Three out of five numbers of the Records of the Indian Museum, recently to hand, contain articles on biting flies and gnats. In the first of these, vol. iv., No. 1, Mr. F. V. Theobald describes certain new genera and species of Culicidæ, typified by specimens in the Indian Museum. It is stated, however, that in the case of the Culices with banded proboscis, some at least of the determinations must be regarded as provisional, since certainty cannot be attained until both sexes have been bred in captivity and the generative organs of the males and the larvæ carefully examined. In No. 3 of the same volume Mr. E. Brunetti records a protest against what he considers unnecessary subdivision and splitting in the Culicidæ, remarking that specialists in the Diptera must regard the present state of affairs as absurd, and that Prof. Williston appears to be the only systematic dipterologist who has attempted to stem the tide. The plea of the unwieldiness of big genera cannot be upheld, it is added, since the systematist is quite accustomed to such genera: a similar protest, it may be mentioned, seems called for in the case of the excessive generic splitting now in vogue in the squirrel and mice family. Mr. Brunetti concludes by stating that the subject will be more fully discussed in the supplement to the catalogue on which he is now engaged.

An article forming part ii. of the fourth volume, by Dr. Annandale, on Indian sand-flies (Phlebotomus), will be read with interest, since not only are these minute insects some of the greatest torments to Europeans in India, but, as may be inferred from the investigations made on their south European representatives, it is practically certain that they are also carriers of certain types of fever.

Finally, in the fourth and last part of vol. iv., Mr. Brunetti publishes a systematic revision of the Oriental blood-sucking flies of the family Muscidæ, with the description of a new genus.

From among a dozen articles in the first and second parts of the fifth volume of the Records, it must suffice to direct attention to one by Dr. R. E. Lloyd, on variation in Indian rats. In a previous paper the author has adduced evidence in favour of discontinuous variation having played a prominent part in the production of races. Individual rats from any particular towns, for instance, sometimes show more or less marked differences from their fellows, and the evidence they afford for discontinuous evolution lies in the manner in which these are distributed among the multitude of whole-coloured specimens. In the present paper it is stated that, among the thousands of normally coloured rats infesting Poona, there is found a colony of about one hundred individuals characterised by the presence of a white breast-patch, these having apparently originated in the city itself. Again, it was found that the rats of Naini Tal differ from the normal type of plains-rat by their shorter tails, longer and greyer fur, and a more or less well-defined white breast-patch. Some rats in the district differ, however, from this type by the under side of the tail being white. Accordingly, we find that in a single limited area there live, under apparently similar conditions, two phases of a widely distributed species, differing from one another solely in one obvious feature, these two phases living apart from each other. Obviously, any explanation as to the origin of the white-tailed phase will apply equally to the case of the white-breasted Poona rats, and the author concludes by endeavouring to explain each instance by the light of the theory of gametic factors. R. L.

THE BRITISH ASSOCIATION AT SHEFFIELD.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. W. E. DALBY, M.A., M.INST.C.E., PRESIDENT OF THE SECTION.

British Railways: Some Facts and a Few Problems.

IT is remarkable how few among us really realise the large part that railways play in our national life. How many of us realise that the capital invested in the railway companies of the United Kingdom is nearly twice the amount of the national debt; that the gross income of the railway companies is within measurable distance of the national income; that to produce this income every inhabitant of the British Islands would have to pay annually 3*l.* per head; that they employ more than six hundred thousand people; and that about eight million tons of coal are burnt annually in the fire-boxes of their locomotives? I hope to place before you in the short time which can be devoted to a presidential address a few facts concerning this great asset of our national life and some problems connected with the recent developments of railway working—problems brought into existence by the steady progress of scientific discovery and the endeavour to apply the new discoveries to improve the service and to increase the comfort of the travelling public.

A great deal of interesting information is to be found in the Railway Returns issued by the Board of Trade. I have plotted some of the figures given, in order to show generally the progress which has been made through the years, and at the same time to exhibit the rates of change of various quantities in comparison with one another.

Consider, in the first place, what the railways have cost the nation. This is represented financially at any instant by the paid-up capital of the companies. The total paid-up capital in 1850 was 240 millions sterling. In 1908 this amount had increased to 1310 millions. The curve marked "Total" in Fig. 1 shows the total paid-up capital plotted against the year. It will be noticed that

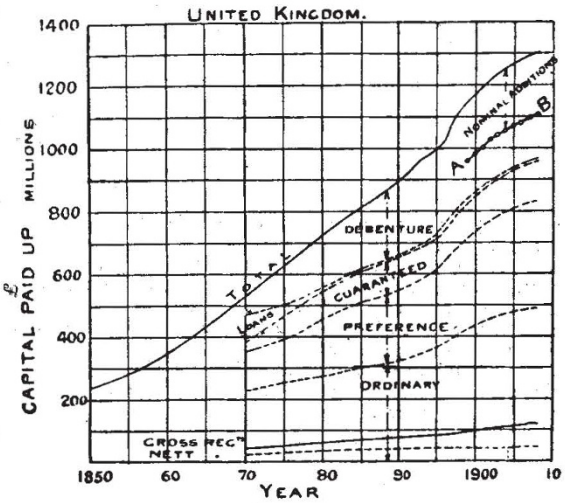

FIG. 1.

the increase per annum is remarkably regular up to about 1896, and is at the rate of not quite 100 millions per annum. After this date the capital increases at a somewhat greater rate, but in 1900 the rate drops with a tendency to a gradually decreasing value. Part of the increase immediately after 1896 is, however, due to nominal additions to the capital. The extent to which this process of watering the stock has been carried is indicated over the period 1898 to 1908 by the curve AB. In the year 1908 the nominal additions to capital amounted to 196 millions of pounds.

Curves are also plotted showing the amounts of the different kinds of stock making up the total. It will be noticed that the ordinary stock is a little more than one-third of the total paid-up capital in 1908, viz. 38 per cent. In 1870 it was about 43 per cent.

The lower curve on the diagram shows the gross receipts, which amounted to 120 millions of pounds in 1908. The dotted line indicates the net revenue after deducting from the total receipts the working expenditure. This, for 1908, was 43½ millions, corresponding to 3·32 per cent. of the total paid-up capital. If the net receipts are reckoned as a percentage of the paid-up capital after deducting the nominal additions, the return is increased to 3·9 per cent. These figures practically represent the average dividend reckoned in the two ways for the year 1908.

Fig. 2 shows by the upper curve the number of miles open for traffic plotted against the year. This curve indicates great activity of construction during the period 1850 to 1870, with a regular but gradually decreasing addition of mileage from year to year afterwards.

At the end of 1908 there were 23,205 miles open, corresponding to 53,669 miles of single track, including sidings. Of this, 85 per cent. was standard 4 feet 8½ inches gauge, 12·3 per cent. 5 feet 3 inches, and 2·2 per cent. 3 feet gauge. The remainder was made up of small mileages of 1 foot 11½ inches, 2 feet 3 inches, 2 feet 4 inches, 2 feet 4½ inches, 2 feet, 2 feet 9 inches, 4 feet, and 4 feet 6 inches gauges.

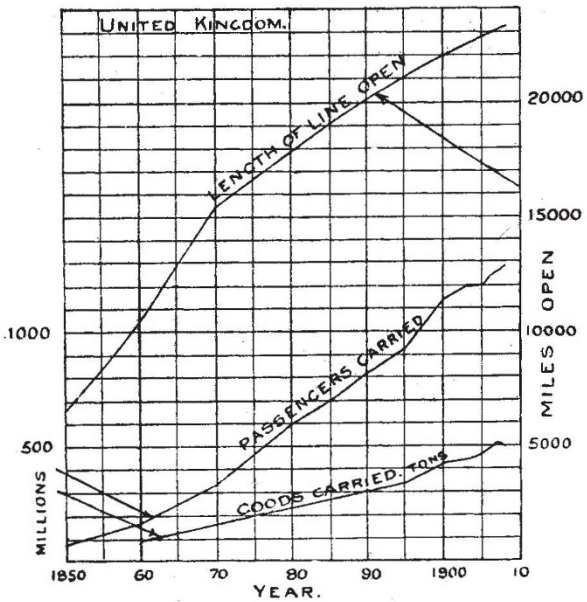

FIG. 2.

The two lower lines of the diagram show, respectively, the number of passengers carried and the tons of goods carried from year to year.

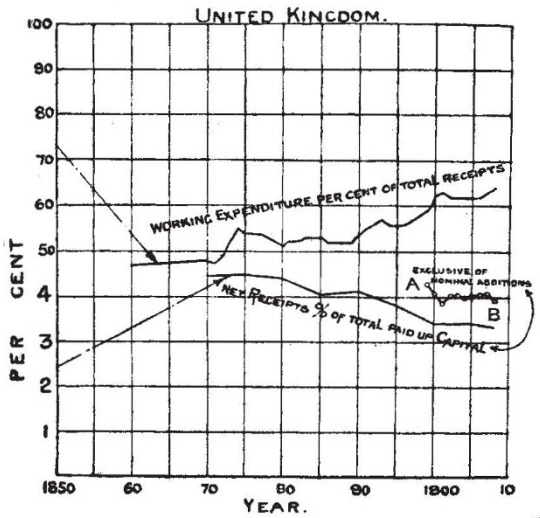

FIG. 3.

The curves of mileage, passengers carried, and goods carried increase regularly with the increase of capital, indicating that up to the present time the possibility of remunerative return on capital invested in railway enterprise in this country is not exhausted. It is true that there is a maximum of goods carried in the year 1907; but the sudden drop in the curve between the years 1907 and 1908 suggests that the drop is only of a temporary character, and there is every reason to believe that the curve will resume its upward tendency with time. In 1908 the railways of the United Kingdom carried 1278 millions of passengers, exclusive of season-ticket holders, and 491 million tons of goods; the quantity of goods carried in 1907 was nearly 515 millions of tons. It is curious that, very approximately, the companies carry per annum one passenger and about 0·4 ton of goods for every pound sterling of paid-up capital.

The proportion of the gross receipts absorbed in carrying out this service is shown by the upper curve of Fig. 3. The proportion has increased, on the whole regularly, from 47 per cent. in 1860 to 64 per cent. in 1908.

The lower curve shows the net receipts as a percentage of the paid-up capital. From 1899 onwards the curve AB shows the net receipts reckoned on the paid-up capital exclusive of the nominal additions. It will be observed that the net receipts have not declined more than half a per cent. since 1870, notwithstanding the increase in working expenditure.

Fig. 4 indicates the cost of working the traffic calculated in terms of the train-mile, no data being available regarding the actual work done as represented by the ton-mile or the passenger-mile. In some respects the train-mile is the fairest way of comparing costs, because when a train is running, whether it is full or empty, the same service must be performed by the majority of the departments.

Cost of Working per Train-mile of Railways in England and Wales.

