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HENRY GILMAN

1893—1986

A Biographical Memoir by

C. EABORN

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HENRY GILMAN, one of the outstanding organic chemists of the century, and one of its best known chemical personalities, died on 7 November 1986. He was born in Boston, Massachusetts, on 9 May 1893, the third member of a family of six sons and two daughters. His father was a tailor, active in trade union affairs. He attended a high school in Boston and from there went on to Harvard University where he received the B.S. degree (*summa cum laude*) in 1915. His first acquaintance with research came during his final year as an undergraduate, during which he worked with Roger Adams on the synthesis of substituted phenyl esters of oxalic acids, demonstrating the use of the new reagent oxalyl chloride; an account of the results appeared in the *Journal of the American Chemical Society* in 1915 (1). This experience was of major importance in arousing Gilman's interest in research and in 1976 he recalled it in the following terms [1]: 'A sheer delight. Here I was, just a senior. We'd work at night until 11 or 12 o'clock, without

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any compulsion—just for the joy of it.' And in the following year he wrote of it a little more fully [2]:

> In my senior year at Harvard I was interested in doing some research with Adams. This was done as an aside, and either carried no credit or only a small token of credit. Not a little of the work was done at night, and I recall how when the research was completed for the day, often near midnight, we would cross the street to a drugstore on Massachusetts Avenue for a chocolate malted milk.
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> The experiments were a great delight for me, and he would come in somewhat frequently for chats. He was, of course, most friendly, interested, and helpful. The study was not 'monumental', but it was exciting for each of us; his first direction of research, and my initiation into research.

Gilman's performance was evidently good enough for him to be invited to stay on for postgraduate work with the renowned head of the department of chemistry at Harvard, E.P. Kohler, known widely as the King of Chemistry, or simply The King. Kohler is credited with having introduced the use of the Grignard reagent to the U.S.A., and there is no doubt that his interest in organometallic reagents had a formative influence on the young Gilman; the one paper they published together was concerned with the bromination of α-keto esters, and includes a description of the use of the Reformatsky reaction, which involves an intermediate organozinc compound closely related to a Grignard reagent (2). On the basis of this work he received an M.A. in 1917 (a year late, it is said, because his supervisor neglected to complete the relevant documentation on time) and the Ph.D. in 1918.

During his graduate work he was awarded a Sheldon Fellowship to travel in Europe, and spent periods with H. Staudinger at the Polytechnicum in Zurich and with W.H. Perkin, Jr, at Oxford. He also visited the Sorbonne. His experiences in Europe made a lasting impact on him and

he would frequently recall them in conversation even into his 90s. (He took special delight in having met at the Sorbonne Marie Curie, the first woman to win a Nobel Prize for Chemistry, and during a visit to the Royal Society in 1975 was able to realize an ambition to meet Dorothy Crowfoot Hodgkin, the most recent female recipient of that award, and the only other woman to win it outright.) His contact with Staudinger probably stimulated an interest, which persisted for many years, in the reactions of ketenes, isocyanates, and cyanates. More importantly, during his stay in Paris (where he met Victor Grignard) he became fully aware of the great advances in organic chemistry made in France by the use of Grignard reagents and this, following his introduction to them by Kohler, fixed in him a determination to explore their chemistry when he was in a position to undertake independent research.

After completing his doctorate, Gilman accepted an invitation from Roger Adams to join him at the University of Illinois as an Associate Professor, but soon afterwards, in 1919, wishing to be his own master, he moved to Iowa State College of Agriculture and Mechanic Arts (ISC), as an Assistant Professor but in charge of organic chemistry there. His qualities were quickly recognized, and he was made a full professor in 1923, when only 30 years old. When he went to ISC it was a Land Grant college and by no means the major university it later became. Gilman has said [3] that when he arrived 'the chemistry program was very modest, fifteen or eighteen undergraduates and perhaps a dozen graduate students. But there was a nice *esprit de corps*. We were young and enthusiastic. We all worked quite hard. And we had a nice, easy relationship with the students.'

Ames itself was then a small town in the middle of farmland, a rural community with an atmosphere very different from that of Boston, but this was of little consequence to

Gilman, who gave almost all his time to chemistry (and most of the rest to keeping himself physically fit to do chemistry). Fortunately even then the college had an excellent chemistry library, so that there was no question of his being out of touch with advances in the subject. Moreover, Ames was on a main trans-continental railway line and only eight hours' journey from Chicago. This enabled him to attend meetings of the American Chemical Society and other such events without major inconvenience.

His arrival in Ames caused some excitement among the young women of the college, faced with a cultured, tall, upright, distinguished-looking, and athletic young man, with a Boston accent, a Harvard background, and experience of some of the great universities of Europe. And interest was all the greater because he seemed to show no awareness of female charms. A woman who was a student there then (and later became a member of faculty) recalls that she and a friend resolved to try to make his acquaintance and telephoned him at his boarding house, only to find themselves speechless when he was brought to the telephone, and they were never again able to summon the courage to approach him. A few years later, the woman who was to become his wife made contact with him as a result of a bet that she could not induce him to take her out and in winning her bet found that he was much less frightening than they had all imagined.

This young woman was Ruth V. Shaw, a native Iowan, born in 1901, who had attended Henry Gilman's first-year class in organic chemistry on her way to an AB in history, which she received in 1924. She subsequently took an AM in English and speech at Cornell University, and for three years taught speech at ISC before they were married in 1929. They were a devoted couple and Henry was most

fortunate to have such a splendid partner when he became virtually blind, as will be described later.

