THE REDISTRIBUTION OF MANKIND

BY

PROF. H. N. DICKSON, M. A., D. Sc.

FROM THE SMITHSONIAN REPORT FOR 1913, PAGES 553–569

(PUBLICATION 2301)

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Since the last meeting of this section the tragic fate of Capt. Scott's party, after its successful journey to the South Pole, has become known; and our hopes of welcoming a great leader, after great achievement, have been disappointed. There is no need to repeat here the narrative of events or to dwell upon the lessons afforded by the skill and resource and heroic persistence which endured to the end. All these have been, or will be, placed upon permanent record. But it is right that we should add our word of appreciation and proffer our sympathy to those who have suffered loss. It is for us also to take note that this last of the great Antarctic expeditions has not merely reached the pole, as another has done, but has added, to an extent that few successful exploratory undertakings have ever been able to do, to the sum of scientific geographical knowledge. As the materials secured are worked out it will, I believe, become more and more apparent that few of the physical and biological sciences have not received contributions, and important contributions, of new facts, and also that problems concerning the distribution of the different groups of phenomena and their action and reaction upon one another—the problems which are specially within the domain of the geographer—have not merely been extended in their scope but have been helped toward their solution.

The reaching of the two poles of the earth brings to a close a long and brilliant chapter in the story of geographical exploration. There is still before us a vista of arduous research in geography, bewildering almost in its extent, in such a degree, indeed, that "the scope of geography" is in itself a subject of perennial interest. But the days of great pioneer discoveries in topography have definitely drawn to their close. We know the size and shape of the earth, at least to a first approximation, and as the map fills up we know that there can be no new continents and no new oceans to discover, although all are still, in a sense, to conquer. Looking back, we find that the qualities

[1] Presidential address to Section E (geography), at the Birmingham meeting of the British association, September, 1913. Reprinted by permission from Report of the British Association for the Advancement of Science, Birmingham, 1913, pp. 536–546. London, 1914.

of human enterprise and endurance have shown no change; we need no list of names to prove that they were alike in the days of the earliest explorations, of the discovery of the New World, or of the sea route to India, of the "Principall Navigations," or of this final attainment of the poles. The love of adventure and the gifts of courage and endurance have remained the same; the order of discovery has been determined rather by the play of imagination upon accumulated knowledge, suggesting new methods and developing appropriate inventions. Men have dared to do risky things with inadequate appliances, and in doing so have shown how the appliances may be improved and how new enterprises may become possible as well as old ones easier and safer. As we come to the end of these "great explorations," and are restricted more and more to investigations of a less striking sort, it is well to remember that in geography, as in all other sciences, research continues to make as great demands as ever upon those same qualities and that the same recognition is due to those who continue in patient labor.

When we look into the future of geographical study it appears that for some time to come we shall still be largely dependent upon work similar to that of the pioneer type to which I have referred, the work of perfecting the geographer's principal weapon, the map. There are many parts of the world about which we can say little except that we know they exist; even the topographical map, or the material for making it, is wanting; and of only a few regions are there really adequate distributional maps of any kind. These matters have been brought before this section and discussed very fully in recent years, so I need say no more about them, except perhaps to express the hope and belief that the production of topographical maps of difficult regions may soon be greatlv facilitated and accelerated with the help of the new art of flying.

I wish to-day rather to ask your attention for a short time to a phase of pioneer exploration which has excited an increasing amount of interest in recent years. Civilized man is, or ought to be, beginning to realize that in reducing more and more of the available surface of the earth to what he considers a habitable condition he is making so much progress, and making it so rapidly, that the problem of finding suitable accommodations for his increasing numbers must become urgent in a few generations. We are getting into the position of the merchant whose trade is constantly expanding and who foresees that his premises will shortly be too small for him. In our case removal to more commodious premises elsewhere seems impossible—we are not likely to find a means of migrating to another planet—so we are driven to consider means of rebuilding on the old site and so making the best of what we have that our business may not suffer.

In the type of civilization with which we are most familiar there are two fundamental elements—supplies of food energy and supplies of mechanical energy. Since at present, partly because of geographical conditions, these do not necessarily (or even in general) occur together, there is a third essential factor, the line of transport. It may be of interest to glance, in the cursory manner which is possible upon such occasions, at some geographical points concerning each of these factors and to hazard some speculations as to the probable course of events in the future.

In his presidential address to the British Association at its meeting at Bristol in 1898, Sir William Crookes gave some valuable estimates of the world's supply of wheat, which, as he pointed out, is "the most sustaining food grain of the great Caucasian race." Founding upon these estimates, he made a forecast of the relations between the probable rates of increase of supply and demand, and concluded that "Should all the wheat-growing countries add to their [producing] area to the utmost capacity, on the most careful calculation the yield would give us only an addition of some 100,000,000 acres, supplying, at the average world yield of 12.7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread eaters till the year 1931." The president then added, "Thirty years is but a day in the life of a nation. Those present who may attend the meeting of the British Association 30 years hence will judge how far my forecasts are justified."

Half the allotted span has now elapsed, and it may be useful to inquire how things are going. Fortunately, this can be easily done, up to a certain point, at any rate, by reference to a paper published recently by Dr. J. F. Unstead,[1] in which comparisons are given for the decades 1881–1890, 1891–1900, and 1901–1910. Dr. Unstead shows that the total wheat harvest for the world may be estimated at 2,258,000,000 bushels for the first of these periods, 2,575,000,000 for the second, and 3,233,000,000 for the third, increases of 14 per cent and 25 per cent, respectively. He points out that the increases were due "mainly to an increased acreage," the areas being 192,000,000, 211,000,000, and 242,000,000 acres, but also "to some extent (about 8 per cent) to an increased average yield per acre, for while in the first two periods this was 12 bushels, in the third period it rose to 13 bushels per acre."

If we take the period 1891–1900, as nearly corresponding to Sir William Crookes's initial date, we find that the succeeding period shows an increase of 658,000,000 bushels, or about half the estimated increase required by 1931, and that attained chiefly by "increased acreage."

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[1] Geographical Journal, August and September, 1913.

But signs are not wanting that increase in this way will not go on indefinitely. We note (also from Dr. Unstead's paper) that in the two later periods the percentage of total wheat produced which was exported from the United States fell from 32 to 19, the yield per acre showing an increase meanwhile to 14 bushels. In the Russian Empire the percentage fell from 26 to 23, and only in the youngest of the new countries—Canada, Australia, and the Argentine—do we find large proportional increases. Again, it is significant that in the United Kingdom, which is, and always has been, the most sensitive of all wheat-producing countries to variations in the floating supply, the rate of falling off of home production shows marked if irregular diminution.

Looking at it in another way, we find (still from Dr. Unstead's figures) that the total amount sent out by the great exporting countries averaged in 1881–1890, 295,000,000 bushels; 1891–1900, 402,000,000; 1901–1910, 532,000,000. These quantities represent, respectively, 13, 15.6, and 16.1 per cent of the total production, and it would appear that the percentage available for export from these regions is, for the time at least, approaching its limit—i. e., that only about one-sixth of the wheat produced is available from surpluses in the regions of production for making good deficiencies elsewhere.

There is, on the other hand, abundant evidence that improved agriculture is beginning to raise the yield per acre over a large part of the producing area. Between the periods 1881–1890 and 1901–1910 the average in the United States rose from 12 to 14 bushels; in Russia, from 8 to 10; in Australia, from 8 to 10. It is likely that in these last two cases at least a part of the increase is due merely to more active occupation of fresh lands as well as to the use of more suitable varieties of seed, and the effect of improvements in methods of cultivation alone is more apparent in the older countries. During the same period the average yield increased in the United Kingdom from 28 to 32 bushels, in France from 17 to 20, Holland, 27 to 33; Belgium, 30 to 35; and it is most marked in the German Empire, for which the figures are 19 and 29.

In another important paper [1] Dr. Unstead has shown that the production of wheat in North America may still in all likelihood be very largely increased by merely increasing the area under cultivation, and the reasoning by which he justifies this conclusion certainly holds good over large districts elsewhere. It is of course impossible, in the present crude state of our knowledge of our own plant, to form any accurate estimate of the area which may, by the use of suitable seeds or otherwise, become available for extensive cultivation. But I think it is clear that the available proportion of the total supply

[1] Geographical Journal, April and May, 1912.

from "extensive" sources has reached, or almost reached, its maximum, and that we must depend more and more upon intensive farming, with its greater demands for labor.

The average total area under wheat is estimated by Dr. Unstead as 192,000,000 acres for 1881–1890, 211,000,000 acres for 1891–1900, and 242,000,000 acres for 1901–1910. Making the guess—for we can make nothing better—that this area may be increased to 300,000,000 acres, and that under ordinary agriculture the average yield may eventually be increased to 20 bushels over the whole, we get an average harvest of 6,000,000,000 bushels of wheat. The average wheat eater consumes, according to Sir William Crooke's figures, about 4½ bushels per annum; but the amount tends to increase. It is as much (according to Dr. Unstead) as 6 bushels in the United Kingdom and 8 bushels in France. Let us take the British figure, and it appears that on a liberal estimate the earth may in the end be able to feed permanently 1,000,000,000 wheat eaters. If prophecies based on population statistics are trustworthy, the crisis will be upon us before the end of this century. After that we must either depend upon some substitute to reduce the consumption per head of the staple foodstuff, or we must take to intensive farming of the most strenuous sort, absorbing enormous quantities of labor and introducing, sooner or later, serious difficulties connected with plant food. We leave the possibility of diminishing the rate of increase in the number of bread eaters out of account.

We gather, then, that the estimates formed in 1898 are in the main correct, and the wheat problem must become one of urgency at no distant date, although actual shortage of food is a long way off. What is of more immediate significance to the geographer is the element of change, of return to earlier conditions, which is emerging even at the present time. If we admit, as I think we must do, that the days of increase of extensive farming on new land are drawing to a close, then we admit that the assignment of special areas for the production of the food supply of other distant areas is also coming to its end. The opening up of such areas, in which a sparse population produces food in quantities largely in excess of its own needs, has been the characteristic of our time, but it must give place to a more uniform distribution of things, tending always to the condition of a moderately dense population, more uniformly distributed over large areas, capable of providing the increased labor necessary for the higher type of cultivation, and self-supporting in respect of grain food at least. We observe in passing that the colonial system of our time only became possible on the large scale with the invention of the steam locomotive, and that the introduction of railway systems in the appropriate regions, and the first tapping of nearly all such regions on the globe, has taken less than a century.

Concentration in special areas of settlement, formerly chiefly effected for military reasons, has in modern times been determined more and more by the distribution of supplies of energy. The position of the manufacturing district is primarily determined by the supply of coal. Other forms of energy are, no doubt, available, but, as Sir William Ramsay showed in his presidential address at the Portsmouth meeting in 1911, we must in all probability look to coal as being the chief permanent source.

In the early days of manufacturing industries the main difficulties arose from defective land transport. The first growth of the industrial system, therefore, took place where sea transport was relatively easy; raw material produced in a region near a coast was carried to a coal field also near a coast, just as in the times when military power was chiefly a matter of "natural defenses," the center of power and the food-producing colony had to be mutually accessible. Hence the Atlantic took the place of the Mediterranean, Great Britain eventually succeeded Rome, and eastern North America became the counterpart of Northern Africa. It is to this, perhaps more than to anything else, that we in Britain owe our tremendous start amongst the industrial nations, and we observe that we used it to provide less favored nations with the means of improving their system of land transport, as well as actually to manufacture imported raw material and redistribute the products.

But there is, of course, this difference between the supply of foodstuff (or even military power) and mechanical energy, that in the case of coal at least it is necessary to live entirely upon capital; the storing up of energy in new coal fields goes on so slowly in comparison with our rate of expenditure that it may be altogether neglected. Now, in this country we began to use coal on a large scale a little more than a century ago. Our present yearly consumption is of the order of 300,000,000 tons, and it is computed[1] that at the present rate of increase "the whole of our available supply will be exhausted in 170 years." With regard to the rest of the world we can not, from lack of data, make even the broad assumptions that were possible in the case of wheat supply, and for that and other reasons it is therefore impossible even to guess at the time which must elapse before a universal dearth of coal becomes imminent; it is perhaps sufficient to observe that to the best of our knowledge and belief one of the world's largest groups of coal fields (our own) is not likely to last three centuries in all.

Here again the present interest lies rather in the phases of change which are actually with us. During the first stages of the manufacturing period energy in any form was exceedingly difficult to trans-

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[1] General Report of the Royal Commission on Coal Supplies, 1906.

port, and this led to intense concentration. Coal was taken from the most accessible coal field and used, as far as possible, on the spot. It was chiefly converted into mechanical energy by means of the steam engine, an extremely wasteful apparatus in small units, hence still further concentration; thus the steam engine is responsible in part for the factory system in its worst aspect. The less accessible coal fields were neglected. Also, the only other really available source of energy—water power—remained unused, because the difficulties in the way of utilizing movements of large quantities of water through small vertical distances (as in tidal movements) are enormous; the only easily applied source occurs where comparatively small quantities of water fall through considerable vertical distances, as in the case of waterfalls. But, arising from the geographical conditions, waterfalls (with rare exceptions, such as Niagara) occur in the "torrential" part of the typical river course, perhaps far from the sea, almost certainly in a region too broken in surface to allow of easy communication or even of industrial settlement of any kind.

However accessible a coal field may be to begin with, it sooner or later becomes inaccessible in another way, as the coal near the surface is exhausted and the workings get deeper. No doubt the evil day is postponed for a time by improvements in methods of mining—a sort of intensive cultivation—but as we can put nothing back the end must be the same, and successful competition with more remote but more superficial deposits becomes impossible. And every improvement in land transport favors the geographically less accessible coal fields.

From this point of view it is impossible to overestimate the importance of what is to all intents and purposes a new departure of the same order of magnitude as the discovery of the art of smelting iron with coal, or the invention of the steam engine, or of the steam locomotive. I mean the conversion of energy into electricity, and its transmission in that form (at small cost and with small loss) through great distances. First we have the immediately increased availability of the great sources of cheap power in waterfalls. The energy may be transmitted through comparatively small distances and converted into heat in the electric furnace, making it possible to smelt economically the most refractory ores, as those of aluminium, and converting such unlikely places as the coast of Norway or the West Highlands of Scotland into manufacturing districts. Or it may be transmitted through greater distances to regions producing quantities of raw materials, distributed there widespread to manufacturing centers, and reconverted into mechanical energy. The Plain of Lombardy produces raw material in abundance, but Italy has no coal supply. The waterfalls of the Alps yield much energy, and this transmitted in the form of electricity, in some cases for great distances, is converting northern Italy into one of the world's great industrial regions. Chisholm gives an estimate of a possible supply of power amounting to 3,000,000 horsepower, and says that of this about one-tenth was already being utilized in the year 1900.

But assuming again, with Sir William Ramsay, that coal must continue to be the chief source of energy, it is clear that the question of accessibility now wears an entirely different aspect. It is not altogether beyond reason to imagine that the necessity for mining, as such, might entirely disappear, the coal being burnt in situ and energy converted directly into electricity. In this way some coal fields might conceivably be exhausted to their last pound without serious increase in the cost of getting. But for the present it is enough to note that, however inaccessible any coal field may be from supplies of raw material, it is only necessary to establish generating stations at the pit's mouth and transport the energy to where it can be used. One may imagine, for example, vast manufactures carried on in what are now the immense agricultural regions of China, worked by power supplied from the great coal deposits of Shansi.

There is, however, another peculiarity of electrical power which will exercise increasing influence upon the geographical distribution of industries. The small electric motor is a much more efficient apparatus than the small steam engine. We are, accordingly, already becoming familiar with the great factory in which, instead of all tools being huddled together to save loss through shafting and belting, and all kept running all the time, whether busy or not (because the main engine must be run), each tool stands by itself and is worked by its own motor, and that only when it is wanted. Another of the causes of concentration of manufacturing industry is therefore reduced in importance. We may expect to see the effects of this becoming more and more marked as time goes on, and other forces working toward uniform distribution make themselves more felt.

The points to be emphasized so far, then, are, first, that the time when the available areas whence food supply, as represented by wheat, is derived are likely to be taxed to their full capacity within a period of about the same length as that during which the modern colonial system has been developing in the past; secondly, that cheap supplies of energy may continue for a longer time, although eventually they must greatly diminish; and, thirdly, there must begin in the near future a great equalization in the distribution of population. This equalization must arise from a number of causes. More intensive cultivation will increase the amount of labor required in agriculture, and there will be less difference in the cost of production and yield due to differences of soil and climate. Manufacturing industries will be more uniformly distributed, because energy, obtained from a larger number of sources in the less accessible places, will be distributed over an increased number of centers. The distinction between agricultural and industrial regions will tend to become less and less clearly marked, and will eventually almost disappear in many parts of the world.

The effect of this upon the third element is of first-rate importance. It is clear that as the process of equalization goes on the relative amount of long-distance transport will diminish, for each district will tend more and more to produce its own supply of staple food and carry on its own principal manufactures. This result will naturally be most marked in what we may call the "east-and-west" transport, for as climatic controls primarily follow the parallels of latitude, the great quantitative trade, the flow of foodstuffs and manufactured articles to and fro between peoples of like habits and modes of life, runs primarily east and west. Thus the transcontinental functions of the great North American and Eurasian railways, the east-and-west systems of the inland waterways of the two continents, and the connecting links furnished by the great ocean ferries must become of relatively less importance.

The various stages may be represented, perhaps, in some such manner as this. If I is the cost of producing a thing locally at a place A by intensive cultivation or what corresponds to it, if E is the cost of producing the same thing at a distant place B, and T the cost of transporting it to A, then at A we may at some point of time have a more or less close approximation to

$$I=E+T.$$

We have seen that in this country, for example, I has been greater than $E+T$ for wheat ever since, say, the introduction of railways in North America, that the excess tends steadily to diminish, and that however much it may be possible to reduce T either by devising cheaper modes of transport or by shortening the distance through which wheat is transported, $E+T$ must become greater than I, and it will pay us to grow all or most of our own wheat. Conversely, in the seventies of last century I was greater than $E+T$ in North America and Germany for such things as steel rails and rolling stock, which we in this country were cultivating "extensively" at the time on more accessible coal fields, with more skilled labor and better organization than could be found elsewhere. In many cases the positions are now, as we know, reversed, but geographically I must win all round in the long run.

In the case of transport between points in different latitudes, the conditions are, of course, altogether dissimilar, for in this case commodities consist of foodstuffs, or raw materials, or manufactured articles, which may be termed luxuries, in the sense that their use is scarcely known until cheap transport makes them easily accessible, when they rapidly become "necessaries of life." Of these the most familiar examples are tea, coffee, cocoa, and bananas, india rubber and manufactured cotton goods. There is here, of course, always the possibility that wheat as a staple might be replaced by a foodstuff produced in the tropics, and it would be extremely interesting to study the geographical consequences of such an event as one-half of the surface of the earth suddenly coming to help in feeding the two quarters on either side; but for many reasons, which I need not go into here, such a consummation is exceedingly unlikely. What seems more probable is that the trade between different latitudes will continue to be characterized specially by its variety, the variety doubtless increasing, and the quantity increasing in still larger measure. The chief modification in the future may perhaps be looked for in the occasional transference of manufactures of raw materials produced in the tropics to places within the tropics, especially when the manufactured article is itself largely consumed near regions of production. The necessary condition here is a region, such as, e. g., the monsoon region, in which there is sufficient variation in the seasons to make the native population laborious; for then, and apparently only then, is it possible to secure sufficient industry and skill by training, and therefore to be able to yield to the ever-growing pressure in more temperate latitudes due to increased cost of labor. The best examples of this to-day are probably the familiar ones of cotton and jute manufacture in India. With certain limitations, manufacturing trade of this kind is, however, likely to continue between temperate and strictly tropical regions, where the climate is so uniform throughout the year that the native has no incentive to work. There the collection of the raw material is as much as, or even more than can be looked for—as in the case of mahogany or wild rubber. Where raw material has to be cultivated—as cotton, cultivated rubber, etc.—the raw material has to be produced in regions more of the monsoon type, but it will probably—perhaps as much for economic as geographical reasons—be manufactured at some center in the temperate zones, and the finished product transported thence, when necessary, to the point of consumption in the tropics.

We are here, however, specially liable to grave disturbances of distribution arising from invention of new machinery or new chemical methods; one need only mention the production of sugar or indigo. Another aspect of this which is not without importance may perhaps be referred to here, although it means the transference of certain industries to more accessible regions merely, rather than a definite change of such an element as latitude. I have in mind the sudden conversion of an industry in which much labor is expended on a small amount of raw material into one where much raw material is consumed, and by the application of power-driven machinery the labor required is greatly diminished. One remembers when a 50-shilling Swiss watch, although then still by tradition regarded as sufficiently valuable to deserve inclosure in a case constructed of a precious metal, was considered a marvel of cheapness. American machine-made watches, produced by the ton, are now encased in the baser metals and sold at some 5 shillings each, and the watch-making industry has ceased to be specially suited to mountainous districts.