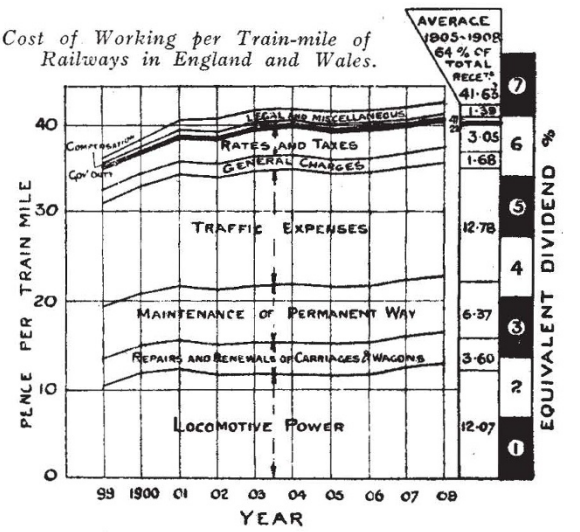

FIG. 4.

The curves bring out clearly that the proportion of the total expenditure per train-mile absorbed by these several services remains fairly constant over a series of years. To the right is exhibited the average for the four years 1905 to 1908. The figures are also reproduced in the following table :—

TABLE I.

Average Working Costs per Train-mile of the Railways in England and Wales taken over the Years 1905 to 1908.

	Pence per train-mile.
Locomotive power	12·07
Repairs and renewals of carriages and waggons	3·60
Maintenance of permanent-way	6·37
Traffic expenses	12·78
General charges	1·68
Rates and taxes	3·05
Government duty	0·22
Compensation	0·47
Legal and miscellaneous	1·39
Total	41·63

Locomotive power absorbs an amount about equal to the traffic expenses; and companies actually pay in rates and taxes a sum nearly equal to the whole amount required to maintain the rolling-stock in an efficient state.

To the right is shown a scale, the divisions of which represent an amount estimated in pence per train-mile corresponding to 1 per cent. of the average dividend. This shows that if the whole of the locomotive power could be obtained for nothing, the average dividend would only be increased by 1¾ per cent. Reckoned on the ordinary stock alone, however, the increase would be about three times this amount.

It may be of interest at this stage to compare the financial position and the cost of the working of railways in their earlier days with the state of things now. For this purpose the position of the old London and Birmingham Railway is compared with the position of the London and North-Western Railway, the system into which it has grown. The years selected are 1840 and 1908.

I have taken out the cost per mile of working the traffic of the London and Birmingham Railway from some accounts given in Winshaw's "Railways." The details are grouped somewhat differently in the list just given, but in the main the various items may be compared.

The number of train-miles on the London and Birmingham Railway recorded for the year January to December, 1839, is 714,998. The accounts given are for the year June, 1839, to June, 1840. The mileage record is thus not strictly comparable with the expense account, but it may be regarded as covering the same period with sufficient accuracy for our purpose.

The costs work out as follows:—

TABLE II.

Cost per Train-mile for the Year ending June, 1840, London and Birmingham Railway.

	Pence per mile.
Locomotive power	23·2
Maintenance of way	27·2
Traffic expenses, including repairs to waggons	25·9
General charges, including legal charges ...	4·5
Rates and taxes...	4·5
Government duty	7·65
Accident account	0·35
Total	93·30

The receipts amounted to 231*d.* per train-mile. Hence the working expenditure was 40 per cent. of the gross receipts.

The gross receipts for the year ending June 30, 1840, were 687,104*l.*, which, after deducting charges for loans, rents, and depreciation of locomotives, carriages, and waggons, enabled a dividend of 9¼ per cent. to be paid on the ordinary stock.

There are two noteworthy facts in these old accounts. First, the allowance for depreciation on the rolling-stock of nearly 4 per cent. of the receipts. Secondly, the fact that the cost of working the traffic is given per ton-mile. This method of estimating the cost of working has gradually fallen into desuetude on British railways. One company only at the present time records ton-mile statistics. Quite recently (in 1909) the committee appointed by the Board of Trade to make inquiries with reference to the form and scope of the accounts and statistical returns rendered by the railway companies under the Railway Regulation Acts have had the question of ton-mile and passenger-mile statistics under consideration. There was considerable difference of opinion concerning the matter, and in the end the committee did not recommend that the return of ton-mile and passenger-mile statistics should be made compulsory on the railway companies.

Returning to the London and Birmingham Railway accounts, the actual figures given by Mr. Bury, the locomotive engineer, were, for the year ending December, 1839:—

Passenger Trains.—Ton-miles, 21,159,796, giving an average of 542,533 ton-miles per engine at 0·86 lb. of coke per ton-mile costing 0·17*d.*

Goods Trains.—17,527,439 ton-miles, giving an average of 584,247 per engine at 0·57 lb. of coke per ton-mile costing 0·11*d.* per ton-mile.

Table III. shows various amounts and quantities in comparison with one another. Beneath the actual figures are placed proportional figures, the London and Birmingham item being in every case denoted by unity.

TABLE III.

Comparison of Capital, Receipts, Miles Open, Train-miles, and Cost of Working between the London and Birmingham Railway for the Year ending June, 1840, and the London and North-Western Railway for the Year ending December, 1908.

	Stock and Share Capital.		Loans and Debentures.		Total.	Gross Receipts.
	£	Interest per cent.	£	Interest per cent.	£	£
L. & B. Ry., 1840	3,125,000	9¾	2,125,900	4⅝	5,250,000	687,000
L. & N. W. Ry., 1908	85,861,760	5 app. average on all types of stock.	39,175,374	3 average.	125,037,134	15,515,334
L. & B. Ry., 1840	1		1		1	1
L. & N. W. Ry., 1908	27·5		18·4		24	22·6

	Miles Open in Equivalent Single Track.	Train-miles Run.	Receipts per Train-mile.	Cost of Working per Train-mile.	Expenditure to Gross Receipts per cent.
L. & B. Ry., 1840	250	714,998	231 pence	93 pence	40
L. & N. W. Ry., 1908	5,406	48,732,644	76½ ,,	50 ,,	65
L. & B. Ry., 1840	1	1	1	1	1
L. & N. W. Ry., 1908	21·6	68·3	0·33	0·54	1·62

The comparison brings out some curious facts. For instance, it will be noticed that the gross receipts of the London and North-Western Railway in 1908 were twenty-two and a half times as much as those of the London and Birmingham Railway in 1840, and that the track mileage open was about twenty-two times as great. The money earned per mile of track open is thus practically the same after a lapse of seventy years. To earn the same amount per mile of track open, however, the trains of the London and North-Western Railway had in 1908 to run 68·3 times the number of train-miles that the trains of the London and Birmingham Railway ran in 1840. That is to say, in order to earn a sovereign a London and North-Western train has now to run three times the distance which it was necessary for a London and Birmingham train to run to earn the same amount.

Another point to notice is that although the mileage and the receipts per mile of track open have each increased in the same proportion, yet the capital has increased at a greater rate, being on the total amount twenty-four times as much as in 1840, and the stock and share capital has increased twenty-eight times. So that with the necessity of running three times the train-mileage to obtain the same return per mile of track open, there runs the obligation to pay interest on an ordinary stock which has been increased in a greater proportion than the mileage and in a greater proportion than the earning power of the line. Lower dividends are therefore inevitable. The cost of working per train-mile has decreased gradually to about half its value in 1840, but, at the same time, the receipts per train-mile have dwindled to one-third of the amount in 1840.

These figures show that a more conservative system of financing the railways might have been adopted in the earlier days with advantage. If, when the receipts per

train-mile were larger, a proportion of the revenue had been used annually for the construction of new works and for the provision of new rolling-stock, instead of raising fresh capital for everything in the nature of an addition to the railway, the companies would to-day have been in a position to regard with equanimity the increasing cost of working.

It is too late in the day to recover such a strong financial position, but even now on many lines a larger proportion of the revenue could be sunk in the line with great ultimate advantage to the financial position.

The Problem of the Locomotive Department.

During the last twenty years the demand on the locomotive has steadily increased. The demand has been met, though with increasing difficulty, owing to the constructive limitations imposed by the gauge. The transference of a train from one place to another requires that work should be done continuously by the locomotive against the tractive resistance. The size of the locomotive is determined by the rate at which this work is to be done. If T represents the tractive resistance at any instant, and V the speed of the train, then the rate at which work is done is expressed by the product TV. The pull exerted by the locomotive must never be less than the resistance of the whole train considered as a dead load on the worst gradient and curve combination on the road, and it can never be greater than about one-quarter of the total weight on the coupled wheels of the engine.

Again, the tractive pull of the engine may be analysed into two parts—one the pull exerted to increase the speed of the train, the other the pull required to maintain the speed when once it has been reached. For an express train the number of seconds required to attain the journey speed is so small a fraction of the total time interval between the stops that the question of acceleration is not one of much importance. But for a local service where stops are frequent the time required to attain the journey speed from rest is so large a fraction of the time between stops that this consideration dominates the design of the locomotive, and, in fact, makes it desirable to substitute the electric motor for the locomotive in many cases.

An accurate estimate of the rate at which work must be done to run a stated service can only be made if there are given the weight of the vehicles in the train, the weight of the engine, the kind of stock composing the train, the speed and acceleration required at each point of the journey and a section of the road; and, in addition to this, allowance must be made for weather conditions.

A general idea of the problem can, however, be obtained by omitting the consideration of acceleration, gradients, and the unknown factor of weather conditions, considering only the rate at which work must be done to draw a given load at a given speed on the level. Even thus simplified the problem can be solved only approximately, because, although the tractive resistance of a train as a whole is a function of the speed, the tractive resistance per ton of load of the vehicles and per ton of load of the engine differ both in absolute value and in their rates of change for a stated speed, and, further, the ratio between the weight of the vehicles and the weight of the engine is a very variable quantity.

For our purpose, however, it will be sufficiently accurate to assume that the resistance of the whole train, expressed in pounds per ton, is given by the formula

$$T = 5\tfrac{1}{3} + \frac{V^2}{256}.$$

It follows that the horse-power which must be developed at the driving-wheels to maintain a speed of V miles per hour on the level with a train weighing W tons is

$$HP = W\left\{\frac{V}{70} + \frac{V^3}{96{,}000}\right\}$$

Fig. 5 shows curves of horse-power plotted from this equation for various weights of train. From this diagram a glimpse of the problem confronting locomotive engineers at the present day can readily be obtained.

To illustrate the point, consider the case of the Scotch express on the West Coast route.[1] This is an historic service, and goes away back to 1844, in which year the first train left Euston for Carlisle, travelling by way of Rugby, Leicester, York, and Newcastle, and occupying 15¼ hours. It was not until 1847, however, that there was a through service to Edinburgh *via* Berwick.

In September, 1848, the West Coast service for Edinburgh was established by way of Birmingham and Carlisle, the timing being 8 hours 55 minutes to Carlisle, and 12 hours to Edinburgh.

In September, 1863, the starting time from Euston was fixed at 10 a.m., and in 1875 the train ran *via* the Trent Valley between Rugby and Stafford, thus cutting out Birmingham and shortening the journey to Carlisle from 309 miles to 299 miles, the timing being 7 hours 42 minutes to Carlisle, and 10 hours and 25 minutes to Edinburgh. The speed has gradually been increased, and in 1905 the timing was 5 hours 54 minutes to Carlisle, and 8¼ hours to Edinburgh. Now the timing is 5 hours 48 minutes to Carlisle, but is still 8¼ hours to Edinburgh.