Gilman began research at Ames without delay, in the early years mainly with Master's degree students, and as soon as 1920 published his first paper based on work there (3). Significantly, it was concerned with the reactions of Grignard reagents, in particular the course of their reactions with ketenes, and was his first independent step in his lifelong devotion to organometallic chemistry. His first student to receive a Ph.D. is said to have been R.M. Pickens, who was awarded the degree in 1925; his work was concerned with the chemistry of derivatives of furan, thiophene and pyrrole (in particular with their effectiveness as local anaesthetics), a field in which Gilman was to work extensively in the following years. Pickens later became director of research at Rayonnier Co., and was probably the first of the many of Gilman's students who went on to reach the highest ranks in industry.

Among Gilman's first doctoral students was W.B. King, who later himself achieved distinction as a Professor at ISC and Iowa State University (ISU), as it became in 1959. He worked with Gilman from 1923 to 1927, and has written of the great admiration he developed for him as a scientist and as a man. Gilman was then, and remained for many years until failing eyesight put an end to it, a highly enthusiastic tennis player, who played a hard competitive game, and took special pleasure in playing regularly against King, who was the state tennis champion. Gilman was interested in all aspects of the game (and for some years acted as an assistant coach in the sport at ISC), and in 1926 he and King went together to watch the Davis Cup matches in Pennsylvania. It is likely that none of his other students was ever as close to Gilman, but their relationship, although friendly, nevertheless had the degree of formality that Gilman thought

appropriate between supervisor and student. Professor King relates that, although he knew Gilman well throughout his life from 1923, and regularly played golf, tennis, and card games with him, he could never, even as a senior professor at Ames himself, address Gilman as Henry, so great was his admiration for him.

It is clear from accounts by Professor King and others that even by the mid-1920s Gilman was regarded in the college as a great man, and certainly the outstanding scientist on the campus. It is remarkable that in the period 1920-1929, starting from nothing and with only the very limited resources of ISC available to him, he published 98 papers, mainly in the *Journal of the American Chemical Society*. The demands that Gilman made on research workers under his supervision in the 1920s set the pattern that persisted for the next 50 years or so. He expected total dedication: students were required to be in the laboratory working every day, including Sundays, late into the night, but there is no indication that at that time they resented this. In the 1930s, however, his demands gave rise to much discontent among the 30-40 members of his research group (an abnormally large number for those days), as several correspondents have made clear. To some extent this was probably a reflection of the general unhappiness during the Depression, when there was much unemployment, poverty and uncertainty, but the complaints of Gilman's students of those days centre on three specific aspects of his behaviour. First the unremitting pressure on them to work all and every day, and to produce results each day; second the low stipends he paid them; and third, and the most important, the length of time, and the uncertainty of its duration, that they were normally required to stay before receiving their Ph.D. degrees.

The students certainly had no opportunity to slack. Gilman

went around his laboratories three times each day, in the morning, afternoon and evening, questioning each student in turn about what he had done since his last visit, what he was now doing, and what he intended to do next. When a project was at an especially interesting stage the student concerned would be questioned on all three visits. Gilman remembered exactly what he had been told on the previous visit and so the hours in between had to be accounted for. The initial questioning usually took the form 'What's new?' and the answer was followed by the question 'What else is new?' and the answer to that by the further question 'And what else?'. One of his students from those days has written: 'Always we would begin to think that we had done very little. The cunning ones soon realized that you should keep some results up your sleeve to report next week in order to make your achievements seem more impressive.'

He did not visit the laboratory every Sunday, but did so sufficiently often that the students could not risk being absent that day. At all times students in the laboratory were expected to be giving their full attention to experiments in progress, and those caught seizing an opportunity to study for graduate course or preliminary examinations were sharply reprimanded. They had some chance to get away with such study, however, because throughout his research career he tried to avoid coming upon embarrassing situations by shuffling his feet loudly outside the laboratory to give warning of his arrival. Gilman himself frequently stayed in the building until after 10 p.m. and then went home to work until after midnight reading or writing. During the whole of his career, except at the time of his eye operation, he was rarely, if ever, away from Ames for more than a week or so at a time, and when he did go away he told no one, not even his secretary, when he would be back, so that his students could not risk taking a day off.

As for the stipends he paid, he fixed the amounts by working out carefully exactly the minimum sum on which each student could manage. This had the secondary advantage of leaving them little to spend on leisure activities which might have kept them away from the laboratory. Someone who worked for him as postdoctoral fellow in the 1940s has told of how, in fixing his salary, Gilman asked him whether soap was provided free in his lodgings, and made an appropriate allowance when told that it was not.

The majority of the graduate students took 5-7 years to get their degrees, at a time when in other universities three years was still usual. Some were required to stay even longer; at least one is known to have taken ten years (and he, tragically, was killed in a fall from a ladder before leaving Ames) and some abandoned the attempt after a lengthy stay. One factor was that Gilman did not in most cases assign a graduate research project but instead directed the student to carry out a series of preparations, often unrelated, which could be expected to give rise to a number of short publications, and it required considerable initiative and ingenuity on the part of the student to devise and carry out additional experiments that would enable him or her to draw the material together into a coherent whole for a thesis. The preliminary examinations that had to be passed before the Ph.D. thesis could be submitted also presented a major hurdle, because they could be taken only with the supervisor's permission. This was normally not readily forthcoming from Gilman, and many students were too afraid of him even to seek it until he offered it. There is a story from those times, which, while undoubtedly apocryphal, and seemingly current outside rather than within Ames, reflects, with exaggeration, not only the distress caused by the length of time Gilman required students to stay with him but also his imperturbable and formal manner. In this story, it is said that

a student who had been working for Gilman for 12 years, producing results for 15 publications, without having been allowed to submit for his Ph.D., burst into Gilman's office, placed a shotgun at his head and asked 'When am I going to graduate, Dr. Gilman?' To which Gilman is alleged to have replied 'Why Mr —, I have been thinking that it is about time for you to get your Ph.D., and I appreciate your bringing the matter to my attention'.

