THE
MATHEMATICAL GAZETTE

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GODFREY HAROLD HARDY, 1877–1947.

I.

THE death of the greatest English mathematician of our time is no mere national loss, for Hardy was recognised throughout the mathematical world as a master of our science. Of his studies, Hardy himself said, in his Inaugural Lecture at Oxford : " What we do may be small, but it has a certain character of permanence ". Few of us would dare to call Hardy's contribution to mathematics small, while none of us can have any doubt about the lasting nature of his work. For a full account of the new pathways he opened up, the new territories he explored, reference must be made to the notices being prepared for the Royal Society and the London Mathematical Society. In the *Gazette*, it is fitting that we should record with special emphasis the debt which teachers of mathematics in this country owe to Hardy for the vast improvements in the teaching of analysis during the past forty years, from vagueness to precision, from obscurity to clarity, along lines mapped out and laid down for us by him.

From Winchester, Hardy went up to Cambridge, where he was Fourth Wrangler in 1898, Fellow of Trinity 1900, Smith's Prizeman 1901, Cayley Lecturer 1914. In 1919 he was appointed to the Savilian Chair of Geometry at Oxford, but returned to Cambridge in 1931 to succeed Hobson as Sadleirian Professor of Pure Mathematics. From a long list of honours, we may mention the award, just before his death, of the Copley Medal of the Royal Society. He joined our own Association in 1905, served as President for 1924–6, and was elected an Honorary Member in 1935.

Hardy was soon recognised as a creative mathematician of the first rank ; his papers and books bear abundant witness to the keenness of his intuition and to the precision and power of his technical mastery. Powerful minds are sometimes unable to profit from interchange of ideas with minds of equal calibre, but Hardy was free from this defect, for it would be difficult to detect any difference of quality between the work for which he alone was responsible and that contained in the many books and research papers produced by collaboration. The romantic if tragically short collaboration with Ramanujan, the long-continued and extraordinarily prolific partnership with Littlewood, provide two instances among many.

The profound influence which Hardy exercised on the teaching of mathematics was due not only to his eminence as a creative mathematician, but also to his unsurpassed power and clarity as a teacher in the lecture room or on the printed page, and to the fact that he knew what he wanted and knew how to persuade or compel others to work towards the ends he had envisaged. Evidence is clear in his books, particularly the revolutionary *Course of Pure Mathematics*, and in the dominant part played by him in the reform of the Tripos, of which Professor Newman writes below. In the years from 1905 to 1914, Hardy's incisive reviews in the *Gazette* played a considerable part in improving the quality of English textbooks; he never failed to praise sound work, but for slipshod incompetence there was no leniency. His articles in the *Gazette* in those years are still of historical interest, since most of them discuss matters on which he was making up his mind while preparing *Pure Mathematics*. His two Presidential Addresses are of permanent value, and one, "The Case against the Mathematical Tripos", to which Professor Newman makes reference, will be reprinted in the forthcoming No. 300 of the *Gazette*.

Brief and inadequate as this notice must necessarily be, the work Hardy did for international mathematics must not go unnoticed. Professor A. V. Hill writes below on one aspect of this work, and perhaps its spirit can be shown by quoting the dedication of the tract on Dirichlet series written in collaboration with Marcel Riesz and published in 1915:

MATHEMATICIS QUOTQUOT UBIQUE SUNT
OPERUM SOCIETATEM NUNC DIREMPTAM
MOX UT OPTARE LICET REDINTEGRATURIS
D.D.D. AUCTORES
HOSTES IDEMQUE AMICI.

T.A.A.B.