In considering the differences which seem likely to arise in what we may call the regional pressures of one kind and another, pressures which are relieved or adjusted by and along certain lines of transport, I have made a primary distinction between "east-and-west" and "north-and-south" types, because both in matters of food supply and in the modes of life which control the nature of the demand for manufactured articles climate is eventually the dominant factor; and, as I have said, climate varies primarily with latitude. This is true specially of atmospheric temperature; but temperature varies also with altitude, or height above the level of the sea. To a less extent rainfall, the other great element of climate, varies with altitude, but the variation is much more irregular. More important in this case is the influence of the distribution of land and sea, and more especially the configuration of the land surface, the tendency here being sometimes to strengthen the latitude effect where a continuous ridge is interposed, as in Asia, practically cutting off "north-and-south" communication altogether along a certain line, emphasizing the parallel-strip arrangement running east and west to the north of the line, and inducing the quite special conditions of the monsoon region to the south of it. We may contrast this with the effect of a "north-and-south" structure, which (in temperate latitudes especially) tends to swing what we may call the regional lines round till they cross the parallels of latitude obliquely. This is typically illustrated in North America, where the angle is locally sometimes nearly a right angle. It follows, therefore, that the contrast of "east-and-west" and "north-and-south" lines, which I have here used for purposes of illustration, is necessarily extremely crude, and one of the most pressing duties of geographers at the present moment is to elaborate a more satisfactory method of classification. I am very glad that we are to have a discussion on "Natural regions" at one of our sederunts. Perhaps I may be permitted to express the hope that we shall concern ourselves with the types of region we want, their structure or "grain," and their relative positions, rather than with the precise delimitation of their boundaries, to which I think we have sometimes been inclined, for educational purposes, to give a little too much attention.

Before leaving this I should like to add, speaking still in terms of "east-and-west" and "north-and-south," one word more about the essential east-and-west structure of the Old World. I have already referred to the great central axis of Asia. This axis is prolonged westward through Europe, but it is cut through and broken to such an extent that we may include the Mediterranean region with the area lying farther north, to which indeed it geographically belongs, in any discussion of this sort. But the Mediterranean region is bounded on the other side by the Sahara, and none of our modern inventions facilitating transport has made any impression upon the dry desert; nor does it seem likely that such a desert will ever become a less formidable barrier than a great mountain mass or range. We may conclude, then, that in so far as the Old World is concerned, the "north-and-south" transport can never be carried on as freely as it may in the New, but only through certain weak points, or "round the ends," i. e., by sea. It may be further pointed out that the land areas in the southern hemisphere are so narrow that they will scarcely enter into the "east-and-west" category at all—the transcontinental railway as understood in the northern hemisphere can not exist; it is scarcely a pioneer system, but rather comes into existence as a later by-product of local east-and-west lines, as in Africa.

These geographical facts must exercise a profound influence upon the future of the British Isles. Trade south of the great dividing line must always be to a large extent of the "north-and-south" type, and the British Isles stand practically at the western end of the great natural barrier. From their position the British Isles will always be a center of immense importance in entrepôt trade, importing commodities from "south" and distributing "east and west," and similarly in the reverse direction. This movement will be permanent, and will increase in volume long after the present type of purely "east-and-west" trade has become relatively less important than it is now, and long after the British Isles have ceased to have any of the special advantages for manufacturing industries which are due to their own resources either in the way of energy or of raw material. We can well imagine, however, that this permanent advantage of position will react favorably, if indirectly, upon certain types of our manufactures, at least for a very long time to come.

Reverting briefly to the equalization of the distribution of population in the wheat-producing areas and the causes which are now at work in this direction, it is interesting to inquire how geographical conditions are likely to influence this on the smaller scale. We may suppose that the production of staple foodstuffs must always be more uniformly distributed than the manufacture of raw materials, or the production of the raw materials themselves, for the most important raw materials of vegetable origin (as cotton, rubber, etc.) demand special climatic conditions, and, apart from the distribution of energy, manufacturing industries are strongly influenced by the distribution of mineral deposits, providing metals for machinery, and so on. It may, however, be remarked that the useful metals, such as iron, are widely distributed on or near regions which are not as a rule unfavorable to agriculture. Nevertheless, the fact remains that while a more uniform distribution is necessary and inevitable in the case of agriculture, many of the conditions of industrial and social life are in favor of concentration; the electrical transmission of energy removes, in whole or in part, only one or two of the centripetal forces. The general result might be an approximation to the conditions occurring in many parts of the monsoon areas—a number of fairly large towns pretty evenly distributed over a given agricultural area, and each drawing its main food supplies from the region surrounding it. The position of such towns would be determined much more by industrial conditions, and less by military conditions, than in the past (military power being in these days mobile, and not fixed); but the result would on a larger scale be of the same type as was developed in the central counties of England, which, as Mackinder has pointed out, are of almost equal size and take the name of the county town. Concentration within the towns would, of course, be less severe than in the early days of manufacturing industry. Each town would require a very elaborate and highly organized system of local transport, touching all points of its agricultural area, in addition to lines of communication with other towns and with the great "north-and-south" lines of world-wide commerce, but these outside lines would be relatively of less importance than they are now. We note that the more perfect the system of local transport the less the need for points of intermediate exchange. The village and the local market town will be "sleepy" or decadent as they are now, but for a different reason; the symptoms are at present visible mainly because the country round about such local centers is overwhelmed by the great lines of transport which pass through them; they will survive for a time through inertia and the ease of foreign investment of capital. The effect of this influence is already apparent since the advent of the "commercial motor," but up to the present it has been more in the direction of distributing from the towns than collecting to them, producing a kind of "suburbanization" which throws things still further out of balance. The importance of the road motor in relation to the future development of the food-producing area is incalculable. It has long been clear that the railway of the type required for the great through lines of fast transport is ill adapted for the detailed work of a small district, and the "light" railway solves little and introduces many complications. The problem of determining the direction and capacity of a system of roads adequate to any particular region is at this stage one of extraordinary difficulty; experiments are exceedingly costly, and we have as yet little experience of a satisfactory kind to guide us. The geographer, if he will, can here be of considerable service to the engineer.

In the same connection, the development of the agricultural area supplying an industrial center offers many difficult problems in relation to what may be called accessory products, more especially those of a perishable nature, such as meat and milk. In the case of meat the present position is that much land which may eventually become available for grain crops is used for grazing, or cattle are fed on some grain, like maize, which is difficult to transport or is not satisfactory for bread making. The meat is then temporarily deprived of its perishable property by refrigeration, and does not suffer in transport. Modern refrigerating machinery is elaborate and complicated, and more suited to use on board ship than on any kind of land transport; hence, the most convenient regions for producing meat for export are those near the seacoast, such as occur in the Argentine or the Canterbury plains of New Zealand. The case is similar to that of the accessible coal field. Possibly the preserving processes may be simplified and cheapened, making overland transport easier, but the fact that it usually takes a good deal of land to produce a comparatively small quantity of meat will make the difficulty greater as land becomes more valuable. Cow's milk, which in modern times has become a "necessary of life" in most parts of the civilized world, is in much the same category as meat, except that difficulties of preservation, and therefore of transport, are even greater. That the problem has not become acute is largely due to the growth of the long-transport system available for wheat, which has enabled land round the great centers of population to be devoted to dairy produce. If we are right in supposing that this state of things can not be permanent the difficulty of milk supply must increase, although relieved somewhat by the less intense concentration in the towns; unless, as seems not unlikely, a wholly successful method of permanent preservation is devised.

In determining the positions of the main centers, or, rather, in subdividing the larger areas for the distribution of towns with their supporting and dependent districts, water supply must be one of the chief factors in the future, as it has been in the past; and in the case of industrial centers the quality as well as the quantity of water has to be considered. A fundamental division here would probably be into districts having a natural local supply, probably of hard water, and districts in which the supply must be obtained from a distance. In the latter case engineering works of great magnitude must often be involved, and the question of total resources available in one district for the supply of another must be much more fully investigated than it has been. In many cases, as in this country, the protection of such resources pending investigation is already much needed. It is worth noting that the question may often be closely related to the development and transmission of electrical energy from waterfalls, and the two problems might in such cases be dealt with together. Much may be learned about the relation of water supply to distribution of population from a study of history, and a more active prosecution of combined historical and geographical research would, I believe, furnish useful material in this connection, besides throwing interesting light on many historical questions.

Continued exchange of the "north-and-south" type, and at least a part of that described as "east-and-west," gives permanence to a certain number of points where, so far as can be seen, there must always be a change in the mode of transport. It is not likely that we shall have heavy freight-carrying monsters in the air for a long time to come, and until we have the aerial "tramp", transport must be effected on the surfaces of land and sea. However much we may improve and cheapen land transport, it can not in the nature of things become as cheap as transport by sea. For on land the essential idea is always that of a prepared road of some kind, and, as Chisholm has pointed out, no road can carry more than a certain amount; traffic beyond a certain quantity constantly requires the construction of new roads. It follows, then, that no device is likely to provide transport indifferently over land and sea, and the seaport has in consequence inherent elements of permanence. Improved and cheapened land transport increases the economy arising from the employment of large ships rather than small ones, for not only does transport inland become relatively more important, but distribution along a coast from one large seaport becomes as easy as from a number of small coastal towns. Hence the conditions are in favor of the growth of a comparatively small number of immense seaport cities like London and New York, in which there must be great concentration not merely of work directly connected with shipping, but of commercial and financial interests of all sorts. The seaport is, in fact, the type of great city which seems likely to increase continually in size, and provision for its needs can not in general be made from the region immediately surrounding it, as in the case of towns of other kinds. In special cases there is also, no doubt, permanent need of large inland centers of the type of the "railway creation," but under severe geographic control these must depend very much on the nature and efficiency of the systems of land transport. It is not too much to say (for we possess some evidence of it already) that the number of distinct geographical causes which give rise to the establishment and maintenance of individual great cities is steadily diminishing, but that the large seaport is a permanent and increasing necessity. It follows that aggregations of the type of London and Liverpool, Glasgow and Belfast, will always be amongst the chief things to be reckoned with in these islands, irrespective of local coal supply or accessory manufacturing industries, which may decay through exhaustion.

I have attempted in what precedes to draw attention once more to certain matters for which it seems strangely difficult to get a hearing. What it amounts to is this, that as far as our information goes the development of the steamship and the railway, and the universal introduction of machinery which has arisen from it, have so increased the demand made by man upon the earth's resources that in less than a century they will have become fully taxed. When colonization and settlement in a new country proceeded slowly and laboriously, extending centrifugally from one or two favorable spots on the coast, it took a matter of four centuries to open up a region the size of England. Now we do as much for a continent like North America in about as many decades. In the first case it was not worth troubling about the exhaustion of resources, for they were scarcely more than touched, and even if they were exhausted there were other whole continents to conquer. But now, so far as our information goes, we are already making serious inroads upon the resources of the whole earth. One has no desire to sound an unduly alarmist note, or to suggest that we are in imminent danger of starvation, but surely it would be well, even on the suspicion, to see if our information is adequate and reliable and if our conclusions are correct; and not merely to drift in a manner which was justifiable enough in Saxon times, but which, at the rate things are going now, may land us unexpectedly in difficulties of appalling magnitude.

What is wanted is that we should seriously address ourselves to a stock taking of our resources. A beginning has been made with a great map on the scale of one to a million, but that is not sufficient; we should vigorously proceed with the collection and discussion of geographical data of all kinds, so that the major natural distributions shall be adequately known, and not merely those parts which commend themselves, for one reason or another, to special national or private enterprises. The method of Government survey employed in most civilized countries for the construction of maps, the examination of geological structure, or the observation of weather and climate is satisfactory as far as it goes, but it should go further and be made to include such things as vegetation, water supply, supplies of energy of all kinds, and, what is quite as important, the bearings of one element upon others under different conditions. Much, if not most, of the work of collecting data would naturally be done as it is now by experts in the special branches of knowledge, but it is essential that there should be a definite plan of a geographical survey as a whole, in order that the regional or distributional aspect should never be lost sight of. I may venture to suggest that a committee formed jointly by the great national geographical societies, or by the International Geographical Congress, might be intrusted with the work of formulating some such uniform plan and suggesting practicable methods of carrying it out. It should not be impossible to secure international cooperation, for there is no need to investigate too closely the secrets of anyone's particular private vineyard—it is merely a question of doing thoroughly and systematically what is already done in some regions, sometimes thoroughly, but not systematically. We should thus arrive eventually at uniform methods of stock taking, and the actual operations could be carried on as opportunity offered and indifference or opposition was overcome by the increasing need for information. Eventually we shall find that "country planning" will become as important as town planning, but it will be a more complex business, and it will not be possible to get the facts together in a hurry. And in the meanwhile increased geographical knowledge will yield scientific results of much significance about such matters as distribution of populations and industries, and the degree of adjustment to new conditions which occurs or is possible in different regions and amongst different peoples. Primary surveys on the large scale are specially important in new regions, but the best methods of developing such areas and of adjusting distributions in old areas to new economic conditions are to be discovered by extending the detailed surveys of small districts. An example of how this may be done has been given by Dr. Mill in his Fragment of the Geography of Sussex. Dr. Mill's methods have been successfully applied by individual investigators to other districts, but a definitely organized system, marked out on a carefully matured uniform plan, is necessary if the results are to be fully comparable. The schools of geography in this country have already done a good deal of local geography of this type, and could give much valuable assistance if the work were organized beforehand on an adequate scale.

But in whatever way and on whatever scale the work is done, it must be clearly understood that no partial study from the physical, or biological, or historical, or economic point of view will ever suffice. The urgent matters are questions of distribution upon the surface of the earth, and their elucidation is not the special business of the physicist, or the biologist, or the historian, or the economist, but of the geographer.

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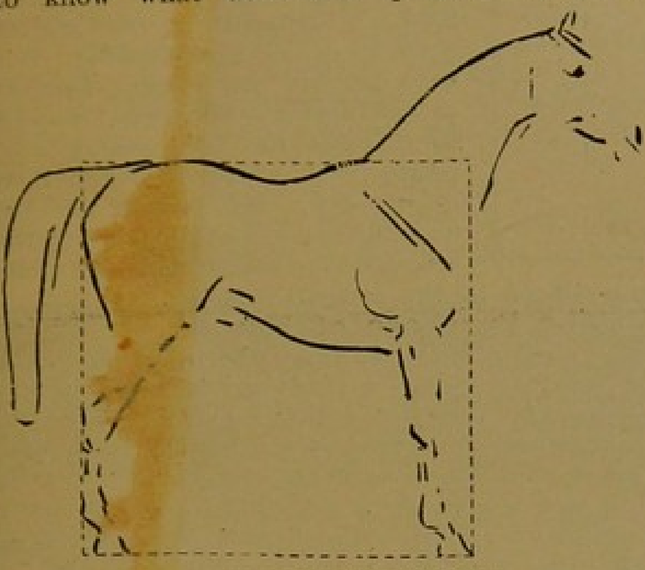
Feeding the Working Horse. We have seen that a horse of given weight can be maintained when at rest on some $6\frac{1}{2}$ lb. of digestible matter—that is, on that portion of the dry material of food which is nutritious and digestible, this being regarded as the maintenance ration. The feeder next requires to know what additional quantity of food



A WELL-FORMED HORSE

His height is equal to his length. Note the dotted lines forming a square. The pictures on this page are from Captain [illegible]e's "Hints on Horses," published by Mr. John Murray.

should be provided for the accomplishment of a given amount of work by a horse of given weight. When we speak of food in this connection we mean the digestible portion of the additional ration provided. An addition to a ration having been made, it is important to understand, although the fact can only be approximate, what it means when translated [illegible]rgy; nor must we forget that energy is expended as well when the animal moves itself as when it is moving its load. Let us again refer to the work of Zuntz, who found that about a third of the total energy provided by food could be utilised in the form of labour. This experimenter points out that a horse weighing 1000 lb. when walking a mile at the rate of from two to three miles an hour would, to quote from Jordan on the "Feeding of Animals," "expend a total energy of 473 foot-tons, 44·4 per cent., or 201 foot-tons, of which belong to the effort of walking over and above the energy needed for mere maintenance." Thus, although we can only regard the results as approximate, [illegible]king and drawing a load 20 miles, the [illegible] performed would be equivalent to the lifting of 9300 tons one foot.

In feeding a horse it should be remembered that speed tells as well as weight. Thus, a fast draught horse expends more energy in accomplishing the same amount of work than a slow draught horse, and consequently it requires more food, although the additional food supplied for the accomplishment of additional work should be rather in the form of grain than of hay, a large quantity of which is not adapted to the limited capacity of the digestive organs of the horse. Many authorities regard 12 lb. of hay as a limit. This being so, it follows that the ration of a horse should be concentrated, well balanced, and mixed with chaff, and supplied more frequently than in the case of ruminants.

The Food for the Fastest. A hackney or nag horse employed for any fast work requires more food, weight for weight, than a draught horse, more energy being expended in a given time, so that the cost of horse labour increases with the speed with which it is performed. In practice, however, horses kept for fast work are kept at rest during more hours daily than draught horses; consequently a balance is struck, and the total food consumed is not materially increased, and time is given to the animal to recuperate. Farmers, as a rule, [illegible] fast horses on the land, but if such animals are worked the full complement of hours daily, they require more food than slower horses, and wear out more quickly. In the table which follows on the next page are some suggested rations for heavy horses.

The difference between the German standard and English practice, as shown by the rations given by farmers, and suggested by Fleming, is remarkable, but in practice there is just as much difference in the weight of the rations supplied by farmers themselves. In many cases meadow, mixed, or clover hay is freely supplied, apart from the chaff used in mixing with the corn, while the oats provided on one farm may reach three bushels per week and on another only two bushels.

Proportions of Food. A French observer of wide experience finds by direct experiment that a draught horse in ordinary work requires 12 lb. of digestible dry matter per 1000 lb. live weight, the proportion of fatty matter increasing with size. On the basis of the argument of Zuntz, if we assume that $6\frac{1}{2}$ lb. of dry digestible matter are required for the purposes of maintenance of a horse of 1000 lb., some 14 lb. of additional digestible dry matter would be required were such a horse engaged in walking with a draught of 1000 lb. on a level road for 20 miles. We

ACTION OF A HACKNEY HORSE WHEN [illegible]

have seen that the ratio between the albuminoids of food on the one hand, and the fats and carbohydrates on the other, varies. Experience suggests that with increased work the albuminoids should be increased, and consequently the ratio reduced. It is for this reason that in heavy work beans are constantly added to oats, especially where such work is fast; but, inasmuch a

RATIONS FOR HEAVY HORSES.
(Per Cent.)

	Dry matter.	Albuminoids.	Fat	Carbohydrates.	Ratio.
Horse at heavy work, weighing 1,000 lb. (Wolff)	25·5	2·8	0·80	13·4	1–5·5
Do. moderate work .	22·5	1·8	0·60	11·2	1–7
Heavy horse at regular work (Fleming). Oats, 18 lb.; beans, 2 lb.; hay, 18 lb.; straw-chaff, 2 lb.	32·8	3·1	1·05	16·5	1–5·9
Farmer's summer ration (McConnell). Oats, 10½ lb.; beans 2 lb.; chaff, 2 lb.; grass, 100 lb.	34·8	3·4	0·9	18·6	1–6
German standard for a horse weighing 1,000 lb., in moderate work	—	—	11·4	—	—
Do. in average work	—	—	13·6	—	—
Do. in heavy work ..	—	—	16·6	—	—

the carbohydrates (sugar, starch, gum) and fats are chiefly employed in the animal economy in supplying the necessary energy, they may be provided in larger proportion for slow work, with the result that the ratio will be wider.

The employment of maize in the ration of a horse depends largely upon circumstances. It is inadequate for fast work; it may be used with judgment for medium or slow work. Maize, however, is not so safe a food nor so well balanced as the oat, although, when the price of both foods is moderate, there is a wide difference in the cost of the feeding matter supplied. Let us suppose that maize costs 25s. per quarter of 480 lb., and oats 20s. per quarter of 320 lb.—this weight providing a good sample. According to the following figures, 100 lb. of maize will provide 73·8 lb. of digestible dry matter, while 100 lb. of oats would provide only 57 lb.; the cost of the former would be 5s. 2½d., and of the latter 6s. 3d., or, in other words, the nutritious matter of the maize would cost ·85d. per lb., and of the oats 1·3d. per lb. [See table.]

Food.	Bushel. lb.	Price.	Digestible and Nutritious. Albuminoids.	Carbohydrates.	Fat.	Digestible. lb. per cent.	Cost of 100 lb.	Cost per lb. Digestible. Pence.
Maize ..	60	3/1½	8·4	60·6	4·8	= 73·8	5/2½	0·85
Oats (good) ..	40	2/6	9·0	43·3	4·7	= 57·0	6/3	1·3

The third table is a suggested ration, to include maize, for a horse weighing 1000 lb. in moderate work, the figures being approximate. With the same weight of maize and hay, the oats might be replaced with 5 lb. of barley or 6 lb. of bran, or 6 lb. of desiccated grains; but a change should be gradual, the complete alternative never being immediately effected. Horses fed on such a ration should, when subjected to severe work, receive an increase in the quantity of oats, in addition to 2 lb. of beans daily. In all cases the horses of the farm benefit by an occasional warm bran mash, which it is customary to supply on the Saturday night, or an occasional handful of linseed meal, or of crushed linseed cake, the albuminoid ration being maintained at about 1·5. The meaning of this ration it is now necessary to explain.

Food.	Dry Organic.	Albuminoids.	Carbohydrates.	Fat.
12 lb. Hay ..	9·7	·70	5·15	·15
6 lb. Oats ..	5·0	·53	2·50	·25
5 lb. Maize ..	4·2	·42	2·90	·25
2 lb. Straw-chaff	1·6	·02	—	·70
	20·5	1·67	10·55	1·35 = 13·57

Albuminoid Ratio. The term means the proportion between the albuminoid and the non-albuminoid digestible matter of food. Nitrogen is a leading element in all albuminoids; it is not present in either fats or carbohydrates. Were we, however, to describe the two sets of constituents as nitrogenous and non-nitrogenous, we might mislead, inasmuch as a portion only of the nitrogenous constituents of food is utilised in the animal economy.

