OBITUARY NOTICES

OF

FELLOWS DECEASED.

CONTENTS.

ARTHUR LISTER, 1830–1908.

My father was the youngest of four sons of Joseph Jackson Lister, F.R.S. The second was Joseph, afterwards Lord Lister, the founder of the modern system of surgery, and past President of the Royal Society. There were three daughters who all married and had children.

The family had belonged on both sides, and for several generations, to the Society of Friends. His mother was of Irish extraction, the daughter of Anthony Harris, a sea captain, whose home was at Maryport, Cumberland, and who owned and sailed his ship; she had before her marriage been a teacher at the Friends' School at Ackworth. I can remember her as a dear, dignified old lady, dressed in the subdued, harmonious colours of the Quaker garb, and muslin cap of the proper cut. I think I remember (I have certainly been told of) her taking exception to some full "bell sleeves" of one of my sisters as "superfluities."

My grandfather I clearly remember as a benevolent-looking, handsome old gentleman, clean-shaven except for short side whiskers. He was very active, even in old age, and I can recall him in his Quaker coat, with the collar not turned down, running backwards on the lawn of his garden while I, a small boy, vainly endeavoured with my utmost efforts to overtake him. He had entered his father's business of wine merchant in London, and quite early in life found himself in a position of comparative affluence. His family was brought up and he remained living, till his death, at Upton House, in the parish of West Ham, then a rural suburb of London on the skirts of Hainault Forest.

It was at Upton that my father was born. There was a beautiful and large garden attached to the house, with two very fine cedar trees beyond the lawn. He employed part of his leisure with investigations on the optical properties of different kinds of glass, and on combinations of lenses, which he ground himself. This led to his discovery of the true principle on which compound lenses should be constructed—an important step in the great modern advance in microscopy. This discovery brought him into touch with several of the foremost scientific men, both English and French, of the day. Prof. Owen was a frequent visitor, and delivered acceptable drawing-room discourses on matters zoological. I remember being introduced to the great man in later years and the kindly interest he took in me as the grandson and namesake of his old friend. Sir John Herschel and Edward Forbes were also friends of the family. The meetings of the British Association, then in its infancy, were frequently attended.

So there was the breath of a larger and cultivated world in the environment of the young people as they grew up, in addition to the strict religious atmosphere which their parents, at any rate in matters of conduct and

Friendly tradition, were careful to maintain. My impression is that less stress was laid on doctrine, and I believe that my grandfather had, at the time of the expected invasion of England by Napoleon, gone through some training as a volunteer.

From his early boyhood and throughout his life, my father was an enthusiastic ornithologist. As a boy he used to wrap flannel round his shoes and steal silently about the garden shrubberies, watching the birds and learning the characteristic notes of the species. He pored over White's 'Selborne' and Bewick's 'British Birds,' and essayed himself to make woodcuts copied from the well-known beautiful illustrations of the latter work. He used to recall the thrill of pleasure with which he received from his father a set of proper engraving tools and some blocks of boxwood for this purpose. Some of his copies of woodcuts are quite remarkably excellent for a boy of 13. In later life, and until his hearing began to grow dull, my father's power of recognising birds by their notes was most exceptional. On country rambles with him one knew that, whatever topic was to the fore, and however interested he might be in it, part of his mind was ever keenly on the alert to the doings and songs of the birds. He would suddenly stop, listening, and then he might resume his walk with the words, "Perhaps only a yellow-hammer." But generally if he stopped there was something of interest. "A cirl-bunting," he would exclaim, "a snipe drumming," or "a grasshopper warbler"—or what not?—and at once the telescopes of the party would be turned to see the bird, if possible; though verification by sight was rarely necessary if he had heard the note distinctly.

He followed his brothers to the Friends' School at Hitchin, kept by Isaac Brown, who, himself something of a naturalist, encouraged his taste for birds and started him on a collection of mosses. I think it was from him that he and his brother Joseph learnt to repeat Latin verses, in the old pronunciation of course, and with a majestic rhythm which I have never heard equalled in the new.

From Hitchin he went to the Friends' School at Grove House, Tottenham, but it was not long before (at the age of 16) he was removed from school, and according to the Friends' custom in those days, when University degrees were not open to them, was "put into business." He was apprenticed to a firm of manufacturing chemists. With them he learnt what he might, both at their London place of business and also, what was much more to my father's taste, at their nursery grounds at Ampthill, Bedfordshire. But, his apprenticeship ended, he was placed by his father as partner in a wool merchant's firm in Bradford—filling a vacancy caused by the retirement of William Edward Forster, afterwards Member for Bradford and Chief Secretary for Ireland. While working at Bradford he had bachelor lodgings at Baildon and keenly enjoyed his wild rambles over the moors. While here he read much poetry and other literature. He had a good memory for poetry and knew a great deal by heart. Milton's sonnets and shorter poems were favourites, and many of the poems of Burns, Shelley, and Moore. He knew

his Shakespeare well, and delighted in Wordsworth. He often repeated the lines, and they touch the keynote of his life, from the poem on Tintern Abbey, beginning:—

> "And this prayer I make,
> Knowing that Nature never did betray
> The heart that loved her; 'tis her privilege,
> Through all the years of this our life,
> To lead from joy to joy. . . ."

The "Ode to Duty" (in part), the "Happy Warrior" and the "Lesser Celandine" were also great favourites. Many of the Odes of Horace and some passages of Virgil he had by heart, and loved to repeat. His ear for music was very correct, and he had great enjoyment in it when it was well played. While at Bradford he learnt to play the flute, with fine feeling, though he would very rarely, and in later life never, indulge his family by playing. He also took lessons in drawing and painting from a most excellent teacher, Mr. James Lobley, whose instructions to a drawing school at Bradford received the warm commendation of Mr. Ruskin. From him also his elder children and other members of our circle received lessons of lasting benefit.

My father had a high appreciation of pictorial art. Frederick Walker's pictures and some of Millais', in his Pre-Raphaelite stage, received perhaps his warmest admiration. In his earlier manhood he practised the gentle art of sketching from nature in water-colour with much success, and assiduously trained his elder children in it, being always most kindly appreciative of their efforts. Fidelity to the thing as you see it was the end to be aimed at, and any departure in the direction of an ideal rendering received scant encouragement. As his children attained, in some cases, some higher degree of proficiency, however, his own efforts ceased.

At Bradford, too, he first made the acquaintance of Susanna Tindall, daughter of William Tindall, of East Dulwich, who, in 1855, became his wife. He soon (in 1857) resigned his place in the Bradford firm and succeeded his father, then retiring from business, in the firm of Lister and Beck, wine merchants, at 5, Tokenhouse Yard, London. He was a representative of the fourth generation of his family in this firm. The young family settled at Sycamore House, Leytonstone, on the border of Epping Forest, and within easy reach of his father's house at Upton, and the homes of two of his married sisters.

He soon made himself master of his business, and his advice and opinion were highly valued among wine shippers and merchants.

He was at this time much devoted to shooting and fishing. He was an excellent shot and was a welcome member of shooting parties of his friends. But the shooting he liked best was a long ramble with a friend and dogs, but without beaters, over some wild tract of country, with a mixed bag as the result. He and his brother Joseph, then absorbed in his early observations and experiments on physiology and surgery, often arranged

to spend part of their summer holidays together at some remote fishing resort. But he was keenly interested in all his brother's work, and his experiments, cases, and improved methods of treatment were described, discussed, and eagerly canvassed, step by step.

In the summer of 1866 my uncle Joseph and his wife joined my father's family for a summer holiday at Torquay. My father then first entered on the study of Systematic Botany with his brother's assistance, he having laid a very good foundation under Lindley, Professor at University College, in the course of his medical training.

From this time onward sport passed more and more into the background, and was soon entirely given up, though to the end of his life he loved to handle his guns.

From flowering plants my father passed on and resumed his study of British mosses, making exquisite water-colour drawings of them under the microscope with the aid of the camera lucida. The use of the camera lucida in microscopic drawing he habitually practised in all his work. Each drawing had the magnification indicated, so that the exact size of the structures shown could be easily ascertained. Even a rough sketch made in this manner, with the outlines hastily traced, may be of permanent value as a record of the size, shape, and relative position of the parts displayed. His own drawings so made, with bold, clear outlines, and the tints and light and shade indicated in washes of water-colour, are models of lucid illustration. He regarded this as a great and too much neglected aid in botanical and zoological departments of study. With a half-whimsical perversity he would often make the most beautiful drawing on some scrap of lined paper, and it was then trimmed into an odd polygonal shape, to save space, and gummed into his note-book. A clean sheet of drawing paper was regarded as something so sacred that only the more elaborate illustrations had a chance of being fairly displayed. It was only by much scolding that his daughters, as they grew up, succeeded in effecting a partial reform.

In this manner, as he extended his investigations to the study of lichens and then to moulds and other fungi, he accumulated a store of accurate and beautifully illustrated notes which were of immense value to him in his work.

In studying the specific characters of fungi his power of accurate drawing was of especial value to him, because of the evanescent character of this class of plants and the difficulty of preserving them. He also invented a simple and most effective method of recording the characters of the gills and the colour of the spores of the Hymenomycetes. The pileus is cut off at the summit of the stalk and laid overnight on a clean piece of blotting paper with the gills downwards, being covered with an inverted wine glass or other cover. In the case of dark-spored fungi the blotting paper used is white, while for white-spored species a tinted paper is employed. The following morning the spores which have been produced in multitudes during the night and fallen in the still air, directly downwards, are found to have defined with exquisite

precision the arrangement of the gills. A wash of gum and water on the back of the blotting paper sets the spores, and a beautiful self-recorded "sporograph," or picture in its own spores, of the under surface of the pileus is obtained.

His brother and his wife came each year from Scotland to spend their Christmas holiday at Leytonstone or, later, at Lyme. Much time would be given, if frost permitted, to skating, which they both keenly enjoyed, or to forest walks, in the company of the children and their cousins. But all the notes and drawings of the work in hand would be shown, room would be made at a table for a second microscope (which had been their father's and was always referred to as "Augustus") and the two brothers would pursue the investigations together, often even skipping about the room in their whole-hearted joy at the unfolding revelations.

