substances it is disengaged from them." In order to determine the quantity of air disengaged from any substance during distillation or fusion, Hales placed the substance in a retort, and luted the retort to a large receiver with a small hole, at the bottom; water was caused to occupy a known space in the receiver, and the amount of air expelled was estimated by noting the amount of water remaining in the receiver at the conclusion of the experiment, after cooling. Hales employed the following apparatus (Fig. 21) to measure the volume of air generated by any kind of fermentation, also by the reaction of one body upon another.

The substances undergoing fermentation were placed in *b*, and over the whole a vessel, *a y*, was inverted, closed below by the vessel *x x*, and containing above a certain amount of air, to the level *y*. If air were generated, the water in *a* sank (say to *y*); while if air were absorbed by the bodies in *b*, the water rose (say to *n*). Sometimes he placed different substances on pedestals in a jar of air, and ignited them, as Mayow had done, by a burning-glass, and noted the alteration in the bulk of air. He did this with phosphorus, brown paper dipped in nitre, sulphur, and other substances. If he required to act upon substances by means of a strong acid, he would place the substance in a

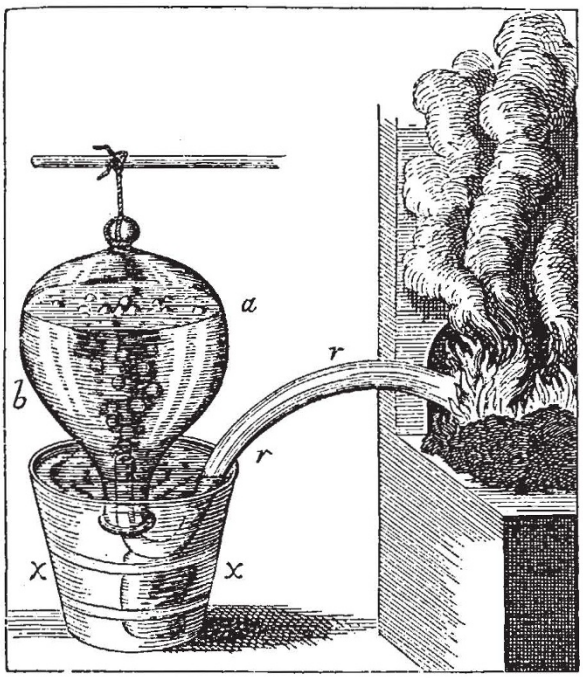

FIG. 23.—Hales' pneumatic experiments.

suitable vessel on a pedestal in a known volume of air, standing over water, and would suspend over it a phial which could be emptied by pulling a string. These devices were closely copied by Priestley and Lavoisier in their experiments upon gaseous bodies. If a substance required to be heated violently, it was placed in a bent gun-barrel, *r r* (Fig. 23), one end of which was placed in a furnace, while the other was placed under a bell jar, *a b*, full of water, inserted in the pail of water *x x*. He distilled a number of substances, apparently taken at random, and determined the amount of gas evolved, but he appears to have been at no pains to determine the nature of the gas, assuming it to be ordinary atmospheric air. Thus he distilled 1 cubic inch of lard, and collected thirty-three cubic inches of gas as the products of decomposition. Tallow, horn, sal ammoniac, oyster shells, peas, amber, camphire, and many other substances, were similarly treated.

Two grains of phosphorus ignited in a closed vessel of air, were found to absorb 28 cubic inches of air. 211 grains of nitre mixed with bone-ash yielded 90 cubic inches of gas; 54 cubic inches of water on boiling yielded 1 cubic inch of air. In order to measure the elastic force of the gas produced by fermenting peas, Hales filled a small, strong bottle, *c* (Fig. 22) with peas, filling up the interstices with water; mercury to a depth of half an inch was then poured in, and of course remained at the bottom of the vessel *c*. A long tube, *a z*, the lower end of which dipped beneath the mercury, was securely fastened into the mouth of the bottle *b*, and fixed air-tight. In a few days' time the peas were in a state of fermentation, and the generated gas had forced the mercury to ascend in the tube *a z* to a height of 80 inches, hence the gas in *c* was existing under a pressure of about 35 lbs. on the square inch.