The Purchase of Horses. In buying a horse an expert may be deceived. The amateur is, therefore, advised to employ professional help, and thus to minimise his risk. Those accustomed to horses, however they may trust their own judgment in other respects, will do well to employ a veterinarian to examine a proposed purchase for health and soundness. A horse should first be seen at home in the stable, and overhauled in every particular. The object should be to ascertain if there is vice, unsoundness in body or limb, and that the age given is correct, as shown by the teeth. Whether led at the walk or the trot, driven or ridden, it is well that a disinterested and capable groom or coachman should be employed unless the purchaser can trust himself. For his first examination the animal should be led to a level spot, where his teeth, eyes, wind, hearing, mane, withers, and limbs may be examined in turn. Something may be learned from the way he stands; hence he should be looked over from both front and back. He should stand firmly and four-square, not resting a weak limb or tender foot. He should be walked and trotted, ridden or in harness, and, in the case of a draught horse, be placed in a loaded cart, which he should be required to draw and to back. Again, he should be tested for shying, kicking, and even bolting, as well as for any other vices which may be suspected.

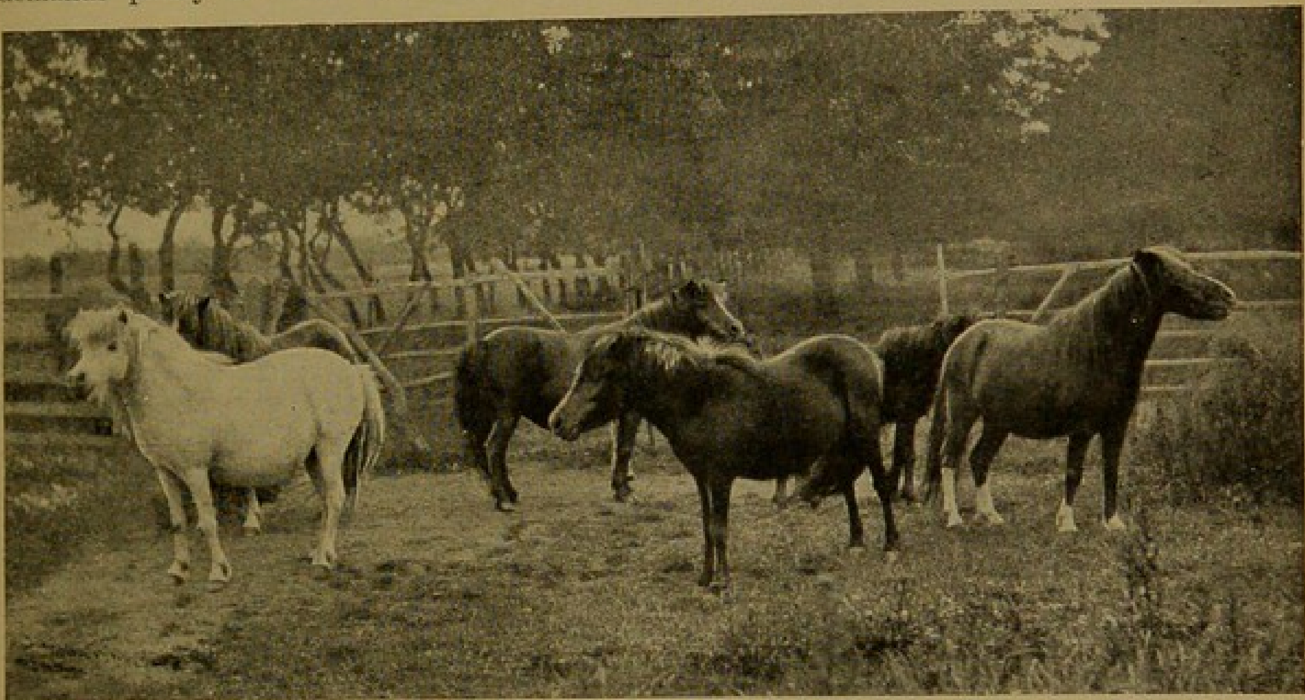
A sound horse should be able to see and hear clearly, and be afraid of nothing he sees or hears. On return to the stable, he should not exhibit timidity, or temper, or weakness of wind or limb either immediately or after a lapse of an hour. For such troubles or diseases as spavin, ringbone, splints, sandcrack, navicular, fistula, poll-evil, and the like, as already suggested, an expert should be employed. In selling a horse a warranty should never be given, either verbally or in writing, if there is a shadow of doubt on any point, for it includes faults of which the owner knows nothing. On the other hand, a buyer should endeavour to obtain a warranty for self-protection.

Horses for the Farm. The farm horse, being required for heavy draught work, as ploughing and rolling, drawing loads of manure to the fields and corn to the station of the merchant, requires great strength and endurance, as well as speed in walking. The object in breeding, therefore, is to obtain these qualifications. He must be of large size, well formed, the muscles being prominent where they are most needed, and the legs and feet absolutely sound and strong. Constitution demands plenty of room in the chest, which should be deep, broad, and long, well-arched ribs providing plenty of room for heart and lungs. Add docility and good temper, and we shall not be far wrong.

Horses for Breeding. In selecting stock for breeding, it is important that the stallion, or sire, should have a long, straight head, and broad forehead; short, wide, muscular loins; prominent, well-curved ribs; a belly proportionate to the size of the animal; fore legs whch are straight, squarely set when looked at from the front, and not too far under the chest. The hind legs should be equally square, well formed, straight, without tendency either to bowness or what is termed "cowhock." The feet should be well formed, sound, neither turned inward nor outward, and always firmly planted on the ground. There should be neither defect of eye nor ear, still less of breathing. In a word, it is imperative that for reproductive purposes both sire and dam should be in perfect health and vigour, and as nearly perfect in form and temper as possible. In many cases, mares are kept for field work and are also used for breeding purposes.

The Mare. The plan is a good one, but never should a weedy, unsound animal be employed as a dam. If a mare has a pedigree, which in large part means reliability of constitution, so much the better. She should be in good condition, and without any serious fault, and the younger the better, although in many cases mares are employed for breeding up to an advanced age. Both sire and dam should be in the full vigour of life. The mare comes into season from seven to ten days after foaling. The breeding mare may be worked nearly to the date of foaling, but she should obtain a rest of a few days under any circumstances. Parturition occurs about eleven months after service, the date of which should be kept, and, as the time closely approaches, it will be noticed that the udder begins to expand. The mare usually foals without assistance, whether on the pastures in sufficiently mild weather, or in the loose-box, where she should be subsequently kept for a few days prior to turning out with her offspring on a fine, warm day in a paddock.

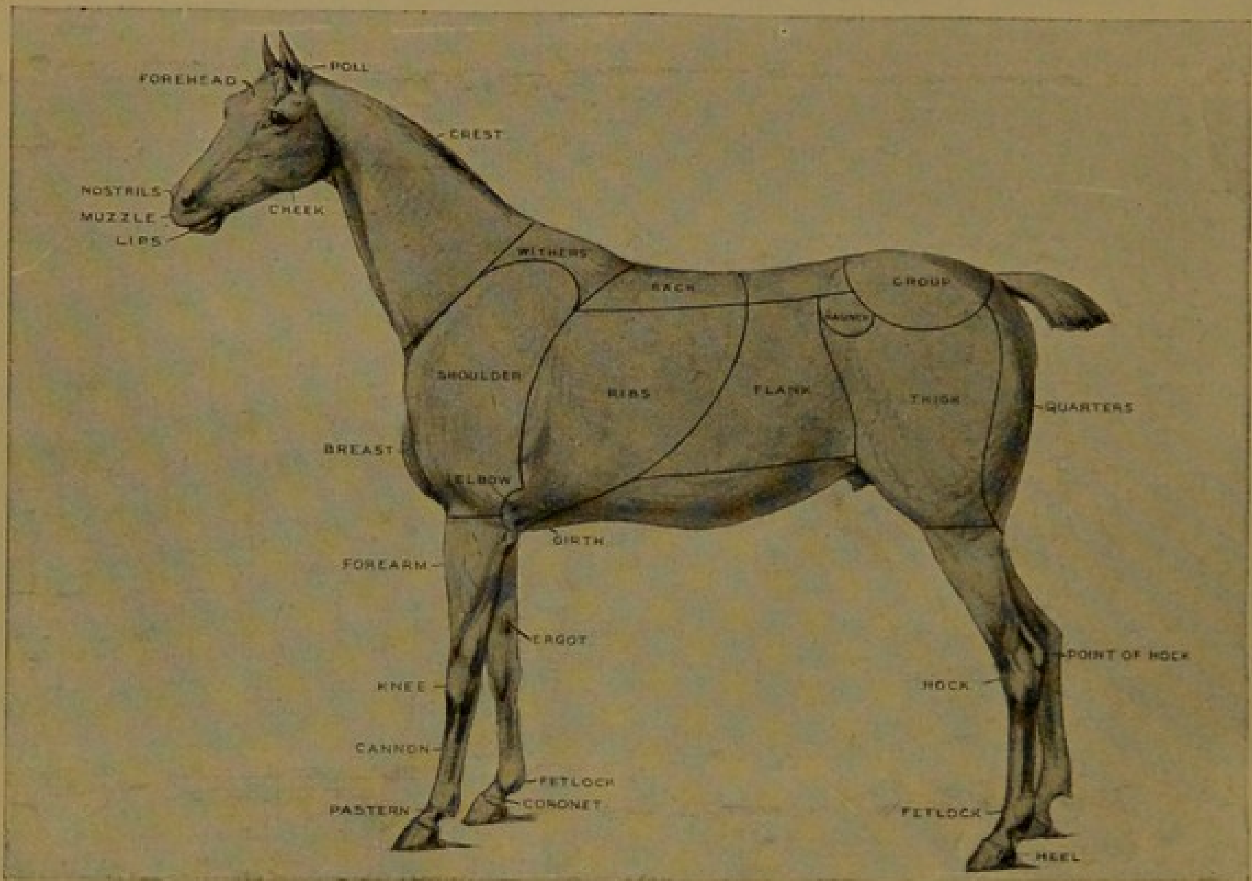
After foaling the mare should receive a few bran mashes and an occasional mash of boiled roots, with crushed oats and sweet hay. The box should be specially cleaned, purified, and littered with clean straw before foaling. If green food be available, it should be gradually introduced, unless the animal has been receiving green rations beforehand. Until mare and foal have been hardened off to outside exposure, they should return to the loose-box at night; subsequently both will benefit by remaining altogether upon a dry, yet soft, turfed pasture, on which they may be fed from a movable crib or manger from day to day. The mare should be kept in condition as well for the benefit of the foal as for her early return to work, and the foal should be liberally fed from weaning onwards. Without good feeding, size is unattainable, especially on poor soil. In the rearing of



A GROUP OF SHETLAND PONIES

young horses, it is important that the best grass should be placed at their disposal, but it should be neither short nor wet, many foals being lost upon both, and on many parasites abound.

Weaning Foals. When the mare returns to work, the hours during which she should be employed should be gradually increased, but she should never work too long in the day before weaning, nor return to her foal while still warm, both practices being liable to cause diarrhœa, or scour, in the youngster. A strong foal may be weaned at the age of six months. If he feeds well, his ration of oats may then be increased, but the food supplied should always be of the best. Extra care should be taken with young stock in winter, and yet there should be no coddling. Colts may be turned into a well-sheltered, or covered yard, where they can lie dry, and where they are protected against biting winds and driving rains. The colt may be castrated at from 12 to 15 months.



THE PARTS OF A HORSE

Breaking. Farm colts and fillies are more easily broken than those of almost any other class. The breeder should make friends with his stock from birth. Thus breaking becomes extremely easy, and almost without any effort a young animal submits to the halter and subsequently to harness for the plough or the waggon. There should be no suspicion of harshness or cruelty in word or deed. When, by the gradual introduction of the halter, the bridle, plough chains, and other harness, the young animal is submissive, he may be placed in harness by the side of a steady old horse, and induced to assist in drawing a log of wood, then a bush harrow, made on the framework of a hurdle or an old gate. This will prepare the way for attachment to a chain harrow, and subsequently to the plough, the roller, the waggon, and the cart. At first the experiment may be a short one, gradually increasing until the colt becomes fit for a short day's work. He should be encouraged by word and act, and rewarded on his return to the stable. In this way a colt may be gradually brought into daily work at the age of two and a half years.

The Age of the Horse. The adult male possesses 40 teeth, and the female 36, the temporary teeth in each sex numbering 24. These teeth are succeeded by the permanent teeth, which begin to appear at from two to two and a quarter years from birth. Where horses mature early, and where they are accustomed to eat coarser food than usual, the permanent teeth sometimes appear earlier than is normal. The 12 front teeth, top and bottom, are known as incisors, while the molars number 24, of which only 12 are temporary. In the male, however, although they are occasionally found in the female at from eight to nine years, there are four canine, or corner, teeth. In the young animal the mouth is complete with the temporary teeth at two years, and with the permanent teeth at five years old. The corner teeth at this age are but shells, while the middle and central teeth are well developed. When a horse has reached eight years and is aged, the marks on his teeth have been worn away, and it is next to impossible to mistake him for an animal of younger years.

JAMES LONG

Sulphur and the Halogens. Iodine and Life. Platinum and its Absorption of Gases. Copper, Silver, Gold, and Mercury. The New Alchemy.

THE REMAINING ELEMENTS

Sulphur. Unlike oxygen, this element is a solid at ordinary temperatures. It has a yellow colour, is insoluble in water, has a lustre of its own quite distinct from metallic lustre, melts on heating, and assumes crystalline form under certain conditions, two distinct kinds of crystals being recognised, while under other conditions it is amorphous, and may even become elastic. Sulphur is thus a very conspicuous illustration of the chemical property which is called *allotropism*, or *allotropy*, and has already been discussed. Both as a liquid and as a gas sulphur exhibits similar properties. We have already noticed that, in the case of the gas, conditions of temperature determine whether the sulphur molecule has the formula S_6 or the more familiar formula S_2. This element is found in the native state in Sicily and in other volcanic regions, and a large proportion of the sulphur in commercial use is obtained from these native deposits. Iron pyrites also yields a certain proportion of commercial sulphur.

An Important Ingredient of Living Matter. This element is of very great interest from many points of view; it has for long been regarded as an absolutely essential constituent of living matter, ranking in this respect with carbon, oxygen, nitrogen, and hydrogen. Some experiments by Dr. Charlton Bastian, F.R.S., now in process of repetition by other observers, appear to show that sulphur may, however, not be essential as these four other elements are—that is to say, that certain very lowly forms of life may possibly survive without it. This uncertain exception apart, sulphur must certainly be regarded as a most important ingredient of living matter, and, therefore, of the food of all living things. It is taken up by the plant in the form of the compounds called sulphates, and is built up into various complex compounds that are of use to animals, which live either upon plants directly or upon other animals, which, in their turn, live upon plants.

Sulphur also has very marked uses, though with a comparatively small range, in medicine. Whether applied externally, as in the form of an ointment, or taken by the mouth, sulphur owes all its medicinal actions and virtues to its formation in the body of compounds, the essential constituent of which is its compound with oxygen (SO_2). This compound is really the anhydride of an acid, *sulphurous acid*, which has the formula H_2SO_3, and which is to be carefully distinguished from the more familiar *sulphuric acid*, which is more completely oxidised, and thus has the formula H_2SO_4. These are discussed later.

The Halogens. The derivation of this term has already been explained, and the four members of this very well defined group of elements have been named *fluorine*, *chlorine*, *bromine*, *iodine*. These are all chemically active in a high degree, and none of them is found free in nature

Fluorine. *Fluorine* is found chiefly in the form of fluorides, such as calcium fluoride, often called fluor-spar (CaF_2), and cryolite, the double fluoride of sodium and aluminium. Minute traces of calcium fluoride occur in the teeth, but are possibly not to be looked upon as more than accidental; traces of this salt are also occasionally found in the bones. Less than thirty years have elapsed since this element was isolated by electrolysis. When obtained in elemental form it is found to be a gas with a faint greenish colour—though, perhaps, pure fluorine has scarcely any colour at all—and makes violent chemical attacks upon almost every known substance, oxygen and nitrogen, however, being conspicuous exceptions. Hence it is an exceedingly difficult element to keep in its elemental form. Indeed, there is no known material of which to make vessels that will not be susceptible to its attacks. The best substance appears to be an alloy of the two rare metals, platinum and iridium. By far the most important compound formed by this element is known as hydrofluoric acid, which has the formula HF. This acid exactly corresponds to the most important acids formed by the other halogens—namely, hydrochloric acid (HCl), hydrobromic acid (HBr), and hydriodic acid (HI). The great French chemist who first isolated the element, M. Moissan, and Sir James Dewar are noted for their researches in regard to the properties of fluorine, and to their discoveries there has been added the interesting demonstration that certain chemical actions can occur even at extremely low temperatures. Notable among these is the union of hydrogen and fluorine to form hydrofluoric acid. It had been supposed that at very low temperatures, such as that of liquid air, chemical action could scarcely occur, but it has now been shown that there yet remains for the chemist a hitherto unexplored region of vast importance, which Sir James Dewar calls *low-temperature chemistry*.

Chlorine. *Chlorine* is also a gas, with a decided yellow-green colour, to which it owes its name (Greek—*chloros*, green). It has a number of uses, and has to be obtained from its compounds in sea-water and elsewhere. The only method of its preparation that need be quoted is that which depends upon the interaction of hydrochloric acid and the dioxide of manganese.

What happens is that the oxygen of the latter turns out the chlorine from the hydrochloric acid, some of the chlorine combining with the manganese and some going free. The following equation represents the action:

$$MnO_2 + 4\ HCl = MnCl_2 + 2\ H_2O + Cl_2.$$

Like fluorine, though in less degree, this element is chemically very energetic, and in its undiluted state is scarcely less dangerous to work with. Pressure and cold readily convert it into a yellow liquid or solid. Also, like fluorine, it has great affinities for hydrogen, and will actually take this element—with which it forms hydrochloric acid (HCl)—not only from organic compounds which contain it, but also from its extremely powerful combination with oxygen to form water. Thus, while chlorine is soluble in water, it very readily decomposes the solvent, keeping the hydrogen and displacing the oxygen. This oxygen, at the moment of displacing, is *nascent*, and has the properties of any nascent element, as we showed when discussing peroxide of hydrogen. Hence, chlorine is, though so indirectly, one of the most powerful of all oxidising agents in virtue of its power of liberating nascent oxygen from water and other substances. This property of chlorine is chiefly used in order to bleach various materials, which it does by thus oxidising and altering the colouring matters that they may contain. The explanation we have given of the oxidising properties of chlorine will enable the reader to understand why the dry gas has no such properties. Chlorine is inimical to every form of life, and is thus probably the most certain and searching of all known disinfectants, though also, unfortunately, the most undiscriminating. This property also doubtless depends upon its oxidising action. Nevertheless, chlorine, when combined with other elements, has very different relations to living matter, for certain chlorides—especially sodium chloride, or common salt (NaCl)—are necessary constituents of the food of practically every living thing.

Bromine. As we advance in the series of the halogens, we pass from bodies which are gaseous at ordinary temperatures to one which is liquid at those temperatures, and finally to one which is solid. *Bromine*, the third member of the series, is a liquid (with a deep red colour) that readily evaporates, producing a gas which has a disagreeable smell (Greek—*bromos*, a stink). In general, its properties closely resemble those of the previous members of the series. It occurs in nature mainly in the form of bromides, many of which are of importance in medicine, in photography, and for other purposes.

Iodine. *Iodine* is a dark crystalline solid at ordinary temperatures, but readily evaporates, forming a violet-coloured gas. It is much less soluble in water than its predecessors; the vapour is very irritant, and has a similar action on the lungs and air passages to that exerted by the other halogens. While chlorine is of great use in medicine, indirectly, in virtue of its extremely marked antiseptic properties, iodine is used in medicine directly, occasionally internally, and very frequently externally. It is still more valuable in the form of its salts, especially the iodides, such as the iodide of potassium (KI), which is obviously the potassium salt of hydriodic acid.

Iodine and Living Tissues. When iodine, in its elemental form, is brought into contact with living tissues it exercises very marked actions. These are best illustrated by a consideration of what happens when a not too strong solution of iodine is painted on the skin. Doubtless the element undergoes rapid combination with certain of the tissues of the skin. In one form or other, it is certainly capable of being absorbed, and of exerting marked actions upon tissues lying at a considerable depth beneath the surface of the skin—almost as much so as if elemental iodine had been applied directly to them. In the language of medicine, elemental iodine and some of its compounds are said to act as *alteratives*, the reason being that they seem to produce very marked changes in the behaviour of various tissues. These changes are often so profound and extensive as to be quite out of proportion, it would appear, to the relatively small amount of substance that produces them. Hence it seems probable that the action of such a substance as iodine may be comparable in some small measure to the behaviour of oxide of barium, which is used, as we recently saw, in the commercial process for the obtaining of oxygen.

Mysterious Power of Iodine. We have seen how chlorine acts as an oxidising agent, and it seems probable that iodine, whether in its elemental form or as an iodide, must have the power of transferring oxygen from place to place, or acting as a so-called oxygen carrier, being thus able, even in very small quantities, to do a very large amount of work, just like the oxide of barium, which helps itself to an extra supply of oxygen, disposes of it, and thus is able to repeat the process indefinitely. Of course, in the example we have quoted, the conditions of temperature and pressure are altered by an agency from without; but it is quite conceivable that there may be a similar automatic mechanism in the body which enables iodine to act as it does.