About the year 1879, when working at lichens, and desiring to read Stahl's important papers on their strange double nature, he set himself, with his eldest daughter's assistance, to learn German. This was entered on with characteristic vigour, his brother gladly participating, when on his holiday visits. Several of the poems of Goethe and Schiller were committed to memory and repeated with great enjoyment.

My father's friend, Dr. D. H. Scott ("dear Scott" as he used to call him), has borne testimony to the thoroughness of his work at lichens. During a visit to Leytonstone he says, "The conversation turned on the question of the fertilisation in lichens, as described by Stahl, on whose conclusions some doubt had at that time been cast by the school of Brefeld. It then turned out that Mr. Lister had fully investigated the subject for himself; he showed the writer a series of drawings of the reproductive processes in *Collema*, which went far to substantiate Stahl's views, since strongly confirmed by the work of Baur and Darbishire." *

While his nephews and elder son were in their boyhood my father was an enthusiastic collector of British Lepidoptera, and delightful evenings were spent in sugaring the trees in his own garden and in Epping Forest. This was done in part to encourage a love of natural history in the boys, but largely also from his own love of these exquisite products of Nature's workmanship. His other excursions on the zoological side of the border, apart from the Mycetozoa, were mainly concerned with such animals as he met in the course of his microscopical work. There are, however, accurate drawings of his of the ascidian *Perophora listeri* found washed up in a storm on the beach at Lyme. He was particularly interested in this species because it had been one of the objects investigated by his father, after whom it was named. With one of the new lenses constructed by himself he had been the first to observe the remarkable reversal in the direction of the heart beats now known to be characteristic of ascidians.†

When my parents settled at Leytonstone it was still a comparatively

* 'Journal of Botany,' October, 1908, p. 333.

† 'Phil. Trans.,' 1834, p. 365.

rural neighbourhood. Now greater London has partially engulfed it, though the boundary of Epping Forest happily bars its further advance in this quarter. A pleasant garden and a field for cows were attached to the house. To accommodate the growing family additions were made to the house, mainly from my father's own designs, and an agreeable set of rooms was arranged, two studies, an intermediate room, and a workshop where the growing collections were housed and his work was done. In 1871 he acquired, with his brother, the house Highcliff, at Lyme Regis at the far western end of the Dorset coast. The fine diversified country with glorious coast scenery of this neighbourhood gave him constant and deep pleasure. He laid out the garden afresh with marked success, and made alterations and additions to the house, again from his own plans. Here some of the cooler months were spent each year with keen enjoyment by my father and his family. Unless visitors were staying in the house and some larger expedition was planned, the morning, and often the early afternoon, would be spent by him in scientific work, but time was always allowed for some long country ramble with his children before dinner-time—or rather before dinner—for his enjoyment in the out-of-door life was so great that he was not a model of punctuality. Until the later years of his life he would return to the drawing-room after the pipe which followed dinner, and read aloud himself or listen to reading. He was an excellent reader both of prose and poetry. Novels he enjoyed if not too analytical of "poor human nature." Scott was a favourite, and Stevenson and some of Wilkie Collins'. Kipling's 'Jungle Books' he greatly enjoyed; biography and books of travel were also welcome. Later in life, however, he preferred to remain in the smoking-room, and then one of his daughters remained and read with him. Huxley's 'Essays,' works on Geology and Astronomy, and a good deal of other fairly stiff reading were gone through and well digested by them.

The other months of the year were largely devoted to business and the public service. As he was able to share the burden of his business with his partners and had more leisure, he took up a variety of public work. In his own religious body he served as clerk to the monthly meeting, administering the business of the Society, and taking a leading part on educational and philanthropic committees. He never spoke in meeting (*i.e.* in meetings for worship) though he took his turn as reader in the Bible reading with which the Sunday morning session began. He chose his seat at the end of a bench near a doorway looking straight out southward into the meeting-house garden (a but little modified piece of forest land) so that the contemplation of the outer world mingled with his inner reflections. I think there must still be the marks and dates, cut after meeting, with his knife in the floorcloth (rather to the scandal of some members), showing the positions reached by the shadow of the top of the doorway at noon on mid-winter and mid-summer Sundays—the latter close to the door, the former, of course, far back in the room.

He was a very active member of the West Ham School Board, and it was at his initiative that the Truant School at Fyfield, near Ongar, was built

and equipped. This enterprise he carried through with all his strength and enthusiasm. He regarded it as of the highest importance to be able to deal with truant boys with rigorous strictness, but also to keep them uncontaminated by the criminal associations to which they were subject in industrial schools. He took great pains in the selection of teachers and endeared himself to them by the sympathetic interest he took in their labours.

He was an active and valued member of the local bench of magistrates, no sinecure in a district including a large East London element. He was glad to work hard, often sitting in the courts three days a week during the summer and early autumn months, and his brother magistrates gladly acquiesced, in their turn, in his absence at other times of the year. He also gave much time and attention to the work of the Essex County Council.

Notwithstanding these varied activities he was able to carry on a good deal of scientific work even at Leytonstone. Epping Forest and Wanstead Park in the immediate neighbourhood furnished fine hunting grounds. On moving down to Lyme in middle or late autumn he looked forward to months of continuous and happy scientific labour undisturbed by public cares.

His third daughter, Gulielma, as she grew up, became his especial companion and assistant in his scientific work, and all his natural history pursuits. She easily acquired his bird lore, and became at least as skilled an observer as he. Her training, at Bedford College, had given her a good grounding in systematic and structural botany, and her fine skill as a draughtswoman was an invaluable asset in their common labours.

While working at moulds and other fungi my father had met with representatives of the Mycetozoa in their sporangial stage. Now regarded as a group of Protozoa, they were at that time usually classified with fungi. Their remarkable life-history soon engaged his eager attention. He watched the hatching of the spores into the flagellate active stage, the transition from flagellula to amœbula and the fusion of these to form the creeping plasmodia, the sclerotial stage of this and the final development of the plasmodium into sporangia. He became very skilful in dealing with these organisms, in the various phases of their life-history.

While hunting one day, in the winter of 1876–7, in Epping Forest he came on a mass of the brilliant yellow plasmodium of *Badhamia utricularis*, which has the habit, almost unique in the group, of feeding not on dead vegetable matter but on certain living fungi. It was spread over a growth of the fungus *Stereum hirsutum* which had sprung from a hornbeam stump. The whole was brought home and carefully protected and observed. Parts were allowed to pass into the dry sclerotial phase in which the protoplasm, having assumed the condition of a mass of minute cysts, is able to retain its vitality for months or even years, resuming its activity on being wetted and supplied with the proper food material. A fragment of the sclerotium thus revived will grow rapidly if properly fed, so that in a few weeks a film of yolky protoplasm covering a soup-plate full of *Stereum* may be obtained from a morsel no bigger than a pin's head. This mass furnished the

material for renewed observation of its marvellous properties for several years.

A meeting of the Linnean Society (February 15, 1877) at which my father exhibited some of the plasmodium of this gathering in active streaming condition (an object which very few had at that time ever had an opportunity of seeing) is well remembered by those who were present. The mysterious rhythmic backward and forward flow through the vein-like channels of the film of undifferentiated protoplasm is indeed a most striking phenomenon. His was no dry and lifeless exposition; he stood rather as one who had ascended into the Mount of Vision and whose high privilege and urgent duty it was to reveal what had been vouchsafed to his view. This was, in fact, his attitude of mind to all the phenomena of nature, whether the ways of beast or bird, the structure of plants, geological or physical phenomena, or the movements of heavenly bodies. It was all a revelation of the mystery of life or of the environment of living things on the earth and in the universe. When moved to speak of these things he would cast aside a shyness which had clung to him from his boyhood, and discourse with a force and eloquence which carried conviction to the hearers and enlisted their sympathies in the cause.

From this time onwards his attention was more and more concentrated on the Mycetozoa. The species were diligently collected on his rambles, compared with the published descriptions, and accurate and beautiful drawings were made of them. Many ladies, friends of the family, lent willing aid, and samples and small collections came dropping in. He soon started a large "ledger," in which references were entered to all notes and drawings of the various species scattered through his note-books, as well as to the specimens themselves, stored in small cardboard boxes, and to microscopic slides on which specimens were mounted in glycerine jelly. He published papers from time to time, at first in his own name but soon in association with his daughter, describing new species or interesting variants from types already described. He was, of course, familiar with the writings of de Bary, whose classical investigation of the Mycetozoa first demonstrated their position in the zoological rather than the botanical kingdom, and he regarded it as a high privilege when Prof. I. Bailey Balfour handed over to him for examination the collection which he had made years before at Strasburg when working under de Bary. Subsequently Greville's collection from the Herbarium of the University of Edinburgh was similarly lent him. He eagerly cultivated any germ of enthusiasm for the group, whether in his own circle or among correspondents, and he soon had a large number of friendly workers and collaborators, both at home and abroad. Every letter of interest was duly entered in the ledger, and he reckoned no pains wasted which were spent on his carefully considered (and duly copied) answers, which were generally accompanied by boxes of typical specimens. His daughter had set herself, some time before, to learn to read Polish, in order that the important systematic work of Rostafinsky, another of de Bary's pupils, might be at their disposal.

In 1892 he was invited by Mr. Wm. Carruthers, the head of the Botanical Department of the British Museum, to prepare a Descriptive Catalogue of the collections of Mycetozoa in the Museum, and into the preparation of this he and his daughter threw all their energies. Lodgings were taken at Kew while the collections in the Herbarium were overhauled, and a pleasant visit was made to Strasburg, where were de Bary's collections in the guardianship of his successor in the Chair of Botany, Graf zu Solms Laubach. From him they had a most friendly reception, and it was a great pleasure to all the family when he paid a return visit, a few years later, to the home at Lyme.

The catalogue, when complete, took the form of a monograph of the group. It was published in 1894. My father also presented to the Museum samples, whole and mounted on slides, of all the species and varieties known to him, and the show case of the Mycetozoa in the Botanical Department is enriched with beautiful water-colour drawings by his daughter, giving magnified views of typical specimens of the group. He took a patriotic pride in thus making the collection in the British Museum as complete as it lay in his power to make it.

The monograph had a sale unwonted in the series, and my father was invited to prepare for the Mycetozoa one of the small paper-covered guides to the collections which are issued by the departments, and this also attained considerable popularity.