Hales also produced gases by various reactions. Thus he poured a cubic inch of sulphuric acid on half a cubic inch of iron filings: no effect took place until he had diluted the acid with water, when forty-three cubic inches of *air* (as he calls it—in reality hydrogen gas) came off. Iron filings mixed with nitric acid, or with ammonia, or sulphur, were found to absorb air. A cubic inch of chalk treated with dilute sulphuric acid produced thirty-one cubic inches of *air* (in reality carbonic anhydride gas). If space permitted, we could say much more of Hales' works. His experiments on respiration, and on various principles of vegetation, are exceedingly ingenious, and often accurate. It has often been said that Lavoisier created modern chemistry by the introduction of the balance into chemical experiments, but here we find Hales weighing his substances, and measuring his gases, years before Lavoisier was born. Hales did not sufficiently investigate the nature of the various gases which he produced in the course of his experiments, but he assuredly paved the way for many of the after discoveries of Priestley, Cavendish, and Lavoisier.

Dr. Hermann Boerhaave, of Leyden (b. 1668, d. 1738), was a contemporary of Hales. He was the author of the first comprehensive system of chemistry:—a bulky quarto in two volumes, entitled *Elementa Chemiæ*, which appeared in 1732, and which for many years was the chemical text-book of Europe. In it he defines chemistry as "an art which teaches the manner of performing certain physical operations, whereby bodies cognizable to the senses, or capable of being rendered cognizable, and of being contained in vessels, are so changed by means of proper instruments, as to produce certain determinate effects, and at the same time discover the causes thereof for the service of various arts."

But hold! our task was to give some account of the *birth* of chemistry, while a science with such a ponderous definition as the above, is no longer infantile. The babe has grown up about us until it has assumed a tremendous individuality. The great discoveries of the fathers of modern chemistry, Lavoisier, Scheele, Priestley, Cavendish, Davy, need not be told here; they belong to the later history of chemistry. We have traced the science from its commencement in the crude metallurgical and other operations of the ancients, to the time when a comprehensive system of the science appeared. And when we think of the vast dimensions of the science of to-day, the numberless text-books in every language, the great laboratories springing up in every country, the immense amount of original research, we are carried back in spirit to those mistaken—but often grandly energetic men—who said to the disciples of their art:—

Ora!
Lege, Lege, Lege, Relege, Labora!
Et Invenies.

G. F. RODWELL

SCIENTIFIC SERIALS

Bulletin Mensuel de la Société d'Acclimatation de Paris. The April number contains much interesting information as to the work done by the Society, which besides gratuitously distributing specimens of various useful animals or plants wherever they are likely to thrive, also lends or lets to those persons, whose tastes or knowledge fit them for the charge, some of the rarer species of animal or vegetable life, thus sowing the seeds of miniature *jardins d'acclimatation* throughout the country. During the last 12 months 3 monkeys have been born at the Paris Gardens, one of them in March last. In that month 75 mammalia and 1,669 birds of various sorts were received, while the Society was able to distribute 62 mammalia and 1,731 birds. The Society aims at encouraging the reproduction of all sorts of useful animals, not merely confining its efforts to the maintenance of a stock for exhibition. An interesting account is given of an oyster breeding establishment and aquarium at Biarritz, and of the cultivation of silkworms in France generally. Our French neighbours have set us the example of cultivating