The further and final stage in the illustration of the sort of process we are describing is furnished by the *ferments*, that extraordinary group of substances the property of which is that, by their mere presence, and without undergoing any change in themselves, they are able to cause the most marked chemical changes in other substances with which they are in contact. We are far from supposing that the above sentences offer a chemical explanation of the properties of iodine, or of any other alterative substance; but it is, in effect, the explanation which is advanced by one of the very greatest students of the chemical interactions between such substances as iodine and the living body—Professor Binz, of Bonn. It was not necessary to refer to the method by which bromine may be obtained in its elemental form, since elemental bromine is of small utility, and since the process is essentially the same as that by which iodine is prepared. It was in the substance called *kelp*, variously defined as seaweed, or the ash of the seaweed, that iodine was first discovered. The plant obtains it from the sea-water in which it lives, and obtains bromine in like manner. When the ash is distilled with sulphuric acid and the now familiar dioxide of manganese, first the iodine comes away, and then the bromine.

Since the first edition of this work a simple and invaluable use has been found for iodine. This element is powerfully antiseptic, and yet *comparatively* harmless to the skin. The surgeons have found that the simple painting of the skin with a solution of iodine in alcohol completely sterilises it, so that a surgical operation can be freely performed. The action occurs at once. All the elaborate scrubbings and washings and dressings, needing two or three days for the best results, are now thus superseded, and the patient's skin can be safely prepared, at shorter notice and with no trouble or subsequent harm, by this simple method.

The Halogens and the Periodic Law. It is now hardly necessary to say that the whole series of halogens offers excellent confirmation of the periodic law of Mendeleeff, and that the chemical properties of these bodies, the conditions under which their compounds are formed, and their reactions generally, correspond in an extremely significant degree to the properties which might have been assumed for them by anyone who had nothing but the periodic law from which to argue. For instance, the atomic weight, the boiling point, the specific gravity, the temperature at which combination occurs with hydrogen, and a whole series of further properties, follow definite gradations in the case of these four elements.

It is not improbable that this group will afford the most valuable help to the chemist and the physicist in their most recent and most important enterprise, which is the attempt to infer, from what they know of the various elements, the details of the atomic structure or architecture of those elements, and the exact manner in which, for instance, the atom of chlorine differs from, yet resembles, the atom of fluorine, while the difference between the two must consist in some detail of structure which is perhaps repeated or doubled in order to get the further differences represented by the bromine atom, and lastly by the atom of iodine.

Peculiar Properties of Platinum. Platinum is a very rare and precious metallic element. Chemically, it may be grouped with another metal, *palladium*, and with certain others of very small importance in themselves, such as *osmium, rhodium, ruthenium, iridium.* These elements occur in nature uncombined and in the metallic state, usually in the form of tiny grains in the sands of certain rivers. Platinum is thus found in California and South America, Australia, and the Ural Mountains.

The processes by which these metals are obtained in any quantity in the pure state are extremely difficult and complicated. When at last metallic platinum is obtained in a form that can be manipulated, it is found to be a white, lustrous, silvery metal of a very great weight (its atomic weight is nearly 195), and having a number of very important physical properties. For instance, it is extremely difficult to fuse or melt, requiring the temperature produced by the immediate union of oxygen and hydrogen in the oxy-hydrogen blowpipe.

Readers of the course on PHYSICS will understand what is meant when we say that this rare metal has extreme tenacity, is very malleable, and very ductile. It does not oxidise even when heated in pure oxygen; strong mineral acids do not affect it, nor is it acted upon by moist air. For all these reasons, platinum is very extensively used in various chemical operations, especially when it is required to deal with powerfully corrosive liquids, such as sulphuric acid and hydrofluoric acid, or when any great heat is required. The metal can be cast and forged, and can also be welded; furthermore, it expands under the influence of heat only very slightly, so that when it is fused through glass, as in the ordinary incandescent electric lamp, alterations in temperature cause the platinum and the glass to expand or contract proportionately, so that the glass is not cracked by the expanding metal when the lamp is lit.

Absorption of Gases by Platinum. In a previous chapter we made some reference to the remarkable property possessed by some substances of absorbing gases within them. Charcoal is a conspicuous and familiar instance of a substance which has this power. It is to be remembered also that there is more than a merely physical absorption of the gas, since in the case of oxygen the result of this absorption is to increase its chemical activity. Hence it seems probable that the molecular arrangement of the gas is disturbed. Now, platinum, when finely divided and forming the black powder *platinum black*, has this property of condensing gases in it to an extraordinary degree, being able to absorb, for instance, some hundreds of times its own volume of oxygen.

Another form of platinum, called *spongy platinum*, and also the platinum black of which we have already spoken, are able to induce chemical actions, such, for instance, as the direct union of oxygen and hydrogen at ordinary temperatures—which is explicable if we accept the view that the condensation of such gases within their pores is more than a merely physical act, and implies a change in the molecular constitution of the gases, so that they become practically as chemically active as if they were *nascent*. Very probably, indeed, they *are* nascent, in the sense that a large number of their molecules are broken up, so that unpartnered atoms of oxygen and hydrogen are wandering about, being thus more ready to effect chemical combinations with foreign atoms than if they went about with each other in pairs, as they do in the molecules of these gases in ordinary conditions. The element osmium, first mentioned above as belonging to the platinum group, has lately been found invaluable for the formation of filaments that can be made luminous by an electric current.

The Last Group of Metals. Finally, we must discuss a very important group of metallic elements consisting of *copper*, *silver*, *gold*, and *mercury*. We may take these elements together, even although they do not exactly fall into a group in the table of the periodic law published by Mendeleeff in 1904. When we were discussing the atmosphere, we saw that the new group of gases discovered in the air by Lord Rayleigh and Sir William Ramsay—helium (already known elsewhere), neon, argon, krypton, xenon—must now be regarded as the zero group of the elements. Not one of these gases has any combining power at all, so far as can be made out. Group one of the elements has already been partly discussed. Its members have combining power, each atom of any typical one of them having, so to speak, one arm, and being therefore called monovalent. The members of this group, in the order of their atomic weight, are hydrogen, lithium, sodium, potassium, copper, rubidium, silver, cæsium, and gold, and the reader will notice that the lighter members of the group have already been considered. Ignoring the very unimportant elements, rubidium and cæsium, we are therefore left with copper, silver, and gold. According to Mendeleeff, mercury, which has so many remarkable peculiarities, belongs not really to this group at all, but to group two. We are bound to note this fact; yet we may conveniently adhere to the long-established arrangement, and discuss mercury together with the other three elements we have named.

What Makes Copper Valuable. All these four elements are found in the elemental state in nature. But the first of them, copper, more commonly occurs in combination either with oxygen or with sulphur. It is very readily obtained from its oxide by the now familiar employment of carbon, in the form of charcoal or coke, which takes the oxygen to itself and leaves metallic copper behind. Or copper may be displaced from the familiar salt known as copper sulphate ($CuSO_4$) by means of iron, which forms sulphate of iron ($FeSO_4$), the copper being precipitated; and a third method of obtaining metallic copper consists in an interaction between the sulphide and the oxide. The sulphur and oxygen of these respectively combine to form the gas sulphurous anhydride, or sulphur dioxide (SO_2), metallic copper being left behind.

This extremely valuable metal has a distinctive colour, an atomic weight of rather more than 63, but a very small degree of hardness. It is very malleable, tenacious, and ductile [see PHYSICS], is fusible—that is to say, melts—at a red heat, and is an excellent conductor both of heat and electricity. In this last respect, as in the others, it resembles silver and gold, but, being much cheaper than either of these metals, it is naturally preferred to them as a material for wires to convey electric currents.

Bronze. Amidst all these valuable physical properties of copper it is to be noted that there is one—viz., its relative softness—which interferes with its utility for many purposes. But when copper forms an alloy with tin there is obtained the substance called bronze, which is very much harder. Bronze has been known since very early times, and the student of what we are now learning to call pre-history speaks, as we have already seen, of the Bronze Age, which succeeded the Stone Age, and marked a great advance in civilisation, largely dependent upon the newly acquired knowledge of manipulating bronze, and was in its own turn succeeded by the Iron Age. Thus, this element, copper, has its own special interest for the philosophic student of the means by which man gradually emerged from primitive savagery. Here we may also note that in recent years it has been discovered that the addition of a small quantity of phosphorus to bronze, producing the alloy called *phosphor bronze*, greatly increases its hardness, and gives it a new value as a material for cog-wheels and other parts of machines where great hardness it desirable.

It was the opinion of the late Lord Avebury that the use of copper was not introduced into Europe at all until it had first been discovered somewhere in the East that a much more valuable substance could be produced by the addition of a small quantity of tin to it—that is to say, by the making of the alloy called bronze. The alloys of copper now in use are very numerous—about 70 per cent. of copper and 30 per cent. of zinc forming brass—while there are various modifications of bronze besides phosphor bronze, the aluminium bronzes and German or nickel silver, the alloy of copper and zinc, to which reference has been made.

Copper and the Human Body. Minute traces of this element are not infrequently found in the human body, yet it is certainly not to be regarded as a desirable constituent of the body, but rather as a more or less undesirable foreign substance which has gained access to it by means of the food. Salts of this metal are often used in order to make more vivid the green colour of vegetables, such as bottled peas, and the question arises whether the use of copper for this purpose is justifiable.

There is good reason to believe that if the quantity employed is very small—though quite large enough for the purpose—it has no injurious action upon the body, copper being exceedingly difficult to absorb, so that even if moderate quantities are frequently swallowed no harm is done. So far as acute poisoning from copper is concerned, the risks are also very much less than is commonly supposed; and the smallness of the risk of chronic copper poisoning may be estimated from the fact that there is no proof of this having occurred even amongst workmen engaged in the manufacture of *verdigris*, which is the acetate of copper.

Silver. This precious and familiar element occurs, as we have already stated, in its elemental form in nature, and is also frequently found in combination with sulphur, the sulphide of silver being known as *silver glance*. It also is found in union with mercury in various parts of the world. We have purposely avoided the use of the word "combination," which would beg the question whether this body is really to be regarded as a compound or as a mixture. Its composition varies, and we know that the composition of a true compound is absolutely invariable. But, on the other hand, this *amalgam*, as it is called, is crystalline, and the relation of the elements in it must probably be regarded as more than mere mixture.

Why Silver is Valuable. The appearance of silver and its capacity for taking a high lustre are familiar; like copper, it is very ductile, malleable, and a good conductor of heat and electricity. Also like copper—and the same applies to gold—it is not oxidised by the air, no matter whether moisture be present or not. Copper, however, can be oxidised at a red heat, but silver only at a much higher temperature and under great pressure, while gold cannot be made to unite with oxygen directly at all.

The marked stability of these metals led them to be called in former days the "noble metals." They vary in their nobility, however, as we have already seen, and even at ordinary temperatures silver loses its lustre and its purity in the presence of compounds of sulphur, such as the gas called sulphuretted hydrogen (H_2S), or the gas we have already mentioned, sulphur dioxide. (SO_2). This change is due to a formation of a thin film of the black sulphide of silver.

A curious illustration of this property of silver is furnished by the consequences not infrequently observed when considerable doses of sulphur are being given medicinally to people who wear silver ornaments, such as bangles, next to the skin. In such cases the patient is sometimes puzzled to know why the bangle cannot be kept clean; its blackening is due to the fact that some of the sulphur given to the patient is passed through the skin, in various forms, which attack the surface of the silver and cause the formation of a thin layer of the black sulphide.

Readers of the course on PHYSICS are now familiar with the "three states of matter," and will not be surprised to hear that at sufficiently high temperatures silver is found in the form of a bluish gas.

The "Nobility" of Gold. This more or less familiar element is closely allied in its properties to those we have previously discussed. It is pre-eminently the noble metal, remaining unchanged in the presence of even moist air, and, indeed, declining to undergo direct oxidation under any conditions whatever. It is very ductile, tenacious, and malleable. Copper, silver, and gold, indeed, are all so malleable that they can be beaten into films that will transmit light, and the thinness to which gold-leaf may be reduced is almost incredible.

A reference to the table in an early lesson will remind the reader of the very great weight of gold. Its atomic weight is rather more than 197. Though gold is so scarce, has such a fine lustre, is so "noble," and is the only yellow metallic element, it is by no means the dearest of the elements. Compared with radium, for instance, it is "dirt cheap." It is even more resistant to chemical action than the other members of this group. The powerful acids, for instance, such as hydrochloric, nitric, and sulphuric acids, will each dissolve copper, but the only means by which gold may be made to yield to them is by the combined action of nitric and hydrochloric acids. The mixture of these two acids, being able to dissolve gold, has been known for many centuries as *aqua regia*, which we may translate as the regal fluid. The compound formed when gold is thus dissolved is called auric chloride, and has the formula $AuCl_3$.

Gold occurs in nature chiefly in its elemental state; its distribution is very wide, though the total quantity is so small. For instance, it occurs in minute quantities in iron pyrites (FeS_2), and in galena, the sulphide of lead (PbS), of which we have already made the acquaintance. Extremely minute traces are found in sea-water.

The Possible Making of Gold. We are all familiar with the fact that the alchemists spent long years in seeking the philosopher's stone which would turn all the base metals into gold. Probably every reader in his time has had his laugh at these vain efforts; and certainly we may agree that there is no such philosopher's stone. But we are now coming to see that the alchemists were not so far wrong after all. They believed that under the differences which the elements display there must be an essential similarity, and we know now that they were right. It is especially that extraordinary element radium, of which we shall have much to say later on, that has taught us to regard the transmutation of the elements not merely as possible, but as, in at least two known cases, an observed and proven fact.

The New Alchemy. So far, all the evidence of such changes that has been established is concerned with downward changes—that is to say, changes from heavier and more complex elements towards lighter and simpler ones. On the other hand, there is no theoretical impossibility in the performance of the reverse process.

There is, indeed, every indication that chemistry is now upon the brink of quite incalculable possibilities. It was at these that the co-discoverer of radium, the late M. Curie, was hinting when he came over from Paris, shortly before his death, to receive a gold medal from the Royal Society. In acknowledging the honour that had been paid him he jokingly remarked that he would do his best to see whether he could not turn the medal into radium.

Ten years ago such a remark would have been a pointless absurdity, but now it is very significant. The work of Madame Curie and others has shown us that the atomic weight of radium is heavier than that of gold; and if gold or any other element, often of far more intrinsic value than gold, is to be produced by transmutation, the element to be transmuted is more likely to be one that is more complex and heavier than gold. It will not be long before phrases like "analysis of the elements" and "synthesis of the elements" make their appearance in text-books. We are on the brink of the *New Alchemy*.

C. W. SALEEBY

THE DEVASTATING ONSLAUGHT OF THE PLUNDERING MAGYARS TEN CENTURIES AGO

THE MAGYARS BURSTING INTO THE DISTRICT OF THE DANUBE AT THE CLOSE OF THE NINTH CENTURY

The Crushing of the Empire between the Northern Barbarians and the Conquering Turk

THE RUINS OF EMPIRE—AND CHAOS

CHARLEMAGNE, great as he was, had not inaugurated the Golden Age. In fact, the eight hundreds and nine hundreds, the two centuries after the coronation of Charlemagne at Rome, were in some respects darker than any that had preceded them.

This was partly due to the weakness of the rulers. The descendants of Charlemagne were not nonentities, like the Merovingians, but they were for the most part selfish and turbulent princes ; and only a very strong hand grasping the imperial sceptre could have kept the discordant elements of that vast empire in orderly subjection.

Such a strong hand was emphatically not possessed by Charlemagne's son and successor, Louis the Good-natured. His sons revolted against him and quarrelled among themselves. France, Germany, and Italy sprang apart, and began those separate lives of theirs which still continue ; and not only so, but in each country the principle of disintegration was at work. Counts and barons who should have been mere officials appointed for life or during good behaviour became hereditary nobles ; in short, Feudalism was born. Amid all these changes the stately vessel of the Carolingian dynasty went hopelessly to pieces, the last direct descendant of Charlemagne who reigned as emperor in Germany being dethroned in 887, the last who was king of Italy dying in 950, the last who was king of France in 987. Out of the driftwood of the family, the representatives through females and the illegitimate descendants, almost all the reigning dynasties and a large part of the still powerful ducal and baronial houses of Europe have been constructed.

Chief, however, among the causes which made Europe miserable were the ravages of the Scandinavian pirates, the Danes as the English called them inclusively, who seem at the end of the seven hundreds to have suddenly awakened to the fact that there were fair lands to the south of them with rich booty, which it needed but good seamanship and well-organised robber-raids to make their own. The *Here*, as the great pirate army was called, visited England at longer or shorter intervals throughout the three centuries from 787, when they first landed in Wessex, till 1066, when Harald Hardrada invaded Yorkshire, and fell before his namesake Harold, son of Godwin. Later in this chapter we briefly relate the story of the victories and defeats which marked the struggle of the Danes with Alfred the Great from 871 to 900, of their subjugation by Edward the Elder and Athelstan from 900 to 940, and of the success with which under their king, Canute, they fastened the Danish yoke upon the neck of the English, so that it seemed for a time probable that our island would be but a humble member of a great Scandinavian empire, dominating the Baltic and the North Sea.

We must not omit to call attention to the fact that in these three centuries of conflict the pirates themselves greatly changed their character, and from barbarous pagans became a Christian and civilised power ; also that they settled in large numbers in the north-eastern part of England and added undoubtedly a valuable element to the population of Northumbria and Mercia. Moreover, the fierce attacks of these dreaded invaders helped to unify the Anglo-Saxon state.

When all the other kingdoms of the so-called Heptarchy had gone down before the ruthless *Here*, Wessex alone successfully resisted their onslaught, and therefore it is that from the royal house of Wessex the present king of England is descended. It is not, perhaps, sufficiently remembered how sorely the scourge of the Danish invasions smote France and Germany as well as England. Wherever there was a broad estuary of a river, there the keels of the Danes might be looked for ; the Elbe, the Seine, the Marne, the Loire, the Garonne, all saw the Dragon-standard of the Vikings mirrored in their waters. Aachen, Charlemagne's own capital, was sacked. Rouen was taken. Paris was once taken and once suffered a terrible two years' siege (885-886). In fact, throughout the eight hundreds it would be hard to say whether England or France suffered the most from the ravages of the terrible Northmen.

Results of the Scandinavian Invasion. But in France the most memorable result of the Scandinavian invasions, the settlement of the Northmen in the fruitful lands at the mouth of the Seine, tended eventually to benefit rather than to injure civilisation. In the early nine hundreds Rolf the Northman closed a life of piratical adventure by becoming the "man" of the Frankish king Charles the Simple, and condescending to receive from him the fair province which has ever since borne the name of Normandy. His descendants, appropriately named the "Long-sworded," "the Fearless," and the like, embraced Christianity of the militant type then fashionable, inhaled the new air of chivalry, and became in some respects its typical representatives. The converted Scandinavian pirate seems to have been a finer specimen of humanity, more chaste, more temperate, and more devout than either his Frankish or his Saxon neighbour, but also more ruthless, more grasping, a "better man of business." He was the keen, well-polished steel, while they were but the clumsy iron weapon. Thus, it was only in the natural order of things that when, in 1066, William the Bastard, Duke of Normandy, landed on the coast of Sussex, his rival, the Saxon Harold, Godwin's son, should fall before him in the battle which bears, not with strict accuracy, the name of Hastings.

The Northmen's Dynasty in Sicily. But memorable as this Norman conquest, which placed a new dynasty on our throne, and introduced a fresh social and political order, must ever be to Englishmen, it is important to remember that it was not by any means the only Norman conquest which Europe witnessed in that age. From the beginning of the ten hundreds, Normans, half pilgrims, half warriors, had been making their way over the Alps and Apennines into Southern Italy. They had mingled as auxiliaries in the endless contests which were going on in that region between Lombards, Greeks, and Germans. At length, in the year 1038, William of the Iron Arm, eldest of the twelve sons of a Norman knight, Tancred de Hauteville, made his prowess felt in a battle with the Saracen lords of Sicily. He obtained the dignity of Count of Apulia. One after another the sons of that prolific Norman house appeared upon the scene, eager to share his fortunes.

Robert Guiscard, the sixth brother, made himself supreme in Southern Italy, dealt fierce blows at the Eastern Empire, took the Pope of Rome, Leo IX., prisoner in battle, and soon afterwards became the vassal of his successor. Meanwhile, his brother Roger, the youngest of the tribe, by his victories over the Saracens, was building up a more enduring dominion in Sicily, and preparing the way for a royal dynasty which, in the eleven and twelve hundreds, was powerfully to influence the fortunes of the whole of Europe, And these Norman conquests in the Mediterranean lands were, be it remembered, strictly contemporary with that other Norman Conquest with which we are familiar as forming the greatest landmark in our history.

Saracen Sea-Power in the Mediterranean. In order to follow the fortunes of the Northmen, we have come down to the end of the eleventh century; but we must, for a little while, remount the stream of time in order to notice other calamities which were distressing Europe.

In the eight hundreds, the danger to Europe of Mohammedan conquest was more menacing than it had ever been since Charles Martel won the battle of Poitiers. For the Saracens had now become a great sea-power; probably, in the decay of the maritime strength of the Eastern Empire, they became the greatest sea-power of the Mediterranean.

In the year 831 they overran and conquered Sicily, which remained theirs for more than two centuries till, as just related, it was won back for Christianity by Roger the Norman. Fifteen years later they appeared at the mouth of the Tiber; Ostia was taken, the Campagna wasted. St. Peter's itself was desecrated and robbed of the treasures of centuries; St. Paul's Without the Gates shared the same fate; the city of Rome itself only just escaped being handed over to a Mussulman emir and echoing the cry of the muezzin. It really seemed as if Mahomet's, rather than Christ's, was to be the holiest name in all the Mediterranean lands. And this lamentable eclipse of the glory of the new empire was witnessed by a generation many of whom must have gazed on the living face of Charlemagne.