The publication of these works, far from bringing any pause in their labours, led, on the contrary, to a great increase in their circle of correspondents and in the specimens referred to them for examination.

The United States, where the group has been much studied, the West Indies, New Zealand, Japan, Java, Borneo, Ceylon, and, in Europe, Germany, France, Scandinavia, Portugal, Switzerland—many were the post-marks on the small neat packages or large cases which frequently arrived from abroad.

All this demanded long hours of strenuous labour from my father and his daughter, and it was often not till driven out by the growing dusk that they started on their accustomed ramble. Papers were published as before as material accumulated, dealing with new and interesting forms.

From the abundant material from all parts of the world which thus came to him, all carefully digested and illustrated in the note-books, my father and his daughter came to possess a knowledge of the typical characters of the species and the range of variation of which each is capable, which was unequalled. A second edition of the monograph was soon called for and it was to the preparation of this, strenuously carried on notwithstanding failing health and powers, that the later years of his life were devoted. It has been published since his death by his daughter (1911). The beautiful illustrations, many coloured, are far superior to those of the first edition (partly the result of the progress which has been made in late years in the art of mechanical reproduction), and the text embodies the mature results of their joint labours on the specific characters of the group. Workers

at Mycetozoa, especially beginners, are apt to publish a description of some aberrant form, which they regard as a new species, but a larger survey will frequently reveal the aberration as one of many variants grouped about and merging into a type form, and quite unworthy of specific distinction. It is the width of survey and the constant endeavonr to approximate the classification to the relation and variation of the species of Mycetozoa as they occur in Nature, under varying conditions of climate and locality, that confer on the second edition of the monograph its unique authority.

Although his chief endeavour was concentrated on this purpose, many of the advances in the knowledge of the life-history and physiology of the group were made by him or one or other of his children. The first observation of the ingestion of living bacteria by the swarm spores (flagellulæ) was his, and also that of the peculiar mode of division of the spore contents of the Exosporeæ after their escape from the spore wall. The remarkable simultaneous division by karyokinesis of the nuclei of the active plasmodium was first seen by his son, and Strasburger's observations of the karyokinetic division of nuclei prior to spore formation in *Trichia* were confirmed and extended to other genera and species. The complete life-history of the group, and especially the point at which gametic union occurs, are still undetermined.

My father became a Fellow of the Linnean Society in 1873 and of the Royal Society in 1898. He was a member of the Essex and Dorset Field Clubs, and he was President of the British Mycological Society only two years before his death.

He was very fond of foreign travel, and it was remarkable how, after he had been occupied for months with what might appear the work of a narrow specialist, often hardly talking of anything besides his beloved "Creepies," once free of his labour his mind responded to the charms of travel. He rejoiced in life on board ship, and never suffered from sea-sickness. He twice visited the North American continent, and his tours in Europe and Egypt with members of his family were often vividly recalled by him.

It was very rarely that he would allow himself to be enticed into paying visits in England, yet he had often immense enjoyment in them when once he had been induced to leave home.

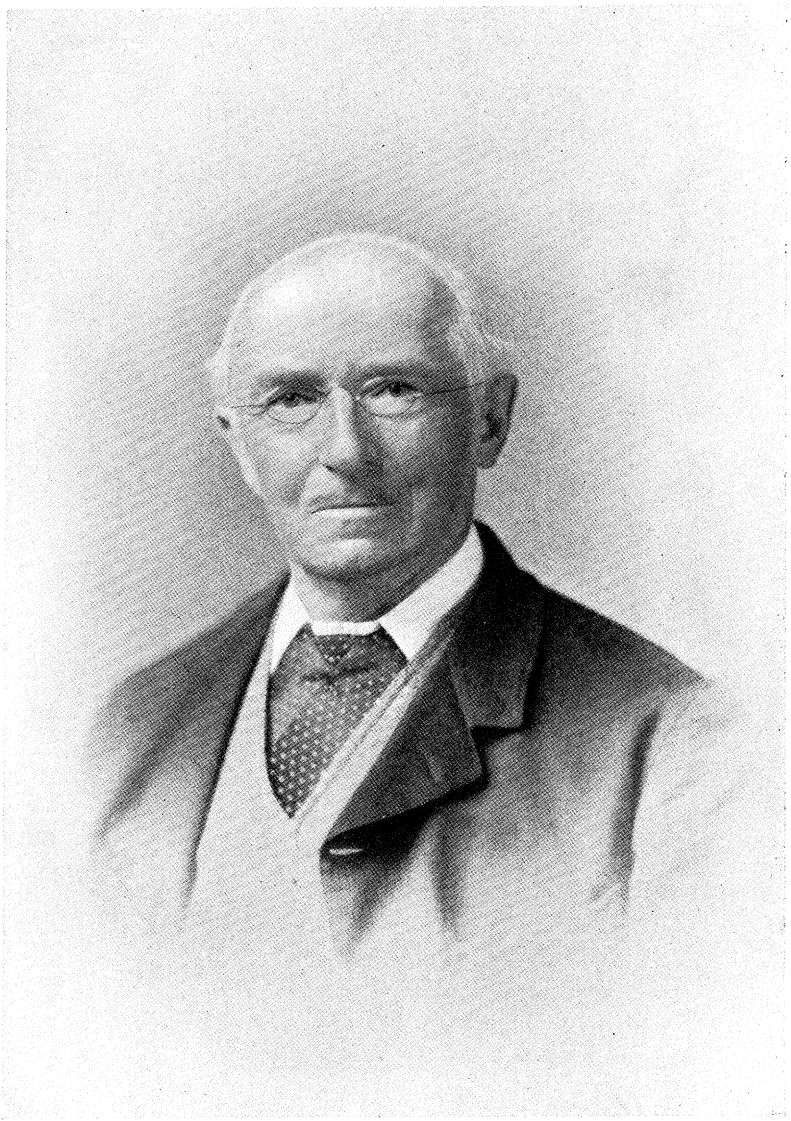
"Labour and Sorrow" are, as we know, the frequent attendants of the declining years of a strong man's life, and to this his was no exception. He suffered more and more from bronchitic attacks, to which he had always been liable, and from other bodily ills. Between the attacks, however, he often attained good measure of enjoyment in life, even in his later years, and owing to the loving devotion of his daughter, on whom, as his powers failed, he came to rely more and more, he was able to carry on his scientific work almost to the end. As I have said, she has been able since his death to embody his riper knowledge of the Mycetozoa, and her own, in the second edition of the British Museum monograph. All that loving care could do to smooth his path was done by his wife and the other members of his family.

He died rather suddenly at his home at Highcliff, Lyme Regis, on Sunday,

July 19, 1908, in his 79th year. He is buried in the burial ground of the Wanstead Meeting House, near Leytonstone, close to the oak tree on which he so often looked out as he sat in Meeting.

The closing years of his life were clouded for himself, and those who were near him, by his failing health and powers. It is to their recollections (if a son may be permitted so to write of his father) of the strong, wise, and loving man that he was in his prime, still attended by clear glimpses of the "Vision Splendid" and with much of the character, to use another Wordsworthian phrase, of "Nature's priest," that his family and his friends look back for the full evidences of the manner of man he was.

J. J. L.



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A. C. L. G. GÜNTHER, 1830–1914.

ALBERT GÜNTHER was born in Esslingen, South Germany, on October 3, 1830, a descendant of a family which had been in the locality for hundreds of years, the Swabian branch of the Günthers having settled in and about Möhringen on the Filder Plateau at the beginning of the fifteenth century. His father was "Siftungs-Commissar" in Esslingen, and Estates Bursar in Möhringen, whilst his mother, Eleonora Nagel, was a daughter of a family which originally came from Bremen, but had been resident in Wurtemburg for four generations.*

He obtained his early education at the Gymnasium at Stuttgart, and thereafter proceeded to the University of Tübingen, where he spent six years, 1847–52, 1856–7, the intervening years being occupied by attendance at the Universities of Berlin (1853) and Bonn (1854–5). This prolonged student-life was mainly due to the wishes of his relatives, who, according to family tradition, had destined him for the ministry of the Lutheran Church. He attended, indeed, the Theological College at Tübingen, and passed the qualifying examination. But the young student's bent lay in another direction, and, just as his brother turned to medicine, so he gravitated to natural science, especially after falling under the influence of the renowned Johannes Müller, who was then in the zenith of his fame, though a fatal accident which had happened to a student on one of his dredging expeditions had seriously affected him. He accordingly, after taking the degree of Ph.D. at Tübingen, in 1852, decided to study science and medicine, choosing zoology as the chief field of his labours, as evinced by his first paper, "Ueber den Puppenzustand eines Distoma," which appeared in the 'Württemberg

* 'Günther Family Records,' Quaritch, London (1910).

Jahreshefte' in 1853, in the same journal by his second note, "Beiträge zur Fauna Württembergs," by his "Fische des Neckars" in 1853; and by his 'Handbuch der Medicinischen Zoologie' in 1858. He fully qualified himself, however, for medicine, even studying for a time in St. Bartholomew's Hospital, and graduated as M.D. at Tübingen in 1858. Thus he also illustrated the indissoluble brotherhood between medicine and zoology, of which Prof. Allman (himself an M.D.) made so much in his introductory lecture in Edinburgh University in 1854, and which has been a striking feature from the earliest times till now.

The "Fische des Neckars"* gives an earnest of that methodical habit, accuracy, and patient investigation of his later years, both as regards the systematic examination of the conformation of each species, its size, colour, fins and fin-rays, scales, skeleton, eggs, parasites, and haunts. It is a model of what a local fauna should be. About thirty species, including the Cyclostomes, were entered, and at that date the young (so-called Ammocœte) was considered a separate genus. This paper appeared also as a separate treatise with a finely coloured plate of *Leuciscus muticellus*, Bonap., which the author had detected in the river, and which was drawn by Prof. Rapp.†

The 'Handbuch der Medicinischen Zoologie' (1858) must have been a useful treatise for medical and other students. It commences with the higher mammalia, concludes with the infusoria and sponges, and touches most forms of service or of interest to the student, and, without being too prolix, it gives a comprehensive grasp of the subject—specially alluding to the medical products derived from the various forms. It does credit to the studious and earnest author even at this early period of his career.