It must be emphasized that not all of Gilman's students felt ill-treated, and it seems that towards a few, probably the hardest and most effective workers, he behaved rather differently, and they were able to regard him with awe rather than fear, and could question him and debate with him. A very select few, usually working in small laboratories, were rarely visited, and having been given on arrival a general indication of the problem they were to tackle were allowed to exercise their own initiative freely, and to work without interruption, subject only to the regular submission of satisfactory written reports. Dr J.M. Straley, who took only the three years of 1933-1936 over his Ph.D., is one of those who had no complaints about the way he was treated by Gilman, partly because, he says, he had studied for a time under one of Gilman's former research students and so knew what to expect, and furthermore he had established a special relationship with Gilman shortly after arriving. He writes: 'I had been at Ames only for a week, working on a list of ten compounds HG had given me to prepare. I had four of them prepared when he demanded 10 g of one on which I had not even begun. I calmly told him that if he would inform me of his priorities I would arrange my activities accordingly. We understood each other completely thereafter.' Dr Straley writes of his three years with Gilman as the most fruitful of his life; he developed a lifelong admiration for Gilman and remembers, as do many others, Gilman's

kindness towards any of his students with personal, including financial, problems. (He recalls that one student, who had been badly injured, physically and psychologically, in World War I, and was unemployable and virtually incapable of research, continued to receive a stipend from Gilman until his death in the 1940s.)

But even those who regarded themselves as relatively well treated were aware of the unhappiness among other members of the group, and all of the following comments (some referring to the early 1940s rather than the 1930s) came from five such people:

> With most of his graduate students there was a strong undercurrent of fear: Gilman was capable of overwhelming criticism with which the students could not cope ... A few of us who were treated differently were fully aware of the problems of the other students, but there was nothing we could do, since Gilman represented absolute authority in the Organic Chemistry Department.
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> The attitudes of the graduate students under Gilman were based largely on overwork, underpay, uncertainty as to the future, and a constant prevailing fear of HG.
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> Sad to say, we all claimed we hated him, but all of us mellowed in later years as realization grew of what a tremendous man and teacher he was.
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> Most of us were united in our detestation of Gilman. Most of us later decided that he was not so bad after all.
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> Everyone regarded his period at Iowa State College as a painful period necessary if one wanted a good job afterwards. Most of us, drinking laboratory alcohol and eating popcorn or potato chips, were united in our detestation of Henry, and wondered how people a few years after getting away could revise their memories and say: 'Well, he wasn't such a bad guy after all.' But most of us became revisionists in turn some years after leaving. Certainly Henry became very charming once we had left.

Some of the quotations above introduce an important aspect of Gilman's treatment of his students. However se-

verely he had dealt with them previously, once they had graduated his attitude changed completely, and all write of his unfailing courtesy, friendliness, and helpfulness once they had qualified. Moreover, because he insisted on complete commitment, and expected self-reliance, close familiarity with the relevant literature, the greatest care in experimentation, and absolute accuracy in observation and reporting, and would not allow them to submit for a Ph.D. until he regarded them as fully ready to work independently, those who did receive the degree under him were in great demand in universities and industry. Because of his reputation and that of his graduates, he could place them in the best companies in posts he judged most suited to their abilities. (It seems, however, that like many leading organic chemists of that time in Britain, he had a low opinion of the inorganic chemistry of the period, and one occasion, when one of his students decided to accept a post in a metallurgical company rather than the oil company Gilman favoured, he exploded 'But man, there's no *carbon* in it.' The student concerned later rose to be head of the company.) The discipline he had drilled into his assistants stood them in good stead, and a count in 1976 [1] revealed that his former students included more than 50 corporate research directors, nine corporate vice-presidents, one corporate president, and three university presidents, and more than 50 became professors of chemistry; these numbers would have been even larger later.

It was assumed by most of those aware of it that in his treatment of his graduate students in the 1930s and into the 1940s Gilman was driven solely by personal ambition. It can, however, be seen in a more favourable light. Thus his seeming parsimony with his research funds could have stemmed in part from his wish to give some useful employment and training to as large a number as possible at a

time when many of them would otherwise have been unemployed or in menial posts. Moreover, it has been said that he kept them only until a vacancy became available for which he felt he could recommend them instead of releasing them into unemployment. There is also general agreement that although the stipends he provided were meagre even for those hard times, he never failed to come to the assistance of students who were in financial trouble, and in emergencies would commonly provide the necessary additional sums from his own pocket.

Through the efforts of his large and hard-working group, in the 1930s Gilman became one of the world's best known and highly regarded chemists. In the decade 1930-1939 he published 183 papers, probably more than any other chemists (though it has to be noted that many were very brief even by the standards of that decade, and by some authors would have been combined into a markedly smaller number of longer papers).* Through his work, especially that on uses of organometallic reagents, he had an influence on almost all organic chemists. He was offered numerous very highly paid posts in universities and industry, and was a consultant to many leading chemical companies, from whom came a large part of the funds he used to support graduate students. His consulting activities were especially important to the meat-packing organization Armour and Company, and many of his Ph.D. graduates were employed there, largely on methods of utilization of waste fats. His advice and their efforts are said to have led to the establishment of a considerable industry based on those fats. The great admiration

*For a few years in this period he published a substantial proportion of papers in overseas journals, mainly *Recueil de Travaux Chimiques des Pays-Bas et de la Belgique*, following what he considered an unjustified rejection of one of them by the *Journal of the American Chemical Society*.]

and awe in which he was held in that company (and, indeed, by then throughout the U.S.A.) is illustrated by a communication from a chemist, Dr S.H. Shapiro, who had a serious accident there in 1954 which resulted in his suffering third degree burns over some 70% of his body. There was doubt that he would live, but a few weeks after the accident Gilman, whom he had never met, appeared at his bedside to offer words of encouragement, and such was the effect of this action by the great man that the patient began from then on to recover, and was still with the organization (as part of the Akzo company) as a retired consultant in 1988.

