In scientific work involving the use of volumetric glassware, a further source of confusion has been introduced into the question. About the middle of the nineteenth century, at a time when, as we have already seen, the mass of a cubic decimetre of water was not at all accurately known, Mohr⁵ suggested, in effect, that the space occupied at 17.5° C. by a quantity of water having an apparent weight in air of one gramme should be taken as the unit of volume for the purpose of calibrating volumetric glassware. His system, therefore, did not involve any knowledge of the weight of a cubic centimetre of water, which was a distinct advantage when accurate data for this was not available, but quite inexcusably he called his unit a cubic centimetre. The system was widely adopted, and the practice still exists to-day of regarding, say a "1000 c.c." flask, as being correct, if, at its own standard temperature, it contains a quantity of water having an apparent weight in air of one kilogramme, this being a stage less definite than Mohr, who did retain a definite standard temperature. Actually such a flask, if its standard temperature were 15° C., would contain 1001.98 cm³. Further, apparatus made on this basis and marked "c.c." exists side by side with apparatus similarly marked "c.c.", but correctly calibrated in terms of the cubic centimetre. Thus of two flasks each marked "1000 c.c.", one might contain 1000 cm³ and the other 1001.98 cm³.

The Joint Committee for the Standardisation of Scientific Glassware found that one of its first tasks was to consider this position, and in 1924 it unanimously recommended:

That the recognised international metric units—the 'litre' (l) and 'millilitre' or thousandth part of the litre (ml)—shall be used as the standard units of volume, and that standard volumetric glassware shall be graduated in terms of these units and marked 'ml' instead of 'c.c.'.⁶

In the edition of the pamphlet, "Tests on Volumetric Glassware", issued in 1924, the National Physical Laboratory also strongly recommended the use of the millilitre for volumetric glassware.

British manufacturers quickly acted on these recommendations, and for some years past practically the whole of the volumetric glassware submitted to the National Physical Laboratory for test has been marked 'ml' by the manufacturers and calibrated in terms of the millilitre.

A parallel development, also recommended by the Joint Committee for the Standardisation of Scientific Glassware, is the increasing use of the

millilitre and the abbreviation 'ml' in publications dealing with methods of analysis. For example, whilst 'c.c.' was used in the first edition of "Standard Methods of Testing Petroleum and Its Products", published in 1924, 'ml' was exclusively used in the second edition published in 1929. The millilitre is also being used in Government publications, for example throughout the section on methods of analysis in Statutory Rules and Orders, No. 421—The Fertilisers and Feeding Stuffs Regulations, 1928. It is also used in papers on analysis in the American official publication, *Bureau of Standards Journal of Research*; incidentally, the Bureau of Standards recommended the use of the millilitre for volumetric glassware in 1916.

Another direction in which the millilitre is being employed in preference to the cubic centimetre is in the use of g/ml as a unit of density instead of g/cm³. In the "International Critical Tables", for example, g/ml is extensively employed. This is a logical development from the fact that ultimately practically all determinations of density involve the density of water, which from the definition of the litre is unity at its temperature of maximum density (approximately 4° C.) when expressed in g/ml. It follows that specific gravities $S_{t/4^{\circ}C.}$ are identical with densities in g/ml at the temperature t . Sometimes, however, specific gravities $S_{t/4^{\circ}C.}$ are quoted as densities in "grammes per c.c.", even though the number of significant figures given is such as not to warrant the difference between the millilitre and the cubic centimetre being thus ignored.

In general, the millilitre is the most appropriate unit to use whenever the particular determination is such that the millilitre is directly involved in virtue of the weighing of quantities of liquid entering, directly or indirectly, into the determination.

It would probably avoid a considerable amount of very undesirable uncertainty and confusion if the correct internationally approved abbreviations ml and cm³ were systematically employed to represent the respective units and the abbreviation 'c.c.' entirely discarded.

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Obituary.

PROF. W. H. PERKIN, JUN., F.R.S.