our oysters; we may learn some day to follow in their steps and turn our attention, so far as our climate will allow of it, to the "education" of silkworms. This art is becoming quite a recognised industry in France, and the success that has attended its adoption is very gratifying. Bamboos, Spanish broom (*Stipa tenacissima*), China grass or China nettles, Californian pines (*Pinus sabiniana*), are among the plants which are referred to as proper to be introduced into France.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, May 8.—Dr. Hirst, F.R.S., in the chair. Prof. Cayley communicated an extract from a letter he had received from M. Hermite "On an application of the theory of unicursal curves," and then gave accounts of the two following papers, "Plan of a curve-tracing apparatus," and "On a rational quintic correspondence of two points in a plane:" another paper entitled "Bicursal curves" (*i.e.* curves with a deficiency *one*) by the same gentleman, was taken as read.—Mr. S. Roberts read a short "Note on the Plückerian characteristics of epi- and hypo-trochoids," &c., showing that the curves were unicursal: he gave also the order and class. In connection with these curves Mr. J. L. Glaisher advocated the use of Mr. Perigal's term "bicircloids." Amongst the presents received were twenty-two memoirs, &c., by the late Prof. de Morgan, presented by Mrs. de Morgan.

Geological Society, April 30.—Joseph Prestwich, F.R.S., vice-president, in the chair.—On the Permian Breccias and Boulder-beds of Armagh, by Prof. Edward Hull, F.R.S., Director of the Geological Survey of Ireland. In this paper the author described certain breccias occurring in the vicinity of Armagh, which he referred, both on stratigraphical and physical grounds, to the Lower Permian series, considering them to be identical with the "brockram" of Cumberland, and the Breccias of Worcestershire and Shropshire. The author further referred to the extensive denudation which the Carboniferous beds have undergone in Armagh, and also alluded to the occurrence of beds of Permian age near Benburb, between Armagh and Dungannon.—Geological Notes on Griqualand West, by G. W. Stow. The geological results of a journey made by Mr G. W. Stow and Mr. F. H. S. Orpen from the Orange Free State into Griqualand West are communicated by Mr. Stow in this paper, with numerous carefully executed sections and a geological map based on the survey map prepared by Mr. Orpen for the Government. From the junction of the Riet and Modder Rivers (south of the Panneveldt Diamond-fields) to Kheis and the Schurwe Bergen, the track traversed three degrees of longitude. The return route north-east to Mount Huxley and Daniel's Kuil, and eastward to Likatlong, on the Hart or Kolang River, was nearly as long. From the Modder, first south-westward and then westward, to the junction of the Vaal and Orange, the olive shales of the *Dicynodon*- or Karoo-series, traversed frequently by igneous rocks, form the country, and are seen in some places to lie unconformably on older rocks. The shales reach to the end of the Campbell Randt, on the other side of the Orange River, and have been, it seems, formed of the débris of those old hills to a great extent. The oldest rocks of the locality are seen cropping out here and there in the gorges at the foot of the Randt, and consist of metamorphic rocks, greatly denuded, on which the massive and extensive siliceo-calcareous strata of the Great Campbell Plateau lie unconformably. These latter and the breccias of their slopes are coated thickly with enormous travertine deposits. Igneous rock-masses occur around Ongeluk, west of the Jasper range, and then bright-red jasper rocks crop up near Matsáp, succeeded to the west by the parallel quartzite range of Matsáp, and again by other bedded jaspers, which seem to lie in a synclinal of the quartzite rocks, which come up again in the Langeberg. These are succeeded by lower rocks, consisting largely of sandstone, grit, and quartzite, with more or less pervading mica, as far as the journey extended in the Schurwe Bergen, also parallel to the former ranges. The maximum thickness of the successive strata is calculated by the author at 24,000 ft.; allowing for possible reduplications, the minimum is regarded as not less than 9,000 ft. —On some Bivalve Entomostraca, chiefly Cypridinidæ, of the Carboniferous formations, by Prof. T. R. Jones, F.R.S. The larger forms of bivalved Entomostraca are not rare in the Carboniferous limestone, and some occur in certain shales of the Coal-measures.