The Nightmare Terror to Europe. While the Saracens still threatened by sea, a more terrible, because more barbarous, foe spread desolation by land. Over the vast Danubian plains, where Attila and his Huns once encamped, the Magyars, or Hungarians, a race perhaps remotely connected both with the Huns and with the Turks, now came thundering and destroying. From 889 till 933, when they were defeated by the Emperor Henry the Fowler in the great battle of Riada, the Hungarian squadrons were a nightmare of terror to Europe. They overran Germany, Burgundy, and Southern France, crossed the Alps into Italy, burned Pavia, and threatened, but did not take, Rome. From many a terrified congregation in the churches of Italy went up the heart-breaking litany: "From the arrows of the terrible Hungarians, good Lord, deliver us." By the middle of the nine hundreds, however, they were beaten down into a reasonable frame of mind; they became civilised and Christianised. In the year 1000 a royal saint, Stefan, received from the Pope the title of King of Hungary, and in later centuries the brave and chivalrous Magyar was the great bulwark of Europe against his Mohammedan kinsman, the Turk.

The Degradation of the Papacy. Beside the miseries of barbarian invasion, Europe, after the collapse of the dynasty of Charlemagne, suffered from religious terrors. As the years wore on towards the fateful era of the thousandth from the Birth of Christ, a presentiment brooded over the nations that the end of the world was at hand. When they needed most the support of religious faith, their spiritual guides most signally failed them. These centuries, the eight hundreds, the nine hundreds, and the early ten hundreds, are admitted by all historians to have been the time of the deepest degradation of the papacy. A long succession of utterly insignificant Popes is followed by one man of eminence, perhaps of genius, Pope Formosus (891–896), but he was a violent political partisan, accused of complicity in the murder of one of his predecessors; and his dead body, having been dressed in papal robes, and subjected to the indignity of a trial, was mutilated by order of a solemn council, stripped, and thrown into the Tiber.

The Church under Feminine Control. Then came the period of the ascendancy of two infamous women, a mother and a daughter, Theodora and Marozia, who for over sixty years (901-964) placed their lovers, their sons, and their grandsons in the chair of St. Peter. After an interval the Counts of Tusculum, petty feudal princes in the neighbourhood of Rome, succeeded in making the papacy a virtual appanage of their house (1012-1048). With such men, licentious and profane, sitting in the holiest place of Western Christendom, the reverence which in the days of Gregory the Great had waited upon the lightest word of "the Apostle" was rapidly departing.

The Empire's Fluctuating Power. The cure for the worst miseries of this anarchic age came this time from Germany. The old Frankish Empire, it is true, had split into pieces. France especially, after the deposition of Charles the Fat, in 887, had been drawing further and further away from the empire, and when, a century later, a new royal dynasty ascended the throne in the person of Hugh Capet, she no longer, even nominally, formed part of it. Still, however, the great political fabric founded by the joint action of Charlemagne and Leo kept its proud title, "The Holy Roman Empire," though now it virtually included only the two countries of Germany and Italy, divided into an infinite number of petty feudal principalities, over which "Cæsar"—as the emperor was styled—wielded a strange and not easily defined dominion, strong and stern in the hands of a man of firm will and with the trick of success, shadowy and of little or no account in the hands of a weakling.

THE GREAT SIEGE OF PARIS BY THE NORTHMEN IN THE YEAR 885

Strong Emperors and Weak Popes. To the former class of strong and successful rulers belonged the Saxon emperors, who wore the imperial diadem during the nine hundreds and whose most celebrated representatives were Otho, or Otto the Great, the final vanquisher of the Hungarians, and his son and grandson, who bore his name (Otto I,. 936–973; Otto II., 973–983; Otto III., 983–1002). These strong rulers ended the political anarchy which had for a hundred years prevailed in Italy, where petty princes of Provence, of Spoleto, of Friuli, in rapid and unremembered succession, had reigned as shadowy kings. In the ecclesiastical realm also they restored a certain measure of order. In 963 Otto the Great summoned a council to meet in Rome, by which Pope John XII., a profligate and tyrannical youth, grandson of the licentious Marozia, was solemnly deposed, and a layman of decent life, a papal secretary, Leo VIII., was chosen in his stead. Still, however, the war of Roman factions continued, and one tumultuary pontiff followed another in rapid succession, till, in 996, the boy-emperor Otto III. placed his cousin Bruno of Carinthia, little older than himself, but a young man of pure and noble character, on the papal throne. Too good for the corrupt ecclasiastics and populace of Rome, this German Pope died in the last year of the nine hundreds, the victim, it was said, of poisonous conspiracy. Ere long followed that degrading dynasty of Tusculan Popes to which reference has already been made.

The Purification of the Papacy. It seemed as if nothing could save the office, once the most venerated in Christendom, from its moral suicide, when help was once more invoked from beyond the Alps, and this time with success. Another German, Bruno, of noble descent, was raised to the papacy by the Emperor Henry III. A saint and a mystic, the new Pope, who took the name of Leo IX., did much in his six years of rule (1048–1054) to raise the reputation of his office from the slough into which it had fallen. Unfortunately for him, he resorted to carnal weapons for the defence of his territory against the Norman Guiscard, by whom he was defeated and made prisoner. The vexation of his defeat and the hardships of his captivity probably hastened his end, for he died the year after the battle, but the moral uplifting which he had given to the popedom survived its author for generations.

Between the Bulgar and the Turk. Turning now to take up the thread of the narrative in the East; when the Empress Irene had been deposed and shut up in a convent, some time elapsed before a fresh dynasty was established. One of the intervening emperors, Michael, very much annoyed his subjects by recognising the imperial title of Charlemagne. Also, when he went to war with the Bulgarians, who by this time offered the most serious menace to Constantinople, he was badly beaten. Consequently he was deposed, and Leo V., "the Armenian," became emperor.

Leo, though not a fanatical Iconoclast, offended the Iconodules, and although he made up for the incapacity of his predecessor by striking so hard at the Bulgars that they remained quiet for a whole generation after him, he too was assassinated, and the soldiers made Michael II. emperor.

It was about this time that the Saracens were effecting that conquest of Sicily to which reference has already been made. Sicily lay nominally within the area of the Eastern Empire, but Michael and his son and successor, Theophilus, found themselves unable to send any effective assistance to the island.

The Separation of the "Catholic" and "Greek" Churches. The splendour of the Bagdad khalifate had not yet waned, though it was not destined to last long. Harun al Raschid's successor, Mamun, was an energetic ruler, anxious to maintain the aggressive tradition. Consequently it was upon the Asiatic boundaries of the Greek and Moslem empires that the struggle was now waged, and Theophilus could not spare troops for the West. For many years there was almost ceaseless warfare, and little practical result. After the death of Theophilus, a competent ruler though a fanatical Iconoclast, his widow governed for some time on behalf of their young son. That son, when he came of age, was shortly afterwards murdered by the favourite whom he had himself associated in the imperial dignity, Basil the Macedonian, the founder of a dynasty which lasted some two hundred years. The distinguishing event of the reign of Michael had been the final breach between the Roman and the Greek Churches, the "Catholic" and the "Orthodox."

An Automatic Government. Basil, in spite of his crime, was a capable soldier, who strengthened his frontiers and to a great extent freed the Eastern Mediterranean from the fleets of Moslem corsairs which had infested it. He did not, however, deliver Sicily, though he did clear the Saracens out of Southern Italy, where they had been winning a foothold. The reigns of Basil's two immediate successors, Leo VI. and Constantine, called Porphyrogenitus, are dis inguished chiefly by the fact that the emperors were men who cared more for art and literature than for war or statecraft. In fact, at this time it might be said that the mere machinery of government had been so far perfected in the Eastern Empire as to work almost automatically.

Facing Turk, Russian, and Bulgar. In the Far East, on the other hand, the Abbaside khalifate was tottering. Mamun had been responsible for introducing the employment of a great bodyguard of Turks from the uncivilised Central Asian outskirts of his dominion, and the Turkish soldiers were learning to regard themselves as the real masters. On the other hand, a Persian family established themselves at Bagdad as the protectors of the khalif; and they, in fact, became practically a reigning dynasty. So it befell that soon after the middle of the tenth century, when the child Basil II. was nominally emperor at Constantinople, two soldiers in succession, Nicephorus and John Zemisces, exercised the real power, even bearing the title of associate emperors, and were able to win back some Syrian territories from the khalifate.

John Zemisces, however, found occupation in beating off the attacks of the Russians; and after his death, when Basil II. took the reins of government into his own hands, the great struggle of his reign was that with the Bulgarians, which he

A DESCENT OF THE DANES UPON THE COAST OF NORTHUMBERLAND

THE EXPULSION OF THE DANES FROM MANCHESTER

The upper picture is by W. Bell-Scott, and is in the Victoria and Albert Museum ; the lower, by Ford Madox Brown, is in the Manchester Art Gallery.

conducted so successfully and so mercilessly that he became known as "Basil the Bulgar Slayer."

The Rise of the Turkish Tribes. After Basil's death in 1025, there ensued a long period of more than fifty years during which the imperial sceptre changed hands repeatedly, and the only period of decent rule was that enjoyed for three years under Basil's niece, Theodora. In 1078, a new dynasty was inaugurated by the elevation to the purple of the crafty and capable, but far from admirable, Alexius Comnenus.

Meanwhile the Turkish tribes had been becoming more and more a menace to the Abbasides and their Persian ministers or masters. Men of Turkish race, too, had been rising to prominence. One of these, Sabuktegin, became governor of a province in what is now Afghanistan, with his capital at Ghazni. At the close of the tenth century he was succeeded by his son, the famous Mahmud of Ghazni. Ghazni had already been made virtually an independent kingdom.

The Great Mahmud of Ghazni. Mahmud, a mighty warrior and a fanatical Mohammedan, did not throw off his allegiance to Bagdad; but while the power which he developed made him during his life a bulwark against the invasions of Turkish hordes, he has two other titles fo fame. He invaded India no less than fourteen times, swept through the Punjab, carried his arms eastwards across the Ganges, and on another occasion struck southward as far as Gujerat. He laid low countless temples and idols; he swept up vast quantities of treasure. He did not, in fact, attempt anything in the nature of an organised conquest; his incursions were merely raids on a huge and terrific scale. But he did initiate the occupation of the Punjab by successive dynasties of Afghan or Turkish captains.

The other feature of Mahmud's rule is that, while his wealth was rendered enormous and almost unparalleled by the vast spoils which he collected in India, his Court became proverbial on account of the encouragement which he gave to learning and literature, as well as architecture. Every contemporary poet or scholar possessed of any sort of title to recognition was welcomed at Ghazni, and was amply endowed out of the enormous treasures carried off from the temples of the idolators.

The Turkish Occupation of Palestine. After Mahmud's death in 1030, it was not long before the power of the Ghaznavide dynasty was challenged and virtually displaced by that of the house of Ghor. But more serious for the world at large was the fact that the group of Turkish tribes called the Seljuks were immediately overrunning Persia, dominating Bagdad, where they took upon themselves to become the khalif's protectors, swept up to the confines of the Greek empire, broke through the Taurus, occupied the east of Asia Minor, and drove westwards over Syria till they made themselves masters of Palestine and the Holy Places revered by all Christendom. The insults and severities inflicted by the Turks upon Christian residents and pilgrims were the occasion, if not the actual cause, of the Crusades.

The Unconquered North of Britain. From the East we turn to our own island to sketch the story of its transformation from Celtic Britain into England and Scotland. For three and a half centuries from the time of Claudius the Romans had occupied the island, holding it in force as far north as the Tyne and the Solway, and maintaining outposts between Tyne and Forth, though never really subjugating the Northern territory. The Celts of the north were Gaels, though whether the large Pictish population are also to be regarded as Gaels is an open question. The Celts of the south were Brythons, better known as Britons. The Britons acquired a Latin veneer, but nothing more save some of the elements of Roman law and the Christianity of the fourth century.

The Coming of the Jutes. When the Roman legions had retired, and the Roman emperor Honorius announced that they would not come back again, the Britons fell back into something like their old tribal organisation of petty principalities. The coasts and the northern border had long been harassed by pirates from Friesland and Schleswig of the Teutonic stock, and by the Caledonian Picts, and the Scots, Gaelic tribes who had migrated from Ireland, to which the Romans had never penetrated. About the middle of the century the Teutonic pirates began to land in force with the intention of permanent settlement; tradition says that the Jutish captains, Hengist and Horsa, were first invited by a southern prince to help him against the Picts, with whom he can hardly have had much to do. At any rate, the Jutes did settle in Kent, probably in Hampshire, and possibly elsewhere.

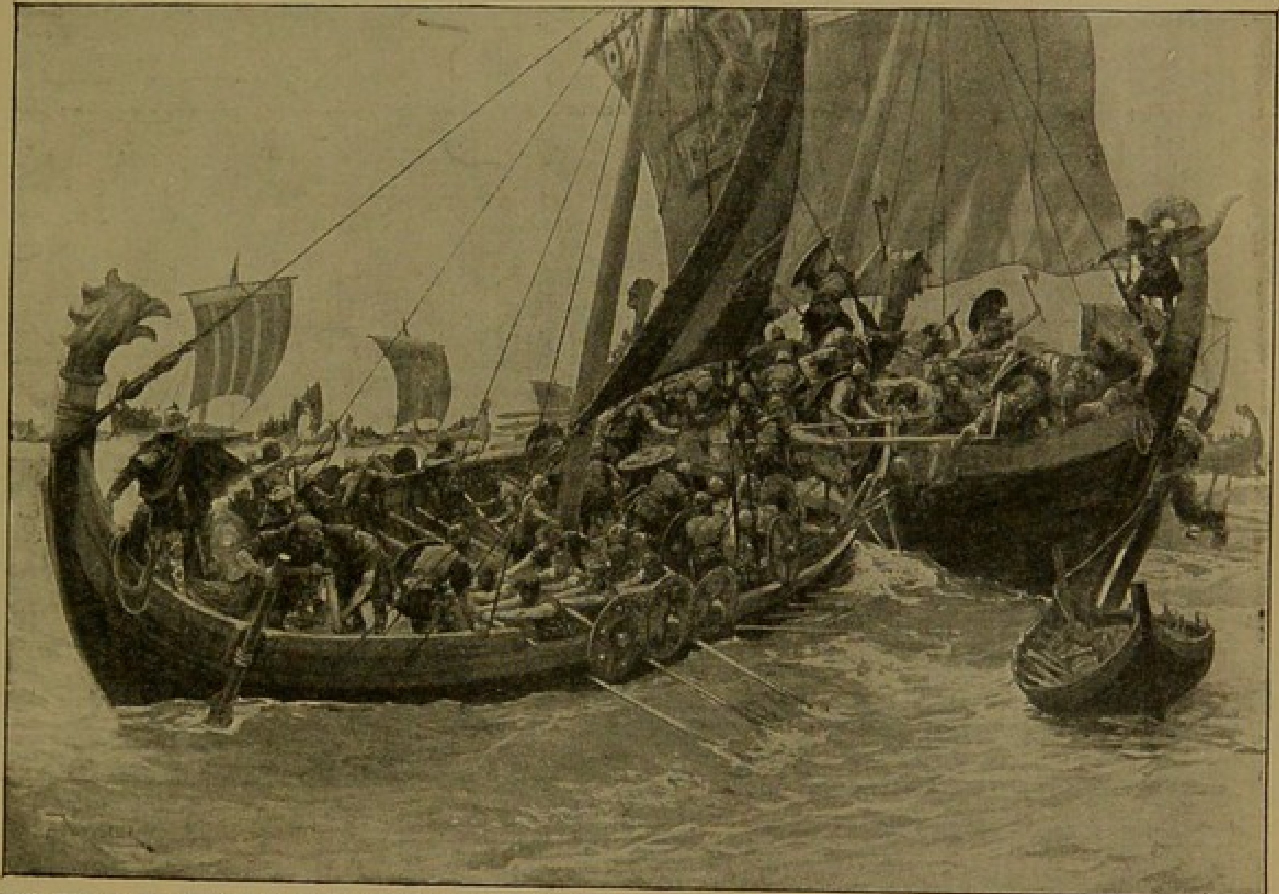
The Coming of the Saxons and Angles. Before the end of the century the kindred tribes of the Saxons were following the Jutes, and attacking the south coast; in the first half of the sixth century the Angles were invading the eastern coast from the Thames to the Forth. The Britons were beaten back before the invaders; in some places they were literally exterminated, in others they beat a gradual retreat. The evidence on the whole is that only a very small remnant of the British population remained in the conquered territories. The conquest was emphatically gradual.

About the end of the fifth century it met with a severe check; it is probable that the mythical King Arthur was actually a captain who did inflict severe defeats upon the invaders. The Britons, however, were definitely driven back into the west country; into Cumbria between Solway and the Mersey; behind the Severn and the Avon; and into the south-western peninsula, called West Wales or "Damnonia," though for many years there was a debatable land, devastated and hardly populated, between the British tribes and the German tribes.

Tribal Divisions. Then the invading tide rolled forward again. In the third quarter of the sixth century the West Saxons in the Thames valley and to the south of it pushed out till they reached the Bristol Channel, and cut off the Southern Britons from their kinsfolk in Wales. It was not till early in the seventh century that the Northern Angles in like manner drove a wedge up to the mouth of the Mersey separating Wales from Cumbria; by which time Angles and Saxons had probably occupied the whole of the midlands. The first established Kentish kingdom had maintained its position, and was more highly organised and civilised than any of the other groups which were now shaping into kingdoms. Of these only two as yet are recognisable, Wessex, extending from Hampshire to Severn mouth, and Northumbria, extending from the Humber to the Forth—to which perhaps may be added the South Saxons in Sussex, who were isolated from the rest by geographical conditions.

middle of the century however, Northumbria was again united under Oswy, a prince who overthrew Penda, and whose supremacy was acknowledged over all England north of the Thames. Under Oswy practically all England became decisively Christian, and attached itself to the Latin Christianity which recognised the supremacy of Rome instead of the Celtic Christianity which was unorthodox.

The Rise of Wessex. At the beginning of the eighth century the King of Wessex was supreme over the minor kingdoms on the south of the Thames; the King of Mercia was in effect overlord also of East Anglia and Essex; and the King of Northumbria ruled beyond the Humber. But Northumbria was falling to pieces; towards the end of the



THE FIRST ENCOUNTER OF THE SHIPS OF ALFRED, THE FATHER OF THE ENGLISH NAVY, WITH THE DANISH INVADERS OFF THE COAST OF DORSET IN 877

The Gradual Predominance of the North. At the close of the sixth century there came to Kent the Roman missionaries despatched by Pope Gregory the Great, under the leadership of Augustine. Kent was readily converted, and early in the seventh century, as we have already seen on page 1370, the new religion spread into East Anglia which now also appears as a definite and perhaps a predominant kingdom. By the second quarter of the century, however, the predominance was passing to Northumbria, of which the two divisions, Bernicia and Deira, were united under a powerful monarch Edwin. Northumbria adopted Christianity, but her power was broken for a time by the obstinate heathen Penda, who had made himself king over the Midlands, or Mercia. In the

eighth century Offa, King of Mercia, was practically overlord of the whole island except Wales, Cumbria, or Strathclyde, and Damnonia—that is, Devon and Cornwall—Wessex owning his overlordship though it had its own king. But just after the opening of the ninth century the crown of Wessex passed to Egbert; five-and-twenty years later Egbert had overthrown the power of Mercia, and the King of Wessex was in his turn recognised as the overlord of all Britain.

The English Power of Egbert. From Egbert dates the supremacy of the house of Wessex; his descendants after Alfred the Great became kings of all England; and the blood of Cerdic, the mythical founder of the house of Wessex, runs in the veins of George V. We have little space to trace the development of

England and Scotland in the days from Egbert to the Norman conquest of the southern country and the establishment of the dynasty of Malcolm Canmore in the north. Of Ireland, it could hardly be said that there was any development; her palmy days had been in those earlier centuries when her missionaries went forth to spread Christianity in neighbouring and also in distant lands. Ireland lay politically apart, and her tribes never attained to any union as an organic political entity.

It is evident on the other hand that Egbert did succeed in establishing a really effective rule over the south and most of the midlands, while the East Anglian rulers were his lieutenants, although he did not apply his powers of organisation to Northumbria. Before the end of his reign the attacks of the Northmen upon the south coast were becoming ominous, though they were always beaten back to their ships. In the days of his son, Ethelwulf, the Danish host more than once wintered in England.

The Repulse of the Danes by Wessex. In the days of Ethelwulf's sons, the Danes made themselves masters of Northumbria and East Anglia, although when they fell upon Wessex they were beaten back after a long struggle by the great King Alfred, remaining, however, in effective possession of that half of England which was called the Danelagh. In the tenth century Alfred's son and grandsons brought the whole of the Danelagh under their dominion.

In the meantime the Picts and Scots who occupied nearly the whole of what we now call Scotland, with the exception of the eastern lowlands, had become more or less united under the chiefs who were called kings of Scots. In the eastern lowlands it may be that Angles and Danes predominated over their Celtic predecessors. Some kind of vague supremacy on the part of the king of England was admitted by the king of Scotland, who "took him as father and lord," but otherwise paid very little attention to his behests.

The Union of Danes and Saxons. Attacks from the Northmen overseas had ceased for three-quarters of a century, but at the end of the tenth century, when the incapable Ethelred the Redeless was on the English throne, they came again. Ethelred's attempts to buy them off merely resulted in fresh attacks and fresh demands for ransom. Finally, King Sweyn of Denmark expelled Ethelred, and on his death, immediately afterwards, his son Canute united England to an empire which, before his death included Norway as well as Denmark.

When Canute's sons died, no attempt was made to prevent the English from recalling to England Ethelred's son Edward, known as the Confessor. It is needless here to relate the familiar story how, on Edward's death, the English made Harold Godwinson king and how William of Normandy came with his magnificent army across the English Channel and overthrew Harold and his army on the field of Senlac, and established the Norman supremacy in England.