II.*

When Hardy came to Cambridge, just before the end of the last century, pure mathematics was in a poor way there. The great discoveries that had been made on the continent during the nineteenth century were hardly known, except to a few isolated workers, and the undergraduate course of studies was quite untouched by them. Two circumstances tended to prevent any change. The applied mathematicians, who had by no means stood still, not only dominated the mathematical school, but were for the most part convinced that the traditional Cambridge course contained everything that was needed for physics. They were impatient of the hair-splitting niceties that seemed to form so large a part of the newer mathematical theories. A second bastion against change was the immense prestige of the Mathematical Tripos, the content of which had hardly changed in a hundred years. To be Senior Wrangler was the great ambition of every able student, and of this there was little hope without the services of the great mathematical coaches, who trained their men like athletes for the contest, and who were naturally not disposed to allow any disturbance of the syllabus they knew so well.

A number of the younger mathematical Fellows, among whom Hardy took a leading part, set themselves to put an end to this state of affairs, first by insisting on the teaching of modern analysis with correct and rigorous proofs, and secondly by attacking the sacred edifice of the Tripos itself. This attack was finally successful in 1910 when the order of merit was abolished, and the days of the great coaches brought to an end. Hardy would indeed have gone much further. Long afterwards, in an address to the Mathematical Association in 1926, published in the *Mathematical Gazette*, he argued seriously and in great

* Extracts from a broadcast on the B.B.C. Third Programme, 7 January, 1948.

detail, that the only satisfactory reform of the Tripos was to abolish it, on the ground that the only harmless examinations, without cramping effect on teaching, are tests of competence with a low passing standard and no classes. This view is still struggling for acceptance in schools, not very successfully at present ; the Universities have never shown any signs of adopting it.

The attainment of decent standards of rigour in teaching was a more gradual process. The publication of Bromwich's *Infinite Series* in 1907 was an important step in bringing the new learning to the more advanced English readers, but Hardy saw clearly from the start the importance of accustoming young students to good standards from the moment of their entry into the University. It was to show that this was feasible that he wrote in 1908 his book *A Course of Pure Mathematics*, now known to so many thousands of students, and so very different from any textbook written before it. Although much of what it contained had not been taught in English universities at all a few years earlier, the preface declared it to be " a book designed primarily for the use of first year students. . . . It is a book for mathematicians : I have nowhere made any attempt to meet the needs of students of engineering or indeed any class of students whose interests are not primarily mathematical." Though many of the theories in it were due to continental mathematicians it was marked as a textbook in the English tradition by the great wealth of examples, of every degree of difficulty, contained in it. It was largely through the influence of this book, and of Hardy's lectures on analysis, that exact standards of proof so quickly became a matter of course among mathematicians in this country. M. H. A. NEWMAN.

III.

Professor G. H. Hardy had been deeply concerned since 1933 with the fate of his fellow-mathematicians on the continent and had interested himself actively and generously, in co-operation with the Society for the Protection of Science and Learning, in finding places in Cambridge and elsewhere for those whom persecution had driven out. Many of these will remember him, not only with admiration for his intellectual eminence but with affection for his sympathy and succour in their emergency. Hardy in many ways was otherworldly, but in his deep solicitude for the dangers and difficulties of his colleagues he showed not only a broad humanity but a fine and resolute loyalty to the universal integrity and brotherhood of learning. A. V. HILL.

BUREAU FOR THE SOLUTION OF PROBLEMS.

THIS is under the direction of Mr. A. S. Gosset Tanner, M.A., 115, Radbourne Street, Derby, to whom all enquiries should be addressed, accompanied by a stamped and addressed envelope for the reply. Applicants, who must be members of the Mathematical Association, should whenever possible state the source of their problems and the names and authors of the textbooks on the subject which they possess. As a general rule the questions submitted should not be beyond the standard of University Scholarship Examinations. Whenever questions from the Cambridge Mathematical Scholarship volumes are sent, it will not be necessary to copy out the question in full, but only to send the reference, *i.e.* volume, page, and number. If, however, the questions are taken from the papers in Mathematics set to Science candidates, these should be given in full. The names of those sending the questions will not be published.

Applicants are requested to return all solutions to the Secretary.