THE death of William Henry Perkin, junior, on Sept. 17, is both a tragedy and a catastrophe in chemistry. The loss is irreparable: men of his type are not being made to-day; they cannot be under the prevailing system. He is taken from us, not after he had accomplished his task, but in the fullness of his working powers, as ardent as ever

in his enthusiasm for the laboratory bench as the *fons et origo* of all chemical discovery. There have been disturbing signs of late years that he was losing some of his physical vigour. At the time of the Pedler lecture, in May last, he admitted that he felt ill but no organic lesion was discovered and his death has not been assigned to any definite cause. The beginning was severe stomach derangement.

Perkin's career was straightforward and uneventful. Born on June 17, 1860, not with a silver spoon in his mouth but one of horn or bone, full of colour, only four years after his father's discovery (when eighteen years old) of the *first* aniline dye-stuff, *Mauve*, he grew up in the healthy atmosphere of rural Sudbury, at first going to school locally, then, at the age of fourteen, to the City of London School, passing at seventeen to the Royal College of Science, whence after two years he went to German universities, first to Wislicenus at Würzburg, then to Baeyer at Munich. He was five years abroad. On his return he spent a year in the Owens College, Manchester. In 1886 he went to Edinburgh as first professor of chemistry at the newly founded Heriot-Watt College, of which (Sir) F. A. Ogilvie was Principal. Hudson Beare was his engineering colleague. Here Kipping was his assistant—until he became mine. I recollect going north to steal him, because of the reputation the two had already made for themselves. In 1892 Perkin passed from Edinburgh to Manchester, to succeed the great Schorlemmer and become the colleague of H. B. Dixon. In 1912 he was appointed to the chemistry chair at Oxford, in succession to Odling. Odling had quietly collected Dürers and given delightful breakfasts: Perkin at once began to make chemistry hum and, at the same time, played the piano and tilled the soil, with his own hands, with a skill and vigour and bonhomie unimagined up to that time to be possible in the river-valley atmosphere of grassy, wordy, Oxford. Having had relations in Oxford, with whom I often stayed as a youth, I have known the town at least since 1860; I have, therefore, always been specially interested in the University. At the time of Odling's appointment, we—young chemists of the day—foresaw and knew what must be the fate of our subject during his reign.

Excepting the fine work of the Harcourt school, Oxford was chemically dead when Perkin went there: now it is alive—even exploding; alive too in the other sciences; rather eaten up with mathematical vanity, perhaps, yet well upon the upgrade, with many of its early failings corrected (see *NATURE*, June 16, 1904; June 30, 1921). The chief danger lies in its neglect of the arts. Whereas, formerly, it was all for words, to-day it is unduly neglecting them and fostering the fell disease of the age—specialisation. It is strange that *Universitas* should now spell narrowness. The pendulum of reform will always swing too far. The unholy competition which prevails in the schools, the false motives which guide study, are common to all schools: the starkly staring vice of an age of highly competitive commerce, unrelieved by any higher æsthetic sense. The spirit in which the Perkins have worked is all but dead—the cry of art for art's sake, of science for the sake of science, is seldom heard: instead, bold advertisement extends even unto the most distant stars; the Nobel prize, medals and honours invite. An Epstein ugliness is allowed everywhere. The Epsteins would even restore us to phallic worship, it seems: at least, the railway magnate is actively aiding them to do so. Perkin

senior would have loathed to pass through St. James's to-day; his sympathy would be entirely with St. Giles.

As soon as the young Perkin could toddle, to be with his father he will perforce have followed him into his laboratory: to be duly taught how to blow himself up without harm, then left to develop: we know he learnt much at home. There is no record of distinction at school. Perkin jun. took to chemistry as a duckling takes to the water: it was in his blood, it was in his bones. He became one of the most accomplished and productive workers the world has known: like his father before him, he did his work—all the critical part of it—himself. His students were more often than not just his body slaves—employed in preparing endless amounts of difficult raw material, for he had princely ways of working with large quantities: yet could do with microscopic amounts. No Lamarckian influences were the cause of his character: no manganese he ate ever made him black (it's pretty certain it hasn't any moth): he was the purest possible product of an hereditary transmission of genius; his younger brother, A. G., is all but his twin as a chemist, also gifted with 'fingers' of surpassing delicacy.