It should be noted, however, that during Edward's reign Malcolm Canmore successfully asserted his claim to the crown of Scotland, which from that day to this has been worn by none save his descendants. A. D. INNES

THE LAST STAND AT SENLAC—KING HAROLD DEFENDED BY HIS BODYGUARD AGAINST THE HORSEMEN OF WILLIAM THE NORMAN

Road Development. Legislation affecting Roads. Construction, Cleaning and Upkeep. Road Board Tests for Materials.

ROAD MAKING AND MAINTAINING

Whether in ancient times better roads and pavements were built than at present, or whether only the best ones remain, is uncertain, but it is certain that some of the remains of such structures found in Rome, for instance, evince engineering skill of high degree. These were laid out carefully, excavated to solid ground, or, in swampy places, made solid by piles. Then the lowest course was of small-sized, broken stones, none less than 3 in. or 4 in. in diameter; over these was a course, 9 in. thick, of rubble or broken stones cemented with lime, well rammed; over this a course, 6 in. thick, of broken bricks and pottery, also cemented with lime; upon this was laid the *pavimentum*, or pavement, composed of slabs of the hardest stone, joined and fitted together as closely as possible. This was costly—the Appian Way, extending from Rome to Capua, a distance of about 130 miles in length, having almost exhausted the Roman treasury—but it was as enduring as Nature's own work. In Peru and Central America similar remains, 1000 to 2000 miles long, were found by the Spaniards, which, as Prescott says, were built of heavy flags of freestone, and, in some parts at least, covered with a bituminous cement which time has made harder than stone itself.

Early English Roads. Road-making in England may be said to have begun in 1346, when Edward III. authorised the first toll to be levied for the repair of roads leading from St. Giles in the Fields to Charing Cross (then a village), and from the same quarter to near Temple Bar. The footway at the entrance of Temple Bar was impeded by thickets and bushes, and in wet weather almost impassable, and the roads westward were so bad that when the sovereign went to Parliament faggots were thrown into the ruts in King Street, Westminster, to enable the royal coach to pass along. The first Act for paving and improving the City of London streets was passed in 1532. The first turnpike road established by law was in 1653. This was made for taking toll of all but foot-passengers on the northern road through Hertfordshire, Cambridshire, and Huntingdonshire.

But no very considerable improvements in the art of road-making took place till the Highland Rebellion of 1745, which gave a great impetus to the construction of roads for military as well as for civic purposes, as is evident from the fact that from 1760 to 1774 no fewer than 452 Acts regarding making, repairing, and improvement of highways were passed.

Macadam. John Loudon Macadam, the great road-maker, was born on September 21st, 1756. During the early years of the nineteenth century he was travelling about the kingdom, making inquiries into the systems of road-making. By August, 1814, he had travelled 30,000 miles, and had spent from his own private resources a sum equal to £5019.

In 1823 he succeeded in getting an inquiry before a Committee of the House of Commons as to his system, and had made a set of road-making implements, so that he might the more clearly explain the principles he advocated, and in 1825, having proved an expenditure of several thousand pounds from his own resources in carrying out his improvements, this amount was reimbursed to him by the Government, together with an honorary tribute of £2000.

Macadam's system of road-making, to use his own term, was "to put broken stone upon a road which shall unite by its own angle so as to form a solid, hard surface." His practice was to lay flints or some other hard material, broken to a uniform size of approximately cubical shape. 1½ in. to 2 in. in diameter, to the depth of 10 in, the only preparation being the levelling of inequalities and the digging of side-drains, the broken material being spread evenly over the road surface and left to be consolidated by the traffic. He used no admixture of binding material, and the stones were perfectly clean. This rule of Macadam, which in theory appears all right, in practice is found impossible to accomplish.

Telford's Highland Roads. About the same time that Macadam was busy engaged in his system of road making and repairing, another pioneer, Telford, was equally busy constructing many miles of roads in the Scottish Highlands, but on an entirely different system. Telford did not believe it possible to construct a hard road by simply laying 10 in. of broken stones upon a soft natural foundation, his method being to keep the broken stones from the subsoil, and to ensure this he first laid down a "pitched foundation," consisting of pieces of stones or other hard substance placed upon the level bed by hand to form a close, firm pavement, and upon this foundation was laid a thickness of broken road-metal.

Main, Rural, and Private Roads. The highways of England and Wales are divided among some 2000 local authorities. All roads which had been disturnpiked between December 31st, 1870, and August, 1878, or were subsequently disturnpiked, became *main* roads under the Highways and Locomotive (Amendment) Act, 1878. Some of the existing roads or portions of roads, although dignified by the term "main," are not "principal" roads, but, being old turnpike roads, whose days of importance have passed away, have now very little traffic on them. By the Local Government Act, 1888, County Councils, who were previously only contributing authorities, were charged with *entire* responsibility for the maintenance of all main roads. In the provinces public highways are managed by City, Town, and Urban District Councils, while in the country they are managed by Rural District Councils.

Prior to 1835, so long as there was an intention on the part of the owner of the soil to dedicate a road to public use, which he signified by throwing open a road unreservedly, and an acceptance by the public signified by the using of the road, the two circumstances sufficed to make a road a public highway; but now roads and streets remain private—that is, not repairable by the inhabitants at large—until they are formally dedicated.

Breaking Up. The opening of roads for the laying of new mains, repairs to existing ones, or other public services is a continual cause of complaint, and one of the stock grievances of the public; and the damage caused to highways by openings made in them by builders, owners, and occupiers of property, and by gas, water, and other companies, is a source of much reasonable irritation and annoyance to Local Authorities who are responsible for their maintenance. A macadamised road opened for the construction of a trench can never be properly reinstated without showing some evidence of it, even when the replacement has been carried out by experienced roadmen. Where, however, other workmen have been employed, as those engaged by builders or house-owners, the damage is greater. The ramming of the materials in refilling the trench is most rarely executed in a sufficient manner, and instead of two men ramming being employed to one filling, which is necessary, and the materials being replaced in layers of not greater thickness than 6 in., ramming is generally performed in a most perfunctory manner—the material is replaced in large lumps, and as a consequence the trench subsides for weeks after. The substance of the sections giving statutory powers are collected into a short compress and in direct sequence.

Powers to Open Roads. The Gasworks Clauses Act, 1847, empowers the undertakers to open and break up any road, and lay down and place pipes, conduits, service pipes, and other works, and from time to time to repair, alter, or remove the same, subject to three clear days' notice being given to the clerk, or other officer of the Local Authority before beginning such work.

The Waterworks Clauses Act, 1847 (incorporated with the Public Health Act, 1875, sec. 57), provides similar power, and sec. 52 gives power to a private individual to open or break up so much of the pavement of any street as shall be between the water-main and his house, building, or premises, after giving due notice. It has been decided by the courts that the word *pavement*, as used in this section, is not confined to the footpath only. Provisos are also contained in the Tramways Act, 1870; the Railway Clauses Consolidation Act, 1847; the Electric Lighting Act, 1882; Forrest Fulton's Act (the usual title of the Water Companies Regulation of Powers Act, 1887), and the Telegraph Acts, 1863, 1873, 1878, 1892.

Quarries, Pits, and Pavement Regulations. Where any quarry dangerous to the public is in open or unenclosed land within 50 yards of a highway, or place of public resort dedicated to the public, and is not separated therefrom by a secure and sufficient fence, under the Quarry Fencing Act, 1887, the Local Authority has power to deal with it. The term *quarry* includes every pit or opening made for the purpose of getting stones, slates, lime, chalk, clay, gravel, or sand, but not any natural opening.

The following can be dealt with by Local Authorities as obstructions in streets:

(*a*) Shop and sun blinds if fixed less than 8 ft. in height.
(*b*) Trees overhanging roadways.
(*c*) Doors and gates opening outwards on the pavements.
(*d*) Defective rain-water shoots from buildings.

Where the Local Authorities do not undertake or contract for the cleansing of footways or pavements adjoining any premises, they may make by-laws imposing this duty on the occupier of any such premises. This is the substance of an important provision in the Public Health Act, which may place occupiers under some responsibilities which have not, perhaps, been considered. Yet there is ocular evidence on the pavement, day by day, opposite most greengrocers' and butchers' shops, of negligence in this matter. By the Public Health (London) Act, 1891, the City householders were relieved of this duty, which was cast upon the Sanitary Authority.

Asphalt. Although mineral rock asphalt was first discovered in 1712, it was not commercially adopted as a paving in Paris until 1854, and in London until about ten years later, and it is only in comparatively recent years that its wider uses have been appreciated.

Mineral rock asphalt is a natural product, a pure limestone naturally impregnated with mineral bitumen. The rock when mined or quarried is of a chocolate colour, fine in grain, evenly impregnated with bitumen, which varies from about 6 to 20 per cent. It is usually found in seams or layers from 6 ft. to 30 ft. in thickness, like coal, and is mined in a similar manner. The principal supplies are taken from the Bassin de Seyssel, Haute Savoie, Switzerland; France; Limmer, in Hanover; and Ragusa, in Sicily. The weight of a cubic yard of natural asphalt is about 34½ cwt. Trinidad asphalt is a colloquial term for the artificial asphalt pavement of America It is made with bitumen, sand, and limestone dust, resembling asphalt in its composition.

Use of Asphalt. During the last fifty years compressed mineral rock asphalt has stood the severe test of enormously increasing traffic in the principal streets of the City of London, the metropolitan districts, and the provincial cities and towns of the United Kingdom, and has proved to be the most satisfactory sanitary paving that can be laid. It is impervious to moisture, and non-absorbent, and, being jointless, nothing can get into crevices and decay. It has a smooth and even surface, is durable, economical, and quickly laid; and the preparation of compressed rock asphalt is similar to that of mastic asphalt for footpaths, except that the powder is placed in specially designed roasters with revolving cylinders, and heated to a temperature of about 280° F. without any admixture of bitumen.

As soon as the superfluous moisture has evaporated, the heated powder is placed in iron-sheathed vans, covered with thick cloths (to retain the heat), and taken to the site where it is to be laid. The asphalt powder is then laid on a Portland cement concrete foundation, 6 in. to 9 in. thick, according to the nature of the traffic, well raked over the cement concrete foundation, and rammed with hot rammers to the thickness required After being smoothed over with a hot smoothing-iron, so as to bring sufficient bitumen to the surface, a heavy roller is passed over it, while the asphalt is still warm, to straighten and consolidate the surface. When opened to the traffic, the asphalt gradually begins to be compressed into solid rock again. In main traffic streets $2\frac{1}{4}$ in. of compressed asphalt are laid on about 9 in. of concrete. In streets of lighter traffic, the practice is 2 in. of compressed asphalt on 6 in. of concrete.

The Asphalt Road. An asphalt road can be constructed exceedingly flat, because a slight gradient is sufficient for rapidly removing the surface water; moreover, the vehicular traffic distributes itself without risk over the entire width of the road, even close up to the gutters, which is not the case, to the same extent, on a stone road. It suffices if, from the apex, which is simply rounded off slightly, two straight lines are drawn as cross or lateral gradients, an extra fall being given to the gutters for a width of about 18 in. As a rule, a lateral fall of 1 in 70 will suffice for the roadway, increased to 1 in 50 at the gutters. For the longitudinal fall 1 in 60 is considered the limit up to which the slipping of horses need not be feared.

The following well-known formula for calculating the camber of asphalt roads has been employed for many years:

$$f = c\frac{S^2}{S-7}$$

where f = camber (versed sine of arc),
s = width of roadway between kerbs,
c = coefficient (= 0·012).

Therefore, the normal camber of a roadway 30 ft. wide would be $0{\cdot}012\,\frac{30^2}{30-1} = 0{\cdot}372$ ft. in the centre.

Foundation and Layings for Asphalt. The concrete for the foundation should be gauged, six of aggregate to one of Portland cement. The thickness should be regulated according to the weight it has to bear. London principal thoroughfares have a foundation of 9 inches in thickness. Other streets where the traffic is of a lighter nature have but 6 inches.

Granited rock asphalt has proved its great durability and sanitary advantages. The earliest of this class of work was carried out ten years ago. For some unexplained reason the North of England has shown the greatest enterprise in adopting this class of roadway. It is to be seen in and around "Cottonopolis."

The primary ingredient, mineral rock asphalt, is manufactured in block form for convenience in handling. It is usual to compound and heat the materials on the site. Briefly, the process is to melt the asphalt, using a small percentage of refined natural bitumen as a flux, and then to incorporate with it about 30 per cent. of clean dry $\frac{1}{4}$ to $\frac{1}{2}$ in. gauge granite chippings, the mixture being subsequently raised to a temperature of 275° F. for laying. In the case of roads carrying heavy motor traffic this composition has been laid 2 in. thick on 6 in. of cement concrete with excellent result, at a cost of 10s. per superficial yard.

In order to meet the demand for an asphaltic material that can be laid without a special foundation, a material known as Rock Asphalt "Carpet" has been introduced. The chief use of the material is for re-surfacing old macadam roads. In its composition mineral rock asphalt obtained from Eschershausen, Germany, plays an important part, This asphalt is claimed to possess the properties of hardness and toughness in unsurpassed degree, whereby it is well adapted for road-surfacing work. An even bed is required for the composition.

An example of Rock Asphalt "Carpet" may be seen at Eltham, where a trial length has recently been laid for the Woolwich Borough Council. In this case the composition was applied in two coats, making a total thickness of $1\frac{1}{2}$ in. The road carries all through-traffic to Dartford. A length has also been put down opposite the Chiswick Town Hall.

Bricks for Paving. Bricks as a material for street paving have received very little attention in England, although this country is justly celebrated for the quality of its bricks.

In Holland this class of paving has been in use for about 150 years, and in America about twenty years, where hundreds of miles have been laid in all sorts of ways and under varying conditions. Bricks obtained from Middlesbrough were laid in Liverpool as a trial in 1881, and a small piece of brick paving to form a carriage-way was laid at Cheltenham in 1900. This paving was laid on a sand cushion with a foundation of 6 in. of cement concrete, the bricks being grouted in with pitch.

Cork Asphalt. Cork asphalt is a compound consisting of bitumen and certain other materials, including cork. It has been used in different parts of the world for a number of years, and possesses all the necessary features which constitute a good paving material. It is durable and elastic, and, being non-absorbent to moisture, is therefore hygienic and sanitary. It is comparatively noiseless, and also non-slippery; and therefore it is unnecessary in wet weather to sprinkle the surface with sand or fine gravel, as is requisite with other pavements. The result of this is that there is a marked absence of mud, and, in dry weather, of dust. These properties make it invaluable for public roadways, especially as freedom from noise, dust, and such discomforts is an object. It is claimed that no other pavement possesses such valuable characteristics, and cork asphalt is thus pre-eminently suitable for all classes of traffic, horse, motor, or otherwise. It is manufactured in the form of homogeneous blocks of uniform size, and the surface, when laid, is regular and even. Frost does not so readily act on it as on other classes of pavement.

The first cost of cork asphalt compares favourably with that of other pavements, and the cost of upkeep is much less, owing to its durable nature. This class of road pavement has been largely used by H.M. Office of Works, by numerous provincial boroughs and corporations, and by the leading railway companies.

This pavement is manufactured in blocks similar to wood blocks in sizes from 9 in. by $4\frac{1}{2}$ in. by 1 in. thick to 9 in. by $4\frac{1}{2}$ in. by 2 in. thick. It is laid on a concrete foundation, its cost compares favourably with that of wood, and its average life is somewhat longer.

Gutta-percha Paving. Gutta-percha, like cork, is the ideal of noiselessness, but is in a very experimental stage as yet, and has hardly come within the scope of practical consideration. A small piece is laid at the entrance to Euston Station, London, and in small, short sections at Glasgow. The sheets are laid down at their sides upon a concrete foundation by strips of iron, which clasp the edges tight on each other. Indiarubber in large sheets about 1 in. in thickness has been introduced in Hanover as a material with which to pave roads, and it has also been used in the courtyard of the Savoy Hotel, London.

Granite Setts. A street pavement composed of this material has been in use for many years. This system was introduced into the country by the Romans. The size of the paving-stones was, however, much larger than modern science finds necessary. One of the first granite pavements laid was that known as the "Euston pavement." This class of pavement consists of squared setts (the most general size being 6½ in. by 3½ in. by 5 in. to 7 in. long), laid on a concrete foundation consisting of cement concrete, the only reliable material. It should never be laid less than 6 in., while 9 in. will carry the heaviest traffic. The concrete should be composed as follows:

Six parts of screened ballast or gravel—all of which will pass through a screen of 2½ in. mesh—and one part of Portland cement, all thoroughly mixed upon a platform and used while in a semi-liquid state. The resultant mixture of one ton of cement, when mixed in the proportion of six to one, is about seven cubic yards of concrete. This will cover an area of 42 super. yd. 6 in. deep, and will take four labourers one day for mixing and laying.

Laying Granite Setts. As the concrete is laid in the trench the top surface should be brought to the proper camber with the shovel. For ordinary traffic, Aberdeen or Norway granites are largely used; these are bedded on a sand packing free from small stones or pebbles, and average 1 in. in thickness, and laid touching one another, each stone being so firmly bedded on the packing that it has not to rely on the next one for support, and the setts laid to break joint. The ramming requires careful supervision, as, in order to avoid the trouble of lifting badly laid setts, the men often try to get an even surface by ramming the high stones extra hard, and omitting to ram the low-lying stones, or stones inclined to give too much.

In the North of England and other places the joints are first filled with clean pebbles, after which the surface is well rammed, and then run with an asphaltic mixture, and covered with a layer of fine gravel, while in the South of England the finished surface is usually grouted over with a liquid prepared from sand and lias lime, or Portland cement, and well washed into the joints. No traffic should be permitted on a newly laid pavement of this class for 14 days. One ton of setts of the size mentioned will cover 3·6 superficial yards, and a pavior will lay an average of 30 superficial yards per day of 10 hours.

Armoured Roads. Sheffield has had more than an average experience of roadways laid on what is known as the "Durax" system (armouring existing surface with small setts). The total area of this kind of paving within the city is about 30,000 yards. Some such roads have been down for about five years under light traffic, and are now in excellent condition without having involved any cost in repairs. The paving has the advantage of possessing more elasticity than an ordinary paved "sett" road; in fact, it may be said that, while a strong granite pavement will break before bending, this lighter form will bend before breaking.

The Macadam Road. For this class of road [1] the ground is excavated in the usual manner to an approximate circular segment, and the foundation formed of "hard core," a term applied to a heterogeneous mixture consisting of chalk, broken stone, bricks, dry rubble, clinkers, and other dry and hard materials. The thickness of the hard core depends on the nature of the subsoil, but 6 in. may be regarded as the minimum thickness, and this should be consolidated by rolling, all hollow places being filled in and made level. Upon this, a thin layer of dug flints or gravel should be uniformly spread and consolidated.

Then, to receive and withstand the wear and tear of the traffic, a 6 in. coating of stones or granite, broken to pass all ways through a ring of 2½ in. internal diameter, should be laid down, and well consolidated by watering and rolling, a little binding material being lightly scattered and swept in over the surface on completion.

Material for Macadamising. It is almost impossible to lay down any hard and fast line as to the material to be used over the whole kingdom for this description of road, as nearly every English county produces descriptions of stone all suitable in a greater or less degree as a road-making material; but where the material is soft, it will be found economical to obtain a harder stone or granite from a distance, as the hardest description of stone should always be preferred. Those now commonly in use are basalt, Aberdeen, Guernsey, and other granites, Mountsorrel and Hartshill and Leicestershire stone. Picked slag, hill-picked surface and land-dug flints, and gravel, are also largely used for suburban side-streets and rural roads where the traffic is not heavy. The cost of granite as a road metal and flints or gravel is roughly as 1 to 3.

Cherbourg Quartzite in England. Until 1885, this material was little known in England. At that date, the first cargo was imported and laid upon a length of road situated close to Gravesend, and remained eight years without needing repairs.

The natural cautiousness of the English engineer when dealing with something which has not been proved has prevented this material from being classed with other granite as a road material.

Rules for Laying Macadam. A rule to find the area of surface that can be covered by one cubic yard of broken material is as follows:

When the metal is not rolled, divide 36 by the thickness of the proposed coating in inches; the quotient is the number of superficial yards that can be covered. When the metal is rolled, divide 27 by the thickness in inches to give the required quotient.

A commonly adopted rule for ascertaining the camber of a macadam road is as follows:

Width of road, say, 30 ft.
At 4 ft. from centre (on each side), fall ½ in.
„ 9 „ „ „ „ „ „ 2 in.
„ 15 „ „ „ (its extreme edge), 6 in.

This class of road is repaired by the old, worn surface being picked up by manual labour, or by means of a scarifier, the new metal being put on and steam-rolled with a small addition of matrix.

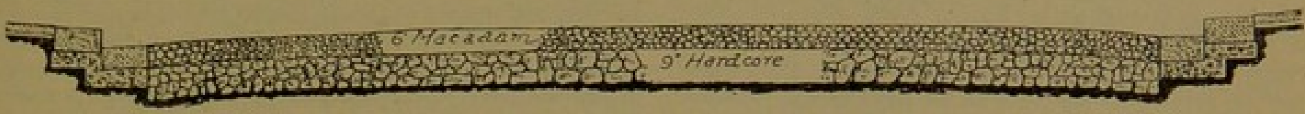
Tar. While it is only within comparatively recent years that tar macadam has been applied to road-making purposes, it has been used in Nottingham, where the first piece of tar macadam was laid in this country, for some 50 years.

There is nothing new in the principle of mixing tar with road metal, but a material manufactured from the best hand-picked selected iron slag, and mixed by machinery specially designed, has been introduced to comply with the largely expressed desire for a tar macadam suitable for roadways, and is specially intended to meet the greatly increasing motor and other similar traffic which is now proving so damaging to the ordinary macadam road, principally due to the suction set up by the rubber tyres, which causes disintegration of the finer material.

