

and the melancholy increase of insanity, suicide, divorce, and crimes that strike at the root of family life. These failures are blemishes upon the century like patches of lupus on the face of a maiden otherwise fair to see. They are as characteristic of the century as are its successes. The indiscriminate panegyrist sees them not or ignores them. And yet they cannot be passed over in any review of the nineteenth century that lays claim to impartiality.

'Truths already Won.'

The feature of the nineteenth century which strikes the eye of the observer most directly and immediately is the extraordinary development which it witnessed within the realms of physical science and invention. In these as in certain other respects it occupies an altogether singular place in history. Few discoveries or inventions, however, stand quite alone. They are usually, as Sir MICHAEL FOSTER has pointed out, 'born of the truths already won.' STANLEY JEVONS, for instance, has shown how 'the science of heat may be said to commence with the construction of the first thermometer,' and to be greatly advanced by the thermo-electric pile; and how chemistry has been created chiefly by the careful use of the balance, which still remains 'substantially in the form in which it was first applied to scientific purposes by ARCHIMEDES' two centuries before the birth of CHRIST. But in almost every branch of invention and discovery Catholics have ever occupied an honorable place as originators and pioneers.

Chemistry.

In the fields of chemistry and physics discovery tripped the heels of discovery in a way that was bewildering to old-fashioned people who were wedded to the snuffers, the flint and steel, the stage coach, the blunderbuss, and 'the tinkling harpsichord' of a century ago. Modern chemistry owed much to the investigations of the old alchemists who toiled and moiled in a vain search for the philosopher's stone. The late Professor C. S. WIERTZ said that modern chemistry is a French science. Its founder was LAVOISIER, a pious French Catholic whose head was docked by the guillotine during the wild troubles of 1794. And ever since his day the working theories of the science, its philosophy, and a great number of its most important discoveries have, says Dr. ZAHM, 'given to the French a prestige and a position as chemical investigators that place them far in advance of their competitors.' Three of the most distinguished chemists of modern times were Frenchmen and devout Catholics: HENRI VICTOIRE DUMAS, MICHEL CHEVREUL, and ANTOINE CESAR BECQUEREL. The last mentioned was the creator of the science of electro-chemistry. Another great and devout Catholic savant was LOUIS PASTEUR: chemist, microscopist, bacteriologist, physicist, and altogether one of the most remarkable scientific men of any age or country. So far back as 1856 he was noted throughout Europe for the originality and success of his investigations into the hidden activities of nature. He traced diseases to their source. He clapped bit and bridle, so to speak, upon microscopic organisms and trained them to aid the human being to combat disease. His discoveries enabled LISTER to devise the antiseptic system of treatment now universally applied in surgery. He was greatly distinguished for his researches in fermentation; discovered the bacilli of various putrefactive diseases; introduced preventive methods circumventing their depredations by inoculation; and discovered antidotes for hydrophobia and for various diseases that till his day had wrought red havoc among fowls, sheep, cattle, and silkworms. Of English chemists the most distinguished were JOHN DALTON and Sir HUMPHRY DAVY. The latter saved great numbers of lives in coal-mines, etc., by his invention of the safety lamp. Metallurgical chemistry has smoothed the path and lined the pockets of the miner and enabled KRUPP, BESSEMER, ARMSTRONG, and others to revolutionise the manufacture of iron and steel. In the person of the agricultural chemist, the nineteenth century produced the great public benefactor foreshadowed by Dean SWIFT in the eighteenth. 'Whoever,' said the Dean of St. Patrick's in his *Gulliver's Travels* (1726), 'could make two ears of corn, or two blades of grass, to grow upon a spot where only one grew before, would deserve better of mankind and do more essential service to his country than the whole race of politicians put together.' Organic chemistry

has given us, among other things, high explosives such as dynamite and nitro-glycerine, coal-tar and its wonderful series of dyes and other by-products; it has produced artificially dye indigo, citric acid, and other substances long supposed to be due to organic processes alone, and has led to some of the best known and most popular discoveries of the nineteenth century. And experiments in phenomenally low temperatures and in the raging heat of the electric furnace have liquefied and even solidified the various gases and melted or vaporised the most solid and hitherto refractory elements in nature.

Some Applications of Chemistry.

Several important inventions which were devised or brought into common use during the departed century were essentially applications of chemistry. Among these were gas illumination, petroleum-oil lamps, lucifer matches, and photography. The honor of having first used an installation for lighting by coal gas (or carburetted hydrogen) belongs to PIERRE MINKELERS, a Professor in the great Belgian Catholic University of Louvain. This distinguished physicist lighted up his lecture room in the University with the new illuminant in 1784—eight years before carburetted hydrogen was used for the first time in Great Britain by WILLIAM MURDOCK to light his workshops at Redruth in Cornwall. The first application of coal gas for out-door purposes was made in 1818. Westminster Bridge (London) was then successfully lighted by the new illuminant, and the link-boy's occupation was doomed. The old flint and steel and tinder held their place without serious competition as practically the only means known to civilised peoples of striking a light till the first quarter of the century had gone by. Then, in or about 1827, the friction match was sprung upon the world by JOHN WALKER, a chemist of Stockton-on-Tees. It revolutionised the process of fire-getting. Phosphorus was added to its composition in 1834. But it was not till 1840 that it became cheap enough to come into general use, and to supplant in great part the old flint and steel and oftentimes damp tinder that were the plague of kitchen-maid and smoker and the cause of more aimless profanity than the barbed-wire fence of a later day.

Perhaps no development of the science of chemistry during the nineteenth century has been of such wide and varied application to the arts and to scientific research as that of photography. The camera-obscura, which is so indispensable in the new art, was invented as far back as the sixteenth century by the great Neapolitan Catholic scientist, GIAMBATTISTA DELLA PORTA, who was the founder of the first scientific association, known as the *Accademia Secretorum Naturæ*. Two French Catholic scientists, NIEPCE and DAGUERRE, were the first to take permanent photographs. NIEPCE's first light-picture was taken at Châlons in 1814. Then invention folds its arms and dozes for a quarter of a century. It woke up with a start in 1839—the year in which DAGUERRE perfected the process known as the Daguerrotype. By this process, says WALLACE in his *Wonderful Century*, 'permanent portraits were taken by him on silvered plates, and they were so delicate and beautiful that probably nothing in modern photography can surpass them.' Collodion films were introduced in 1850. During the past twenty years improvement has advanced at a break-neck pace. With its enormously increased sensitiveness, the photographic plate will now record with equal phlegm the flight of birds, the rush of racing horses, the lightning-flash, or a Lee-Metford bullet in full spin. The amateur photographer with his kodak is almost as much a feature of the life of our time as was the frilled bean with his hanger in the days of the Second CHARLES. Altogether, it would be difficult to over-estimate the value of this *mira virtus ingeni novumque monstrum*—'this new marvel of a marvellous age,' as LEO XIII. calls it—in art, astronomy, meteorology, physics, biology, ethnology, history, topography, geography, press-work, and in almost every branch of science and intellectual pursuits.

Electricity

The science of electricity touches that of chemistry at many points. Few of the physical sciences showed such