determined, all the principal engineering constants, from the tenacity of wrought-iron to the calorific value of coal, or the efficiency of a steam-engine, or the accuracy of an indicator-spring, or the discharge-coefficient of an orifice. He thought that this kind of practical experience could be gained best in an Engineering Laboratory, in connection with some institution where technical instruction was given. He claimed that, in the matter of engineering laboratories, as a branch of technical education, England had really taken the lead, instead of being, as was too often the case in such matters, in the rear.

After distinguishing between laboratories whose chief function was original investigation or research, and those whose main object was the practical education of young engineers, and after giving an outline of the method of work which he had adopted, he went on to enumerate the principal subjects upon which experiments in an engineering laboratory might be carried out, summarising them thus:—(1) Elasticity and the strength of materials; (2) the economy, efficiency, and general working of prime movers, and especially of the steam-engine and boiler; (3) friction; (4) the accuracy of the apparatus commonly used for experimentation, such as springs, indicators, dynamometers, gauges of various kinds, &c.; (5) the discharge over weirs and through orifices, and hydraulic experiments in general; (6) the theory of structures; (7) the form and efficiency of cutting-tools; (8) the efficiency of machines, especially of machine-tools and of transmission-gearing; (9) the action and efficiency of pumps and valves; (10) the resistance of vessels and of propellers, and experiments in general connected with both. The paper dealt mainly with the three first subjects, the others receiving brief mention only.

In discussing the best form of testing-machine for laboratory purposes the author described specially the Werder machine, used by Bauschinger and largely elsewhere in engineering laboratories on the Continent, the vertical machine of Mr. J. H. Wicksteed, and the horizontal machine of Messrs. Greenwood and Batley, on Mr. Kirkaldy's principle, used by himself. Incidentally he described a number of other testing-machines, including the Emery machine at the United States Arsenal at Watertown, Fairbanks' machine, and others. The three machines first named were compared in some detail in respect to their accuracy, mode of applying load, methods of making observations, adaptability for varied experiments, simplicity, and accessibility, and the comparative advantages and disadvantages of each were discussed, the author preferring, on the whole, the Greenwood type. The method of testing employed by the author, with pump, accumulator, and Davy motor, was then described and illustrated,

Different apparatus for the measurement of minute extensions, compressions, &c., occurring below the limit of elasticity, were next discussed, the instruments specially mentioned being those of Prof. Unwin, Prof. Bauschinger, Mr. Stromeyer, and the author, as representing micrometric, optical, and mechanical exaggeration of strains. Automatic test-recording apparatus was next dealt with, Prof. Unwin's, Mr. Wicksteed's, Mr. Ashcroft's, and the author's diagramming machines being mentioned and illustrated. Automatic diagramming apparatus for elastic strains was next discussed. The paper contained *facsimiles* of various diagrams, both ordinary and elastic. In concluding this section of the paper, brief references were made to machines for transverse tests, torsional tests, shearing tests, cement and wire tests, secular experiments, experiments on repeated loads, &c.

In discussing the design of an experimental engine for laboratory purposes, the author first enumerated the principal conditions under which such an engine should be capable of working, summarising them thus:—(1) Condensing or non-condensing; (2) simple or compound; (3) compound, with cranks at various angles; (4) with the greatest possible variation of steam-pressure; (5) with the greatest possible variation of cut-off and other points in the steam distribution; (6) with the greatest possible variation of brake-power; (7) with considerable variation in speed; (8) with or without throttling; (9) with or without jackets, and with varying conditions as to their use; (10) with variation of clearance-spaces; (11) with variation of receiver-volume; (12) with or without arrangements for intermediate heating; (13) with variation in the reciprocating masses. He then enumerated the principal quantities which had to be measured during an engine-test. making remarks upon each important point in passing. A list was given of the principal experimental engines in existence, including those in London, Birmingham, Leeds, Munich, and Liége. This section was concluded by a description of the arrangement of an experimental boiler.

Under the head of friction-experiments, the principal points were summarised upon which experiments were required, in order that anything like a complete theory of friction in machines might be worked out. These included the variations of velocity, intensity of pressure, extent of contact, temperature, lubricant, method of lubrication, and nature of rubbing material. Friction-measuring machines, used or proposed by Prof. Thurston, Prof. R. H. Smith, Mr. Tower, and himself, were briefly described. The paper concluded with a few remarks on laboratory experiments connected with hydraulic work, the theory of structures, the form and efficiency of cutting-tools, the efficiency of machines and of transmissions, the action and efficiency of pumps and valves, and the resistance of vessels and propellers.

In an appendix there were added:—(*a*) Forms used by the author for conducting engine-trials. (*b*) Notes on the principal engineering laboratories in Europe and in America, with brief accounts of the chief apparatus used in each.

