chance efforts of individuals; an organisation is formed with a directing, a centralised authority, to which the whole body defer.

This is now wanted in England for Science, which cannot be cultivated without system, nor can it be governed without system. In a former number of this journal an article from the pen of Prof. Roscoe gave an interesting picture of the scientific organisation of Germany, which may be taken as typical of the Continent. Their arrangements, which carry Government intervention to a point not as yet contemplated by anyone in England, so far from having the deadening effect imputed to Government aid, has produced in large numbers men of the highest attainments and the largest and most original views, and is developing a continuity of results of the greatest practical and theoretical value. The physical education and intelligence of the people is confessedly ahead of that which the same classes in England can boast. The arts in which we once justly claimed pre-eminence are in many instances now more advanced with them than with us mainly because the principles on which they depend are, more assiduously studied, and the artisans by whom they are practised more thoroughly instructed by them than by ourselves. Many branches of trade in England already painfully attest their superiority. As a matter of fact, individual enterprise, which it is so easy glibly to pronounce the incarnation of vigour, has not borne the fruit at home which Government support, with its supposed emasculating tendency, has yielded abroad.

Are we, then, to fall back in the race of nations, to see our trade and our manufactures dwindle away, and our naval and military systems take second rank, because there is an apparent noble independence in the attempt to do single-handed what single hands are proved incapable of doing? We assert that, other things being as nearly equal as variations in religion, customs, and form of government will admit, the degree of cultivation of Science by nations will ultimately determine their places in the human family. No nation on earth has a greater abundance of natural resources and of accumulated wealth than we; no people have higher gifts or nobler aspirations; none need less fear despotic interference from its Government; no nation, therefore, is better qualified to carry out a system which has proved so successful in less-favoured countries.

The question that presses for decision is, What shall we call on the Government to contribute to scientific advancement, and in what manner shall the scientific administration of the future be constituted? The present Government is ready, we doubt not, to perform its part, if only the necessity be shown by competent testimony to exist. It is the duty of men of science, who alone can speak on the subject with authority, to give this testimony, and to help the Legislature to place on a footing worthy of a great nation a department of its duties which has hitherto been, to a most injurious extent, overlooked.

THE THAMES SUBWAY

SEVERAL attempts have been made to pass under the Thames. The chalk and alluvial deposits of the valley at Gravesend would even now offer formidable, if not insurmountable, difficulties to the attempt, once made, to tunnel through strata with water sources so unmanageable. The Thames bed at Limehouse had hidden dangers, which, however, did not succeed in stopping the bold attempt, made some forty years since, to pass beneath the river—an attempt carried in fact to a successful issue in spite of innumerable difficulties, but at an overwhelming expense. The skill and ingenuity displayed were equal to the occasion, but the object attained was not commensurate with the magnitude of the work, and for years it served rather as a warning than an example to be followed.

A better geological knowledge of the Thames valley has, however, been gradually acquired during the last half-century; and it has become evident that while some parts of the valley present the greatest difficulties to the execution of any such work as a tunnel under the river, other parts present conditions singularly favourable for such works. It is found that the chalk *e*, Fig. 2, which disappears at Croydon and reappears at Watford, passes under London at a depth of from 200 to 300 feet; that next over the chalk come beds of sand, shingle, and clay, from 80 to 100 feet thick taken together, *c* and *d*; next above these is a single massive formation of clay, in round numbers from 100 to 200 feet thick under London, and acquiring a still greater thickness—as much as 450 feet—at places not far distant. This clay is so compact and tenacious, that, except in a few places, it is perfectly impervious to water. The various railways in the neighbourhood of London, as at Primrose Hill, Copenhagen Fields, Norwood, and elsewhere, show how readily tunnels can be made through it. It has also been ascertained that this clay, known to geologists as the London Clay, though thin and uncertain at Limehouse, dips westward from that place and gradually acquires a greater thickness, until at London Bridge it forms a mass 129 feet thick. It therefore became evident that while, at and below Limehouse, any tunnel passing under the Thames would have to pass through the soft and permeable beds of sand and shingle lying between the London Clay and the chalk—beds charged with water—forming in fact originally the great water-bearing beds under the London Clay at London, and therefore almost impassable to any tunnel under the Thames; above Limehouse, and thence to London Bridge, the gradually increasing mass of London Clay presents ground more and more favourable for the execution of such a work. If a place could be found where, on the one hand, without going to too great a depth, the alluvial beds on the surface and any accidents in the Thames bed itself, and on the other hand the beds of sands and shingle below the London Clay, could be avoided, while at the same time the intermediate London Clay was thick enough to allow of the passage of a tunnel and for a sufficient thickness of roof and floor, it was clear that at such a place the conditions for the construction of a tunnel would be as favourable as could be desired.