Three specific examples are plotted on the diagram, showing the power requirements in 1864, 1885, and 1903 for this train. Typical trains in 1864, 1885, and 1903 weighed, including engine and tender, 100 tons, 250 tons, and 450 tons respectively. The average speeds were thirty-

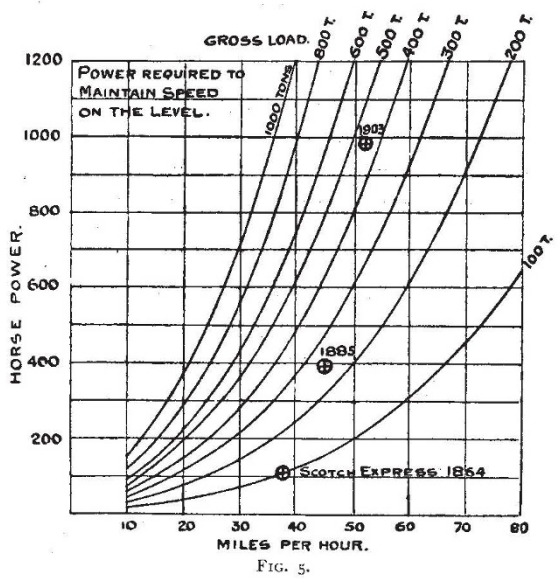

FIG. 5.

eight, forty-five, and fifty-two miles per hour respectively. A glance at the diagram will show that the power required to work this train was about 100 horse-power in 1864, 400 horse-power in 1885, and 1000 horse-power in 1903.

It must not be supposed that the increase in the weight of the train means a proportionate increase in the paying load. Far from it. On a particular day in 1903, when the total weight of the Scotch express was 450 tons approximately, the weight of the vehicles was about 346 tons. There were two dining-cars on the train, and the seating accommodation, exclusive of the seats in the dining-cars, was for 247 passengers, giving an average of 1·4 tons of dead load to be hauled by the engine per passenger, assuming the train to be full. In the days before corridor stock and dining-cars were invented the dead load to be hauled was about a quarter of a ton per passenger for a full train.

In a particular boat special, consisting of two first-class saloons, one second- and third-class vehicles, one first-class dining-car, one second and third-class dining-car, one kitchen-car, and two brake-vans, seating accommodation was provided, exclusive of the dining-cars, for 104 passengers, and the dead load to be hauled averaged 2·72

[1] I am indebted to Mr. Bowen Cooke for particulars of the Scotch Express Service.

tons per passenger. Notwithstanding this increase in the dead load of luxurious accommodation, the fares are now less than in former days on corresponding services. Similar developments have taken place in almost every important service, and new express services are all characterised by heavy trains and high speeds.

Characteristic Energy-curves of Steam Locomotives.

This steadily increasing demand for power necessarily directs attention to the problem, What is the maximum power which can be obtained from a locomotive within the limits of the construction-gauge obtaining on British railways? The answer to this can be found without much ambiguity from a diagram which I have devised, consisting of a set of typical characteristic energy-curves to represent the transference and transformation of energy in a steam locomotive, an example of which is given in Fig. 6. While examining the records of a large number of locomotive trials, I discovered that if the indicated horse-power be plotted against the rate at which heat energy is transferred across the boiler-heating surface the points fall within a straight-line region, providing that the regulator is always full open and that the power is

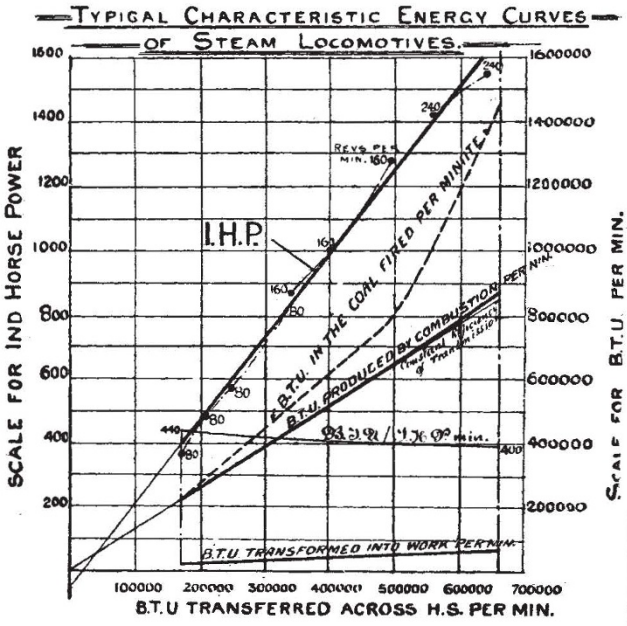

FIG. 6.

regulated by means of the reversing lever—that is to say, by varying the cut-off in the cylinders. It is assumed at the same time, of course, that the boiler-pressure is maintained constant. I have recently drawn a series of characteristic energy-curves for particular engines, and these are published in *Engineering*, August 19 and 26, 1910. A typical set is shown in Fig. 6.

The horizontal scale represents the number of British thermal units transferred across the boiler-heating surface per minute. This quantity is used as an independent variable. Plotted vertically are corresponding horse-powers, each experiment being shown by a black dot on the diagram. The small figures against the dots denote the speed in revolutions of the crank-axle per minute. Experiments at the same speed are linked by a faint chain-dotted line. A glance at the diagram will show at once how nearly all the experiments fall on a straight line, notwithstanding the wide range of speed and power.

The ordinates of the dotted curve just below the I.H.P. curve represent the heat energy in the coal shovelled per minute into the fire-box—that is, the rate at which energy is supplied to the locomotive. The thick line immediately beneath it represents the energy produced by combustion. The vertical distance between these two curves represents energy unproduced, but energy which might have been produced under more favourable conditions of combustion. Some of the unproduced energy passes out of the chimney-top in carbon monoxide gas, but the greater proportion is found in the partially consumed particles of fuel thrown out at the chimney-top in consequence of the fierce draught which must be used to burn the coal in sufficient quantity to produce energy at the rate required. The rate of combustion is measured by the number of pounds of fuel burnt per square foot of grate per hour. In land practice, with natural draft, 20 lb. of coal per square foot of grate per hour is a maximum rate. In a locomotive the rate sometimes reaches 150 lb. per square foot per hour. In the diagram shown the maximum rate is about 120 lb. per square foot, and the dotted curve begins to turn upwards at about 70 lb. per square foot per hour. The vertical distance between the curves shows what has to be paid for high rates of combustion.

I found that in almost every case the curve representing the energy actually produced by combustion differed very little from a straight line, passing through the origin, showing that at all rates of working the efficiency of transmission is approximately constant. That is to say, the proportion of the heat energy actually produced by combustion in the fire-box which passes across the boiler-heating surface per minute is nearly constant, and is therefore independent of the rate of working.

The lowest curve on the diagram represents the rate at which heat energy is transformed into mechanical energy in the cylinders of the locomotive. It seems a small rate in proportion to the rate at which heat energy is supplied to the fire-box, but it is not really so bad as it looks, because the engine actually transformed 60 per cent. of the energy which would have been transformed by a perfect engine working on the Rankine cycle between the same limits of pressure. The engine efficiency is represented in a familiar way by a curve labelled "B.T.H. per I.H.P. minute." It will be seen that the change of efficiency is small, notwithstanding large changes in the indicated horse-power.

The diagram indicates that the indicated horse-power is practically proportional to the rate at which heat is transferred across the boiler-heating surface, and as this is again proportional to the extent of the heating surface, the limit of economical power is reached when the dimensions of the boiler have reached the limits of the construction-gauge, the boiler being provided with a fire-grate of such size that, at maximum rate of working, the rate of combustion falls between 70 and 100 lb. of coal per square foot of grate per hour. A boiler of large heating surface may be made with a small grate, necessitating a high rate of combustion to obtain the required rate of heat-production. Then, although a large power may be obtained, it will not be obtained economically.

Returning now to the consideration of the type of locomotive required for a local service with frequent stops, the problem is to provide an engine which will get into its stride in the least time consistent with the comfort of the passengers. The average speed of a locomotive on local service is low. The greater part of the time is occupied in reaching the journey speed, and the brake must then often be applied for a stop a few moments after the speed has been attained. In some cases the stations are so close together that there is no period between acceleration and retardation. Without going into the details of the calculation, I may say that to start from rest a train weighing, including the engine, 300 tons, and to attain a speed of thirty miles per hour in thirty seconds requires about 1350 indicated horse-power. During the period of acceleration the engine must exert an average tractive pull of nearly fifteen tons.

Mr. James Holden, until recently locomotive engineer of the Great Eastern Railway, built an engine to produce an acceleration of thirty miles per hour in thirty seconds with a gross load of 300 tons. The engine weighed 78 tons, and was supported on ten coupled wheels, each 4 feet 6 inches diameter. There were three high-pressure cylinders, each 18½ inches diameter and 24 inches stroke. A boiler was provided with 3000 square feet of heating surface and a grate of 42 square feet area. Boiler

pressure, 200 lb. per square inch. This engine practically reached the limit of the construction-gauge.

An acceleration of thirty miles per hour in thirty seconds is considerably below what may be applied to a passenger without fear of complaint. But it is clear that it is just about as much as a locomotive can do with a train of reasonable weight. Even with a gross load of 300 tons nearly one-third of it is concentrated in the locomotive, leaving only 200 tons to carry paying load. The problem of quick acceleration cannot therefore be properly solved by means of a steam locomotive. But with electric traction the limitations imposed on the locomotive by the construction-gauge and by the strength of the permanent way are swept away.

The equivalent of the boiler-power of a dozen locomotives can be instantaneously applied to the wheels of the electric train, and every axle in the train may become a driving axle. Thus the whole weight of the stock, including the paying load, may be utilised for tractive purposes. If, for instance, the train weighed 200 tons, then a tractive force equal to one-fifth of this, namely, 40 tons, could be exerted on the train, but uniformly distributed between the several wheels, before slipping took place. The problem of quick acceleration is therefore completely solved by the electric motor.

Electric Railways.

December 18, 1890, is memorable in the history of railway enterprise in this country, for on that date the City and South London Railway was opened for traffic, and the trains were worked entirely by electricity, although the original intention was to use the endless cable system of haulage. This line inaugurated a wonderful system of traction on railways, in which independent trains, moving at different speeds at different parts of the line, are all connected by a subtle electric link to the furnaces of one central station.

Since that epoch-marking year electric traction on the railways of this country has made a gradual if somewhat slower extension than anticipated. But electrically operated trains have in one branch of railway working beaten the steam locomotive out of the field, and now reign supreme—that is, in cases, as indicated above, where a quick, frequent service is required over a somewhat short length of road. The superiority of the motor over the steam locomotive, apart from questions of cleanliness, convenience, and comfort, lies in the fact that more power can be conveyed to the train and can be utilised by the motors for the purpose of acceleration than could possibly be supplied by the largest locomotive which could be constructed within the limits of the construction-gauge. There are many other considerations, but this one is fundamental, and determines the issue in many cases.

A few facts relating to the present state of electric railways in the United Kingdom may prove of interest. At the end of 1908 there were in the United Kingdom 204 miles of equivalent single track worked solely by electricity and 200 miles worked mainly by electricity, corresponding to 138 miles of line open for traffic. Of this, 102 miles belong to the tube railways of London and 201 miles to the older system formed by the District and the Metropolitan Railways and their extensions.