Visiting his mother in England in 1855, he met Dr. John Edward Gray and Prof. Owen in the British Museum, and both, having a knowledge of his previous work, took an interest in him, and a friendship sprang up between them. Two years later Dr. Günther was selected to arrange and describe the Fishes, Amphibians, and Reptiles in the National Collection, which task, sufficiently onerous then, became increasingly laborious as time advanced, whilst the work at first had little relation to adequate financial inducement. The eager naturalist cared little for the latter if only the opportunity for extending knowledge, and for placing the varied collections committed to his care on a proper footing, were given him, and from October, 1857,‡ onward, he devoted himself to this task. Those familiar with his cellar-like apartments in the old Museum will appreciate the enthusiasm and unswerving loyalty, as well as remarkable ability, he brought to bear on his work, apparently indifferent to depressing surroundings and formidable difficulties connected with literature and specimens.

In glancing at the remarkable list of memoirs (246) and papers entered

* 'Württembergische Naturwissenschaftliche Jahreshefte,' Stuttgart, 1853.

† For much information contained in this notice of Dr. Günther I am indebted to his son, Mr. R. Günther, M.A., Fellow of Magdalen College, Oxford.

‡ They started him with 2,000 bottles of snakes in 1857.

in the Catalogue of the Royal Society the reader is struck by the variety as well as by the laborious nature of most of them. Few men have produced such a series of meritorious contributions to our knowledge of zoology, ranging from Distomes and Spiders to Mammalia, but chiefly concentrated on Fishes, Amphibians, and Reptiles, though Birds and Mammals come in for a considerable share; and yet this list is incomplete—without for the moment alluding to his separate works. Some of his earlier papers appeared in the 'Württemberg Jahreshefte' and in 'Wiegmann's Archiv,' but after he was settled in the British Museum the majority of his valuable contributions were published in the 'Proceedings' and 'Transactions' of the Zoological Society, those of the Royal Society, and in the 'Annals of Natural History'—of which he was so long the chief editor. His lucid and terse descriptions of new fishes, frogs, snakes, lizards, tortoises, of birds and mammals, his anatomical memoirs on *Hatteria* (*Sphenodon*) and *Ceratodus*, his descriptions of zoological gardens at home and abroad, his papers on the distribution of reptiles, on zoological nomenclature, and on fossil fishes were sufficient for the foundation of several reputations. Every collection of note made by explorers all over the world came to him at least for the fishes, frogs, and reptiles, and occasionally for the birds and mammals. Special memoirs on certain groups were intermingled with faunistic reports and descriptions of new forms in the British Museum, ranging from an undescribed spider from Cochin China, a new species of long-tailed titmouse, the insectivorous mammal *Potamogale*, to a new poison-organ in batrachoid fishes, and the skeleton of *Ausonia*. Further, as the founder and first editor of the 'Zoological Record' in 1865, he placed naturalists under a debt of gratitude which continues now with unabated force, since the modern developments in this field are largely due to his original efforts. His object, "to acquaint zoologists with the progress of every branch of their science in all parts of the globe, and to form a repertory which will retain its value for the student of future years," has been amply borne out.

His incisive criticism (1859) of the work of a Continental author on the snakes is incorporated, again, in his description of a new genus of West African snakes (*Elapops*), and revision of the South American *Elaps*; whilst his researches make a distinct advance on our knowledge. His historical account of *Echeneis* (1860) reveals not only the classical knowledge of the author, but an intimate acquaintance with the extensive literature and of the rich collections in the British Museum, so that he was enabled not only to correct previous errors, but to add two new species to the genus.

Most instructive was his paper (1859) on the sexual differences in recent and fossil frogs and fishes, and especially of *Ceratophrys*, the female having a skull about three times as large as that of the male. Its peculiar and solid structure in both sexes is due to the mode of life of these frogs, which feed on other frogs, birds, mice, and young rats; thus Dr. Günther found in the stomach of one a *Cystognathus* half the size of its destroyer, for, with its wide cleft and enormous cavity of the mouth, its powerful muscles from the

tympanic and neighbouring bones, and short teeth, it securely holds its prey. These parts, indeed, form a contrast with those in other Anura. His acuteness in discriminating the fossil humerus of the male *Cystognathus*, which is specially developed in connection with propagation, rested on his thorough knowledge of the living forms, and so with the presence of the thick ray in the pelvic fin of the Tench.

He notes that the inhabitants of the Sandwich Islands search the tidal pools at low water for small fish-fry, and convey them to ponds (fresh water) "in which in a short time they increase to a size fit for the table" (E. T. Bennett, formerly Secretary Zoological Society). Dr. Günther adds (1861) that though he considers the acclimatisation of foreign fishes as a matter of subordinate value from a practical point of view, it is a problem of high scientific importance, because it involves the solution of the question, how far the power of man is able to interfere with the original distribution of fishes. He advises the selection of forms from a similar climate, *e.g.* the Wels (*Silurus glanis*) of the Continent. If tropical forms are wished, the Gorami (*Osphromenus olfax*) a freshwater fish reaching 15 lb., and which has been introduced into Mauritius and Cayenne, the climbing Perch (*Anabas scandens*), and the Pla Kat of Siam (*Betta pugnax*) as deserving trial.

The grasp which, even at this early age, Dr. Günther had obtained of the distribution of Reptiles and Batrachians is evident in the masterly paper communicated to the Zoological Society in 1858. A careful perusal of this demonstrates that the author had forestalled many interesting features which have since been described by others. The contrast between snakes and amphibians in connection with temperature and temporary physical disadvantages is pronounced, and this makes snakes well adapted for clearing up the question, Creation *versus* Evolution. He contrasts the reptilian distribution with that of birds (which P. L. Sclater had communicated to the same society a few months earlier, and which had often been the subject of discussion between the two naturalists), and it is possible that the views of Dr. Günther had some influence even in regard to the birds. He united, however, the Ethiopian shores of the Mediterranean with the Palæarctic region, instead of considering Spain and Portugal as approximating more to Africa than to Europe, as Schlegel did. He differed from the latter also in showing that a snake like *Dasypeltis scaber*, living on trees in Africa, devouring eggs of birds, the shells of which it breaks by gular teeth and with irregular arrangement of the lateral scales, cannot be a representative of the genus *Tropidonotus*. The Hydridæ of the Indian region, the linking of Japan to this region, the large proportion of venomous snakes in Australia, the two systems radiating from the Mississippi in the north and the Amazon in the south in the Nearctic region, the comparative paucity of snakes in the Neotropical region, are all forcibly portrayed in this communication. In the same way the peculiarities of the distribution of the Amphibians are dealt with throughout the several regions, many striking facts being brought forward for the first time. The total absence of Batrachians from New

Zealand, the absence of the tailed forms from Tropical Africa, the Arctic character of the Batrachian fauna of Japan, whereas its snakes are Tropical, the absence of *Hyla* in India and Africa, the spread of the European *Rana temporaria* to the Nearctic region and its absence in the Neotropical, and the resemblance of the Batrachian fauna of South America to that of Australia, are a few of the salient points of this important communication. In after years he was enabled to supply Mr. Darwin with so many interesting facts relative to the reproduction and the wedding-dress of fishes, amphibians and reptiles, and to such an extent that Darwin wrote "My essay, as far as fishes, batrachians, and reptiles are concerned, will be in fact yours, only written by me."

To Alfred Russel Wallace's 'Geographical Distribution of Animals' Dr. Günther contributed much important information concerning the distribution and classification of fishes and reptiles, the gigantic tortoises of Galapagos and the Mascarene Islands, the height to which reptiles reach on the Himalayas, and on the distribution of fishes—especially the identity or close affinity of those occurring on each side of the Isthmus of Panama, rendering it probable that Central America has been partially submerged up to comparatively recent geological times. His researches on the freshwater fishes of the same region would point to a like conclusion, seeing that a number of fish-faunas can be distinguished, corresponding to some extent with the islands into which the country would be divided by a subsidence of about 2000 feet, the most important of the divisions separating Honduras from Costa Rica.

His work on the Reptiles of British India, published by the Ray Society in 1864, is a systematic treatise of great merit, for not only does the author give the results of his labours in the British Museum, but he examined every available collection at home, and included those of Burma, Siam, Cochin China, and Southern China. The philosophical spirit in which he dealt with the genera and larger groups is manifest throughout, and the 26 lithographic plates, chiefly by Ford,* can hardly be surpassed. The work is a monument of patient labour, wide knowledge, and scrupulous care.

His careful account of the anatomy of *Hatteria* (*Sphenodon*), in 1867, enabled him to make a step in advance in the classification of recent Reptilia, a step which zoologists have since followed in connection with the characters of the Rhynchocephalia. The fixed quadrate, cartilaginous ali- and orbitosphenoids, the union of the mandibular rami by ligament, the uncinate processes of the ribs, double temporal bars, amphicœlous vertebræ and absence of copulatory organs, showed characters of ordinal importance. Researches since that period have borne out the prediction of the author that discoveries of extinct allied forms would further add to our knowledge. Thus the group of the Prosauri with its sub-order Proterosauri including *Palæohatteria* from the Lower Red Sandstone of Saxony, and

* He greatly pleased Mr. Darwin by getting this skilful artist, in 1870, to do his wood-engravings.

Proterosaurus from the upper Permian of Thuringia and Durham, show how correctly Dr. Günther had anticipated the extension of the group.

The treatise, along with Lieut.-Colonel Sir Lambert Playfair, on the Fishes of Zanzibar, added many new species to the fauna of the East Coast of Africa, and by the patronage of the Government of Bombay the authors were able to illustrate their volume with finely coloured lithographic plates by Ford.