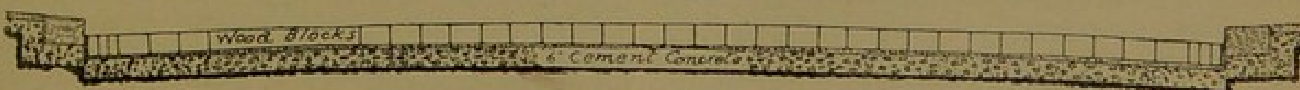
Cost of Tar Macadam. With roads made of tar macadam, the initial cost is not very much in excess of that for ordinary macadam, while the life is considerably greater, thus largely reducing—by 40 to 60 per cent.—the cost of repairs and the expenses of scavenging. The material is non-slipping, and has been laid on slopes and cambers of as much as 1 in 30 without any more effect than on an ordinary macadam road.

Preparation of Roadway. The surface of the roadway or other area proposed to be paved should (in the case of an existing road or old foundation) be scarified by a steam scarifier, or picked over by hand labour and levelled, to leave a camber, or fall, of the cross section of ½ in. to ⅝ in. to 1 ft., care being taken to excavate all soft and weak places, which should be taken out at least 1 ft. in depth, and filled in with good, dry, hard core. The whole surface should then be moderately steam-rolled to ensure thorough consolidation (a very essential point), but the rolling should be discontinued before the surface becomes "smooth," as a "key" is necessary, and an air circulation is required in the foundation. The tar slag-macadam is then laid on the foundation prepared as above in two coats of varying thickness, according to the traffic for which it is required, each coat being well rolled with steam-roller, weighing not more than six tons, and the surface on completion being dusted over with fine chippings, and finally well rolled until it is quite hard. The material of the *bottom* coat should be spread with shovels in the same way as ordinary macadam, and should be allowed to lie open before being rolled, for at least 24 hours, to allow it to become partially set and *tough*, which ensures the levels remaining true; and the *top* coat laid with rakes (kept heated) to enable a level and true surface to be obtained. This coat should also remain open a few hours before rolling, and, where possible, the rolling of the material should not be done during rain, or until it has had sufficient time to dry.

The thickness at which the material should be laid may be taken generally as shown below.



1. TRANSVERSE SECTION OF A MACADAM CARRIAGE-WAY



2. TRANSVERSE SECTION OF A WOOD-PAVED CARRIAGE-WAY

Roadways with local or through traffic: Work to be laid in two coats, totalling 4½ in. in thickness. Bottom coat, 3½ in. thick of 2-in. gauge material. Top coat, 1 in. thick of ¾-in. gauge material.

Roadways with light traffic: Work to be laid in two coats, totalling 3½ in. in thickness. Bottom coat, 2¾ in. thick of 2-in. gauge material. Top coat, ¾ in. thick of ⅝-in. gauge material. The life of this description of paving may be taken as seven and five years respectively.

The practice of tarring the surfaces of waterbound macadam roads which have not sufficient traffic to justify their conversion to tar macadam is to be commended. The dressing mitigates the dust nuisance, and prolongs the life of the macadam.

Wood Paving. The first wood-paved roadway laid in London was in front of Old Bailey in 1839. Since this date wood has made giant strides as a street paving [2]. "It is admitted by all that it is of little use to lay any pavement without a good and substantial foundation, and none of the substances used requires this more than wood. Such being the case, a substantial concrete foundation is first laid, and it should cost the same, whether granite, wood, or other material be placed upon it; consequently, the only thing to be considered is the cost of the wearing surface, its lasting qualities, and its desirability as a pavement when completed."

Woods for Paving. A wood pavement as now laid consists of a good, hard foundation of Portland cement concrete, laid 6 in. thick, and floated over to an even surface, conforming with the contour line of the proposed finished road. When sufficiently set, rectangular blocks of Jarrah, Karri, or others of the eucalyptus or blue gum types, 9 by 6 by 3 in., on the face, cut die square, with the fibre vertical, are laid with close joints upon the finished surface of the concrete. To allow for the expansion of the wood transversely across the street, a 1½-in. expansion joint of sand is provided next to the kerb. The interstices between the blocks are often grouted with liquid Portland cement and fine sand, a bituminous mixture of tar and pitch, or tar alone. The mixture is poured over the surface and "squeegeed" or brushed until it disappears between the wood blocks. The surface is then sprinkled with coarse sand or fine grit, and the traffic allowed to squeeze it, thus preserving the wood and rendering it less slippery.

Creosoting the Blocks. If soft woods are used, the blocks should be creosoted by at least 10 lb. of creosoted oil being driven into every cubic foot of wood, so that each block may be thoroughly penetrated. The life of the blocks is not materially increased by the creosoting, but they are rendered less absorbent. The life of this pavement depends upon the amount of traffic, quality of the material used, the locality (whether open or confined), and the width of the street, but the average estimated wear of Jarrah or Karri blocks is ⅜ in. per annum.

Karri wood is hard, heavy, and tough, and it is recognised as one of the most durable woods for street paving. It is cut from a tree whose average height is 200 ft. by 4 ft. in diameter at 3 ft. to 4 ft. from the ground, and has its first branches at a height of 120 ft. to 150 ft. The concrete foundation is similar to that described under Granite Setts.

Soft woods have been used mostly in London on account of their being less noisy under traffic than hard woods, but their chief objection is that they wear more quickly than hard woods.

The comparative expansion of creosoted against plain soft wood blocks after immersion in water for 48 hours has been found to be as follows:

On length of block	creosoted	·099	; plain	·6
,, width	,, ,,	·57	; ,,	·83
,, depth	,, ,,	·15	; ,,	·31

These represent, in a thirty-feet carriage-way, 2½ inch for plain blocks and practically ¾ inch for creosoted blocks, if under the same conditions.

Road Sanitation. The sanitation of roads is a question which has not received, by scientific and practical investigation, the attention as to its influence upon health demanded by its importance.

In 1856, when the Metropolis Local Management Act came into operation, there were no asphalt or wood-paved roads; steam-rollers were unknown, and the mud was up to one's ankles on a wet day.

Street Cleaning. The Public Health Act, 1875, contained provisions for the proper cleansing and watering of streets. The Public Health (London) Act, 1891, made it compulsory for every sanitary authority to employ a sufficient number of scavengers, or contract with any scavengers, for the execution of the duties of the authority under this Act with respect to the sweeping and cleansing of the several streets within their district, and the collection and removal of street refuse.

Street-sweeping by rotary brush machines drawn by horses is found to be 33 per cent. cheaper than if done by hand. It might be expected that, where streets have been paved to a very even surface with wood or asphalt, they should be kept much cleaner than they are, but the difficulty is that not only is mud and dust produced by the droppings on any particular street under observation, and from the sanding it receives to reduce slipperiness, but there is also a large amount of dirt from adjoining streets transferred by the wheels of vehicles; and in any wide-jointed paving, such as granite setts, it is surprising what an amount of mud may be retained in the joints after the surface has been as effectually cleaned as ordinary processes can make it; for as soon as traffic begins to run over a road just swept, horses' feet and wheels at once begin to disturb the mud from the joints, and it soon appears as if nothing had been done to clear it.

Cost of Cleaning. Macadam must head the list as the most costly for cleansing; next to that granite paving must be placed. Very close after this comes soft wood, the disintegration of which is very rapid, and the spongy nature of its surface assists to accumulate mud. Hard wood-paving can be placed at a considerable distance below soft wood, for if paved with close joints its surface is almost impervious, and it is easily cleaned. The road material costing the least for cleaning is asphalt.

Value of Road Materials. For years past endeavours have been made by various processes to determine the relative values of road-stones, and with more or less success. We have now under everyday traffic conditions, and upon a reasonably large scale, tests from which it is hoped accurate conclusions may be reached. The Road Board, in co-operation with several local authorities, have arranged for many different kinds of materials to be laid under identical circumstances supporting the same intensity of traffic.

In Kent, and within ten miles of London Bridge, a length of about 1½ miles of the London-Folkestone road has been divided into 23 sections, each representing about 1000 superficial yards, and upon these materials ranging in price from 1s. 9d. to 9s. 3d. per square yard have been laid. The first four sections were laid by the Kent County Council, the remaining 19 sections being given to contractors.

Materials in the Road Board's Test. The materials under test are as follow: Ordinary water-bound granite, the same (tar painted), single pitch grouting, double pitch grouting, Durax armouring, Kentish ragstone, tarred macadam, bitumenous macadam, granite grouted with Tarvia, asphalt macadam, natural asphalt matrix, slag tar macadam (single and double thickness), Plascom, Cormastik, Tarmac, Roadoleum, Roemac, Roadamant, Tarviated macadam, Lithomac, Pitchmac, Trinidad Lake asphalt (3 and 4 inches thick).

In each section, sockets are fixed on concrete bases, and measuring apparatus has been designed which fits in these, and by which means wear will be capable of measurement to the minutest part of an inch. Periodically, the wear will be measured and carefully plotted upon large-scale diagrams. Traffic statistics will be taken bi-monthly, and reduced to a denominator of tons per yard width of surface per annum. The traffic upon this section of road is heavy, representing upwards of 150,000 tons per yard width per annum, and including a frequent motor-omnibus service.

Cost of Maintenance. It is well known that our highways were the foundations and nursery for developing the mechanical traffic which has entered into a stage of prosperous commercialism, and is now creating an enormous burden upon the local ratepayer without equal contributory advantage; and thus it appears a great misfortune that legislation should have limited the powers of the Road Board to contributing "towards" the cost of "improvements" and not maintenance. The Road Board's income being derived from the tax on fuel, and mechanical traffic developed from that fuel being a serious addition to the expense of maintenance, it appears only reasonable that legislation should empower a contribution towards such expense.

Some interesting proposals in regard to road construction and maintenance were recently made by Colonel Crompton, consulting engineer to the Road Board, who said it seemed to him that in future road-construction schemes would have to be carried out in much the same fashion as railways were built. A class of contractors would have to be encouraged who would be responsible for local schemes. The mode of construction of highways would have to be reconsidered. It would be necessary to consider schemes to deal with great lengths at a time. He believed the present high prices of road-construction to meet omnibus traffic were due to the short lengths undertaken. The modern road surveyor would find himself able to deal with certain constructing firms and to give contracts out not only for construction, but for maintenance, as had been done not only in England but abroad. He believed there was a great opening for engineers and machinery in this direction, and that in a few years' time highways would show as great a development as railways.

A. TAYLOR ALLEN

Table showing the comparative cost, life, and maintenance charge of road surfacing

Description of Material	Average Life. Years	First cost per sq. yd.	Maintenance per sq. yd. per ann.	Cleaning per sq. yd. per annum
		s. d. s. d.	s. d. s. d.	d. d.
Water-consolidated macadam	2 to 3	3 6 to 5 0	0 3 to 0 9	1 to 4
Tar macadam (on existing foundation) ..	6	2 0 to 3 0	0 1 to 0 3	1
Asphalt (compressed).. ..	15 to 18	15 0 to 18 0	1 0 to 1 6	1 to 2
Hard-wood ..	15 to 16	13 0 to 16 0	1 0 to 1 3	1 to 2
Soft-wood	12	9 0 to 11 0	1 2 to 1 6	2 to 3
Sett paving ..	20 to 25	15 0 to 17 0	0 5 to 0 9	2 to 3

A Further Study of the Prose-writers from Roger Ascham to John Dryden. Examples of their Styles.

THE SHAPING OF ENGLISH PROSE

Roger Ascham. As our Anglo-Saxon forebears fought against the influences of Norman-French, so ROGER ASCHAM (b. 1515 ; d. 1568), the tutor of Queen Elizabeth, reflected the native English spirit in his strong masculine prose and his antagonism to the "Italianate Englishman," who modelled his conduct and his studies on what he or others brought back from Italy in those early days of Continental intercourse and travel. Ascham was devoted to the old English pastime of archery, and wrote a defence of it in English—"Toxophilus"—which he dedicated to Henry VIII., adding an address to the gentlemen and yeomen of England in which occurs a passage that forms at once an apology for and a defence of his native tongue : "As for the Latin or Greek tongue, everything is so excellently done in them that none can do better ; in the English tongue, on the contrary, everything is in a manner so meanly, both for the matter and handling, that no man can do worse." Then follows the remark : "He that will write well in any tongue must follow this counsel of Aristotle, to speak as the common people do, to think as wise men do." There are several important works on education which belong to the sixteenth century, but Ascham's "Scholemaster" is the first in point of time, and contains not a little advice the value of which is of a permanent charactei. One of the truths that he urges is being propagated in our own day with all the energy of our twentieth century reformers: namely, the need of awakening in the mind of the pupil an interest in his work. In this connection the appended extract from the "Toxophilus" will be of interest to the reader :

The Wisdom of Ascham. "If men would go about matters which they should do and be fit for, and not such things which wilfully they desire, and yet be unfit for, verily greater matters in the commonwealth than shooting should be in better case than they be. . . . This perverse judgment of men hindereth nothing so much as learning, because commonly those that be unfitted for learning be chiefly set to learning. As if a man nowadays have two sons, the one impotent, weak, sickly, lisping, stuttering, and stammering, or having any mis-shape in his body, what does the father of such one commonly say ? This boy is fit for nothing else but to set to learning and make a priest of. . . . Fathers in old time, among the noble Persians, might not do with their children as they thought good, but as the judgment of the commonwealth thought best. This fault of fathers bringeth many a blot with it, to the great deformity of the commonwealth. . . . This fault, and many such like, might be soon wiped away if fathers would bestow their children always on that thing whereunto nature hath ordained them most apt and fit. For if youth be grafted straight and not awry, the whole commonwealth will flourish thereafter."

Henry VIII., who encouraged Ascham, must have it placed to his credit also that he gave similar aid to Sir THOMAS ELYOT (b. about 1490; d. 1546), who wrote on behalf of good government, and translated Plutarch "On the Education of Children."

The Bible and English Literature. As poetry, in a chronological sense, takes precedence of prose in the history of English literature, so religious works precede secular in influencing the growth of English prose. We may not pause to consider this subject at any length ; but the services of the early translators of the Bible cannot be overestimated. First among these translators was JOHN WYCLIFFE (b. 1325 ? ; d. 1384). Here it is important to remember, however, that neither the "Wycliffe Bible" nor any of its successors was the work of one man, although "Wycliffe's Bible," "Tyndale's Bible" and "Coverdale's Bible" are common terms. The Gospels are the only part of the "Wycliffe Bible" certainly written by the great Reformer himself. Before Wycliffe's time only portions of the Scriptures had been translated into English. Wycliffe —to follow the accepted story—set himself a few years before his death, in 1384, to the task of producing the first complete English Bible. By 1382 he had completed the New Testament. His friend Nicholas, of Hereford, translated most of the Old Testament and the Apocrypha. John Purvey, a pupil of the Reformer, revised the work four years after Wycliffe's death. The translation (or paraphrase), which was made from the Vulgate (or Latin version), was originally issued in manuscript form; of this 150 copies are still extant. Written as it was for the common people, it is remarkable to find with how much ease "Wycliffe's Bible" can still be read. Wycliffe was a Yorkshireman, and we are told that when, a few years ago, several long passages were read to a congregation in his native county, not only were they understood by the hearers, but almost every word was found to be still in use.

William Tyndale. The work of Wycliffe was carried on and improved by WILLIAM TYNDALE (b. 1484 ? ; d. 1536), a pupil of Erasmus, the great co-worker with Martin Luther in the Reformation. When Erasmus published his Latin version of the New Testament in 1516, he declared his wish that even the weakest woman should read the Gospels. "I long," he said, "that the husbandman should sing portions of them as he follows the plough, that the weaver should hum them to the tune of his shuttle, that the traveller should beguile with their stories the tedium of his journey." Tyndale declared: "If God spare me I will one day make the boy that drives the plough to know more of the Scriptures than the Pope of Rome." Tyndale, who was a good Greek scholar, studied Hebrew for the purpose in hand, and while consulting the Vulgate went back to the originals as the basis of his version. He was helped in his task by a fugitive friar named Roy and others. It was "Tyndale's Bible" which, revised by MILES COVERDALE (b. 1488; d. 1568)—the first complete printed English Bible—and edited and re-edited as "Cromwell's Bible" (1539), and "Cranmer's Bible," or "The Great Bible" (1540), was set up in every parish church in England, in some cases being chained to the lecterns, or reading desks.

The Influence of the Bible. To quote Dr. Stopford Brooke, "It got north into Scotland and made the Lowland English more like the London English. It passed over to the Protestant settlements in Ireland." After its revision in 1611—there had been printed meanwhile the "Genevan Bible," a work handier in size than its predecessors, in Roman type and with the text divided into verses—it went as the Authorised Version with the Puritan Fathers to New England and fixed the standard of English in America. "Many millions of people now speak the English of Tyndale's Bible, and there is no book which has had, through the 'authorised' version, so great an influence on the style of English literature and the standard of English prose." In Edward VI's reign THOMAS CRANMER (b 1489; d. 1556) edited the English Prayer Book (1549–52). "Its English," Dr. Stopford Brooke notes, "is a good deal mixed with Latin words, and its style is sometimes weak or heavy, but on the whole it is a fine example of stately prose. It also steadied our speech." To tell the influence of the Bible on English writers from Shakespeare's time to Swinburne's would be to specify nearly all the best work of our greatest writers. Need we therefore urge its study upon our readers, when scarce any writer of note but has either acknowledged its inspiration or shown trace of it in his work? Too much stress cannot be laid upon the need—apart from all religious considerations—of Bible-reading on the lines laid down by Richard Moulton in that admirable work "The Literary Study of the Bible."

Theology and Philosophy. The development of English rhetoric and English philosophic thought between the close of the fifteenth and the earlier part of the eighteenth century may be studied in the writings of HUGH LATIMER (b. 1485?; d. 1555), Bishop of Worcester, whose sermons well sustain the homely and direct character of his native tongue; JOHN KNOX (b. 1505; d. 1572), the Scottish reformer and historian; JOHN FOXE (b. 1516; d. 1587), whose "Actes and Monuments," commonly known as "Foxe's Book of Martyrs," "gave to the people of all over England a book which, by its simple style, the ease of its story-telling, and its popular charm, made the very peasants who heard it read feel what is meant by literature"; JOHN JEWEL (b. 1522; d. 1571), Bishop of Salisbury, a learned Protestant controversialist; RICHARD HOOKER (b. 1554?; d. 1600), author of "The Laws of Ecclesiasticall Politie," a great theologian whose memory is enshrined in "Walton's Lives," and whose character is fitly indicated on his monument at Bishopsbourne, Kent, as "judicious"; WILLIAM CHILLINGWORTH (b. 1602; d. 1644), a notable anti-Romanist; JOSEPH HALL (b. 1574; d. 1656), Bishop of Exeter and Norwich, one of the first of English satirists; JEREMY TAYLOR (b. 1613; d. 1667), Bishop of Down and Connor, the author of "Holy Living" and "Holy Dying," and a voluminous writer who, in the words of his friend Bishop Rust, of Dromore, "had the good humour of a gentleman, the eloquence of an orator, the fancy of a poet, the acuteness of a schoolman, the profoundness of a philosopher, the wisdom of a chancellor, the reason of an angel, and the piety of a saint"; THOMAS HOBBES (b. 1588; d. 1679), a philosopher who applied the principles of geometry to the judgment of human conduct, and who, in his "Leviathan," "De Cive," "Human Nature," and other works, showed himself to be "the first of all our prose writers whose style may be said to be uniform and correct and adapted carefully to the subjects on which he wrote"; THOMAS FULLER (b. 1608; d. 1661), the style of whose best-known work, "Worthies of England," shows admirable narrative faculty, "with a nervous brevity and point almost new to English, and a homely directness ever shrewd and never vulgar"; SIR THOMAS BROWNE (b. 1605; d. 1682), a Norwich physician and author of "Religio Medici," than whom, according to Mr. Edmund Gosse, "among English prose writers of the highest merit there are few who have more consciously, more successfully, aimed at the translation of temperament by style," and who "unquestionably tasted the divine pleasure of writing for its own sake"; JOHN BUNYAN (b. 1628; d. 1688), author of "The Pilgrim's Progress," a work as famous as "Robinson Crusoe," as fascinating in a narrative sense, and of perennial influence on the religious thought of the young of all nations; ISAAC BARROW (b. 1630; d. 1677), another eloquent preacher and controversialist (note especially his treatise on "The Pope's Supremacy"), and as a mathematician worthy to stand near his pupil ISAAC NEWTON (b. 1642; d. 1727); RICHARD BAXTER (b. 1615; d. 1691), whose life may be studied as an example of self-help by the side of Bunyan's, and the style of whose many writings "is one of the finest specimens of direct masculine English, and a model for all who wish to talk to people instead of at them"; JOHN TILLOTSON (b. 1630; d. 1694), perhaps the only primate who took first rank in his day as a preacher, but who "probably presents more examples than any other author of passages wherewith to exercise the skill of the student of English composition in weeding out their superfluous words and phrases"; JOHN LOCKE (b. 1632; d. 1704), author of "Two Treatises of Government," "An Essay concerning Toleration," "An Essay Concerning Human Understanding," a work especially to be commended to students on "The Conduct of the Understanding," and a philosopher who is spoken of as "the unquestioned founder of the analytic philosophy of mind"; and GILBERT BURNET (b. 1643; d. 1715), Bishop of Salisbury, and author of a "History of the Reformation" and a "History of My Own Times."