It is not an easy matter to ascertain exactly how much capital is invested in these undertakings for the purpose of electric working alone, since some of the lines originally constructed for a steam locomotive service have been converted to electric working. On the converted lines there is the dead weight of capital corresponding to the locomotive power provided before electrification took place. The capital invested in the 102 miles of tube railways in London is a little more than 25,000,000*l*.

The total number of passengers carried (exclusive of season tickets) on the 138 miles of electrical track during the year 1908 was nearly 342 millions, being roughly one-third of the total number of passengers carried on all the railways of England and Wales during the same period.

The average cost of working this traffic is 22·3*d*. per train-mile. This figure includes the service of the lifts, which is presumably returned with the traffic expenses. The charges work out in this way:—

TABLE IV.

Average Working Cost per Train-mile of the Electric Railways worked wholly or mainly by Electricity in England and Wales for the Year 1908.

	Pence per train-mile.
Locomotive power	8·40
Repairs and renewals of carriages and waggons	1·50
Maintenance of permanent way	2·40
Traffic expenses	5·22
General charges	1·52
Rates and taxes	2·36
Government duty	0·088
Compensation	0·116
Legal and miscellaneous	0·75
Total	22·35

The corresponding total receipts were 38·65*d*. per train-mile. The working expenses are thus 58 per cent. of the total receipts. Comparing this with the figures given above for the whole of the lines in England and Wales, it will be seen that the cost for locomotive power on the electric railways appears to be about two-thirds of the cost on steam lines per mile run, the cost for repairs and renewals of carriages and waggons about one-half, and the cost for traffic expenses about one-half.

The two kinds of working are not, however, strictly comparable, as all the conditions of traffic in the two cases are different, and the length of the electric lines is relatively so small that the problems which arise out of the transmission of electric power over long distances are excluded. The traffic expenses and the cost of repairs and renewals of carriages and waggons, general charges, &c., are practically independent of the kind of power used for locomotive purposes, and, moreover, the difference in weight of electric trains and the steam-hauled trains is on the average so great that no comparison can be instituted without ton-mile statistics.[1]

Method of Working.

With two exceptions, the method of working the electrified lines of this country is in the main the same. A third conductor rail is laid on insulators fixed to the ordinary track sleepers, and is maintained throughout the whole of its length at as nearly as possible a pressure of 600 volts, except in a few cases where the pressure is 500 or 550 volts. Collecting shoes sliding along the rails are fixed to the trains, and through them current is supplied to the armatures fixed to or geared with the axles. The current flows through the armatures back to the stations or sub-stations through the running rails, which are bonded for the purpose, or sometimes through a fourth rail carried on insulators fixed to the track sleepers, as in the cases of the District and Metropolitan Railways.

Differences in the equipment arise out of the geographical necessities of the distribution. For a short line the power is produced at a central station, and is distributed by feeders to the conductor rail direct. For longer lines power is produced at higher voltage (11,000 volts in the case of the District Railway), and is then distributed to sub-stations conveniently placed along the line, where it is transformed to a lower voltage, converted to direct current, and then by means of feeders is distributed at 600 volts or thereabouts to the third rail.

In 1908 the Midland Railway Company opened for traffic the electrified line connecting Lancaster, Morecambe, and Heysham. The method of electrification was a departure from the general direct-current practice hitherto applied to electrified lines in this country. Power was supplied to the trains at 6600 volts, single phase, at twenty-five alternations per second, along an overhead conductor. The pressure was reduced by transformers carried on the motor-coach itself, and was then used by single-phase motors. The traffic conditions on this line are simple.

[1] Most valuable information regarding the cost of converting the line between Liverpool and Southport from steam to electric working will be found in Mr. Aspinall's presidential address to the Institution of Mechanical Engineers.

In December, 1909, the electrified portion of the London, Brighton, and South Coast Railway from Victoria, round by Denmark Hill, to London Bridge was opened for traffic. This work marks an epoch in the history of electric traction in England. For the first time the single-phase system was applied to meet the exacting traffic conditions of a London suburban service where the main condition is that the trains should be accelerated rapidly. The system has shown that it can meet all the conditions of the service perfectly. Energy is purchased, and is distributed by overhead conductors direct to the trains at 6600 volts, single phase, at twenty-five alternations per second, where it is used by the single-phase motors after suitable transformation by apparatus carried under the motor carriage. The results of this electrification will be of unusual interest, because not only has the method applied shown itself to be quite suitable for dealing with a stopping traffic where quick acceleration is the dominating condition, but it contains the germ of practicable long-distance electrification. The near future may see the extension of the system to the line between London and Brighton, giving a frequent non-stop service which would bring Brighton in point of time nearer than the suburbs on opposite sides of London are to one another.

Power Signalling.

During the last ten years a considerable number of trial installations of power-signalling apparatus have been made by the railway companies of this country. The electric lines have generally adopted power signalling, and the District Railway has installed a complete system on all its lines and branches.

The term "power signalling" is applied to any equipment in which the actual movements of the points and signals are done by power, the signalman's work being thus reduced to the movement of small light control levers or switches. Of the several systems tried and proposed, three bulk largest in the equipments applied in this country, namely, the all-electric, the low-pressure pneumatic, and the electro-pneumatic systems.

The "all-electric" system is represented by installations of the McKenzie-Holland and Westinghouse system on the Metropolitan and Great Western Railways, by installations of the "Crewe" system on the London and North-Western Railway, and by installations of Siemens Brothers on the Great Western Railway. The general feature of the all-electric system is that the points are operated by motors sunk in a pit by the side of the rails; the signals are pulled off electrically, and all the apparatus is controlled electrically.

The low-pressure pneumatic system is represented by installations on the London and South-Western Railway and the Great Central Railway. The points and signal arms are moved by air compressed to about 20 lb. per square inch, and led to cylinders connected to the points and to the signal arms. The control is also done by means of compressed air, small pipes leading from each air cylinder to the cabin.

The electro-pneumatic system has found most favour in this country up to the present time. The equipment installed includes such notable stations as the Central at Newcastle with 494 levers, and the Glasgow Central with 374 levers, and the whole of the Metropolitan District system of underground railways. In this system an air cylinder is connected to each set of points and to each signal-arm. Air compressed at 65 lb. per square inch is supplied to the cylinders from a main running alongside the railway kept charged by small air-compressors placed at convenient intervals. Each air cylinder is provided with a small three-way air-valve operated by an electromagnet. The movement of each air-valve is controlled electrically from the cabin through the electromagnet associated with it. The system grouped round any one signal-cabin may be regarded as an engine fitted with a large number of cylinders, each working intermittently by compressed air, and where in each the valve-rod has been changed to an electric cable, all the cables being led to a signal-cabin, where the operation of the valves is done by means of an apparatus which is as easily played upon as a piano, with this difference, however, that the notes are mechanically interlocked, so that a signalman cannot play any tune he pleases, but only a tune which permits of safe traffic movement. Moreover, the instrument is so arranged that the movement of the small lever determining the movement of a signal-arm cannot be completed unless the signal-arm actually responds to the intention of the signalman, thus detecting any fault in the connections between the box and the arm.

The obvious advantage of power signalling is the large reduction of physical labour required from the signalman. His energy can be utilised in thinking about the traffic movements rather than in hauling all day at signal levers. One man at a power frame can do the work of three at the ordinary frame. The claims made for power signalling, in addition to the obvious advantage of the reduction of labour, are briefly that the volume of traffic which can be dealt with is largely increased, that the area of ground required for the installation is considerably less than with the ordinary system, with its rodding, bell-crank levers, chains, and pulleys, and that where the conditions are such that power signalling is justified the maintenance cost is less than with a corresponding system of normal equipment.

Automatic Signalling.

Several of the power-signalling installations are automatic in the sense that between signal-cabins on stretches of line where there are no junctions or cross-over roads requiring the movement of points, the movement of the signal arm protecting a section is determined by the passage of the train itself. The most important equipment of this kind is that installed on the group of railways forming the "Underground" system. This includes the District Railway with all its branches. On this line the particular system installed is the electro-pneumatic, modified to be automatic except at junctions. Signal-cabins are placed only at junctions and at places where points require to be operated. The stretch of line to be automatically signalled is divided into sections, and the entrance to each section is guarded by a signal-post. Calling two successive sections A and B, the train as it passes from Section A to Section B must automatically put the signal at the entrance to B to danger, and at the same time must pull off the signal at the entrance to A. These operations require the normal position of the signal-arm to be "off" instead of at danger, as in the usual practice. The position of the arm in this system conveys a direct message to the driver. If "on" he knows that there is a train in the section; if "off" he knows that the section is clear. Each signal-arm is operated by an air motor, as briefly described above, but the cables from the valves are now led to relays at the beginning and end of the section which the signal protects. The contrivance by means of which the train acts as its own signalman is briefly as follows. One rail of the running track is bonded, and is connected to the positive pole of a battery or generator. The opposite rail is divided into sections, each about 300 yards long, bonded, but insulated at each end from the rails of the adjacent sections, and each section is connected to a common negative main through a resistance. A relay is placed at the beginning and at the end of each section, and is connected across from the positive to the negative rail. Current flows and energises the relay, in which condition the relay completes a circuit to the electromagnet operating the admission valve of the air cylinder on the signal-post, air is admitted, and the signal-arm is held off. This is the normal condition at each end of the circuit. When a train enters a section it short-circuits the relays through the wheels and axles, in consequence of which the relays, de-energised, break the circuit to the admission valve, which closes, and allows the air in the cylinder to escape, and the signal-arm, moved by gravity alone, assumes the "on" or danger position. At the same time the short circuit is removed from the section behind directly the train leaves it, the relays are at once energised, the admission valve to the air cylinder on the protecting post of the section is opened, air enters, and the signal is pulled down to the "off" position.

The speed at which traffic can be operated by this system of power signalling is remarkable. At Earl's Court junction box forty trains an hour can be passed each way—that is, eighty per hour—handled by the one signalman in the box. As the train approaches the box, both its approach to the section and its destination must be

notified to the signalman. When it is remembered that with ordinary signalling, to take an express train, for example, a signalman hears some twenty-four beats on the gongs in his box, and sends signals to the front and rear box, which give altogether some twenty-four beats on the gongs in these two boxes, forty-eight definite signals in all, for every express train he passes into the section which his signals protect, it will be understood that the system must be profoundly modified to admit such a speed of operation as eighty trains per hour per man. The modification is radical. No gong signals are used at all. There is a small cast-iron box standing opposite the signalman with fifteen small windows in it, each about 1½ inches square. Normally, each window frames a white background. A click in the box announces the approach of a train, and a tablet appears in one of the empty windows showing by code the destination of the train. The signalman presses a plug in the box, a click is heard, and a tablet is seen in a precisely similar apparatus in the next box. When the train passes the man presses another plug, and the tablet disappears.

Four wires run between the signal-boxes along the railway, and by combining the currents along the four wires in various ways fifteen definite signals can be obtained, a number sufficient for the District traffic. Each of the fifteen combinations is arranged to operate one particular tablet in the box. Current from these four wires is tapped off at intermediate stations, and is used to work a train indicator showing the passengers assembled on the platform the destinations of the next three trains. The whole equipment is a triumph of ingenuity and engineering skill, and is a splendid example of the way electricity may be used to improve the railway service, quite apart from its main use in connection with the actual driving of the trains.