Gilman also consulted for the Quaker Oats Company, and it was their interest in furfural that stimulated and financed his work on furan derivatives, and hence on other heterocyclic aromatic compounds, on which a good part of his research in the first half of the century was focused. He is known to have consulted also for the du Pont Company (and there is a report that very early in his career, in 1925, he and Roger Adams were invited, to become joint directors of the corporate research laboratory of that company) and for the Ethyl Corporation, Shamrock Oil, Metal and Thermit, and Parke-Davis.

World War II inevitably brought some changes in Gilman's research activities and in particular he was engaged on aspects of the Manhattan Project (the code name for the programme of work on the atom bomb), specifically the preparation of volatile uranium derivatives, mainly alkoxides. (Results of that work were described in papers that appeared in the 1950s) He was also commissioned to work on the synthesis of species with potential anti-malarial activity and on other species of possible pharmaceutical interest, including organobismuth compounds. His status and his participation in the war-effort brought him the power to have

experienced former students seconded to him from the posts to which they had gone, and one correspondent has written of his dismay at finding himself back at Ames after he thought he had at last escaped forever! Gilman still had a large research group of some 30 or more students and postdoctoral fellows, and still made the same demands on them as he had in pre-war days, so that even though some of his work was necessarily secret he continued to publish extensively, and 156 of his papers appeared in the years 1940-1949.

That the students of the 1940s were driven as hard by Gilman as those in the 1930s, and required to take similarly long periods over their Ph.D.s, is confirmed by the appearance in 1947 of a satirical poem composed by one of his students J.W. Morton, Jr, and entitled Gilmania, with the subtitle 'Being a thesaurus of pictorial efforts on the part of divers organic-chymists as a brief commentary upon their experience in the laboratories of Iowa State College of Agriculture and Mechanic Arts'. Published anonymously, but purporting to be a hitherto unpublished section of the Prologue to Chaucer's Canterbury Tales, it was printed on high quality paper, complete with illustrations in the form of pseudo-medieval drawings, and was in two parts. The first, 'The man of chemistry', read as follows:

Ther was also a man of chymistre,
I wot that HENRY GILMAN highte he;
He had grete lore of bodyes organeke,
And of the same ful longe colde he speke.
Of metall-carbon bondes and their wayes
He mighte discours for fourty nightes and dayes,
Ere of his lerneynge cam he to the ende;
And noon his sayinges rightly colde amende.
To him ech yeere a dele of clerkes ther came,

To lere of him the carbon-chymists game;
Ech clerk abood with him ten yeers or so,
Then went his way with-outen wordes mo.
I mene, that this was trewe, but for the faster;
For some took fiftene yeers to get a Master.

Auctor he was, and Editor as wel;
His *Treatis* did lyke very hoot-cakes sel,
And specialy at *Ames*, in *Iouay*,
This boke founde market large, it is no nay.

A mery lyf this HENRY GILMAN lad;
He alweys was in finest clooth y-clad;
His coot was butoned with butones thre,
Nat even butones he lat idle be.
Advances grete in chymistrye he maked.
Bifor his anger al his clerkes quaked.

The second part, 'The carbon chemist', meant to be 'sung to the vulgar air, Strip Polka', relates the sad tale of an organic chemist who went to Ames to work with Gilman expecting to get his Ph.D. in nine quarters, was made to work for seven quarters on ethyllead, and eight quarters on phenyltin, then was assigned to butylzinc, tolylsilver, and xylylyttrium, but gave up, and became a garbage man, 'when Uncle Henry said to me one day, "You can start on bornylneon right away".'

The original edition of 50 copies, was printed at a press owned by the father of one of Dr Morton's fellow graduate students, and sold within Ames at a price that just covered the costs of production. It was reprinted in 1954 and 1957. Its existence and general nature became very widely known in the U.S.A., though relatively few people seem actually to have seen it. It is often assumed that the publication was produced in anger by a seriously disaffected student, but Dr Morton has indicated that it was meant as a good-

humoured, though pointed, satire of the type students have long been given to.

Although many of his students from the period before about 1950 do not have happy recollections of their time with Gilman, those in Ames who knew him other than as his students praise him without qualification as a gentleman of the highest quality. He had a friendly if very formal manner and treated those around him, including janitors and storekeepers, with courtesy and consideration, and always warmly welcomed visiting relatives of his students. Two secretaries who were with him in 1930s have written of him with great respect and affection. One, Mrs A.S. Hull, writes:

> He was a fine gentleman, and I liked working for him very much. Even then he wore heavy lenses, and the long hours he put in must have put a great deal of stress on his vision. He was never impatient or temperamental in spite of his great intellect. He was most devoted to his lovely wife and daughter, who at that time was a toddler. When his daughter came on the telephone his face would light up, and I thought it very touching that this enormously dignified and prominent man became so like a delighted child himself when speaking to her. It was a great privilege to be associated with Dr Gilman.