The eight volumes of the Catalogue of Fishes in the British Museum is a work of extraordinary research, the list of the authors and their works alone occupying, for example, in the first volume of the Acanthopterygian Fishes, about 12 pages. Thus in the first two volumes the number of species in each is nearly double that of Cuvier and Valenciennes, the last general ichthyological work, more than double in the third, and so on throughout the series. The labour of examining the descriptions and determining species by them, of correcting erroneous interpretations, and of giving an account of each which would have the "distinctness of a diagnosis and the accuracy of a description," must have been enormous, not to allude to the task of going over the numerous special and ever increasing collections in and beyond the Museum, and correcting the synonymy. It is not generally known that the author worked at the first three volumes under great disadvantages, especially in regard to financial aid and time, facts which should be borne in mind in their review. The vast area from which the collections were drawn sufficiently explains the nature of the undertaking, since Arctic and Antarctic, Temperate and Tropical seas and fresh waters, were equally ransacked for their fishes. Yet in the second volume he was far from being satisfied as to the completeness of the task, since so many forms entirely new to science had rewarded him, that he urged the collection of fishes in every country, for, he added, "we may well conclude that not one-tenth of existing species are known" (1860).

In his progress with the task allotted to him, he states that though weighty reasons have been brought forward against the natural limits of the Acanthopterygian order of Johannes Müller, he still feels satisfied with Müller's ordinal arrangement, and is of opinion that no character is of equal importance to that of the structure and position of the fins, and that the number of the vertebræ is of great value in distinguishing families. He, however, shared the opinion of those who consider the coalescent pharyngeal bones as of sufficient importance to unite acanthopterous and malacopterous fishes into one order, and changed the name *Pharyngognathi acanthopteri* into *Acanthopterygii pharyngognathi*. His *Acanthini* coincide essentially with the *Malacopterygii jugulares* of the old authors, and he observes they are a very natural order. His experienced remarks concerning the cod and the sole are worthy of remembrance, some ichthyologists placing them indeed in distinct orders; but the absence of symmetry is the only constant character on which such an opinion can be founded, and it is but little developed in the more highly organised forms such as *Psettodes*, a genus in which the asymmetry is almost entirely limited to the position of the eyes,

which are on the right side in one half of the specimens and on the left in the other. The vast literature in such a family as the Salmonidæ absorbed as much patience and time in the investigation of a single species as in other fishes for that of a whole family. The small family of the Umbridæ, however, gave Dr. Günther some compensation, since of its two species one occurred in Central Europe, the other in North America, the close affinity of the two being recognised by him for the first time, and constituting "one of the most striking instances against the geographical continuity of identical forms." In the Preface to his eighth volume many valuable observations were made, some of which are widely applicable. Thus, in defining a species, he considered it to be well established only when it is founded on characters which, from an examination of numerous examples, are found to be permanent, not subject to gradual variation, and not dependent on season, sex, or age, or which are known to be so from the examination of allied forms. An idea of the extensive and laborious nature of Dr. Günther's task is gained by his statement that 6843 species of fishes in his Catalogue are well established and described, whilst 1682 others are doubtful. "Assuming that about one-half of the latter will ultimately be admitted, and that since the publication of this work 1000 species have been described elsewhere, *we may put the total number of fishes known at present as about* 9000." At the date of publication of the last volume, he calculated there were 29,275 examples of fishes in the British Museum, a vast array, largely due to his own initiative, and to his personal influence, yet he modestly states that it contains not two-thirds of the known species, and instances the gaps yet present, even in such well known forms as the herrings, the sharks, and the rays. He therefore urged the necessity of keeping pace with the rapid progress in ichthyology resulting from the efforts in other countries; adding that no other class of vertebrates offers a similar gradation of development of the most important systems and organs, rendering its systematic arrangement a most difficult problem. His further remarks as to the importance of fishes in elucidating the geographical distribution of animals and the relations of the various epochs to one another doubtless proved an invaluable aid in determining the importance of such an Expedition as that of the "Challenger." He modestly concludes this epoch-making labour by stating that, "if it should assist my fellow-labourers and enlist others—if it should contribute to the advancement of truth, I shall not repent having devoted the best years of my life to its execution."

Early in his career, Dr. Günther kept in touch with the Museum Godeffroy at Hamburg; indeed, in 1868, he was instrumental in enriching some private collections of invertebrates through this agency, for the staff of the ships employed by the firm of merchants specially collected every group. Dr. Günther undertook the Monograph on the South Sea Fishes, thereby making a noteworthy addition to his famous works both in text and illustration, since the artist, Andrew Garrett, had lived in the Pacific Islands and made drawings from life of all the fishes which fell in his way, just as the late Colonel Drummond-Hay, of Seggieden, did with those off the Bermudas,

but with this difference, that Garrett's specimens and drawings went to the Museum Godeffroy, whilst Colonel Drummond-Hay's specimens were lost by the thirst for alcohol of a man left in charge during the absence of the Colonel in Britain. Portions of Dr. Günther's work, which was undertaken on condition that a selection of the fishes, including all the types, should be presented to the British Museum, were issued in 1873 and 1881. A long blank, mainly due to financial reasons, then occurred, and it was fully a quarter of a century later before Friedrichsen, the publisher, wrote to Dr. Günther asking if he could proceed, since Dr. Martin Godeffroy had now advanced funds. Thus, after his retirement from office, the veteran ichthyologist was enabled to complete his great task in 1909 and 1911. This fine work could only have been accomplished by one with an encyclopædic knowledge of fishes and their synonymy, and in touch with the vast collections in the British Museum; and the gorgeous coloration of many of the fishes and their interesting habits make the work of special interest and value.

Having to re-write the article on "Ichthyology" in the Eighth Edition of the 'Encyclopædia Britannica' originally prepared by Sir John Richardson, Dr. Günther took the opportunity of publishing an 'Introduction to the Study of Fishes' (1880), a treatise which, in limited compass, places before the student the history and literature of the subject, the structure, growth, and variation of fishes, their distribution and systematic relations. This work is invaluable to the student and ichthyologist, and is especially interesting in those chapters dealing with the distribution of fishes, and the problems opened up by the appearance of identical families, genera, and species in distant continents, such as, for instance, *Galaxias*, in Southern Australia, New Zealand, and the southern parts of South America. A German translation of this work was published in 1886.

When elected to preside over the Biological Section of the British Association in those palmy days (1880) when zoologists, botanists, physiologists, anthropologists, and the rest all fell under this head, he chose as the subject of his address that which his predecessor, Dr. J. E. Gray, had chosen before him (1864?), viz., "Museums: their Use and Improvement," and his experienced remarks were worthy of the theme. He made three groups of museums—(1) National, (2) Provincial, and (3) Educational—though these pass into each other and there may be hybrids between them. He gave an outline of the new Natural History Museum at South Kensington, pointing out that in this, the greatest National Museum, it would be impracticable to group the recent with the fossil forms, however strongly the principle of studying the two may be held, for all agree that zoologists and botanists should not be content with the study of the recent fauna and flora, nor should palæontologists carry on their researches without due reference to the living forms. In the museum two series are necessary, viz., those illustrating the leading points of popular and scientific interest, and, secondly, the study-series. He also emphasised the construction of cases of metal as a substitute

for wood, and in this he anticipated what thirty years later became the rule in the finest collections. In insisting on the formation of a Natural History Library in connection with the National Collection, and in the policy of distributing duplicates to provincial museums, he held enlightened views, which have since been fully acted on.

His work on the Shore Fishes of the "Challenger" (1879) showed that even the limited opportunities of the naturalists for making such collections were productive, for the series consisted of 1400 specimens, of which 94 were new to science. Yet the chief efforts of the explorers were devoted only to such localities as were previously more or less uninvestigated, and which were rarely visited. His familiarity with the subject and his methodical method of working enabled him to issue this volume whilst Sir Wyville Thomson was still at the head of the "Challenger" office. Dr. Günther took the opportunity of widening our knowledge with regard to the mutual relations of the fishes of the deep and shallow waters, and of demonstrating the wide range of many, both as regards depth and locality. He fixed the dividing line between these and the deep-sea fishes at 100 fathoms, though Sir Wyville Thomson and he at first thought that the dividing line should be from 300 to 350 fathoms, and his grounds were that "no fish not known at present to have occurred beyond the 100 fathom line is admitted in the Report; and, further, that no truly bathybial fish is known to live habitually above that line."

In his great work on the Deep-sea Fishes of the "Challenger" (1887) he combined all the information gained during the subsequent productive cruises of the "Knight Errant" and "Triton," as well as such new materials as could be gleaned from the fragmentary and preliminary notices of the expeditions by the two Institutions of the United States, and by the expeditions of the French, Norwegian, and Italian Governments. The total specimens were referred to 266 species, of which 177 fell to the share of the "Challenger" and 14 to the exploration of the Faröe Channel. The number of new forms amounted to no less than 144, whilst 10 were added to the fauna of the British seas. Every trained zoologist will coincide with his concluding words in the preface, viz.: "My technical descriptions of the Challenger fishes will be found to be much more concise than those given by some recent writers . . . . . the practice of circumstantially describing every minute detail of the surface of a fish, repeating every point of structure common to all the species of the genus or family, and indiscriminately mixing individual characters with specific, not only renders the use of these lengthy descriptions a laborious and thankless task, but actually leads to misunderstandings not less frequently than the insufficient short diagnoses that have been prepared by inexperienced describers."

In this valuable treatise he first gives a careful historical digest of the subject, referring especially to the work of the Norwegian North Atlantic Expedition and to that of the United States Fish Commission under Prof. Alex. Agassiz and Dr. Spencer Baird, the former expedition reaching

1400 fathoms and the latter 2900 fathoms, a similar depth having produced fishes in the "Challenger." No part of this fine treatise is more interesting than that in which the characteristics of the deep-sea fishes are portrayed by the author, such as the size of the eyes, the black colour of the pharynx and of the surface of the cœlom, the fibrous, fissured, and cavernous structure of the feebly developed bones, the thin lateral muscles, and the loose connection of the vertebræ. As a consequence, when they are drawn to the surface these specimens require the most careful manipulation to prevent their breaking into fragments. Yet under the normal conditions of their abyssal home, that is under the enormous pressure of the surrounding element, the fibro-osseous tissues and the thin muscles suffice for rapid and powerful movements. When drawn up the expansion of the gases in the air-bladder causes the gullet and stomach to be thrust out of the mouth and the eyes from their sockets. These deep-sea fishes possess a largely developed muciferous system on head and body, and in addition a series of phosphorescent organs. Dr. Günther gives a lucid and comprehensive description of the modifications of these organs as to distribution, appearance and structure, grouping his remarks under nine heads. He considered that these fishes contribute to a considerable extent to the luminosity of the abyssal depths, and that such light enables the possessor to see; and in those in which the organs are highly developed and specialised, the light is under the will of the fish, which thus can use its "searchlight" for the purpose of discovering prey or for other purposes. Further, the occurrence of such organs in the cavities of the gills or within the mouth does not invalidate such a view, as the membranes and bones are semitransparent. On the other hand, he pointed out that the luminous organs which are placed on barbels, filamentous fin-rays, or tentacles serve as lures, and that even those on the caudal peduncles of Scopelids, Sternoptychids, and others probably have the same function.