The facts and problems I have brought before you will, I think, show the important influence that scientific discovery has had upon our railway systems. Scientific discovery and mechanical ingenuity have reduced the cost of locomotive working to a point undreamt of by the pioneer locomotive builders. Electric railways are the direct fruit of the discoveries of Faraday. The safety of the travelling public was enormously increased by the invention of continuous brakes and by the discovery of the electric telegraph, and is greatly increased by the development of modern methods of signalling; and the comfort of travellers is increased by modern methods of train-lighting, train-warming, and the train kitchen. Inventions of a most ingenious character have from time to time been made in order to furnish a steady and ample light in the carriages. The smoothness of travelling on our main lines is evidence of the thought which has been lavished both on the wheel arrangements of the carriages and on the permanent way. Problems in connection with the continuous brake are many and interesting. Some of the problems of modern signalling would have quite baffled the scientific electrician of a quarter of a century ago. When engineers endeavour to apply the results of scientific discovery they often find themselves confronted by new problems unperceived by the man of science. Together they may find a solution, and thus enlarge the boundaries of knowledge, and at the same time confer a practical advantage on the community. The pure man of science, the practical engineer, act and react on one another both to the advantage of pure science and to the advantage of the national welfare. The future success of our railways depends upon the closer application of scientific principle both to the economic and engineering problems involved in their working, some decrease in unprofitable competition with one another, and a more just appreciation on the part of the State of the part railway companies play in our national well-being.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY W. CROOKE, B.A., PRESIDENT OF THE SECTION.

ONE-AND-THIRTY years have passed since the British Association visited this city. At that time anthropology was in the stage of probation, and was represented by a branch of the section devoted to biology. Since then its progress in popularity and influence has been continuous, and its claims to be regarded as a science, with aims and capabilities in no way inferior to those of longer growth, are now generally admitted. Its advance in this country is largely due to the distinguished occupant of this chair at our last meeting in Sheffield. During the present year Dr. E. B. Tylor has resigned the professorship of anthropology in the University of Oxford. Before this audience it is unnecessary for me to describe in detail the services which this eminent scholar and thinker has rendered to science. His professorial work at Oxford; his unfailing support of the Royal Anthropological Institute and of this section of the British Association; his sympathetic encouragement of a younger generation of workers—these are familiar to all of us. Many of those now engaged in anthropological work at home and abroad date that interest in the study of man, his culture and beliefs, which has given a new pleasure to their lives, from the time when they first became acquainted with his "Primitive Culture" and "Researches into the History of Mankind." These works enjoy the almost unique distinction that, in spite of the constant accumulation of new material to illustrate an advancing science, they still maintain their authority; and this because they are based on a thorough investigation of all the available material and a profound insight into the psychology of man at the earlier stages of culture. He has laid down once for all the broad principles which must always guide the anthropologist: that a familiarity with the principles of the religions of the lower races is as indispensable to the scientific student of theology as a knowledge of the lower forms of life, the structure of mere invertebrate creatures, is to the physiologist. "Few," he assures us, "who will give their minds to master the general principles of savage religion will ever think it ridiculous or the knowledge of it superfluous to the rest of mankind. . . . Nowhere are broad views of historical development more needed than in the study of religion. . . . Scepticism and criticism are the very conditions for the attainment of reasonable belief." I need hardly say that his exposition of the principles of animism, as derived from the subconscious mental phenomena of dreams and waking visions, has given a new impulse and direction to the study of the religion of savage races.

Dr. Tylor, on his retirement from the active work of teaching, carries with him the respectful congratulations and good wishes of the anthropologists here assembled, all of whom join in the hope that the Emeritus Professor may be able to devote some of his well-earned leisure to increasing the series of valuable works for which we are already indebted to him.

In his address from this chair Dr. Tylor remarked that twenty years before that time it was no difficult task to master the available material. "But now," he added, "even the yearly list of new anthropological literature is enough to form a pamphlet, and each capital of Europe has its anthropological society in full work. So far from any finality in anthropological investigation, each new line of argument but opens the way to others behind, while those lines tend as plainly as in the sciences of stricter weight and measure towards the meeting ground of all sciences in the unity of nature."

Since these words were written there has been a never-ceasing supply of fresh literature, which is well represented in the publications of the present year. Every contributor to this science must now be a specialist, because he can with advantage occupy only one tiny corner of the field of humanity; and even then he is never free from a feeling of anxiety lest his humble contribution may have been anticipated by some indefatigable foreign scholar. In short, the attempt to give a general exposition of the sciences devoted to the study of mankind has been replaced by the monograph. Of such studies designed to coordinate and interpret the facts collected by workers in the field we welcome two contributions of special importance.

Prof. J. G. Frazer has given us a monumental treatise on totemism and exogamy, in which, relying largely on new Australian evidence and that collected from Melanesia by Dr. Haddon and his colleagues, Dr. Rivers and Dr. Seligmann, he endeavours to prove that totemism originated in a primitive explanation of the mysteries of conception and childbirth. As contributing causes he discusses the

influence of dreams and the theory of the external soul, the latter being occasionally found connected with totemism; and he points out that one function of a totem clan was to provide by methods of mimetic or sympathetic magic a supply of the totem plant or animal on which the existence of the community depends, this function being not metaphysical or based on philanthropic impulse, but on a cool but erroneous calculation of economic interest. He has also cleared the ground by dissociating totemism from exogamy, the latter, as an institution of social life, being, he believes, later in order of time than totemism, and having in some cases accidentally modified the totemic system, while in others it has left that system entirely unaffected. The law of exogamy is, in his opinion, based mainly on a desire to prevent the union of near relations, and on the resulting belief in the sterilising effects of incest upon women in general and edible animals and plants. In dealing with totemism as a factor in the evolution of religion he gives us a much-needed warning that it does not necessarily develop, first into the worship of sacred animals and plants, and afterwards into the cult of anthropomorphic deities with sacred plants and animals for their attributes. In the stage of pure totemism totems are in no sense deities, that is to say, they are not propitiated by prayer and sacrifice; and it is only in Polynesia and Melanesia that there are any indications of a stage of religion evolved from totemism, a conclusion which demolishes much ingenious speculation. It is hardly to be expected that in a field covered by the wrecks of many controversies these views will meet with universal acceptance. But the candour with which he discards many of his own theories, and the infinite labour and learning devoted to the preparation of his elaborate digest, deserve our hearty recognition.

In his treatise on "Primitive Paternity," Mr. E. S. Hartland deals with the problems connected with the relations of the sexes in archaic society. Mother-right he finds to be due not so much to the difficulty of identifying the father as to ignorance of physiological facts; and he supposes that the transition from mother-right to father-right originated not from a recognition of the physical conditions of paternity, but from considerations connected with the devolution of property; as Prof. Frazer states the case, it arises from a general increase in material prosperity leading to the growth of private wealth.

We also record the steady progress of the great "Encyclopædia of Religion and Ethics," under the editorship of Dr. J. Hastings, which promises to provide an admirable digest of the results of recent advances in the fields of comparative religion and ethnology.

It is now admitted by all students of classical literature that the material collected from the lower races is an indispensable aid to the interpretation of the myths, beliefs, and culture of the Greeks and Romans. Most of our universities provide instruction of this kind; and Oxford has opened its doors to a special course of lectures dealing with the relation of anthropology to the classics. One of its most learned mythologists, Dr. L. R. Farnell, when about half-way through his treatise on the cults of the Greek states, admitted the increasing value of the science in elucidating the problems on which he was engaged. Even with this well-advised change of method he has left the field of peasant religion, nature-worship, and magic, which must form the starting-points for the next examination of Greek beliefs, practically unworked. The formation of a Roman Society, working in cooperation with and following the methods which have been adopted by the Society for the Promotion of Hellenic Studies, is a fresh indication of the increasing importance of the work upon which we are engaged.

In the field of archæology Dr. A. J. Evans has commenced the publication of the Minoan records, which open up a new chapter in the early history of the Mediterranean. It is now certain that the origin of our alphabet is not to be found, as De Rougé supposed, in the hieratic script of Egypt, but in the Cretan hieroglyphs; and that the influence of the Phœnicians in its development was less important than has been generally supposed. Before the full harvest of these excavations can be reaped we may have to await the discovery of some bilingual document, like the Rosetta Stone, which will solve the mysteries of the Minoan syllabary.

As regards physical anthropology, the validity of the use of the cephalic index, particularly in discriminating the elements of mixed populations, has been questioned. The recent Hunterian lectures delivered by Prof. A. Keith, as yet published only in the form of a summary, are designed to place these investigations on a more scientific basis. In particular increased attention is being given to the influence of environment in modifying a structure generally so stable as the human skull. Thus it has been ascertained that the immigrant into our towns, by some process of selection or otherwise, develops a longer and narrower head than the countryman. The recent American Commission, under the presidency of Prof. Boas, reports that "racial and physical characteristics do not survive under the new climate and social environment. . . . Children born even a few years after the arrival of their parents show essential differences as compared with their European parentage. . . . Every part of the body is influenced, even the shape of the skull, which has always been considered to be the most permanent hereditary characteristic." Similar results appear from a comparison of the American negro with his African ancestor.

I may here refer briefly to the work on folk-lore. Though in recent years it has not maintained the importance which it at one time secured in the proceedings of this section, we still regard it as an essential branch of the study of man. The Folk-lore Society, after thirty-two years' useful work, finds that much still remains to be done in these islands to secure a complete record of popular beliefs and traditions, many of which are rapidly disappearing. It has therefore formulated a scheme for more systematic investigation in those districts which have hitherto been neglected. A committee including representatives of the two allied sciences is also engaged on the necessary task of revising and defining the terminology of anthropology and folk-lore.

The materials collected by field workers in various regions of the world, and popular accounts of savage religion, customs, and folk-lore continue to arrive in such increasing numbers that the need of a central bureau for the classification of this mass of facts has become increasingly apparent. It is true that we have suffered a set-back, it is to be hoped only temporary, in the rejection of an appeal made to the Prime Minister for a grant-in-aid of the Royal Anthropological Institute. But if we persist in urging our claims to official support the establishment of an Imperial Bureau of Ethnology cannot be long deferred.

One result of this accession of fresh knowledge, largely due to improved methods of research, is to modify some of our conceptions of savage psychology. We now understand that side by side with physical uniformity there may be wide differences arising from varieties of race and environment. It is becoming generally recognised that we can no longer evade the difficulty of interpreting beliefs and usages by referring them to that elusive personality, primitive man. Between the embryonic stage of humanity and the present lie vast periods of time; and no methods of investigation open to us at present offer the hope of successfully bridging this gap in the historical record. To use the words of Prof. Frazer: "It is only in a relative sense, by comparison with civilised men, that we may legitimately describe any living race of savages as primitive." Hence the hypothesis of the unilinear evolution of culture which satisfied an earlier school will no longer bear examination.

Further, not to speak of the artistic endowments of palæolithic man, we find to our surprise that a race like the Australian Arunta, whose lowness in the scale of humanity does not necessarily connote degradation, has worked out with exceptional ability through its tribal council their complex and cumbrous systems of group marriage and totemism. They have developed a cosmogony which postulates the self-existence of the universe; they have reached a belief in reincarnation and transmigration of the soul. So far from their social system being rigid it is readily modified to suit new conditions. They live in peace with neighbouring tribes, and have established the elements of international law. On the moral side, though there is much that is cruel and abhorrent, they are not wanting in kindliness, generosity, gratitude. The savage, in short, is not such an unobservant simpleton as some are inclined to suppose; and any interpretation of his

beliefs and usages which ignores this fact is certain to be misleading.