The year 1947 dealt Gilman a severe blow. He had always worn spectacles with thick lenses and even in the 1930s had obvious problems with his eyes, which were often inflamed, though the difficulties were evidently not such as to prevent him from playing tennis and handball. By the late 1930s, however, the difficulties had become so severe that much of the checking of the proofs of the major treatise on organic chemistry that he edited (see below) had to be carried out by his graduate students, who also took turns to read to him from current journals. In 1947 a combination of glaucoma and a detachment of a retina, which could not be remedied surgically, left him blind in one eye and with only about 10% vision in the other, and even that small

residual vision deteriorated progressively, though with some periods of slight remission, during the remainder of his life. From 1947 on, although he could read to a limited extent by holding the page close to his eye, preferably with the aid of a large magnifying glass, he had to rely completely on students and his wife to read the literature to him. Selected students and postdoctoral fellows were called upon to write up their own work and that of others, though all their efforts had to be read to him, and he made many corrections and changes, so that his mark was placed firmly on the published versions even though the style varied somewhat from paper to paper. Although he was in great difficulty in unfamiliar surroundings without someone to guide him (which was rare because Ruth was almost always at his side when she was needed) he still behaved in exactly the same way in the chemistry building, making his rounds several times each day and rebuking severely anyone not at his bench when he should have been. It is said, too, that the students could never rely on the poorness of his sight, usually being detected if they tried to take advantage of it and frequently seeing him pick up a report and spot errors of chemistry, grammar, or spelling.

He still attended scientific meetings even into his late 80s, and such was Ruth's skill at acting as his eyes (for example, with a remarkable memory for faces, alerting him to the identity of persons approaching him) that many encountering him did not realize that he was almost completely blind. He travelled from time to time to conferences or on lecture tours abroad, and in visits in 1963 and 1971 was treated with great deference, and very warmly received, in the U.S.S.R., where organometallic chemistry was held in the highest esteem. It was a feature of his conference presentations, as of his publications, that he always gave generous credit to other workers in the field, and if he

had to disagree with the conclusions of others he always did so in a gracious manner which made his comments seem compliments rather than criticisms.

The years following his loss of sight were, in fact, his most prolific in terms of numbers of publications, 312 appearing in the decade 1950-1959, and 198 in 1960-1969. As is evident from this rate of publication he continued to supervise the work of a fairly large, though steadily decreasing, number of research workers in that period; in the period 1960-1964, for example, he had at any one time about 8-10 graduate students and two postdoctoral fellows. In the later 1960s the proportion of postdoctoral fellows increased. Students with him in the 1950s and 1960s were under the same unrelenting pressure to work hard as those of earlier decades, but it is clear that they looked upon him then, as they remember him now, with real affection as well as respect. One change was that they now usually took only four years to get the Ph.D., the normal period in the U.S.A. by that time. (Gilman is on record as complaining in 1976 of the Ph.D.s of that date [1]:'Just when you're ready to get the maximum from them they stop', a not-uncommon view among research supervisors in many countries!) A factor of some importance is that the Department of Chemistry at ISC underwent a rapid development after World War II and several very able organic chemists joined the faculty, so that Gilman's students no longer worked in isolation and he no longer had the absolute power that he had previously exercised.

Remarkably, he never retired from the Distinguished Professorship at ISU, but after reaching the usual retirement age of 70 in 1963 he received only a small salary to supplement his pension. He remained active in research until 1975, when he was 82 years old. Much of his support in the 1960s and 1970s came from the U.S. Air Force, but he received a

substantial new grant from the National Science Foundation in 1972, at the age of 79. Even in the 1970s his research workers found him a hard task-master. Dr M.T. Rahman, from Bangladesh, who was a postdoctoral fellow with him, relates that in 1974, when Gilman was 81 years old, he visited each of his four research assistants, all postdoctoral fellows, three times a day, questioning each of them in turn in the form 'What have you done since I was last with you?', 'What are you doing now?', and 'What do you intend to do?'; just as he had in the 1920s. Dr Rahman writes:

> He expected us to have four reactions on the go, and to meet such an impossible expectation it had been known for a postdoc to put some liquid in a flask and have the stirrer going to make up the fourth, because although Henry could not see well his hearing was acute. The little noise would be heard, and had to be accounted for, and sooner rather than later the experiment would be asked after, and would have to be completed, despite another grace period when the postdoc claimed the compound was on the column for separation.
>
> He had a store of all the compounds ever made by his research associates, neatly arranged, and cross-referenced on index cards.* I once asked him the secret of his success, thinking that he might refer me to this systematic organization and hard work, but he replied 'The intelligent use of the chemical literature'.

Dr Rahman goes on to say that Gilman was very annoyed with an American postdoctoral fellow who helped him to buy a car, since possession of this would encourage him to be away from the laboratory at weekends.

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*The collection of chemicals was acquired by Dr Alfred Bader of the Aldrich Chemical Company. There were about 20 000 of them, and after rejection of a large number for various reasons (many were by now common chemicals, some had decomposed, and others were available in only very small quantities) just under 3000 are available for purchase, as the Henry Gilman Collection, at prices intended to cover the costs of distribution.]

An important event in Gilman's career was the publication in 1938 of a two-volume treatise entitled *Organic chemistry, an advanced treatise*, which he had conceived and edited. This work consisted of chapters covering a wide range of topics in organic chemistry written by eminent authorities on them. It was the first publication of its kind, and for advanced students represented a considerable improvement on the general organic textbooks available to them at the time. It served as a model for many later multi-author publications, but judged in the context of the time in which each appeared was probably the best and most influential of them, since for every chapter Gilman had been able to get the leading expert in the U.S.A. Moreover, the topics were selected and the contributions carefully coordinated and edited by Gilman himself, who had an encyclopaedic knowledge of organic chemistry and a seldom-matched enthusiasm for it. Gilman's own chapter on organometallic compounds was a masterly summary of the state of the subject at the time, and played a major part in its development; it can still be read with profit. The book served as a standard text for several generations of graduate students in the U.S.A., and was much used also in other countries. A second, updated and expanded, edition of the two volumes appeared in 1943, and two additional volumes in 1953. If there were any chemical laboratories in which Gilman's name was not already one of the best known in organic chemistry, there could have been few unaware of it after the appearance of this very influential treatise.