Another notable observation of Dr. Günther's was the reduction of the gill laminæ in these fishes: the horny rods which support the plaits of the mucous membrane being deficient in firmness, the laminæ are reduced in number and the respiratory surface diminished. He was inclined to associate this with their sojourn in the low temperature of the abyssal depths and its effect on circulation and respiration. He also points out that the spawn of some of them (*e.g. Polyprion cernium*) develops at the surface, whilst the young fishes, after a short pelagic existence, descend to the bottom as in the flat fishes. He considers, however, that in others the spawn will be deposited on the bottom and hatched there, thus affording an extreme contrast to the former, which were developed under the accelerating influences of light, warmth, and a constant supply of oxygen. The oviposition and hatching of the eggs of fishes, indeed, are marvellous in their infinite variation.

Equally interesting are his remarks on the vertical and horizontal distribution of these deep-sea fishes, the families, for instance, which descend to the greatest depth, viz. 2900 fathoms, are Berycidæ, Pediculati, Ophidiidæ,

Macruridæ, Sternoptychidæ, Scopelidæ, Stomiatidæ, and Murænidæ, besides the Alepocephalidæ, and the Halosauridæ, which have no representatives in the surface-fauna. He shows that the abundance and variety of fish-life decreases as the depth increases, and that the uniformity of the physical characters of the sea-bottom gives rise to the almost unlimited horizontal distribution of deep-sea fishes, so that the same genera and even the same species may occur in the depths of the eastern, western, northern, and southern hemispheres.

The whole of this fine work teems with novelties in the structure of the remarkable forms so carefully dealt with by the author, and which were graphically illustrated by the brothers Mintern.

One of the most interesting labours was his final one on the History of the Zoological Department of the British Museum from the year 1856 to the year 1895, when Günther retired from active service, and which was published by the Trustees at the end of 1912. This record of 39 years' experience of the National Collection is told with great accuracy and rare modesty, and perhaps more than any other evidence testifies to the zeal, perseverance, and popularity of the Keeper—even under circumstances not always conducive to progress. The increased grant, from £1100 to £1500 per annum, during this period enabled the Keeper to effect greater uniformity in the growth of the branches of the collections, and to follow Dr. Gray's plan of forming a study-series as well as an exhibition-series. The collections in 1856 were well arranged in cases, and the specimens were clean and well preserved, whilst the richness in rare types made the Museum even then not behind those on the Continent. Those who knew the collections at the former date, however, can appreciate the vast changes which were inaugurated in such departments as the mammals, birds, reptiles, and fishes, as well as in the invertebrates in general—especially during the period of Dr. Günther's keepership. Whilst he laboured at the specimens and catalogues himself, he also encouraged others in the same field. Thus the catalogues on almost every group of note made considerable progress.

The labours during his keepership (1875–95) may be dealt with under the following heads :—

1. *The Increase and Arrangement of the Collections.*—The appointment of Dr. Günther as Keeper in 1875 was followed by a great increase in the collections generally, by such additions as those of the "Transit of Venus" Expeditions, the Arctic Expedition, collections by naval officers, the "Challenger" collections, the Bowerbank collection of Sponges, the Gould collection of Birds, the Godman and Salvin collections of Birds, the Hewitson collection of Exotic Butterflies, the collections from the East India Company's Museum, collections from the International Fisheries' Exhibition of 1883, Zeller's Microlepidoptera, the Hume collection of Birds, Godman and Salvin's American Birds, the Tweeddale collection of Birds and Works, the Walsingham collection of Lepidoptera, the Godman North American Birds, the Day collection of Indian and other Fishes, the Keyserling Arachnids, the

Frey Lepidoptera, the Carter Sponges, the Parker Foraminifera, the Hume Heads and Horns of Large Game, the Anderson Egyptian Mammals, the Pascoe Coleoptera, the Stainton Lepidoptera, the Lilford Birds of Europe, F. Moore's Indian Moths, the Godman and Salvin Insects, Saville Kent Corals, and many others. An idea of the vast increase during Dr. Günther's period of office may be gained by comparing the census of 1868, viz., 1,000,000, with that in 1880, viz., 1,300,000, and in 1895, 2,245,000. Much of this increase was due to the constant efforts of the Keeper and his friendship with the leaders of expeditions, naval and military officers, as well as with naturalists at home and abroad.

In the arrangement of the collections increased progress was by-and-by obtained by the employment of temporary workers distinguished for their knowledge in certain departments, the Treasury being less reluctant to the temporary employment of such specialists than to additions to the permanent staff. Thus Messrs. Seebohm, P. L. Sclater, O. Salvin, E. Hargitt, and Count Salvadori aided in cataloguing the birds, Mr. (afterwards Sir) George Hampson and Mr. Warren worked amongst the insects, whilst Mr. George Brook took (alas, only for a short time) the Madreporarian corals in hand. Others who aided in this work were Prof. Rupert Jones in the Foraminifera and Mr. H. M. Bernard, who, on the death of Mr. G. Brook, took up his task. Noteworthy advances were thus made by the combined labours of these skilled naturalists and by those of the staff.

Dr. Günther also instituted in 1875 a fascinating method of exhibiting the birds which breed in Britain, with their nests, eggs, and young exactly as in their native surroundings, only the perishable parts of the plants being artificially reproduced, whilst the actual parents and the makers of the nests were in every case secured. No more popular part of the great Museum exists than the long Bird Gallery, in which these beautiful and interesting groups are exhibited, for the life-like attitudes and the suggestive surroundings appeal to the average citizen as well as to the cultured man of science. Dr. Günther's experience as a field naturalist and aviculturist enabled him to grasp all the essential features in such a display, and to combine accuracy with the most charming effects. In his record of the collections he pays a tribute to Lord Walsingham's help in securing suitable specimens.

2. *The Staff.*—When Dr. Günther received the appointment of Keeper, Mr. F. Smith succeeded him as Assistant Keeper in charge of the Entomological collections, and, in 1878, there were nine Junior Assistants, viz., Mr. A. G. Butler (Myriopoda, Arachnida, and Lepidoptera), Mr. C. O. Waterhouse (Coleoptera), Mr. E. A. Smith (Mollusca), Mr. E. J. Miers (Crustacea), Mr. R. Bowdler Sharpe (Birds), Mr. Oldfield Thomas (Mammalia), Mr. S. O. Ridley (Polyzoa, Hydrozoa, and Anthozoa), Mr. F. J. Bell (Worms and Echinoderms), and Mr. O'Shaughnessy (Reptiles and Fishes). This staff Dr. Günther found to be insufficient for overtaking the labours entailed by the ever increasing collections, and the Treasury, in 1882–83, sanctioned a First-Class Assistant, Mr. G. A. Boulenger (Reptiles and Fishes), and two

Second-Class Assistants, Messrs. W. R. Ogilvie-Grant (Birds), and Mr. J. J. Quelch (Polyzoa, Anthozoa, and Hydrozoa). In addition, an articulator and two boy attendants were appointed. A most important change was at the same time instituted by the re-arrangement of the duties of the attendants (13), many of whom were skilled manipulators, so that when they were relieved of menial duties they became of much assistance to the scientific staff in manipulating specimens, and in writing and copying. Some of these assistants had considerable knowledge of the collections, and were able, for instance, so early as 1863, to name collections for outsiders. By this change the preparation of the various catalogues was expedited.

3. *Catalogues and Guides.*—One of the duties of the Keeper was to superintend the preparation of catalogues and guides of the vast collections, and Dr. Günther from the first set himself with energy to this department, showing an example by his own Catalogue of the Gigantic Land-Tortoises, living and extinct, 96 pages and 55 plates (1877). A continuous series of catalogues and guides marked his tenure of office, and rendered the Museum a centre of zoological progress, as well as a popular resort for information in Natural History. When the Trustees consulted the Keepers about the Index Museum proposed by Sir Richard Owen, the Superintendent, Dr. Günther's recommendation to them was as follows:—"To render the exhibition-series in every way instructive, a more perfect plan of labelling throughout the collection should be introduced, and a new guide-book should be prepared. A clearly written guide, well illustrated with woodcuts, will supply all the information useful to the public and draw their attention to the more remarkable types. As the different divisions of the animal kingdom will be separated in distinct rooms, it will be possible to prepare this guide on an entirely different plan from that at present in use at the British Museum, viz., in the form of a popular, but systematic, handbook of Natural History." The Index Museum was proceeded with, though greatly altered in aim and constitution in subsequent years, and Günther's suggestion in regard to the guide-books was successfully carried out, so that these were instructive not only to the visitors to the Museum, but to Provincial Museums and schools of Natural History all over the country.

The plans of the new Natural History Museum at South Kensington were submitted to Dr. Gray in 1871, and when Dr. Günther became Keeper in 1875, he and the other Keepers watched the arrangements for the several galleries as instructed by the Trustees. Yet he was greatly handicapped by the arrangements made by the architect, so that it was found impossible to have the mammals on the ground floor as intended, and thus the birds had to be placed there. It was during his tenure of the office of Keeper that the transfer of the vast zoological collections from Bloomsbury to their new home in South Kensington took place, viz., in 1882–83. The Superintendent, Prof. Owen, was then advanced in life, so that the chief responsibility fell on Günther, and the successful manner in which this delicate task was carried out reflects credit equally on his administrative capacity and his

ingenuity, and, indeed, the Trustees paid a tribute to Dr. Günther and his staff for "the successful removal of the zoological collections without any accident of importance," and acknowledging "their sense of the forethought and care shown in the direction of the removal, and of the zealous assistance of officers and attendants in effecting it." The enormous labour involved in the re-arrangement, for which careful plans of the galleries had previously been prepared, so that in many cases the specimens were placed at once in position, may be estimated by the fact that besides the removal of about a fourth of the collections in 1882, no less than 350 journeys were made by vans in 1883, in addition to the transfer of very delicate specimens in cabs or by hand. To the persevering efforts of Dr. Günther perhaps, more than any other, the design of a special Spirit Building is due, and it has the form of a large quadrangular hall with a floor and a roof of cement, besides other ingenious arrangements for the control of free spirit, and for the effective application of water in case of fire.