This popularisation of our science has not, however, been universally welcomed. It has been urged with much reason that this overabundance of material tends to encourage an unscientific method, particularly the comparison of isolated facts without due regard to the context of culture to which they are organically related. There is much force in this contention; and probably when the work of this generation comes to be critically reviewed we shall be rightly charged with rashly attempting a synthesis of facts not generically related, with reposing too much confidence in evidence collected in a haphazard fashion, and with losing sight of their historical relations in our quest after survivals. Those who have practical experience of work among savage or semi-savage races understand the difficulty of collecting information on subjects outside the range of their material interests. Only a skilled linguist is able to interpret their hazy religious beliefs. We fail to evolve order from what is and always must be chaotic; we fail to discriminate religion from sociology because both are from the savage point of view identical; and generally it is only the by-products of religion, such as demonology, witchcraft, mythology which reward our search. The most dogmatic among us, when they consider the divergent views of Messrs. Spencer and Gillen and Strehlow, may well hesitate to frame theories about the Arunta.

In the next place it has been objected that the scientific side of anthropology is in danger of being submerged by a flood of amateurism. It is only within recent years that a supply of observers trained in scientific methods has become available. Much of the work in India, the dominions, and other parts of the Empire has been done by amateurs, that is to say, by officers in the service of the Crown, missionaries, or planters, who understand the languages, manners, and prejudices of the people, but have not received the advantage of scientific training. Some of this work is, in its kind, useful; but there seems reason to believe that inquiries conducted by this agency have almost reached their limit. The existing material may be supplemented and corrected by workers of the same class; but from them no important additions to our knowledge can reasonably be expected.

Criticisms such as these have naturally suggested proposals for improving the qualifications of this agency by providing a course of training for public servants before they join their appointments; and excellent arrangements with this object have been made by several of our universities. In addition to this schemes are in the air for the establishment of a School of Oriental Studies in London or of a College for Civilians in Calcutta. We must, however, recollect that the college established by Lord Wellesley at the beginning of the last century with the intention, to use his own words, of promoting among junior officers "an intimate acquaintance with the history, language, customs, and manners of the people of India," failed to meet the aims of its founder. We must also remember that recruits for the Colonial services do not undergo any training in this country; and that in the case of the Covenanted Civil Service of India the period extends only to a single year, during which the candidate is expected to learn the rudiments of at least one Oriental language and to acquire some knowledge of the law and history of India. It seems obvious that this leaves little time for the scientific study of anthropology; and the most that can be expected is to excite in the young official a desire to study the native races and to define the subjects to which his attention may usefully be directed. There is, again, the obvious risk of letting loose the half-trained amateur among savage or semi-savage peoples. He may see a totem in every hedge or expect to meet a corn-spirit on every threshing-floor. He may usurp the functions of the arm-chair anthropologist by adding to his own proper business, which is the collection of facts, an attempt to explain their scientific relations. As a matter of fact, the true anthropologist is born, not made; and no possible course of study can be useful except in the case of a few who possess a natural taste for this kind of work.

Having then practically exhausted our present agency it is incumbent upon us to press upon the Governments throughout the Empire the necessity of entrusting the supervision of ethnographical surveys to specialists. This principle has been recognised in the case of botany, geology, and archæology, and it is high time that it was extended to anthropology. It is the possession of such a trained staff that has enabled the American Government to carry out with success a survey of the natives of the Philippine Islands; and it is gratifying to record that the Canadian legislature, in response to resolutions adopted by this section at the Winnipeg meeting, has recently voted funds to provide the salary of a superintendent of the ethnological survey. We may confidently expect that other Governments throughout the Empire will soon follow this laudable example. These Governments will, of course, continue to collect at each periodical census those statistics and facts of sociology and economics which are required for purposes of administration. But beyond these practical objects there are questions which can be adequately investigated only by specialists.

The duties of such a director will necessarily be threefold: First, to sift, arrange, and coordinate the facts already collected by non-scientific observers; secondly, to initiate and control special investigations, in particular that intensive study of smaller groups within a limited area which, in the case of the survey of the Todas by Dr. Rivers, has so largely contributed to our knowledge of that tribe. Such methods not only open out new scientific fields, but, and this is perhaps more important, establish a standard of efficiency which improves later surveys of these or neighbouring races.

The field for inquiry throughout the Empire is so vast that there is ample room for expeditions independent of official patronage. In some respects the private traveller possesses advantages over the official—in his freedom from the bondage of red tape and from the suspicion which inevitably attaches to the servant of Government that his inquiries are conducted with the object of imposing taxation or of introducing some irksome measures of administration. He is always sure to receive the aid of local officers, whose familiarity with the native races must be of the highest value.

The third duty of the director will be to organise in a systematic way the collection of specimens for home and colonial museums. Our ethnographical museums, as a whole, have not reached that standard of efficiency which the importance of the Empire and the needs of training in anthropology obviously require; and our students have to seek in museums at Berlin and other foreign cities for collections illustrative of tribes which have long been subject to British law. It is only necessary to refer to the recent handbook of the ethnographical collections in the British Museum to see that there are wide gaps in the series which might easily be filled by systematic effort. No time is to be lost, because the tragedy of the extinction of the savage is approaching the final act, and our grandchildren will search for him in vain except perhaps in the slums of our greater cities.

Assuming then that in the near future anthropological inquiries will be organised on practical lines, I invite your attention to some special problems in India which deserve intensive study, and which can be solved in no other way. India is a most promising field for such inquiries. Here the student of comparative religion can trace with more precision than is possible in any other part of the Empire the development of animism and the interaction on it of the forces represented by Buddhism, Hinduism, Islam, and Christianity. The anthropologist can observe the most varied types of moral and material culture, from those represented by the heirs of its historic civilisation down to forest and depressed tribes little raised above the level of savagery.

The first question which awaits examination is that of the prehistoric races and their relation to the present population. Unfortunately the materials for this inquiry are still imperfect. The operations of the archæological survey, with the scanty means at its disposal, have rightly been concentrated upon the remains of architecture in stone, which starts from the Buddhist period, and upon the conservation of the splendid buildings which are our inheritance from older ruling powers. The prehistoric materials have been collected by casual workers who were not always careful to record the localities and circumstances of the discovery of their contributions to the local museums. Many links are still wanting, some altogether absent from Indian

soil; others which systematic search will doubtless supply. We can realise what the position of prehistoric archæology in Europe would be if the series of Neolithic barrows, the bone carvings of the cave-dwellers, the relics from kitchen-middens and lake dwellings were absent. The caves of central India, it is true, have supplied stone implements and some rude rock paintings. But the secrets of successive hordes of invaders from the north, their forts and dwellings, lie deep in the alluvium, or are still covered by shapeless mounds. Tropical heat and torrential rain, the ravages of treasure-hunters, the practice of cremation have destroyed much of the remains of the dead. The epigraphical evidence is enormously later in date than that from Babylon, Assyria, or Egypt; and the oriental indifference to the past and the growth of a sacred literature written to subserve the interests of a priestly class weaken the value of the historical record.

Further, India possesses as yet no seriation of ceramic types such as that devised by Prof. Flinders Petrie which has enabled him to arrange the Egyptian tombs on scientific principles, or that which Prof. Oscar Montelius has established for the remains of the Bronze Age. Mr. Marshall, the Director of the Archæological Survey, admits that the Indian museums contain few specimens of metal work the age of which is even approximately known.

Though the record of the prehistoric culture is imperfect, we can roughly define its successive stages.

The palæolithic implements have been studied by Mr. A. C. Logan, whose work is useful if only to show the complexity of the problem. Those found in the laterite deposits belong to the later Pleistocene period, and display a technique similar to that of the river-drift series from western Europe. The Eoliths, which have excited such acute controversy, have up to the present not been discovered; and so far as is at present known the palæolithic series from India appears to be of later date than the European. Palæolithic man seems to have occupied the eastern coast of the peninsula, whence he migrated inland, using in turn quartzose, chert, quartzite, limestone, or sandstone for his weapons; that is to say, he seems not to have inhabited those districts which at a later time were seats of neolithic culture. Early man, according to what is perhaps the most reasonable theory, was first specialised in Malaysia, and his northward route is marked by discoveries at Johore and other sites in that region. Thence he possibly passed into India. The other view represents palæolithic man as an immigrant from Europe. At any rate, his occupation of parts of southern India was antecedent to the action of those forces which produced its present form, ere the great rivers had excavated their present channels, and prior to the deposition of the masses of alluvium and gravel which cover the implements which are the only evidence of his existence.

Between the palæolithic and the neolithic races there is a great geological and cultural gap; and no attempt to bridge it has been made except by the suggestion that the missing links may be found in the cave deposits when they undergo examination.

There is reason, however, to believe that the neolithic and the Iron Age cultures were continuous, and that an important element in the present population survives from the neolithic period. Relics of the neolithic are much more widely spread than those of the palæolithic age. They extend all over southern India, the Deccan, and the central or Vindhyan range. Up to the present they are scanty in the Punjab and Bengal; but this may be due to failure to discover or identify them. Mr. Bruce Foote has discovered at various sites in the south factories of neolithic implements associated with wheel-made pottery of a fairly advanced type, showing that the Stone Age has survived side by side with that of metal down to comparatively recent times. The Veddas of Ceylon, the Andamanese, and various tribes on the north-east frontier, in central and southern India, are, or were up to quite recent times, in the Age of Stone. In fact, when we speak of ages of stone or metal we must not regard them as representing division of time but generally continuous phases of culture.

There is no trustworthy evidence for the existence of an Age of Bronze. The single fine implement of this metal which has been discovered is probably, like the artistic vessels from the Nilgiri interments, of foreign origin; and other implements of a less defined type seem to be the result of imperfect metallurgy. This is not the place to discuss the problem of the origin and diffusion of bronze. Babylon, Asia Minor, and China have each been supposed to be a centre of distribution. The Egyptian specimen attributed to the third dynasty, say before the fourth millennium B.C., is believed by Prof. Petrie to be the result of a chance alloy; but the metal certainly appears in Egypt about 1600 B.C., and it is believed to have originated in central Europe, where the Zinnwald of Saxony or the Bohemian mines provided a suppiy of tin. The absence of a Bronze Age in India has been explained by the scarcity of tin and the impossibility of procuring it from its chief source in the Malay-Burman region, where the mines do not seem to have been worked in ancient times. But another view deserves consideration. Prof. Ridgeway has shown that all the sites where native iron is smelted are those where carboniferous strata and ironstone have been heated by eruptions of basalt; and iron was thus produced by the natural reduction of the ore. In Africa as well as India the absence of the Bronze Age seems to be due to the abundant supplies of iron ores which could be worked by processes simpler than those required in the case of bronze. In India iron may have been independently discovered towards the close of the neolithic period, and iron may have displaced copper without the intervention of bronze.

However this may be, the Copper Age in India, which has been carefully studied by Mr. V. A. Smith, is of great importance. Implements of this metal in the form of flat and bar celts, swords, daggers, harpoon, spear, and arrow heads, with ornaments and a strange figure probably human, have been found at numerous sites in northern India. In western Europe, according to Dr. Munro, the Copper Age was of short duration; but Mr. Smith believes that in India the variety of types indicates a long period of development.