With M.S. Kharasch he was instrumental in creating the *Journal of Organic Chemistry*, which made its appearance in 1936, and for many years he served on its editorial board. At various times he served on the editorial boards of several other important journals.

Gilman had a major influence on many hundreds of chem-

ists through his undergraduate and postgraduate lectures. At some time during his first 25 years at Ames he gave all the organic chemistry courses at all undergraduate and postgraduate levels, and as the only senior organic chemist was also in overall charge of all the lecture courses and laboratory classes. A measure of his success is that a ranking of 14 Midwest universities on the basis of the quality of instruction in organic chemistry, conducted in about 1930, placed ISC first [4]. In the later part of that period, however, he concentrated mainly on the third and fourth year courses in organic chemistry for chemistry and chemical engineering majors. From all available accounts his lectures for most of that period were outstanding, and correspondents have written of how he came to classes admirably prepared, lectured without notes with great clarity, writing up all the essential material on the blackboard, and speaking firmly and slowly, with appropriate repetition, so that full notes could be taken; he insisted that these notes be taken in bound notebooks. The lectures were enlivened by numerous anecdotes. His air of authority and his enthusiasm made a deep impression on many of his audience, but his classes were by no means unalloyed pleasure for all of them. He began most lectures with at least a ten minute session in which he questioned members of the class, calling on them by name, in some years with the help of a plan showing the seats to which they had been assigned. He was severe on those who failed to answer satisfactorily and would persist in his questioning of them, so that they became more and more confused; it is said that female members of the class were frequently reduced to tears, and greatly feared his lectures. Sometimes the questioning would go on for the whole of the 50 minute period. In winter, when temperatures were often below zero on the Fahrenheit scale, if answers were unsatisfactory he would call for the windows to

be thrown open in order to keep the class more alert and at that stage an assistant would bring in a fur-lined overcoat for him to put on. He was especially severe on chemical engineering students, maintaining a constant confrontation with them, in a tactic designed, as one who attended such classes has pointed out, to keep the attention of students for whom organic chemistry was not a topic to which they were naturally inclined. It is on record [4] that he once left two assistants in charge of his lectures to chemical engineering students when he went away to a conference. During his absence the engineers placed a notice in the student newspaper reading 'All is forgiven Henry, please return'.

There are indications that in the later 1930s and the 1940s Gilman's lectures were not always successful and one correspondent says that in the third year course in organic chemistry he attended in 1943, Gilman 'tried for six weeks in vain to impart information to the class. We could not establish any level of communication. The solution proved to be to assign a graduate student as the instructor!' (The same correspondent added that there was a belief at the time that Gilman made graduate students stay on without their Ph.D.s in order to maintain a cadre of experienced instructors!) It is possible that he became less effective as a class teacher in the 1940s as he became even more immersed in research and as his eyesight deteriorated, but some who attended classes at that time have written with much enthusiasm about them and it is evident that they appealed to some, probably the most dedicated, more than others. Several correspondents, probably representative of hundreds of their contemporaries, have stated that Gilman's undergraduate classes gave them an enthusiasm for organic chemistry that stayed with them throughout their careers.

Gilman was a determined opponent of discrimination against black Americans long before it was fashionable to

be so, and his attitude was especially unusual in the Midwest. Even in the early 1930s he usually had at least one black graduate student in his group and one of them, N. Calloway, was the first black person to receive a Ph.D. in chemistry from a university west of the Mississippi: he went on to a distinguished career in medicine and became president of a company. A black student with him some years later, Dr S.P. Massie, went on to become a professor, and Chairman of the Department of Chemistry, at the U.S. Naval Academy. Another black student, F.D. Patterson, became President of the Tuskegee Institute, for which Gilman served as an adviser for some years. Gilman also served on the Board of Trustees of the Carver Research Foundation. Mr H. Oatfield, who joined Gilman's group as a Master's degree student in 1931 from the William Marsh Rice University in Houston, Texas, and went on to a distinguished career in industry, relates that on his arrival Gilman sent him to Calloway for instruction on how to go about tackling his first research assignment, and believes that this was done to test the attitude of someone who had just come from Houston, where colour prejudice was extreme. (As it happens Oatfield had himself been appalled by the treatment of black people in Texas.) There is much evidence that Gilman, whom some believe to have been the subject of prejudice himself, never allowed race, nationality, creed or political beliefs to influence his treatment of individuals. He certainly did distinguish between people, especially students, in terms of their personal qualities, and in particular their integrity and dedication to hard work.

Gilman's good manners included genuine consideration for others, not just formal courtesies, though the latter were also much appreciated by recipients of them. He always spoke firmly and softly, and was never known to show anger. Although he could on occasions, when especially dis-

satisfied with a student's attention to chemistry, deliver a cutting rebuke, his displeasure was normally indicated by no more than a long drawn out 'Oh', which left no one in any doubt about his feelings, or by striking his forehead with his fist and exclaiming 'What a blow!' In one of his more severe admonishments, to a student who had allowed lunch to interrupt his recrystallization of a product, he said 'What man, have you ice-water in your veins?' On more than one occasion, it seems, a student who (in common American style) reported that a reaction 'was allowed to sit overnight' was rebuked with the response 'No, it was allowed to *stand* overnight; nothing sits in this laboratory'.