The first to apply this knowledge was Mr. P. H. Barlow, C.E., F.R.S., who fixed upon a spot intermediate between London Bridge and Limehouse (where the thickness of London Clay must be about 80 ft.), and at a sufficient distance below London Bridge to render an underground passage of the Thames a work of great public utility. A space of vacant ground near the western entrance to the Tower was obtained from the Crown; and on the Middlesex side a small wharf offered sufficient width for the tunnel to

pass under, and be carried to the shaft in Vine Street. Allowing for any likely greater depth of a former channel, or for any effect the river might have had on the clay, Mr. Barlow considered he would be safe in allowing a minimum thickness of 20ft. of London Clay to exist between the river and the top of the tunnel—a conjecture, the correctness of which has been fully proved in the execution of the tunnel; for not the slightest percolation of water from the river was detected during any part of the work. It is a question, in fact, whether a less depth might not have sufficed. Greater difficulties were apprehended in the making of the two shafts, as the gravel on either side of the river was known to be charged with water—that on the Middlesex side especially. On the north side of the river the ground rises at Tower Hill, and thence towards the City, to a height of about 40ft. above Thames high-water mark; and the London Clay is capped by a thick bed of gravel, the spring at the base of which supplies so many of the City pumps. This gravel, however, does not slope down to the river, but is cut off at the sloping ground. When the shaft on the north side came to

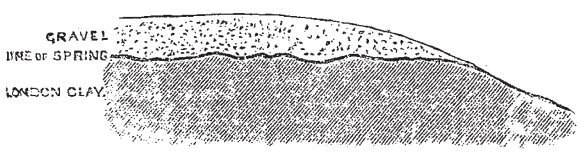

FIG. 1

be made, it was found, after passing this 14ft. of made ground, that the site of it was exactly on this intermediate hill of clay, and that the gravel which thinned out only a few feet higher had therefore been escaped. The shaft consequently was carried without difficulty through the 14 feet of made ground and 44 feet of London Clay to a depth of 58 feet. On the south side, the gravel, alluvial, and made soils, *a*, were found to be 35 feet thick, and charged with water, which rose and fell with the tide (highest just before low water) in the river, to the extent of 3 feet. By the use of iron-tubing, a passage through has been effected, although with more difficulty, and the shaft carried to a depth of 17 feet in the clay *b*, or a total depth of 52 feet. Between these two points Mr. Barlow laid the tunnel at a slight curve, so as to have a depth in the centre 18 feet greater than at the ends. The shafts have a diameter of 10 feet at top and 8½ feet at bottom. The tunnel is 7 feet in diameter, and is formed by cast-iron tubing in lengths of 1½ feet each, each ring being composed of thin segments with a key piece. An iron shield, devised by Mr. Barlow, was pushed on in advance of the work, and the tubes fixed in as soon as the requisite length of excavation had been completed, and the small space left between the clay and tube filled in at once by concrete. The work was carried on day and night, and advanced without interruption. No subsidence occurred in any part, and a regular and steady progress of 9 feet daily was made. Mr. Barlow, junior, is the engineer of the work, and Mr. Greathead the contractor; and the whole plan and execution of the work does very great credit both to the projector, Mr. Barlow, and to the engineer and contractor. With the exception of a slight leak in the iron tubing of the shaft on the south side, and which has been remedied after but a short delay, not the slightest mishap has occurred in the execution of the work, nor has a single fatal or even serious accident happened to any of the men. Last month the junction between the north and south side was effected, and the error of direction from the two ends was found not to amount to one inch. The passage under the river will be made in an omnibus, by means, probably, of a stationary engine; and lifts on either side will take the passengers up and down. A few minutes will suffice for the journey, and it is hoped that the work may be opened to the public in a few weeks. A remarkable feature of this interesting work has been its small cost. Mr. Barlow's estimate was 16,000*l.*, and it is now tolerably certain that the entire cost will be under 18,000*l.* Another feature has been the rapidity of execution. The shaft on the north side was commenced on the 16th of February last. On the 26th of April the tunnel, which is 1,320 feet long, was commenced, and on the 8th of October the passage under the river was safely effected. Before the public at large was aware that another Thames Tunnel was completed, the old London wonder has been duplicated.

As the object has been chiefly to speak of the geological problem, a section is annexed to show the structure of the ground at this part of the river.

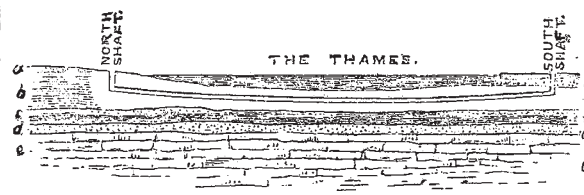

FIG. 2

Very few fossils were found, and these chiefly in the clay of the north shaft. They consist of *Cryptodon angulatum*, *Corbula globosa*, *Pinna affinis*, *Dentalum nitens*, *Fusus*, and column of *Pentencrinite*. In the tunnel pieces of wood pierced by the *Teredo*, and some teeth of Shark, were met with. As the London Clay thickens to the west and north-west, and extends uninterruptedly to Windsor on the one hand and to Watford on the other, covered in places near London by beds of gravel and sand, which never, however, exceed thirty to forty feet in thickness, and rarely exceed fifteen feet, there is thus in this area a formation which lends itself singularly well to the construction of subways and tunnels.

J. PRESTWICH

THE MAMMALIA OF SWITZERLAND.

Faune des Vertébrés de la Suisse. Par Victor Fatio Dr. Phil. Vol. I. *Histoire Naturelle des Mammifères.* (H. Georg, Genève et Bale, 1869.)

M. FATIO'S book is one which will be valuable to all Swiss naturalists, and to those who take an interest in the productions of the mountainous region of central Europe. It fulfils its function admirably as far as it goes, but, like all works treating of local Faunas or Floras, its general interest is diminished in proportion to the diminution of the area investigated. It has not, for example, the importance or value to a distant reader which such a volume as the "Naturgesch. der Säugethiere Deutschlands und Mitteleuropas" of Blasius possesses; but to local natu-