.

* Tennyson,