BIRDS' NESTS AND EGGS[1]

THE philosophy of birds' nests and eggs involves questions far too profound to be settled in an hour's lecture. The extreme partisans of one school regard birds as *organic automata*. They take a Calvinistic view of bird-life: they assume that the hedge-sparrow lays a blue egg because, under the stern law of protective selection, every hedge-sparrow's egg that was not blue was tried in the high court of Evolution, under the clause relative to the survival of the fittest, and condemned, a hungry magpie or crow being the executioner. The extreme partisans of the other school take an entirely opposite view. They regard the little hedge-sparrow, not only as a free agent, but as a highly intelligent one, who lays blue eggs because the inherited experience of many generations has convinced her that, everything considered, blue is the most suitable colour for eggs.

Perhaps the first generalisation that the egg-collector is likely to make is the fact that birds that breed in holes lay white eggs. The sand-martin and the kingfisher, which lay their eggs at the end of a long burrow in a bank, as well as the owl and the woodpecker, which breed in holes in trees, all lay white eggs. The fact of the eggs being white, and consequently very conspicuous, may have been the cause, the effect being that only those kingfishers which bred in holes survived in the struggle for existence against the marauding magpie. But the converse argument is equally intelligible. The fact that kingfishers breed in holes may have been the cause, and the whiteness of the eggs the effect; for why should Nature, who is generally so economical, waste her colouring-matter on an egg which, being incubated in the dark, can never be seen? The fact that many petrels and most puffins, which breed in holes, have traces of spots on their eggs, whilst their relations the auks and the gulls, who lay their eggs in open nests, nearly all lay highly-coloured eggs, suggests the theory that the former birds have comparatively recently adopted the habit of breeding in holes, and that consequently the colour being no longer of use is gradually fading away. Hence, we assume that the colour of the egg is probably the effect of the nature of the locality in which it is laid.

The second generalisation which the egg-collector is likely to make is the fact that so many of these birds which breed in holes are gorgeously coloured, such as kingfishers, parrots, bee-eaters, &c. The question naturally arises, Why is it so? The advocates of protective selection reply, Because their gay plumage made them so conspicuous as they sat upon their nests, that those that did not breed in holes became the victims of the devouring hawk, exactly as the conspicuous white eggs were eaten by the marauding magpie. But the advocates of sexual selection say that all birds are equally vain, and wear as fine clothes as Nature will let them, and that the kingfisher is able to dress as gorgeously as he does because he is prudent enough to breed in a hole safe from the prying eyes of the devouring hawk. The fact that many birds, such as the sand-martin and

[1] Abstract of a lecture delivered by Mr. H. Seebohm at the London Institution on December 20, 1886.

the dipper, which breed in holes, are not gorgeously coloured, while others, such as the pheasants and the humming-birds, are gorgeously coloured, but do not breed in holes, is evidence, as far as it goes, that the gorgeous colour of the bird is not the effect of its breeding in a hole, though the white colour of the egg probably is. It must be admitted, however, that the latter cases are not parallel. Whilst the hen kingfishers and bee-eaters are as gorgeous as their mates, the hen pheasants and the hen humming-birds are plainly, not to say shabbily, dressed. If birds be as vain as the advocates of sexual selection deem them, it must be a source of deep mortification to a hen humming-bird to have to pass through life as a foil to her rainbow-hued mate. Whilst the kingfisher relies for the safety of its eggs upon the concealed situation of its nest, the humming-bird depends upon the unobtrusiveness of the plumage of the sitting hen.

A very large number of birds, such as the grouse, the merlin, most gulls and terns, and all sandpipers and plovers rely for the safety of their eggs upon the similarity of their colour to the ground on which they are placed. It may be an open question whether these birds select a site for their breeding-ground to match the colour of the eggs, or whether they have gradually changed the colour of their eggs to match the ground on which they breed; but, in the absence of any evidence to the contrary, it is perhaps fair to assume, as in the previously mentioned cases, that the position of the nest is the cause, and the colour of the egg the effect.

Many birds make their nests in lofty trees, or on the ledges of precipitous cliffs. Of these, the eagles, vultures, and crows are conspicuous examples. They are, for the most part, too powerful to be afraid of the marauding magpie, and only fear the attacks of beasts of prey, amongst which they doubtless classify the human race. They rely for the safety of their eggs on the inaccessible positions of the nest. Many of them also belong to a still larger group of birds who rely for the safety of their eggs upon their own ability, either singly, in pairs, or in colonies, to defend them against all aggressors. Few colonies of birds are more interesting than those of herons, cormorants, and their respective allies. These birds lay white or nearly white eggs. Nature, with her customary thrift, has lavished no colour upon them because, apparently, it would have been wasted effort to do so; but the eggs of the guillemot are a remarkable exception to this rule. Few eggs are more gorgeously coloured, and no eggs exhibit such a variety of colour. It is impossible to suppose that protective selection can have produced colours so conspicuous on the white ledges of the chalk cliffs; and sexual selection must have been equally powerless. It would be too ludicrous a suggestion to suppose that a cock guillemot fell in love with a plain-coloured hen because he remembered that last season she laid a gay-coloured egg. It cannot be accident that causes the guillemot's eggs to be so handsome and so varied. In the case of birds breeding in holes secure from the prying eyes of the marauding magpie, no colour is wasted where it is not wanted.