No mention of iron occurs in the Rig-veda; but it appears in the Atharvan, which cannot be dated much later than 1000 B.C. It is now recognised that there is a still obscure stratum of Babylonian influence underlying the Aryan culture; and if, as is generally supposed, the manufacture of iron was established by the Chalybes at the head-waters of the Euphrates, who passed it down the delta, its use may have spread thence among the Indo-Aryans. It certainly appears late in the south Indian dolmen period; and we have the alternatives of believing that it was introduced there by the Dravidian trade with the Persian Gulf, which certainly arose before the seventh century before Christ, or that it was independently discovered by the Dravidians who still extract it in a rude way from the native ores.

The great series of dolmens, circles, and kistvaens which cover the hills and plateaux of the Deccan and the region to the south seem to belong to the Iron Age. Whether the construction of these monuments was due to the migration of the dolmen-building race from northern Africa, or whether the builders were a local people utilising the material on the spot must remain uncertain. The excavations conducted by Mr. Breeks and others disclose tall jars, many-storeyed cylinders of varying diameter, with round or conical bases, fashioned to rest on pottery ring-stands, like the classical amphoræ, or to be imbedded in softer soil. The lids of these vessels are ornamented with rude, grotesque figures of men, animals, or more rarely inanimate objects, depicting the arms, dress, ornaments, and domesticated fauna of the period. It has been suspected that these figurines may be of a date earlier than the implements of iron with which they are associated, and that they were deposited with the dead in a spirit of religious conservatism. At any rate, the costumes and arms represented on the older pottery present no resemblance to those depicted on the later series of dolmens and kistvaens. The pottery also seems to belong to different periods, the larger jars being of a later date than the true funereal urns which are found at a lower level, and contain a few cremated bones, gold ornaments, bronze and iron rings, with beads of glass or agate. These people clearly regarded bronze as an article of luxury, as it appears in the form of ornaments or in the series of splendid vases preserved in the Madras museum. It is difficult to suppose that these were of local origin; more probably they were imported in the course of trade along the western coast or from more distant regions.

Another and equally remarkable phase of culture, com-

bining distinctly savage features with a fairly advanced civilisation, is illustrated by the Adittanalur cemetery in the Tinnevelli district recently excavated by Mr. Rea. Two skulls discovered here are prognathous, suggesting a mixture of the Negrito and Dravidian types. There is no trace of cremation, and in most cases the smallness of the urn openings implies that the corpses were exposed to birds of prey, and that only such bones as could be discovered after removal of the flesh were collected for interment; or, according to another interpretation of the facts, we have an instance of the custom of mourners carrying with them, like the modern Andamanese, the relics of the dead. These interments certainly extended over a long period, neolithic weapons being found in some graves, while in others iron arms were discovered fixed point downwards near the urns, as if they had been thrust into the ground by the mourners. In the richer graves gold frontlets, like those of Mycenæ and other Greek interments, were fastened over the forehead of the corpse. These were, like the Greek specimens, of such a flimsy type that they could never have been used in real life. It is a remarkable instance of a survival in custom that at the present day some tribes in this region tie a triangular strip of gold on the forehead of the dead, the import of which, on the analogy of the death masks of Siam, Cambodia, ancient Mexico, and Alaska, we may interpret as an attempt to guard the corpse from the glances of evil spirits while the spirit is on its way to deathland, or to be used in processions of the corpse.

The question remains: To what races may we attribute these successive phases of culture in southern India? The Tamil literature, as interpreted by Bishop Caldwell and Mr. V. Kanakasabhai, shows the existence of an advanced type of archaic culture in this region; but the evidence to connect this with the existing remains is as yet wanting. We may reasonably assume that neolithic man survives in the existing population, because we have no evidence of subsequent extensive migrations, except the much later arrival of Indo-Aryan colonies from the north, and that of the Todas, whom Dr. Rivers satisfactorily identifies with the Nayars and Nambutiri Brahmans of Malabar. The occurrence of a short-headed strain among some tribes in western India probably represents some prehistoric migration by sea or along the coast line from the direction of Baluchistan or the Persian Gulf. The suggestion that it is the result of a Scythian or Hun retreat from northern India in the face of an advancing Aryan movement is not corroborated by any historical evidence, and is in itself improbable. The customs of dolmen and kistvaen burial still persist among some of the present tribes, and they display some reverence for the burial places of their forgotten predecessors. This feeling may, however, be due to the habitual tendency of the Hindu to perform rites of propitiation at places supposed to be the haunts of spirits, and need not necessarily connote racial identity.

The most primitive type identifiable in the population of south India is the Negrito, which appears among the Veddas of Ceylon, and among the Andamanese, who retain the Negrito skin colour and hair, but have acquired, probably from some Mongoloid stock, distinct facial characters. It has been the habit with some writers to exaggerate the Negrito strain in the south. But tribes like the Badagas and Kotas, which have been classed as representative of this type, possess none of the Negrito characters, which appear only among the more primitive Kurumbas, Malayans, Paniyans, and Irulas. In all the modern tribes the distinctive Negrito marks—woolliness of hair, prognathism, lowness of stature, and excessive length of arm—have become modified by miscegenation or the influences of environment.

The resemblances in culture of the Indian Negrito with the cognate races to the east and south-east of the Peninsula are too striking to be accidental. The Kadirs of Madras climb trees like the Bornean Dayaks, clip their teeth like the Jakun of the Malay Peninsula, and wear curiously ornamented hair combs like the Semang of Perak, among whom they serve some obscure magical purpose. The Negrito type deserves special examination in relation to the recent discovery of Pygmies in New Guinea, and the monograph on the Pygmy races in general by Dr. P. W. Schmidt, who regards them as the most archaic human type, from which he supposes the more modern races were developed, not by a process of gradual evolution, but *per saltum*. If there be any force in these speculations he is justified in expressing his conviction that the investigation of the Pygmy races is, at the present moment, one of the weightiest and most urgent, if not the most weighty and most urgent, of the tasks of ethnological and anthropological science.

This Negrito stock was followed and to a considerable extent absorbed by that which is usually designated the Dravidian. The problem of the origin of this race has been obscured by the unhappy adoption of a linguistic term to designate an ethnical group, and its unwarrantable extension to the lower stratum of the population of northern India. At present the authorities are in conflict on this, the most important question of Indian ethnology. One school denies that this people entered India from the north or north-west on the ground that the immigration of a dolichocephalic race from a brachycephalic area is impossible, and insists that the distinction between the so-called Dravidians and Kolarians is linguistic, not physical. The other theory postulates the origin of the Dravidians from the north-west, that of the Kolarians from the north-east; and avoids the difficulty of head form by referring the Dravidians to one of the long-headed races of central or western Asia or north Africa, or by suggesting that their skull form has become modified on Indian soil by environment or miscegenation.

Recent investigations, archæological or linguistic, throw some new light on this complex problem. Sir T. Holdich, in his recent work "The Gates of India," asserts that Makrán, the sea-board division of Baluchistan, is full of what he calls "Turanian," or Dravidian remains. He explains the position of the Brahui tribe in Baluchistan, on whom the controversy mainly turns, by assuming that while they now call themselves Mingal or Mongal and retain no Dravidian physical characters, the survival of their Dravidian tongue is due to the fact that it is their mother language, preserved by Dravidian women enslaved by Turco-Mongol hordes. Relics of the original Dravidian stock, he suggests, may be found in the Ichthyophagi, or fish-eaters, whom Nearchus, the admiral of Alexander the Great, observed on the Baluchistan coast, living in dwellings made of whale-bones and shells, using arrows and spears of wood hardened in the fire, with claw-like nails and long shaggy hair, a record of the impression made upon the curious Greeks by the first sight of the Indian aborigines.

In the next place, inquiries by Dr. Grierson in the course of the Linguistic Survey prove that what is called the Mon-khmer linguistic family, which preceded the Tibeto-Burmans in the occupation of Burma, at one time prevailed over the whole of Further India, from the Irawadi to the Gulf of Tongking, and extended as far as Assam. To this group the Munda tongue spoken by some hill tribes in Bengal is allied; or, at least, it may be said that languages with a common substratum are now spoken not only in Assam, Burma, Annam, Siam, and Cambodia, but also over the whole of Central India as far west as the Berars. "It is," says Dr. Grierson, "a far cry from Cochin-China to Nimár, and yet, even at the present day, the coincidences between the language of the Korkus of the latter district and the Annamese of Cochin-China are strikingly obvious to any student of language who turns his attention to them. Still further food for reflection is given by the undoubted fact that, on the other side, the Munda languages show clear traces of connection with the speech of the aborigines of Australia." The last assumption has been disputed, and it is unnecessary to discuss this wider ethnical grouping. Though identity of language is a slippery basis on which to found an ethnological theory, it seems obvious that the intrusive wedge of dialects allied to the Mon-Khmer family implies that the Central Indian region was at one time occupied by immigrants who forced their way through the Eastern Himalayan passes, their arrival being antecedent to the migration which introduced the Tai and Tibeto-Burman stocks into Further India.

When the solution of this problem is seriously undertaken under expert guidance, the first step will be to make an exhaustive survey of the group of forest tribes, from the Santáls and Paháriás on the east, passing on to the Kols and Gonds, and ending with the Bhíls on the west. At present our information of the inter-relations of these tribes is fragmentary, and their superficial uniformity does not exclude the possibility that they represent more than one

racial element. It will also be necessary to push inquiry beyond the bounds of the Indian Empire, and, like the trigonometrical surveyor, to fix the base line as a datum in India, and extend the triangulation through the borderlands. It is in these regions that the ethnological problems of India await their final solution. Many of these countries are still beyond our reach. Until the survey of the routes converging at Herat, Kabul, or Kandahar is complete, the extent of the influence of the western races—Assyrian, Babylonian, Iranian, Arab, and Greek—cannot be determined. Recent surveys in Tibet have thrown much light on that region, but it is still only very partially examined. In Nepal the suspicious native Government still bars the way to the Buddhist sites in the Tarai and the Nepal valley, and thus a wide chapter in the extension of Hindu influence beyond the mountain range remains incomplete.

The second great problem is the origin and development of caste. We have yet to seek a definition which will cover the complex phases of this institution, and effect a reconcilement between the views of Indian observers who trace it to the clash of races or colours, and that of the sociologists, who lay little stress on race or colour and rely more upon the influence of environment, physical or moral. We must abandon the insular method which treats it only in relation to India, and ignores the analogous grouping of rank and class which was prepotent in Western Europe and elsewhere, and is now slowly losing ground in the face of industrial development. It is by the study of tribes which are on the borderland of Hinduism that we must look for a solution of the problem. The conflict of the Aryan and aboriginal culture, on which the religious and social systems of Hinduism were based, is reproduced in the contact between modern Hinduism and the forest tribes. Since the Hindus are the only members of the Aryan stock among whom we find endogamous groups with exogamous sections, the suggestion of Prof. Frazer that they may have borrowed it from the non-Aryans gains probability. The Dravidians within the Indian totemic area have worked out an elaborate system of their own, which is well described in the recent survey of the Malayans by Mr. F T. Richards. How far this is connected with their preference for mother-right and their strong family organisation, of a more archaic type than the joint family of the Aryans, is a question which deserves examination. The influence, again, of religion must be considered, and this can be done with the most hopeful results in regions like eastern Bengal, where a people who have only in a very imperfect way adopted Hinduism are now being converted wholesale to Muhammadanism.