An aspect of the good manners he acquired in Boston and which stayed with him all his life was that he was always neatly and appropriately dressed. Students with him in the 1920s and 1930s recall that they almost invariably saw him in a tweed suit, tailored for him in Boston, with three buttons (all fastened, as noted in *Gilmania!*), and with lapels, pockets, and cuffs sewn within about a quarter to half an inch from the edge; for a long time they thought he had only the one such suit, which he wore every day to the laboratory, but later realized that he had at least two identical ones that he wore in turn. That he was not prone to react rapidly to changes in fashion is revealed by the fact that a photograph taken in about 1968 shows him wearing just such a suit, similarly buttoned [5]. He greatly enjoyed conversation with friends and was always prepared to listen and learn; he gave his complete attention to anyone, of whatever status, speaking to him, often with his prominent chin cupped in his hand. He had a large fund of recollections and anecdotes, and a phenomenal memory for events in the lives of former students and colleagues whom he had not seen for many years. He had a warm, gentle sense of humour. An example is the following passage from a letter

he wrote in 1962 [6] concerning one of the most hard-working students he ever had, a George F Wright, who was with him in the 1930s and later achieved considerable distinction as a professor at the University of Toronto: 'It was prohibition time. One weekend he needed some very good alcohol to purify a sensitive furan compound; the storeroom was closed, so he drove in his old car to one of Al Capone's caves in Boone and bought the alcohol. This is the only time I ever heard of a student bringing alcohol *into* the chemistry building.'

Throughout his life, up to the time of his final illness, Gilman maintained an extensive correspondence with surviving old classmates at Harvard (including J.B. Conant, who became a famous president of that University), former students and postdoctoral fellows, former colleagues, and numerous friends around the world. From time to time, when a certain issue, chemical or general, was on his mind, he would seek the view of a wide range of his correspondents; in his eighties, for instance, he became interested in cases in which the advance of chemistry had been delayed by the failure of a research supervisor to entertain good ideas for future work suggested by a student and sent letters to correspondents in several countries seeking accounts of examples of this. (His interest in the matter had been originally aroused during his visit to Europe as a postgraduate, where Grignard told him how Barbier had for some years prevented him from trying out the method which later became standard for the preparation of Grignard reagents.) An outstanding feature of his correspondence was his generosity towards other chemists whose work he admired. Young people, inside and outside the U.S.A., who had never met him were greatly encouraged by his letters expressing regard for their recent papers, and many an established chemist derived much pleasure from a short

note from him saying how much he admired their overall contributions to chemistry.

A notable aspect of Gilman's character was that, even though he had for many years heard himself referred to as, for example, 'The American Liebig,' 'The Master Chemist', and 'The Father of Organometallic Chemistry', and in 1968 'one of the most inspirational and legendary figures to grace the chemical scene this century' [5], he never developed any trace of the pomposity and arrogance that is sometimes evident in those who have achieved such world-wide eminence. Although he was, for a professor, highly-paid, and received substantial additional sums for consulting, he and his family maintained an unostentatious, though comfortable, lifestyle. One indulgence he and his wife permitted themselves was a new home, outstandingly luxurious at the time for Ames, which they had built in 1936. One who was a student with him then, and was invited with his colleagues to a party to view the house, has told of the awe in which they looked around it, admiring especially the fully-fitted basement and attic, a feature he had never before encountered, and finding that the whole house had air-conditioning, something virtually unknown in Ames in those days. Several generations of students enjoyed parties there in later years, often given so that they could meet eminent visitors.

Gilman was rightly the recipient of much admiration for the way in which he responded to severe loss of sight which developed into almost total blindness. He allowed the handicap, which would have caused most people to give up, to make the minimum possible change in his behaviour, and this was all the more remarkable because if he had abandoned research in 1947 he would still have been one of the outstanding organic and organometallic chemists of the century. In the event, of his 1020 research publications, 584 appeared after 1947 compared with 436 up to then, and

moreover these later papers were generally more substantial than those in the earlier years. That chemistry still held the same excitement for him in the years following the loss of most of his sight is illustrated by a story told by Professor R.A. Benkeser, who after taking his Ph.D. with Gilman joined the chemistry faculty at Purdue University. Gilman went there by train in the late 1940s or early 1950s to give a lecture and on arrival was taken by Benkeser to the Union Building where he was to stay overnight. At the reception desk the clerk handed him a telegram that had just arrived and this read simply 'The mixed melting point was undepressed'. It turned out that, although it was irrelevant to his lecture, Gilman had arranged for the student to wire him because he could not wait until the next day, when he would be back at Ames, to find out whether a synthesis had been successful.

One aspect of his life that was necessarily changed by the deterioration of his sight involved his previous commitment to keeping fit through regular exercise. He had always played vigorous tennis in the summer and four-wall handball in the winter, usually with graduate students; because of the time of day they took place the games were referred to for many years as 'five o'clocks'. He lived about a mile away from the campus and usually walked the distance briskly six times a day, often inviting a student to walk with him on the way home, and discuss the student's progress on the way so that, it is said, the walk commonly resembled an oral examination.* His son relates that each evening Henry and

*Most unusually for someone in his position in the U.S.A., he never learnt to drive a car, possibly because he did not trust his eyesight even before the major deterioration, and students with him in the 1930s relate that when driven by others he would keep the door slightly open with his foot, so that he could escape rapidly in an emergency!]

his wife would go for a final brisk walk before he continued working in his study well past midnight. It was one of the hardships he had to accept that, after first giving up his tennis and handball, as his sight became even worse he had finally to abandon even his vigorous walks.