To understand the sons it is necessary to have known the father. When their characters have been grasped, he and his two sons will stand out as a veritable trinity—one nature in three bodies: necessarily with variations but alike at core, intellectually and morally. It is a matter of interest, that a third son, by a second wife, who also took to chemistry and became a consultant, was purely commercial in his outlook and had none of the holy fire in him which almost consumed his father and step-brothers. I am one of the very few who knew the father intimately but many are left who have known the sons: if we are ever to understand the psychology of the chemist, it behoves us all, without delay, to write down all that we know of the triad, giving such analyses as each of us can—leaving the several accounts to be collated and woven into a memoir by competent sympathetic hands. I already have one invaluable notice, from one of the first to work under him in Manchester. Whoever may write "Father and Sons" will have an opportunity of framing an epic of modern discovery of surpassing interest.

W. H. Perkin the first was a phenomenon. At fourteen he took his own photograph; he also applied to Faraday for a ticket of admission to the Royal Institution and attended his lectures. Less than ten years afterwards, Faraday returned the compliment by being present at the lecture Perkin gave at the Chemical Society (May 1861) on "Colouring Matters derived from Coal Tar". He made his discovery of mauve (1856) when a lad of eighteen: it is true, while a student under Hofmann—but as a private venture, in his laboratory, at home. The primary discovery meant little, it was an accident; the separation of the dyestuff by one so young and untrained was a great feat; a still greater was the persistence he showed in getting it tested as a dyestuff in practice; greatest of all was

the marvellous skill and enterprise he displayed in undertaking its manufacture for dyers' use. The founder of the organic chemical industry, now a colossal enterprise, he was a full-blown manufacturer at nineteen: so magnetic was his enthusiasm, that his father (a builder) was inspired to put most of his capital into the son's new venture, his brother to become his helper, especially on the business side. Almost everything had to be done for the first time—materials got together, appliances designed, processes invented, every detail worked out.

Perkin sen., in fact, was possessed not merely with scientific interests but with an astounding technical *flair*. A few years later, when Graebe and Liebermann made the colouring matter of madder root, *alizarin*, artificially, Perkin joined in the chase and was the first in the field with a practical process, that upon which the most remarkable and intricate industry of modern times has been largely built up. It is noteworthy that Faraday was the first to use the sulphonation method which Perkin adapted to the manufacture of *alizarin*. Still later, by the discovery of a method of producing coumarin—the odoriferous principle of the Tonka bean—Perkin was to lay the foundation stone of the artificial perfume industry, though by this time he was too tired of the works to develop his discovery; he also contributed not a little to the artificial production of indigo, the importance of which, of course, he could not foresee.

Nevertheless, successful to a moderate degree as he was as a manufacturer, he was so possessed by the ~~divine fire of scientific inquiry~~ that Perkin sen. gave up his business in the early 'seventies and turned his attention once more exclusively to his laboratory. I learnt to know him at this period and became his fellow secretary at the Chemical Society. Great as he was as a manufacturer on the technical side, he lacked the commercial spirit. I have never known a more upright, less worldly man. Herein lies the explanation of the son. The holy spirit of inquiry, which burnt so steadily in the father, flared up in the son, at an early age—probably the fire was greatly fanned by Baeyer. In praise and pursuit of what he always spoke of as Research, Perkin jun. was as mad as several *Mad Hatters*. His joy over each beautiful new substance was extreme—he gloried in constructing. This gave him his power but limited his sense of proportion and his influence. He had no patience with those who did not engage in research: in fact, he thought little of them as chemists. In his laboratory, he was master of a supreme technique. Yet he never displayed the technical *flair* shown by his father. I believe the work he did for the chemical industry, during and after the War, was of no particular moment—he had not really seized its problems and made little contribution to its development, except in details. Of all our chemists, he has been the most human, the most inspiring, in his absolute adoration of the laboratory and its ineffable art—an art fully disclosed only to the few—an art insufficiently encouraged and practised to-day: yet the art upon which alone industry and progress are founded. Hypotheses may be built up in the air

and stated upon paper: they can only be tested and developed in the laboratory. Our schools have yet to give proper training in the use of the laboratory—to put it upon a scientific and real footing.