Geologists' Association, May 2.—H. Woodward, F.R.S., president, in the chair.—On the valley of the Vézère (Perigord), its limestones, caves, and pre-historic remains, by Prof. T. Rupert Jones, F.R.S., F.G.S. The river Vézère, rising in the department of Corrèze, traversing the department Dordogne, and joining the river Dordogne near Larlat, runs from the old metamorphic rocks of the central plateau of France, through carboniferous, triassic, jurassic, and cretaceous strata. The last mentioned are chiefly limestones, nearly horizontal, presenting steep and often high cliffs, either washed by the river, or bordering its broader and older valley. The softer bands of limestone have been hollowed out along the valley by frost and water, and here and there present recesses and caves. These in several instances have been artificially enlarged, and in very many cases have afforded shelter to pre-historic people, and still retain heaps of bones and hearth-stuff, with flint implements of numerous kinds, carved bones and antlers, and occasionally human bones. The most common bones and antlers are those of reindeer, which must have abounded in southern France, whether remaining all the year round or migrating from plain to mountain and back again in their season, for the cave-folk killed them of all ages in vast numbers. The cold climate necessary for the reindeer has long passed away; the musk-ox and the hairy mammoth disappeared also with the reindeer; and looking at the great changes in geographical outlines and contours that have taken place since the extinction of the European mammoth, the author thought that some eight or nine thousand years would not be too long for the bringing about of such changes. That the Old cave folk of Périgord saw the living mammoth, a lively outline sketch of its peculiar and shaggy form, on a piece of ivory, found in the Madelaine Cave, is satisfactory evidence. The special geology of the district, the characters of the several caves and their contents, and the most striking of the implements of stone and bone were described in this paper; the human remains found at Cro-Magnon, a gigantic chief and his more ordinary companions, were specially treated of; and the high probability of their belonging to the same race of men as the older Cave-folk was discussed at some length. (For details on this subject see NATURE, vol. vii. p. 305 *et seq.*)

Anthropological Institute, May 6.—Col. A. Lane Fox, V.P. in the chair. A paper was read on "Eastern Coolie Labour," by Mr. W. L. Distant. The aim of the paper was to show the dissimilarity in the capacity and aptitude for certain work which exists among different peoples under the same conditions. The working of a large sugar estate by means of European capital, European appliances, and European superintendence, with the manual labour of some hundreds of Asiatics, including Klings, Chinese, Javanese, and Malays, was taken as an example. In describing the labours of these peoples, the differences were examined in their capacity for work in general, their aptitudes and dislikes for certain work, and also in their methods of working, viz. by task or otherwise, taken in conjunction with their social condition, and the terms under which they are engaged. In contact with the European the Chinaman seems to prosper; he bargains with him, whilst the Javanese sullenly works for him, and the Kling sinks to a crouching menial in his presence. The European seems affected in the same way; he can chat with the Chinese, tolerate the Javanese, but despises the Kling. European civilisation and prejudice are confronted with Eastern ignorance and prejudice. It is the need of money that has brought these different peoples together. English, Scotch, Portuguese, Klings, Javanese and Chinese are only attracted together in the hope of gain, and under this creed progress and civilisation generally remain in the hands of the strongest and richest party.—A paper by Mr. Howorth was read on "The westerly Drifting of Nomads from the fifth to the nineteenth century, Part x.: the Alans or Lesghs." Col. Lane Fox exhibited two beautifully chipped flint bracelets, four iron bracelets, and other articles found in a tomb in the valley leading to the tombs of the Kings of Thebes; also a large and finely worked flint knife from a tomb in the same neighbourhood. Lieut. S. C. Holland, R.N., exhibited a series of photographs of Ainos, and various articles of Aino manufacture.—The Rev. Dunbar I. Heath has been elected Treasurer in the place of the late Mr. Flower.

Zoological Society, May 6.—Prof. Newton, F.R.S., vice-president, in the chair. The secretary read a report on the additions that had been made to the Society's menagerie during the months of March and April, 1873, and called particular attention to an example of the Broad Banded Armadillo (*Xenu-*