Regarded in this brief summary, the works of these theological writers may appear uninviting; but the general reader no less than the student cannot neglect them all without missing a fruitful part of the great and rich field of our national literature. Foxe's "Book of Martyrs," Taylor's "Holy Living" and "Holy Dying," Hobbes's "Leviathan," Fuller's "Worthies," Browne's "Religio Medici," Bunyan's "Pilgrim's Progress" and "The Holy War," Locke's "Human Understanding"—these especially, and others that we have named, are works of which every one who aspires to a sound appreciation of our literature should have first-hand knowledge; and just as we in early youth read Bunyan for the sheer pleasure of his narrative, so in manhood we may read the other religious and philosophical writers for their charm of style, their wisdom and humanity.

Prose of the Poets and Historians. Both Spenser and Shakespeare wrote prose. Spenser's "View of the Present State of Ireland" is written in a most pleasing style. Shakespeare's prose has been the theme of many commentators; see, for example, the admirable little manual of the late George L. Craik. The student is recommended to study the "men in buckram" section of "Henry IV." The "Arcadia" and the "Defense of Poesie" of Sir Philip Sidney (b. 1554; d. 1586) are also to be studied in this connection. The first popular English history in the language is "The History of England to the Time of Edward III." of the poet SAMUEL DANIEL (b. 1562; d. 1619). After Daniel's work may be considered the "History of the World," written in the Tower by SIR WALTER RALEIGH (b. 1552; d. 1618), and to be read for its human and personal interest more than on account of its intrinsic value as history. EDWARD HYDE, first Earl of Clarendon (b. 1609; d. 1674), friend of poets like Jonson and Waller, wrote a "History of the Rebellion." This was modelled on the style of the Roman historian Tacitus, and is specially notable for its biographical value. The "Life of Colonel Hutchinson," the Puritan, by his widow, LUCY HUTCHINSON (b. 1620), is one of the most delightful of biographies with a historical character for subject, and taken up as a study will be read through for the charm and simplicity of the narrative. To the domain of history and antiquarian study belong the writings of WILLIAM CAMDEN (b. 1551; d. 1623), JOHN SELDEN (b. 1584; d. 1654), JOHN STOW (b. 1525?; d. 1605), RAPHAEL HOLINSHED (b. about 1580), and WILLIAM HARRISON (b. 1534; d. 1593). Mention must also be made here of the invaluable Diaries of SAMUEL PEPYS (b. 1633; d. 1703) and JOHN EVELYN (b. 1620; d. 1706), and the Letters and other writings of JAMES HOWELL (b. 1594; d. 1666), and the exquisite epistles of DOROTHY OSBORNE (b. 1627; d. 1695), afterwards the wife of Sir WILLIAM TEMPLE (b. 1628; d. 1699), diplomatist and essayist.

The Beginning of the Essay. The meaning of the word essay is "a testing." As we understand it to-day, an essay is a valuation of a subject, usually of a literary or social nature, from the standpoint of the writer. The "Essays of Montaigne," the translation of which by JOHN FLORIO (b. 1553; d. 1625) preserves for us a vigorous and perennially delightful example of Elizabethan prose, hardly come within the limits of the essay as we understand the word. Shakespeare was evidently familiar with his Florio as he knew the translation of Plutarch's "Lives" by Sir THOMAS NORTH (b. 1535; d. 1601). The Elizabethan and Jacobean pamphlets were, in a sense, essays, but we see in them perhaps more distinctly the beginning of the modern newspaper, because they were published for controversial purposes. They form in themselves a somewhat absorbing branch of literary and historical study. A number of the writers of these pamphlets also wrote tales, so that while the "Euphues" of LYLY [see LITERATURE, page 594] is generally regarded as the earliest English novel, it is not quite isolated as an example of English prose narrative. Even if we leave Sidney's "Arcadia" out of the question, there are the tales as well as the pamphlets of ROBERT GREENE [see page 679]; THOMAS LODGE (b. 1558; d. 1625), whose "Rosalynde" inspired Shakespeare's "As you Like It"; and THOMAS NASH (b. 1567; d. 1601), whose "Jack Wilton" provided the prototype of Falstaff. Londoners who desire to learn how their predecessors lived three centuries ago will find a world of entertainment in "The Gull's Hornbook" of THOMAS DEKKER (b. 1570; d. 1637?). The more permanently interesting of all the pamphlets is the "Areopagitica," a trenchant plea for the liberty of the printing press, by JOHN MILTON (b. 1608; d. 1674).

The First English Essayist. The first of the English essayists is FRANCIS BACON (b. 1560; d. 1626). The student can have no better guide than is provided in the fiftieth of Bacon's "Essays"—the one entitled "Of Studies." We quote part of this as exemplifying Bacon's method and perspicuity of style:

"Studies serve for Delight, for Ornament, and for Ability. Their Chiefe Use for Delight, is in Privatenesse and Retiring; For Ornament, is in Discourse; And for Ability is in the Iudgement and Disposition of Businesse. For Expert Men can Execute, and perhaps Iudge of particulars, one by one. But the generall Counsels, and the Plots, and Marshalling of Affaires, come best from those that are *Learned*. To spend too much Time in *Studies*, is Sloth; To use them too much for Ornament, is Affectation; to make Iudgement wholly by their Rules is the Humour of a Scholler. They perfect Nature, and are perfected by Experience: For Naturall Abilities, are like Naturall Plants, that need Proyning by *Study:* And *Studies* themselves, doe give forth Directions too much at Large, except they be bounded in by experience. . . . Reade not to Contradict, and Confute; Nor to Beleeve and Take for granted; Nor to find Talke and Discourse; But to weigh and Consider. Some Bookes are to be Tasted, others to be Swallowed, and Some Few to be Chewed and Digested. That is, some *Bookes* are to be read onely in Parts; Others to be read but not Curiously; And some Few to be read wholly, and with Diligence and Attention. . . . . Reading maketh a Full Man; Conference a Ready Man; and Writing an Exact Man. . . . *Histories* make Men Wise; *Poets* Witty; *The Mathematiks* Subtill; *Naturell Philosophy* deepe; *Morall* Grave; *Logick* and *Rhetorick* Able to Contend."

The Prose of Ben Jonson. Of Bacon's Essays Hallam rightly declared that it "would be derogatory to any educated man to be unacquainted with them." Next to them we should place the "Discoveries" of BEN JONSON [see LITERATURE, pages 854-5], which Mr. Swinburne prefers before Bacon's Essays and Mr. Saintsbury describes as coming "in character as in time midway between Hooker and Dryden." Jonson's "Discoveries" have been too long neglected. A recent writer acutely says: "A comparison of the vocabulary of Sir Philip Sidney's 'Defense of Poesie' with that of the 'Discoveries,' written nearly sixty years later, will disclose a far larger number of words demanding explanation in the latter. On the other hand, a like comparison between the two works with reference to the structure of sentence and paragraph will exhibit a form and symmetry, a sense of order and proportion, and a consciousness of the demands of literary presentment in the 'Discoveries' for which we may look in vain in the somewhat loosely-strung periods and formless paragraphs of the 'Defense.' This contrast, as Prof. Schelling, the first adequately to edit the 'Discoveries,' points out, becomes the more startling when we remember that Sidney's work is characterised by a logical sequence and continuity of thought, and that Jonson's is more or less of a commonplace book containing, as he himself says, 'discoveries' made upon men and matter, as they flowed out of his daily readings, or had their reflux to his peculiar notions of the times." Here is a brief extract from Jonson's tribute to the eloquence of Bacon. It is largely an adaptation from Seneca on an Augustan orator:

Ben Jonson's Praise of Bacon. "There happened in my time one noble speaker who was full of gravity in his speaking; his language, where he could spare or pass by a jest, was nobly censorious. No man ever spoke more neatly, more presly (concisely), more weightily, or suffered less emptiness, less idleness, in what he uttered. No member of his speech but consisted of his own graces. His hearers could not cough or look aside from him, without loss. He commanded where he spoke, and had his judges angry and pleased at his devotion (disposal). No man had their affections more in his power. The fear of every man that heard him was lest he should make an end."

Lowell has applied this passage to Emerson. There is a great deal in Jonson's "Discoveries" concerning education and study that will generously reward the most careful attention. After Jonson, considered as an essayist, come ABRAHAM COWLEY (b. 1618; d. 1667), whose language is at once simple and graceful, and SIR WILLIAM TEMPLE (b. 1628; d. 1699), distinctly a predecessor of Addison.

It is difficult to classify the "Anatomy of Melancholy" of ROBERT BURTON (b. 1577; d. 1640), but Johnson greatly admired it, and it is full of quaint and curious learning. The "Microcosmographie" of JOHN EARLE, Bishop of Salisbury (b. 1601; d. 1665), is at once of social and philosophical value, but stands, like the "Anatomy," by itself. Three other books that demand notice are the "Lives" and "Compleat Angler" of IZAAK WALTON (b. 1593; d. 1683), the first a gem of literary biography, the second one of the first of "country books"; and the "Autobiography" of LORD HERBERT of CHERBURY (b. 1581; d. 1648), which Mr. Swinburne has placed among "the hundred best books."

Criticism. The place of honour as the first of English critics belongs to JOHN DRYDEN [see LITERATURE, pages 976-7]. In the words of Lowell, Dryden, more than any other single writer, contributed, as well by precept as example, to free English prose from "the cloister of pedantry," and by his masterly handling to give it "suppleness of movement and the easier air of the modern world."

"His style," Lowell continues, "has the familiar dignity so hard to attain, perhaps unattainable except by one who feels that his own position is assured. Swift was as idiomatic, but not so elevated; Burke more splendid, but not so equally luminous. That his style was no easy acquisition, though, of course, the aptitude was innate, he himself tells us, when he tells us that the Court, the College, and the Town must be joined in the perfect knowledge of a tongue. 'The proprieties and delicacies of the English are known to few; it is impossible for a good wit to understand and practise them without the help of a liberal education, long reading, and digesting of those few good authors we have amongst us, the knowledge of men and manners, the freedom of habitudes and conversation with the best company of both sexes, and, in short, without wearing off the rust which he contracted while he was laying a stock of learning.'"

The introductions to Dryden's works are specially worthy of study. The famous "Essay on Dramatic Poesy" has already been commended. Nearly the whole of Dryden's criticisms will be found edited by Prof. W. P. Ker in his "Essays of John Dryden."

J. A. HAMMERTON

The Poor Law Service as a Career. Doctors and Nurses in Hospitals and Asylums.

POOR LAW DOCTORS AND NURSES

With a single exception, our survey of the municipal service is now complete. Hitherto we have been concerned mainly with the general duties of local government. We have now to consider the machinery that exists throughout the country for maintaining the destitute poor, and for tending the sick and insane among them. This work is performed, for the most part, by local boards of guardians, but the maintenance of hospitals and asylums for the poor is often entrusted to special and more powerful authorities, in which the Poor Law guardians are duly represented. The boards of guardians have no direct relation with county or borough councils, and are entrusted with no such general powers. They are elective bodies of a quite special class, charged with only a single function—the administration of Poor Law relief.

The guardians of the poor, indeed, are the unpaid official almoners of the nation's charitable doles to those of its population whom adverse conditions prevent from supporting themselves. Under the strict direction of the Local Government Board, the funds raised for this purpose by means of the Poor Rate are administered by the guardians through the agency of a large staff of officers of various grades.

Indoor and Out Relief. The help thus rendered to the poor is of two classes. Outdoor relief, in the form of weekly grants of money, food, firing, and free medical aid, is sometimes granted in cases of temporary want, and is also given under certain conditions to enable the widowed, aged, and infirm to keep the grim wolf Hunger from their doors. For the rest of the sad army of poverty there is the system of indoor relief, comprising various institutions in which the destitute are housed and cared for. In addition to the workhouses, they include cottage homes and schools for the children, infirmaries for the sick, asylums for the insane, and casual wards as purely temporary shelters. This main distinction between indoor and outdoor relief runs through all Poor Law matters; and, as we shall see, it affords a convenient means of classifying the various members of the staff employed by the guardans.

The Problem of Relief. The developments of the past few years have awakened unusual interest in the problems of pauperism, and every thoughtful reader must have reflected on the grave responsibilities with which the guardians of the poor are entrusted, and the heavy cost of the pauper to the State. The growth of the Poor Rate, the classification of workhouse inmates, Poor Law labour colonies, the treatment of tramps, the wisdom or unwisdom of extensive out-relief—such aspects of this great national question are constantly under debate in the public Press. To discuss them here would be idle. But it will help us to grasp the great importance of the Poor Law service if we consider the latest official returns of pauperism.

These show 298,877 indoor and 499,020 outdoor cases receiving relief in England and Wales, which gives a total of 797,897 persons (including approximately a quarter of a million children) maintained at the public expense. During the last recorded year their cost amounted to over fifteen millions sterling!

The Service as a Career. Let us turn from more general considerations to discuss the aspect of the Poor Law service in which we are specially interested—namely, the prospects it affords as a career.

Excepting always the medical and nursing section, it must be admitted that the inducements to engage in this branch of municipal work, for men and women of real ability and ambition, are somewhat scanty. The service, as a whole, suffers from lack of organisation and system. There are no education tests prescribed for candidates on entrance, and few suitable qualifications by means of which an energetic subordinate officer may demonstrate his fitness for advancement. Many efficient officers remain for weary years, not only without promotion, but without even the smallest advance of salary to reward ability or encourage endeavour. Further, while posts of distinctly inferior grade are properly remunerated, there are few appointments of intermediate worth, and still fewer really valuable prizes. The popular outcry against the burden of the Poor Rate tends to keep stipends small; and the general level of salaries for clerical and executive work under the guardians is certainly lower than that prevailing under the local councils.

An Expert's Views. In connection with this matter, it should be mentioned that a powerful voluntary organisation exists in the service, under the title of the National Poor Law Officers' Association, for the dual purpose of increasing the efficiency of officials and of improving their status. A former President, Dr. James Milward, of Cardiff, has expressed himself so justly and wisely on the prospects of the Poor Law service that his remarks are worthy of quotation.

"It will, I think, readily be admitted," said Dr. Milward, "by most people who have had much practical experience of the Poor Law, that its great fault is that it stands almost or quite alone among the branches of the public service in not providing a career for its members. In our Civil Service generally the prospect of promotion is active in stimulating the official to do his duty—and a little more. Unfortunately, here there is no such motive. No matter how able, zealous, or efficient an officer may be, he rarely passes from one grade to a higher. There are no prizes in his profession."

Uninviting Prospects. That the state of things thus sketched calls for an effective remodelling of the Poor Law system is hardly to be denied. The aims of the Association in the direction of reform are thus summarised by the authority already quoted: "We have still before us the two great problems of the training and promotion of officers, with all that those problems involve. First comes the question of the examination of the candidates for the various branches of the service. Instead of adult applicants for posts relying on their own persuasive powers or the influence of friends, they should qualify themselves, as in other branches of the public service, by examination when young; and, entering the service at the bottom, should learn their business in subordinate offices, and rise according to their abilities, with salaries graduated according to their posts and the length of their service."

There are indications that some such reorganisation as is here depicted may be expected in the future, though it is as yet too early to attempt a precise forecast. The powerful Royal Commission on the Poor Law, which issued its report in 1909, made sweeping recommendations for remodelling the whole system of relief, and for placing the Poor Law service on a more satisfactory footing. And though experts regard it as unlikely that any such complete reorganisation will be effected by statute for some years to come, improvements in the service are constantly being effected meanwhile by means of Local Government Board orders. Further, a Poor Law Examinations Board, constituted in 1910, holds examinations annually for relieving officers and for workhouse officers. In this way the Board has laid the foundations of a new and important system; the value of its certificates is becoming more widely recognised every year, and ultimately these tests may become compulsory for the higher branches of the Poor Law service.

Humanising the Poor Law. Prospective candidates must not overlook the fact that an officer of the guardians works under conditions which to a sensitive nature are depressing or painful. He is brought into daily contact with the direst poverty, and all its attendant miseries of dirt, disease, and vice. To a humane public servant, however, this very circumstance gives his work among the obscure poor its greatest dignity and worth. It offers countless occasions for helping the helpless and befriending those who sorely need a friend. In the case of applicants for relief or maintenance, the relieving officer is charged with the duty of fully investigating their circumstances and character before their request is submitted; and, in deciding the nature and extent of the aid to be offered, the board is necessarily guided in the main by that official's report. Similarly, the fortunes of the appeals of workhouse inmates for special leave in search of work, indulgences in the matter of diet, and other privileges are largely determined by the views of the guardians' clerk and the master or matron of the house. These instances will show what responsibility and power the Poor Law officer possesses, and what scope his work affords for patience, conscientiousness, and humanity. In this connection it is noteworthy that a leading municipal authority, whose opinion the present writer sought as to the most useful branch of Local Government work, replied as follows: "For a career of sheer usefulness and service, as distinguished from high monetary reward, I regard the administration of the Poor Law as foremost, and would specially mention the valuable work of the nurses in our infirmaries and hospitals for the pauper classes."

How we have Improved. How vastly official methods of treating pauperism have progressed since the days when the "sturdy beggar" was whipped, branded, and enslaved, readers will scarcely need to be reminded. The records of Exeter workhouse show that two centuries ago the task of "performing cures on wounds and sores" on the hapless inmates was entrusted to the tender mercies of—the beadle! The strides made during even the last fifty years or so toward a humaner method can best be realised, perhaps, by comparing a modern workhouse with that described in "Oliver Twist." Yet much still remains for individual effort to accomplish in the humanising of the Poor Law.

A single instance, selected almost haphazard from among many such, will serve to illustrate the possibilities of kindly service awaiting the humane official. The introduction into Hull workhouse of the "Brabazon" system of skilled work, which has added a new pleasure and interest in life to many of the unhappy inmates, was due in the first instance to the consideration of the master and matron. To be able to soften in ways like this the operation of a Poor Law system, which in itself is apt to be hard and grim, is a prospect which might have tempted St. Francis of Assisi to become a guardians' officer.

Service Pensions. Under the Superannuation Act of 1896, servants of the guardians, in return for a deduction which in the case of new appointments is two per cent. of their pay, are entitled to resign on two-thirds salary after forty years' service, or on a smaller proportion if invalided earlier. Female nurses and attendants may join the scheme or not, as they please, but with all other officers the system is compulsory.

Hospitals and Asylums. The Poor Law infirmary or hospital is on practically the same footing, in respect of its administration, as the asylum for pauper lunatics and imbeciles. These two classes of institution may therefore be considered together. In discussing them we may adopt the convenient method (already followed more than once in this course) of selecting a leading and typical authority and commenting on such differences in the conditions of employment as distinguish it from less important bodies.

Metropolitan Asylums Board. In its Poor Law administration, as in so much else, London affords us the most striking instance of this class. The Metropolitan Asylums Board, popularly known as the "M.A.B.," was created by the Metropolitan Poor Act of 1867 to furnish proper provision for the imbecile poor, and for others who were stricken with fever or smallpox. It now owns 10 great fever hospitals, 3 others for smallpox, a motor and steamship ambulance service for the removal of patients, 6 institutions for the mentally defective, 2 large hospitals and 5 schools and homes for sick children, a training ship for boys, the 21 metropolitan casual wards, and 2 sanatoria for consumptives under the National Insurance Act. These are controlled by 73 managers, 55 of whom are elected by the London boards of guardians, the remainder being nominated by the Local Government Board.

A SCENE IN A WORKHOUSE INFIRMARY

Through the courtesy of the clerk, Mr. T. Duncombe Mann, we are furnished with authoritative particulars as to the staff of this great Poor Law association. In respect of medical appointments, the following details are given:

Infectious Hospitals. There are 11 medical superintendents at £400 a year, rising £25 annually to £700, all with unfurnished houses, and some receiving extra remuneration for acting as clinical instructors to medical students. These officers are in supreme control, and their duties are therefore very wide-reaching. About 50 assistant medical officers are employed in two grades. Those in Class I receive £280 the first year, and afterwards £300 per annum; while for Class II the scale of pay is £180, rising £20 annually to £240—all with board, lodging, and washing. Among the assistant officers about fourteen vacancies occur every year.

Imbecile Asylums. Medical superintendents receive £600, rising £50 yearly to £800, with unfurnished houses. Their staff of 14 medical assistants comprises three classes of appointment. The scale of pay in the first class is £300 to £360; in the second, £210 to £250; and in the third, £180 to £200. All assistants receive board, lodging, and washing in addition to their pay.

The medical officers of workhouse infirmaries are less liberally remunerated. Where several resident doctors are required—as in the larger London unions—the senior officer may receive between £350 and £450 a year, and his assistants from £120 to £250 or £300, according to their grade. But there is no uniformity in the rates of pay offered by the guardians, and in country areas the scale is often lower.

District Medical Officer. In order to make complete our survey of medical appointments in the Poor Law service, it is necessary to refer to the district medical officer, better known among his patients as the "parish doctor." This is a non-resident post, the local practitioner who holds it being required, in return for a fixed salary paid him by the guardians, to furnish the poor of his district with medical treatment and drugs. Extra fees are prescribed by the Local Government Board for certain operations, and there may be special charges made for childbirth cases, and for cod-liver oil and similar medicines supplied. The remuneration paid is never very considerable, varying from a purely nominal sum to £150 or so yearly. But many a struggling young medical man finds his sheet-anchor in the £80 or £100 a year he receives as parish doctor; and even more flourishing practitioners do not disdain such an addition to their incomes. This official, however, is now yielding ground to the "panel doctor"—the medical officer provided for insured persons by the National Insurance Act of 1911—and the earnings of the "parish doctor" will inevitably diminish still further in the future.

Matrons and Nurses. The responsible officer in charge of the nursing and household establishment in Poor Law hospitals and asylums is the matron. Her post is generally admitted to be an arduous and an anxious one. With or without the aid of an assistant, she is required to superintend the work of her staff of nurses, to train the probationers, and, while thus attending to the professional side of her duties, to secure the smooth working of the whole institution by