The formation of a Zoological Library had early been considered both by Dr. Gray and Dr. Günther, and the subject became more urgent when the transfer from the neighbourhood of the great National Library in Bloomsbury was decided on; yet it was not till 1879–81 that a commencement was made. Dr. Günther prepared the first catalogue of books in the Zoological Department, with the help of John Saunders, comprising 1700 titles, including 182 works. The Treasury allowed the unexpended balance (£5700) of the previous year to be devoted to this purpose, making a further grant of £5000 for each of the five following years. Dr. Günther had taken upon himself the work connected both with the Zoological and the General Library in the new Museum, selecting, indeed, the books himself at Quaritch's, but, as the works increased in number, the Trustees granted for several years the assistance of Mr. J. E. Harting in the Zoological Library. By purchase, presentation, or exchange the Departmental Library had, in 1895, amassed 10,036 separate works or 16,238 volumes, a sufficient proof of the constant care and thoughtful supervision of the Keeper, at whose suggestion John Saunders, who had been specially trained for this work, was placed in attendance on the Library. Thus one of the most important adjuncts to the National Collection was established, and has been of signal service to every member of the staff as well as to the numerous British and foreign workers who resort to the great collection for study.

In connection with the Library Dr. Günther arranged for the transference from Bloomsbury of several valuable collections of original drawings of animals, such as J. Abbot's original drawings of the Insects of Georgia—in 17 volumes, and of Major-General Hardwicke's drawings of Indian animals —in 33 volumes. This department is an important one and merited the attention the Keeper bestowed on it. He also formed a large private collection of zoological drawings, the arrangement of which formed the recreation of his leisure hours.

Dr. Günther's profound knowledge of fishes was utilised in public

inquiries, as, for instance, in distinguishing salmonoids, and was of much service to the public authorities in such cases; nor were his labours on the effects of pollution of salmon- and trout-rivers less important. He carried out, for instance, careful experiments on the effects of the pollution of the lower Thames, noticing the length of time that fishes would survive in water tainted with sewage, the effluents from gas-works, and other injurious mixtures. He, indeed, carefully surveyed the river in a steam-vessel placed at his service by the Metropolitan Board of Works. In the case of the "yellow fins" of the Allan Water, again, his experienced advice was decisive, though a skilful lawyer, by presenting a Lochleven trout to another less wary scientific witness, created a diversion in favour of a contrary view.

Throughout his life in England his fondness for pets of diverse kinds continually asserted itself. Thus in his young married life at Surbiton an artificial tree by the fireplace of his dining-room harboured a chameleon and a small parroquet, the former invariably and successfully contesting for the most comfortable perch with the latter—until on a dusky winter morning it left its bough to crawl on the carpet, the colour of which it assumed, and was unwittingly trodden on by a servant. Tree-frogs uttered their curious notes from a Wardian case with its plants, and other species hopped about on the green moss beneath. At Surbiton, also, he had a pet alligator, which he kept in his bedroom, and a giant tortoise in the garden along with the old-world *Hatteria* (*Sphenodon*) from New Zealand. His aviary contained blue tits, cormorants (which were fed on fish offal and rats), a raven, hoopoes, and shrikes, whilst others occupied cages in the house. A nest of young kestrels (now in the University Museum, St. Andrews) shows how successful he was in the rearing of his pet animals, and the same may be said of his efforts with the Tussah silk moth of India. Many will remember his success in rearing for the first time the red-backed shrike in his aviary at Kew Gardens, for, though the first brood did not live to maturity, the second brood of five reached the adult condition, the parents feeding them especially on earth-worms, which they cut in small pieces. Moreover, he noted that their song imitated that of the garden warbler. He took much interest in the nesting of a pair of storks in Kew Gardens, where several pairs still remain—a source of interest to ornithologists and the public, and an additional charm to the magnificent grounds. His remarkable grackle (a gift from Lord Lilford) at Kew Gardens was known to all his visitors, and its performances were a source of never-ending interest and amusement. A small pond in his garden at Hampton Wick again gave an opportunity for observing the habits of fishes. When detained indoors by rainy weather, his active mind found exercise and recreation indoors in the care of his private collections.

Though devoted to his scientific labours, Günther was a delightful companion, and one of the kindest parents—ever ready to sacrifice himself for the happiness of his family, whose interests and welfare were to him paramount. As a host he will be remembered by many a man of science at home and abroad; and as a genial friend whose vast stores of information

were ever at the disposal of others. Delighting in the study of nature, he was equally at home in the country and in the metropolis, and many a useful hint he gave to those who in their rural retreats had devoted themselves to the fauna and flora around them. He was, moreover, an expert angler and a skilful shot.

Dr. Günther was in correspondence with naturalists all over the world, and was a member of many learned societies at home and abroad; was President of the Biological Section of the British Association, 1880; President of the Linnean Society, 1904; and Vice-President of the Royal Society. He received the Royal Medal of the Royal Society, the Gold Medal of the Linnean Society, and the Medal of the Avicultural Society.

As a systematic zoologist Dr. Günther held a foremost position—whether we view the vast extent of his labours, their accuracy, or their importance. For nigh sixty years he pursued his studies with rare singleness of purpose, great natural ability, and conspicuous success—unmindful of those external encouragements which by some are held in great estimation. It was sufficient for him that he was advancing knowledge and doing his duty to the public; whilst the work itself was both spontaneous and pleasurable. His administrative labours in the British Museum alone and his skill in the transference of the great collections to South Kensington are remarkable and demonstrate the all-round nature of his accomplishments. He devoted his untiring energies throughout a long life to the advancement of science in its strictest sense.

W. C. M.

WALTER HOLBROOK GASKELL, 1847–1914.

WALTER HOLBROOK GASKELL was born on November 1, 1847, at Naples, where his parents were passing the winter for the sake of his father's health. His father, John Dakin Gaskell, was a barrister—a member of the Middle Temple—who followed his profession for a few years and then retired to private life. His mother was Anne Gaskell, second cousin of his father. Gaskell as a boy lived with his father at Highgate, and attended Sir Roger Cholmeley's School at that place. At school he worked chiefly at mathematics, but had considerable interest in natural history, and appears to have made more than the usual schoolboy collections connected with that subject.

He came up to Cambridge in October, 1865, when he was not quite 18, as a member of Trinity College. In his third year he was elected to a Foundation Scholarship, and proceeded to the B.A. degree in 1869, being 26th Wrangler in the Mathematical Tripos. After taking his degree he studied for a medical career, and in the course of his preliminary scientific work he attended the lectures on Elementary Biology and Physiology given by Michael Foster, who came to Cambridge as Prælector in Physiology at Trinity College in 1870. Foster led a considerable number of his early pupils to a scientific career. He first aroused an interest in scientific problems and then, sometimes gradually, sometimes suddenly, suggested that there was no better course in life than that of trying to solve them. Gaskell, as far as my recollection serves, was influenced in the latter way. In 1872 he went to University College Hospital, London, for clinical work. On his return to Cambridge, Foster, in the course of a conversation with him, suggested he should drop his medical career for the time and try his hand at research in physiology. Gaskell (I believe) adopted on the spot this suggestion, and instead of proceeding to the M.B. degree went to Leipzig to work under Ludwig (1874).

At this time Ludwig's laboratory was much the most important school of physiological research in Germany or elsewhere. It attracted students from all parts of the world. All the work was planned by Ludwig, who had an almost unerring sense of the lines of work which would yield profitable results. To this the success of the school was mainly due. Its popularity was increased by the method of procedure adopted by Ludwig. This has been described by Sir T. Lauder Brunton, who was with Ludwig in 1869–70. The experiments were carried out by Ludwig with the pupil as assistant, Ludwig wrote the paper and then published it, occasionally as a conjoint work, but more usually in the name of his pupil. As I have heard from Gaskell, the method was the same in his time. The work given him was a continuation of that on the innervation of skeletal muscle already

begun in the laboratory. This led him by a series of steps, which were perfectly logical, but impossible to foresee, from point to point of scientific enquiry up to his theory of the origin of vertebrates.

Soon after his return to England in 1875, Gaskell married Miss Catherine Sharpe Parker, a daughter of Mr. R. A. Parker, of the firm of Messrs. Sharpe, Parker, and Co., solicitors, by whom he had one son, Dr. J. F. Gaskell, and four daughters, two of whom survive him. He settled in Grantchester, about a mile and a half from Cambridge, and in the Cambridge Physiological Laboratory he carried further the investigation on the innervation of the blood vessels of striated muscle. He found (1877), amongst other facts, that stimulation of the nerve supplying the mylohyoid muscle of the frog caused considerable and constant dilatation of the blood vessels, although contraction of the muscle itself was prevented by curare. This was the most decisive instance known at the time of such action in a purely muscular structure. It did not, however, settle the question of the occurrence of vaso-dilator fibres in the nerves of skeletal muscle, the discussion of which was carried on by Heidenhain and others.

From the behaviour of the arteries under nervous stimulation he passed to the investigation of the behaviour of the small arteries and of the heart with varying reaction of the blood, and, finding that a small addition of alkali increased the tone of both, and that a small addition of acid decreased it, he suggested that, besides the nervous control of the circulation, there was also a chemical control in each organ and tissue by the products set free in activity, so that, for example, the contraction of the muscle by setting free acid led to an increased flow of blood through it. The suggestion was not entirely new, but it was wider in range than any of its kind previously made and rested on more solid facts. This work directed his attention to the heart, and for the next four or five years he devoted his time to the questions of the innervation of the heart, and the cause of the heart beat. With these questions others were busily engaged, notably Engelmann and Heidenhain.