Perkin jun. has set Oxford a great example and a great task: that of organising the teaching of chemistry as a *whole science* and making it effective as such, as the necessary helpmate of all the experimental sciences and as underlying life. Oxford and Cambridge are national universities, not technical schools; it should be their office to provide general scientific instruction for all—not to rear narrow specialists. They receive between them by far the most important share of the intellectual ability of the country. It behoves them to return this in the highest state of efficiency. Unfortunately, the method which prevailed in the past, especially in literary subjects—coaching in association with competitive examination—has been extended into natural science studies. The result is an artificial system of education which is not calculated to fit the recipients for really efficient service in the world. The coached mind never gains a proper freedom. The work the system entails upon teachers—work that is highly remunerative and therefore popular—can have but one result: that of sterilising the teachers' practical activities as original inquirers. Men coming from universities where coaching does not prevail, on the average, are better trained for public service than are those coming from our two ancient universities. The public schools suffer greatly under the system: having been coached themselves, the teachers they draw from Oxford and Cambridge naturally coach rather than train the young minds they direct. The whole country suffers as a consequence. The funds and administration of the two universities have been made the subject of public inquiry and regulation: far more important would it be to examine into their ethics and raise these in standard. An appointment in chemistry at Oxford to-day is no local affair but a matter of national concern—such is the present and coming supreme importance of the science.

The act by which Perkin jun. made himself most noteworthy in the University of Oxford was in securing the provision of a fourth year, to be spent in learning the methods of research, as necessary for the honours degree. It is a grave question whether this be a wise provision. It involves the assumption, that the years previous to the fourth are not years in which the spirit of inquiry is inculcated and rampant. They should be—yet, if they were, it would not be necessary to set aside the fourth year for the purpose. To begin in the fourth is too late. There are many students who never can become original workers: at least some of these may be trained to be very effective teachers. Men of the Perkin spirit may well have exaggerated the value of the quality which is their inherited and almost divine prerogative.

Perkin jun. has painted a wonderful gallery of chemical portraits—among them several masterpieces: in the polymethylene series, in the terpene series, last but not least in that most fascinating of all—the great group of natural alkaloids. To

discuss these is now impossible: of their permanent great value there can be no doubt. He painted many studies in preparation for larger compositions; he scarcely ever descended to pot-boilers. Probably, he is most deserving of study as a great master of method: the certainty of his touch was most remarkable; the range and extent of his knowledge of past achievement was astounding. Yet he formed no school at Oxford. The fine laboratories he built were largely used for elementary instruction in organic chemistry but men did not go to him from the colleges: those who worked under and with him mostly came from outside. He was no prophet in his own house. The college system must be made to give way to one of unselfish co-operation, if training in chemistry, as a complete science, ever be given in Oxford. The mistake Perkin jun. made in going there was not to make this a condition of his entry—he was strong enough to exact such bargain. The change had already been made in Cambridge. The man appointed to be his successor should be strong enough to carry out this necessary, most vital reform.