Again, when we speak of the tribe in India, we must remember that it assumes at least seven racial types, ranging from the elaborate exogamous groups of the Rajputs to the more archaic form characteristic of the Baloch and Pathán tribes of the western frontier, attached to which are alien sections affiliated by the obligation to join in the common blood-feud, which in process of time develops into a fiction of blood-brotherhood. Thus among the Marri of Baluchistan we can trace the course of evolution: admission to participate in the common blood-feud, admission to participation in a share of the tribal land, and finally admission to kinship in the tribe.

This elasticity of structure has permitted not only the admission of non-Aryan tribes into the Rajput body in modern times, but prepares us to understand how the majority of the Rajputs were created by a similar process of fusion, the new-comers being known as the Gurjaras, who entered India in the train of the Huns in the fifth or sixth centuries of our era. The recognition of this fact, by far the most important contribution made in recent times to the ethnology of India, is due to a group of Bombay scholars, the late Mr. A. M. T. Jackson, whose untimely death at the hand of an assassin we deeply regret, and R. G. and D. R. Bhandarkar. Mr. D. R. Bhandarkar has recently proved that a group of these Gurjara Huns, possibly the tribal priests or genealogists, were admitted first to the rank of Brahmans, and then, by a change of function, of which analogies are found in the older Sanskrit literature, becoming Rajputs, are now represented by the Guhilots, one of the proudest septs. This opens up a new view of tribal and caste development. Now that we can certainly trace the blood of the Huns among the Rajput, Jat, and Gujar tribes, a fresh impulse will be given for the quest of survivals in belief and custom connecting them with their Central Asian kinsfolk.

In what I have said I have preferred to speculate on a problem for work in the future rather than dwell upon the progress which has been already made. In the sphere of religion we have passed the stage when, as Prof. Max Müller said, "the best solvent of the old riddles of mythology is to be found in the etymological analysis of the names of gods and goddesses, heroes and heroines," or when the "disease of language" theory was generally accepted. The position, in fact, has completely changed since Comparative Religion has adopted the methods of Anthropology. The study of myths has given way to that of cults, the former being often only naïve attempts to explain the latter. India offers wide fields for inquiry by these new methods, because it supplies examples of cult in its most varied and instructive phases. The examination of Hinduism, the last existing polytheism of the archaic type, is likely to explain much hitherto obscure in the development of other pantheons. It is no longer possible to refer the complex elements of this or any other group of similar beliefs to a single class of physical concepts. The sun, the dawn, the golden gates of sunset, or the dairy no longer furnish the key which unlocks the secret. It is by the study of the Animism, Shamanism, or Magic of the lower tribes that Hinduism can be interpreted. This analysis shows that behind the myths and legends which shroud the forms of the sectarian gods the dim shape of a Mother goddess appears, at once chthonic or malignant because she gives shelter to the dead, and beneficent because she nurtures the sons of men with the kindly fruits of the earth. Beside her, though his embodiment is much less clearly defined, stands a male deity, her consort, and by a process of magic, mimetic, sympathetic, or homœopathic, their union secures the fertility of the animal and vegetable creation.

Much, however, remains to be done before the problems of this complex polytheism can be fully solved. The action of archaic religions, as has been well said, "takes place in the mysterious twilight of sub-consciousness"; and the foreign observer is trammelled by the elaborate system of tabu with which the Hindu veils the performance of his religious rites. This feeling extends to all classes, and the ceremonial of the jungle shrines is as little open to examination as the *penetralia* of the greater temples. The great army of mendicant friars jealously conceals the secrets of its initiation, rites, and beliefs, and this field of Indian religious life remains practically unworked. Much may be done by the training of a body of native observers who are not subject to the tabu imposed upon the foreigner. Here the difficulty lies in the contempt displayed by the higher educated classes towards the beliefs and usages of the lower tribes. There are some indications that this feeling is passing away, and in recent years much useful ethnological work has been done by native scholars.

The problems of ethnology, so far as they are concerned with the origin of prehistoric races and their relation to the existing population, are more or less academic. Ethnography, which examines the religious, cultural, and industrial conditions of the people, has more practical uses. At the present time it is incumbent upon us to preach, in season and out of season, that the information which it is competent to supply is the true basis of administrative and social reform. If, for example, we were now in possession of the facts which an anthropometrical survey of our home population would supply, many of our social problems would assume a clearer aspect. Such, for instance, are the questions of degeneration due to slum life and malnutrition, the influence of alcoholism on industrial efficiency, the condition of dangerous and sweated industries, and that of the aliens settled in our midst. It is characteristic of the genius of the English people, that while we are not yet prepared to admit the need of such a survey, the provision of medical inspection and relief for children in elementary schools will soon render it inevitable.

This is more clearly the case in those regions where a large native population is controlled by a small European minority. The Negro question in America teaches us a useful lesson, applicable to native races in most parts of

the Empire. In India, whenever the Government has made really serious mistakes, the failure has been due to ignorance or disregard of the beliefs or prejudices of the subject people. A little more than a century ago a mutiny of native troops at Vellore was due to injudicious attempts to change a form of headdress which they believed to be a symbol of their religion or caste; ignorance of the condition of the Santáls allowed them to be driven to frenzy by the extortions of moneylenders which culminated in a serious outbreak; the greased cartridges of the Great Mutiny, and the revolt against measures, adopted in defiance of native feeling to check the plague epidemic, teach a similar lesson.

In India at the present time "the old order changeth, yielding place to new"; and at no period in the history of our rule was it more necessary to effect a reconciliation between the foreigner and the native. While the tabus of marriage relations and commensality will for an indefinite period prevent the amalgamation of the races, much of the present disquiet is due to ignorance and misunderstanding on both sides. The religious and social movements now in progress deserve the attentive study of the British people. In religion various attempts are being made to free Hinduism from some of its most obvious corruptions, to harmonise Eastern and Western ideals, and to elevate the former so as to enable them to resist the pressure of the latter. Such is Vedantism, a revival of the ancient pantheistic philosophy, which not only claims supremacy in India, but asserts that its mission is to replace the dying faiths of the Western world. The spread of monotheism, as represented by Bhagavata beliefs, is equally noteworthy; and the effect of the revival of the cults of Ganpati, god of luck, and of Sivaji, the Mahratta hero, on the political situation in the Deccan deserve the most careful consideration.

The social movement is the result of that fermentation which is in progress among the subject peoples in many parts of the world. While the educated Indian claims social equality with the foreigner, he is occupied with a serious problem at his own doors. The degraded castes, popularly called the "untouchables," are revolting against the obloquy which they have long endured at the hands of the higher races. Many of them have sought relief by joining the Christian or Muhammadan communities, and the progress of conversion is so remarkable as to excite the surprise and alarm of the orthodox classes. Measures have been designed to improve their almost intolerable position. It remains to be seen how far any concessions which are likely to satisfy them can be reconciled with the ideals of the caste system.

It is true that the people of India prefer to celebrate many of their religious and social rites free from observation of the foreigner, and that there are forbidden chambers in the Oriental mind which no stranger may enter. But the experience of those best qualified to express an opinion is that a sympathetic interest in the religious and social life of the people, so far from tending to increase the existing tension, is a valuable aid towards the promotion of mutual goodwill and sympathy. Orthodox native States not only show no aversion to ethnographical inquiry, but are themselves actively engaged in such surveys. Even the Rajputs, who ordinarily display little taste for scientific work, are beginning to undertake the collection of the bardic chronicles which embody their tribal folk-lore and traditions.

When the divergencies in the beliefs and institutions of the foreigner and the indigenous races are realised and understood, a compromise must be effected, each side discarding some hereditary prejudices—the Hindu that aversion to the manners and customs of the European which is the chief barrier to the promotion of intercourse between the races; the European that insularity of thought which makes it difficult for him to understand all that is valuable in novel types of belief and culture, as well as that lack of imagination which inclines him to exaggerate what seems to him intolerable in the economical condition, the social organisation and beliefs of races whose environment differs from his own.

Anthropology has thus a practical as well as a scientific side. The needs of inquirers whose interest mainly lies in the investigation of survivals and in the stages of evolution in culture and belief can, as I have endeavoured to show, be met only by the adoption of improved methods of inquiry and a more rigorous dissection of evidence. Unfortunately the inadequate resources of the societies devoted to the study of man, as contrasted with the extent of the sphere of inquiry and the importance of the savage or semi-savage races as factors in the progress of the Empire, prove that the practical value of anthropology is as yet only imperfectly realised. If its progress is to be continuous we must convince the politician that it has an important part to play in the schemes in which he is interested. Thus it is certain that in the near future the relations between the foreigner and the native races will demand the increasing attention of statesmen at home and abroad. Here anthropology has a wide field of action in the examination of the causes which menace the very existence of the savage; of the condition of the mixed races, like the Mulatto or the Eurasian; of the relations of native law and custom to the higher jurisprudence; of the decay of primitive industries in the face of industrial competition. One of its chief tasks must be the examination of the physical and moral condition of the depressed classes of our home population, and the effect of modern systems of education on the mind and body of the child. It will thus be in a position to assist the servants of the State to meet the ever-increasing responsibilities imposed upon them; and it will help to dispel the ignorance and misconceptions which prevail even among the intelligent classes in this country in regard to the condition of the native races, who, by a strange decree of destiny, have been entrusted to their charge. By such practical contributions to the welfare of humanity it will not only secure the popular interest which is a condition of efficiency, but engage the ever-increasing attention of those to whom its scientific side is of paramount importance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. ARTHUR HALE has been appointed second demonstrator in the chemical department of the Finsbury Technical College.

AMONG the public introductory lectures to be given at University College (University of London) during October, we notice the following:—October 3, niton: one of the argon series of gases, Sir W. Ramsay; October 4, the origin of scenery, Prof. E. J. Garwood; October 6, the life and times of Sennacherib, Dr. T. G. Pinches; recent investigations into the mental growth of children, Dr. C. Spearman; October 10, climatic control, Prof. L. W. Lyde; instinct, Prof. Carveth Read; October 13, experimental phonetics, Mr. D. Jones.

WE see from the calendar of the day section of the Bradford Technical College for next session that, to meet the growing demands and necessities of the textile and other departments, a block of buildings is in course of erection in close proximity to the present college. The buildings for the textile department, when completed and equipped, will be worthy of the chief centre of the wool industry in this country. The new equipment will be of a complete character, enabling wool to be taken in the fleece and turned out, in conjunction with the dyeing and finishing department, in the dyed and finished state. In connection with this extension of the college, it has been decided to put down a plant for the department of engineering which, although primarily intended for educational purposes, will at the same time serve to supply light and power to the present building, the new extensions, and the school of art. From the point of view of both mechanical and electrical engineering students this will constitute a valuable advance. The whole of the plant has been so designed that any one set may be available for demonstration or experiment without interfering with the supply of current for lighting or power. More extended trials will be carried out during the summer months, when only a small portion of the plant is required for generating purposes. Students will thus have excellent opportunities of obtaining practical instruction in steam and electrical engineering, and of becoming acquainted with the running of a power station.