He seemed hardly to change in appearance or attitude in the last 30 years or so of his life, and at a gathering in Midland, Michigan, in 1982 to mark the 21st anniversary of the creation of the Frederic Stanly Kipping Award of the American Chemical Society, of which he had been the first recipient in 1962, he was upright, gracious, alert and interested in the reports of others, still showing the same happy sense of curiosity and wonderment at an interesting new observation which had been a life-long characteristic. This was in spite of the fact that in the previous year, after some years of serious heart trouble, he had, at the age of about 88, been fitted with a pace-maker; of the event he recounted with delight that the surgeon had instructed him to return ten years later for a replacement battery. His composure in face of his loss of sight had been an example and inspiration to all who knew him. It was noted of him in 1977 that 'he speaks easily, casually of his "impaired vision", but he is wrong. His eyesight may have been dimmed, but his vision has not' [1].

Gilman was a well-informed, highly literate, and articulate person. In his later years became concerned about the lack of culture among science students (a matter he referred to in his interesting Priestley Award Address in 1977) and began to explore the possibility of making formal instruction in the humanities a required element of a postgraduate degree course in chemistry. He had a strong sense of history and it gave him very special pleasure that he was made an Honorary Fellow of the (British) Chemical Society, the oldest chemical society in the world, and took great

delight in joining the Royal Society, the oldest scientific society, and in signing the Charter Book containing the signatures of those such as King Charles II, Newton, Priestley, Dalton, Faraday, Darwin and Ramsay. During his visit to Britain to be formally admitted to the Society he revealed a strong wish to visit Nelson's flagship H.M.S. Victory, and was taken there by Dr D.R.M. Walton. Although he could see little of it, he derived great pleasure just from standing on its deck.

Gilman enjoyed a very happy family life. He had been brought up in the Jewish faith but upon marriage he joined the Episcopal Church, to which his wife belonged, and they remained active members of it throughout their married life. As has been seen, for the last 40 years of his life he was able to sustain his remarkable level of activity only with the help of his devoted and able wife. Sadly she died a little over two months after Henry, and she was followed almost six months later by their daughter Jane, who had returned to Ames in the latter part of their life and given them increasing support. A son survives them, as do four grandchildren, who brought them great pleasure.

The final word in this section can appropriately come from Professor W.B. King who, as mentioned earlier, was a research student with Gilman in 1923-27 and subsequently his colleague at ISC and ISU throughout their working lives. He writes: 'When he arrived at Heaven's gate, I can imagine St Peter saying "Let this gentleman in; few appear with such an enviable record of dedication and discovery, honesty and courage!"'

HONOURS, DISTINCTIONS AND TRIBUTES

The main formal honours and distinctions bestowed on Gilman are listed below.

1945 Elected to National Academy of Sciences
1951 Iowa Award and Midwest Award of American Chemical Society
1961 Honorary Fellow of the (British) Chemical Society
1962 First American Chemical Society Frederic Stanley Kipping Award in Organosilicon Chemistry
Distinguished Professor, Iowa State University
1974 Chemistry building, Iowa State University named 'Gilman Hall'
Annual series of Gilman Lectures established at Iowa State University, endowed by gifts from friends and former students
1975 Elected Foreign Member of the Royal Society
Distinguished Fellowship Awards, Iowa Academy of Sciences.
1977 Priestley Medal of the American Chemical Society
1982 Iowa Governor's Science Medals
1987 Gilman Graduate Fellowship Fund established in his memory at Iowa State University

Among published tributes are the following:

(a) article (with photographs) by R.A. Benkeser in the *Journal of Organic Chemistry* in 1968 on the occasion of Gilman's 75th birthday [5];

(b) tribute in *Chemical and Engineering News* in 1977 marking the award of the Priestley Medal [1];

(c) article by R.K. Ingham as the introduction to a special issue of the *Journal of Organometallic Chemistry* on the occasion of Gilman's 90th birthday [8];

(d) appreciation (with photograph) by J.D. Roberts in *Organic Syntheses* in 1987 [9];

(e) Appreciation (with photograph) by J.J. Eisch in the *Journal of Organometallic Chemistry* in 1988 [10].

On the occasion of Gilman's 90th birthday a celebratory dinner was held in his honour on the ISU campus and was

attended by 278 members of his family, friends, and former students, a good number from abroad. He was presented with several volumes of congratulatory letters sent by 500 of his friends and colleagues. An account of the event mentions that he had supervised 242 graduate students [7].

Although Gilman was a dominant figure in chemistry in America in the 1930s, and was made a member of the National Academy of Sciences in 1945 (he was the first chemist at a Land Grant Institution to achieve this distinction), it can be argued that the importance of his overall contribution to chemistry was formally recognized sooner in Britain than in the U.S.A., in that in 1961 he was made an Honorary Fellow of the Chemical Society, the highest distinction the British chemical community can bestow, and in 1975 was elected to Foreign Membership of the Royal Society, the highest distinction the British scientific community can confer on someone from outside the British Commonwealth, and yet only in 1977 received the Priestley Medal of the American Chemical Society, its highest award. There are those who argue with some force that so influential was his work that he could appropriately have received the highest formal international recognition open to a chemist.

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L.D. Metcalfe, J.W. Morton, Jr, H. Oatfield, D.E. Pearson, M.T. Rahman, S.H. Shapiro, (the late) D.A. Shirley, H.J. Shine, J.H. Stocker, R.W. Strassburg, J.M. Straley, W.S. Trahanovsky, B.W. Wakefield, and H.L. Yale. Very helpful comments on the draft manuscript were made by R.A. Benkeser, R.W. Bott, J.W. Cornforth, J.J. Eisch, W.B. King, P.D. Lickiss, J.W. Morton, Jr, H. Oatfield, J.M. Straley, W.S. Trahanovsky, and H.L. Yale.

The portrait photograph reproduced was taken in 1969.

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