Although Perkin's fame among chemists was even greater than that of his father and the value of his work was fully recognised here, it was not everywhere properly rated abroad; the list of his honours is not long. Especially have we to complain that he was never awarded the Nobel prize. His work may be equated with that of anyone who has secured this: very few of the chemists to whom it has been given have done work of the same importance to our science. His work was not merely that of a pioneer and highly original in design and execution: he pulled many plums out of the chemical pie, succeeding not once but often in solving grand problems. Still, there was nothing of the sensational about his work and his modesty ever prevented him from advertising. In this respect he was a simpler man even than his father. The Swedish assessors seem to have no eye for an English chemist—thus, in the past, they have overlooked men such as Crookes and Dewar. "Most injustice is not inflicted deliberately but because people do not take the trouble to think things out. Thinking gives them headaches and, if persisted in, may cause them to change their opinions. So it simply isn't done" (Rudyard Kipling). I have heard it said, that this was because these were not nominated by their countrymen: the excuse will not apply to Perkin jun. If the rules for the race involve this, the sooner they are altered the better: it should rest with the assessors to take all necessary steps to make the award in a scientific spirit, not contingent upon chance nomination. Colleagues, if not countrymen, are too often jealous of each other and inclined to work in companies. Overdue also is an inquiry of the effect of the prize upon our scientific *morale*—whether it have not introduced a wrong spirit into the art of experimental inquiry and whether the money could not be used to better purpose.

Perkin jun. was also overlooked by his father's Livery Company, the Leathersellers. He should long ago have been made an honorary freeman.

His father's picture hangs in their Great Hall. The gown he wears is proof that he was appreciated, at least by Scottish learning: the St. Andrews scarlet is made dominant through him in the City of London. I have often said that some day the picture will be the most valuable possession of the Guild. When Master, Perkin grimly sought to make water prevail at their festive board and would have filled the Loving Cup with mere soda-water; perhaps this made the name less thought of than it should have been.

Perkin jun. had a very happy life. He was ever full of *joie de vivre*. He was happy in his achievement, happy in his home. He married in 1887. Kipping, in the course of his studies, had discovered beauty among his cousins in the Quantocks and took the chief with him, in the long vacation, to Bridgwater, to stay with his uncle, W. T. Holland. Perkin at once fell to the eldest daughter; Kipping, a little later, married the second. Afterwards, when Kipping was my chief assistant at the Central Technical College, Kensington, and Lapworth a student with me, visiting Kipping, Lapworth was captured by the youngest sister. Three distinguished chemists thus became intimately linked through their wives. It is a distressing fact that these unions were not all fruitful: only Kipping had children. The two Perkin brothers have no issue, so that the male line comes to an end with them. There would seem to be some influence at work promoting sterility in scientific workers. The problem is one needing close attention, especially by the advanced woman; no birth control seems called for, rather the opposite. Perkin was a man of great physical as well as spiritual energy. Whatever he did was done with an astounding intensity and concentration of purpose—he never spared himself. In Manchester, he played cricket and also tennis with great vigour. Then, when the pace became a little too rapid, he took to gardening and became an expert in the glass-house cultivation of auriculas, carnations and chrysanthemums; he has always been noted as a successful grower of carnations. At Oxford, he gloried in roses and the herbaceous border.

To him father and sons fully will be to tell a wonderful story of effort and achievement. Such differences as there have been between them are rather of time than of temperament. The father was an early Victorian, with a highly developed vein of narrow Victorian piety—an evangelical, almost a puritan—accentuated probably by his wife's rigidity of outlook. Sons brought up in such an atmosphere naturally tended to go off at a tangent—yet never viciously. It has been told of one brother, that he added to his pocket money by playing the flute in a music hall orchestra: the parents would have thought him to be in the grip of the devil had they known this. The sons have belonged to our modern period, though scarcely to the 'skirt above knee' stage: a display of ankle to the beauty line was sufficient for W. H. jun., who was always the simple aesthete. W. H. sen. was a good judge of wine in his early days and his brother was always the bon-vivant; later he became total

abstainer and vegetarian, probably to his injury. W. H. jun. loved good living and kept a good cellar—college port appealed to him when of the right age. He was eminently hospitable, especially to musicians—entertaining if possible, everyone of musical distinction who happened to come to Manchester or to Oxford, greatly enjoying the opportunity that this gave him of indulging his love for chamber music and playing piano in trios and quartettes. The father played both the piano and the violin—the sons have been little short of professionals, the younger being master of almost every wind instrument.