The more deeply Nature is studied, the more certain seems to be the conclusion that all her endless variety is the result of evolution. It seems also to be more and more certain that natural selection is not the cause of evolution, but only its guide. Variation is the cause of evolution, but the cause of variation is *unknown*. It seems to be a mistake to call variation spontaneous, fortuitous, or accidental, than which expressions no adjectives less accurate or more misleading could be found. The Athenian philosophers displayed a less unscientific attitude of mind towards the Unknown when they built an altar in its honour.

SCIENTIFIC SERIALS

American Journal of Science, December 1886.—On the crystallisation of native copper, by Edward S. Dana. This elaborate memoir, which is illustrated with four plates figuring fifty-four varieties of native copper crystalline forms, is based chiefly on the fine collection of over sixty specimens from Lake Superior, belonging to Mr. Clarence S. Bement, of Philadelphia, supplemented by reference to the cabinets of Yale College Museum and Prof. G. J. Brush. The planes here determined are disposed in the three groups of tetrahexahedrons, trisoctahedrons, and hexoctahedrons, and include several new to the species. The paper also comprises an historical summary from the studies of Haüy and Mohs (1822) to the recent contributions of W. G. Brown.—On the trap and sandstone in the gorge of the Farmington River at Tariffville, Connecticut, by W. North Rice. The trap and sandstone of this locality are here specially studied with a view to the general elucidation of the history of these formations in the Connecticut Valley. The author's researches confirm the conclusion already arrived at by Prof. W. M. Davis, that some of the sheets of trap intercalated among the sandstones and associated rocks are contemporaneous, and others intrusive.—Comparative studies upon the glaciation of North America, Great Britain, and Ireland, by Prof. H. Carvill Lewis. This is an abstract of a paper by the author, read at the Birmingham meeting of the British Association last September. Its object is to show that the glacial deposits of the British Isles, like those of America, may be best interpreted by considering them with reference to a series of great *terminal moraines*, which both define confluent lobes of ice, and often mark the line separating the glaciated from the non-glaciated areas.—On certain fossiliferous limestones of Columbia County, New York, and their relation to the Hudson River shales and the Taconic system, by J. P. Bishop. The author describes some new fossils recently discovered in a metamorphic limestone occurring in the Chatham and Ghent districts on the western border of the Taconic slates of Columbia county, and tending to throw further light on the age of the Taconic formation. His investigations are still in progress, but from the facts so far determined, he considers that the fossils are of Trenton age, suggesting a synclinal having the Trenton limestone outcropping on both sides, and with the eastern edge pushed over westward.—Crystallised vanadinite from Arizona and New Mexico, by S. L. Penfield. The specimens here described and figured belong partly to the collection of the late Prof. B. Silliman, partly to that of Prof. Geo. J. Brush. Those from Pinal County, Arizona, are specially interesting, being of a deep red colour, and usually showing the very simple combinations already described by L. H. Blake.—The viscosity of steel and its relations to temper, by C. Barus and V. Strouhal. Having during the course of their former researches expressed the belief that the qualities of retaining magnetism exhibited by steel would probably stand in relation to the viscous properties of the metals, the authors here make a first search for such a relation. For several reasons their investigations are limited to torsional viscosity, and a new and very sensitive differential method is partially developed for the study of this property, with incidental reference to the viscosity of iron and glass. The results of the method as applied to steel are further compared with the known behaviour of permanent linear magnets tempered under like conditions.—Some remarks upon the journey of André Michaux to the high mountains of Carolina in December 1788, in a letter addressed to Prof. Asa Gray, by C. S. Sargent. Michaux's chief object was to secure living specimens of *Magnolia cordata*, and the locality explored by him appears to have been the highland region of North and South Carolina about the head waters of the Savannah River. The author has recently visited the same district for the purpose of re-discovering the same plant where Michaux was thought to have found it, but he searched for it in vain, and he concludes that Michaux's *Magnolia cordata*, as known in gardens, must be regarded as a rare and local variety of *M. acuminata*.—Note on the age of the Swedish Paradoxides beds, by S. W. Ford. It is argued on several grounds that these beds, or at any rate those above the division characterised by *Paradoxides kjerulfi*, are of the age of the Menevian group. Even this species should probably be referred to the same group, so that the strata containing it may be regarded as constituting a legitimate portion of the Swedish Paradoxides measures.

Rivista Scientifico-Industriale, November 1886.—On the development of atmospheric electricity which accompanies the condensation of aqueous vapour to rain or snow caused by a lowering of the temperature, by Prof. Luigi Palmieri. Those physicists who still doubt the reality of this phenomenon are recommended to conduct their researches with the Bohnenberger electroscope, as perfected by the author.—On the electric conductibility of vapours and gases, by Prof. Constantino Rovelli. Some experiments are described, fully confirming the important conclusions recently announced by Prof. Luvini regarding the non-conducting property of aqueous vapour.—On the pairing-season of frogs and toads in the Venetian district, by Dr. Alessandro P. Ninni. This period is shown to be determined by the atmospheric conditions, being advanced or retarded according to the mildness or severity of the weather in spring.