Sweet were the uses he made of heredity—with it seeing good in many things. His loss is to be bitterly deplored in our science and in our society.

HENRY E. ARMSTRONG.

MRS. H. R. MILL.

FRANCES MILL, who died Sept. 10, was the daughter of Dr. F. R. MacDonald, and was born at Inverary, Argyll, where for a time she attended the Parish School. The effects of its democratic atmosphere were perhaps discernible in the adaptability and wide sympathies which made her later an accomplished hostess, and enabled her to find points of contact with all sorts and conditions of people. She displayed early a great interest in geography and the kindred sciences, and a visit of about a year's duration to Australia, prior to her marriage to Dr. H. R. Mill in 1889, stimulated this interest, and helped to prepare her for her prolonged collaboration with him in his geographical and meteorological work. She proved a quick and

careful proof-reader, prepared the indexes to most of her husband's books, and acquired great skill in the painting of lantern slides for use in connexion with his lectures.

Mrs. Mill assisted in the bathymetrical survey of the English Lakes, carried out by Dr. Mill and Mr. Heawood, in which her quickness, accuracy, and skilful steering of the boat proved of great value. Her powers of observation and keen perception of the unusual are commemorated in the name of the rare Central African monkey *Cerco-pithecus Francesca*. The skin of this monkey was sent to her with some other furs by a missionary friend, and though it was twice rejected by the authorities of the Natural History Museum as coming from a region too well known to yield anything new, her persistence led finally to an admission that it belonged to a previously undescribed species.

Over a long period of years Mrs. Mill attended regularly the annual meetings of the British Association, and took part in the Canadian meeting of 1897 and the South African one of 1905. She accompanied her husband also in all his travels, visiting every Dominion of the British Empire, in all the continents and over all the oceans. She was a familiar figure at the meetings and social gatherings of the Royal Geographical Society, and enjoyed the friendship of all the great travellers and explorers of the last forty years. In London, at Mill Hill, and after 1914 at Dormans Park, Surrey, her hospitable instincts found free play within a large and varied circle; for wide as her scientific interests were, they by no means exhausted the range of her activities.

News and Views.

At the quarterly meeting of the Council of the Royal College of Surgeons of England on Oct. 10, Lord Moynihan, president of the College, announced the foundation of a research scholarship in surgery by Lord Melchett. There is great need for such scholarships, as at present candidates for the staffs of our great hospitals have often to spend their time in coaching and offices of drudgery to gain a livelihood while waiting for a vacancy. The Melchett Scholarship, which is worth £500 a year and promised for a period of seven years, will permit a young surgeon to devote his time to research in one of the basal subjects of surgery—particularly experimental surgery. The Council of the College of Surgeons, by accepting Lord Melchett's gift and by founding another scholarship of like value from its own funds, has taken a step to supply a need which has long been felt in medical London. The laboratory accommodation in connexion with the museum of the college is being extended, and it is proposed that the scholars should be associated with the museum in their researches. The president of the college is also hopeful that a farm for experimental research in surgery and pathology will be established near London and in direct connexion with the museum.

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At intervals reports have found their way into the Press from Germany of some experiments conducted by a pyrotechnic specialist on the discharge of a rocket to very great heights. From a report in the *Times* of October 11 it appears that the Ministry of Communications has given permission to discharge a rocket which is designed to reach a height of some fifty miles in about one minute. There are no recording instruments to be carried; the height will be determined trigonometrically, although some difficulty should be experienced in following an object moving at a mile per second at such close range. The rocket apparently is 30 ft. long and 18 in. in diameter and consists of a double tube of metal which will be filled with liquid oxygen. By some mechanism not explained, four carbon rods immersed in it will be burned and the discharge of the generated gases will provide the propulsive force. The head of the rocket is fitted with revolving steering fins and the tail with stabilising fins. The nose contains a parachute which it is hoped will unfold when the motive power is exhausted and bring the rocket gently back to earth. The rocket will weigh 143 lb. when loaded. From the information published, it is scarcely likely that the optimistic hopes of the inventor will be