In the early seventies it was universally held that the beat of the heart was due to the nerve cells present in it, and that it was initiated by the nerve cells of the sinus venosus. There were very varied views as to the method of working of the nervous mechanism, especially as to the parts played by the nerve cells of the septum of the auricle, and the nerve cells of the base of the ventricle. As it became more widely recognised that parts of the heart which had no discernible nerve cells could contract rhythmically, it was felt that the nervous theory did not account for the whole of the phenomena. Moreover, some of the pharmacological results could not be satisfactorily explained on the theory as then put forward. But no one had any more satisfactory explanation to offer.

The question of the action of the nerve cells in the heart was part of the general question of the functions of the peripheral ganglia. In 1869, Engelmann argued that the peristaltic contraction of the ureters did not depend on nerve cells and that the contraction was conducted from one

muscle cell to the next without the intervention of nerve fibres. In 1875 he advocated a similar view as regards the passage of contraction from one part of the ventricle of the frog's heart to the rest, and he thought this was probably also the case in the auricle. But in one important point he kept to the old theory and considered that the passage of contraction from auricle to ventricle was brought about by nerve cells and nerve fibres. Gaskell (1881) at first adopted the current theory with some modifications in detail, but in 1883 he abandoned it, and argued that the contraction of the heart was of muscular origin; it started in the sinus and spread as a peristaltic wave to the other chambers, the delay in the passage of the contraction wave from one chamber of the heart to the next being due to a slow conduction in the modified muscular tissue which he found at the junction of the sinus venosus with the auricle, and at the junction of the auricle with the ventricle. In the course of his work Gaskell made a large number of original observations on the behaviour of the several parts of the heart and of the cardiac muscle. The term "block" Gaskell adopted from Romanes' account of the passage of contraction waves in Medusæ; the phenomena had been partly worked out in the frog's ventricle by Engelmann, but they were much more completely elucidated by Gaskell's work on the heart of the frog and the tortoise. It was known that the contraction of the ventricle might only occur at every second, third, or fourth beat of the auricle. Gaskell obtained this effect experimentally by varying the degree of block between the two chambers. After the lapse of years the invention of the string galvanometer brought the observation of heart block in man into the region of clinical medicine.

The different effects produced on the heart of the frog by stimulating the vagus nerve were investigated simultaneously by Gaskell and by Heidenhain. Gaskell observed that stimulation of the vagus sometimes caused an increase in the strength of the beats in addition to the quickening which had been already described by Schmiedeberg and others, and which had been attributed to special accelerator nerve fibres. Heidenhain found that by stimulating the medulla oblongata at different points, acceleration and augmentation, or slowing and weakening, of the heart beat could be obtained. Gaskell traced in the crocodile and frog the origin of the accelerator fibres to the sympathetic system, and this was followed up by a more complete anatomical investigation by Gaskell and Gadow. The innervation of the heart of lower vertebrates was thus brought into line with that of the mammal. In addition, he gave a more complete account than had been given by Heidenhain of the cause of the independence of the slowing and the weakening of the heart beat caused by pure vagus fibres, and of the quickening and the increase of strength caused by sympathetic fibres. A little later Gaskell showed that an electrical change can be produced in quiescent heart muscle on stimulation of the cardiac nerves, and that the change is different according as the vagus or the accelerator nerve is stimulated.

Gaskell's work in this field was of the first importance. His papers are a storehouse of observations of a fundamental nature. He elaborated his theories and gave an admirable account of the whole subject in an article on "The Contraction of Cardiac Muscle" in Schäfer's 'Text Book of Physiology,' published in 1900. It may be mentioned that the rhythm of the heart was the subject of his Croonian Lecture to the Royal Society in 1881, and that on the work mentioned above he was elected a Fellow of the Society in the following year.

In the course of his dissection of the accelerator nerve in mammals, Gaskell was struck by the overwhelming preponderance of non-medullated nerve fibres in it, although the nerves centrally of ganglia from which the accelerator fibres arose were mainly medullated, and this determined him to investigate the relation of the sympathetic system to the spinal cord. At this time the question of the relation of the sympathetic and other peripheral ganglia to the cerebro-spinal system was in a state of profound confusion, and general agreement had been reached on a few points only. A great number of facts had been described, and they covered a wide area of descriptive anatomy in different classes of vertebrates, of histology of nerve fibres and nerve cells, and of physiology. Few observers covered more than a small portion of the ground. Results were coming quickly and the ground was tilled rather hastily. The practical disappearance of the theory that the "vegetative" nervous system was independent of the "animal" nervous system had led to the peripheral ganglia being less considered as a whole than they had been at an earlier time, and to special explanations being put forward for the working of the several parts. Thus, those writers who tried to give an impartial summary of the state of knowledge found themselves reduced to stating a number of more or less contradictory facts and irreconcilable theories.

Gaskell did not approach the subject from the point of view of what had already been done or said. He approached it from the point of view suggested by his observations on the accelerator nerves in the mammal. This method had the disadvantage that it led him to leave uninvestigated some of the chief difficulties which were felt at the time, but it had the advantage that it enabled him to come to a rapid decision on certain important points. Gaskell confined his attention to the efferent "visceral" fibres. His most important conclusions were, that all efferent visceral fibres, whether in cranial or in spinal nerves, were small medullated fibres, and that they left the cerebro-spinal system in three groups—the cervico-cranial, the thoracic, and the sacral—the thoracic portion being what was ordinarily called the sympathetic. These conclusions re-established the connection of small medullated fibres with the whole of the "organic" system described by Bidder and Volkmann in 1842, gave an explanation of Reissner's statement in 1862 that the anterior roots of the thoracic nerves contained bundles of small medullated fibres, whilst those of the cervical and lumbar nerves contained only a few such fibres scattered amongst the larger ones, supported the view which had been

held by some anatomists that the white rami communicantes constituted the sole connection between the spinal cord and the sympathetic, and brought all the involuntary nerves of whatever origin into one system of ganglionated nerves as had been recently advocated by Dastre and Morat.

In these conclusions there was one weak spot. Whilst it was definitely shown that the outflow of visceral fibres from the central nervous system to the sympathetic was enormously greater in the regions in which there were only white rami, it was not shown that no fibres passed out by the grey rami. Gaskell's observation of the rarity of small medullated fibres in the grey rami was not in accord with earlier observations, and he did in fact under-estimate their number. Further, physiologists of repute had described vaso-motor, pupil or heart effects as being caused by stimulation of the cervical nerves, which had grey rami only. It might then be said that the few small medullated fibres present in the centrally running branch of the grey rami represented the few scattered small medullated fibres of the anterior roots of the corresponding spinal nerves. Thus the difference between the thoracic and other regions of the spinal cord might be one of degree only. So far, however, as subsequent investigation has gone, Gaskell's conclusion was correct, and the grey rami receive no efferent fibres from the spinal cord. Gaskell's work clarified the air. It gave anatomists and physiologists a clearer view of the general arrangement of the efferent nerves governing unstriated muscle and glands, and it directed the attention of physiologists to points which they had singularly neglected. It is to be noticed also that Gaskell's earlier theory that the heart-beat is not due to the activity of local nerve cells has an intimate bearing on the much discussed question of the automatic and reflex action of peripheral ganglia.

In the paper setting forth the conclusions given above, Gaskell discussed a number of other problems of the sympathetic system. His theories were based on facts known at the time, but the experiments to test their wider application were few. Some are still under discussion, some are superseded. The most far-reaching of these theories was on the nature of the difference between motor and inhibitory nerve fibres. In 1881 he had advocated the view that the vagus is the trophic nerve of the heart. Löwit, in 1882, had suggested, on the lines of Hering's theory of assimilatory and dissimilary processes in the body, that the cardiac inhibitory fibres favour assimilation, and that the accelerator fibres favour dissimilation. Gaskell, developing his trophic theory, took a more definite and a wider view and urged that all inhibitory fibres are anabolic, and all motor fibres are katabolic.

Gaskell's microscopical and anatomical observations led him to questions of morphology. He argued that in a typical spinal segment a lateral root was to be distinguished in addition to the ventral and dorsal roots. The lateral root consisted of two parts, one arose from the lateral mesoblast plates of van Wijhe and supplied the respiratory muscles of Ch. Bell's system, the other formed the ganglionated nerves of the visceral system. On this basis

he discussed the homologies of the cranial and spinal nerves, and returned to this subject in a paper published a few years later. For his work on the nervous system he was awarded the Marshall Hall Prize of the Royal Medical and Chirurgical Society in 1888, and was elected an Honorary Fellow of the Society.

In 1890, the Nizam of Hyderabad supplied funds to a Commission for the investigation of the cause of death under chloroform—the second which he had supported. The Commission reported that death was due to an action of the respiratory centre, and that if the respiration were carefully attended to it was unnecessary to pay any attention to the pulse. These conclusions were directly opposed to common belief based both on experimental and clinical observation. One of the members of the Commission asked Gaskell to criticise their Report. Gaskell arranged with Dr. Shore to make a joint experimental enquiry. Gaskell and Shore, employing various methods, notably that of cross circulation from one animal to another, brought forward evidence, which was generally regarded as conclusive, that chloroform had a direct weakening action on the heart. Their paper, published in 1893, checked a tendency to regard the respiration as the only factor to be considered in administering chloroform. It was a useful piece of work, but it gave Gaskell the only enemy he ever made.

This investigation was a side track from the main line of the work which Gaskell had been pursuing for some years. His morphological studies on the homologies of the cranial and spinal nerves had led him to consider the problem of the origin of the nervous system in vertebrates, and this again led him to a theory of the origin of vertebrates to which he gave nearly all his time in later years. Dr. Gadow has been kind enough to write the following account of this part of Gaskell's researches :—

"Gaskell's physiological research has always been to a considerable extent on the morphological side, and this combination of the sister sciences culminated in his enquiry into the origin of vertebrates. He was drawn to this at present hopelessly difficult problem neither by accident nor design but by the complete failure of various morphological friends to account for certain structures the understanding of which was necessary for his research. He therefore determined to find out for himself, and thus it has come to pass that a man between 30 and 40 years of age, M.D. of Cambridge and a physiologist of renown, devoted about 25 years of his life to essentially morphological studies, more than—in the nature of things—applies to some of his rather bitter scientific opponents. Moreover, entering the new field quite unbiassed, his critical mind enabled him, when studying for instance the best comprehensive text-books on embryology, to discover the weak sides of that discipline. It was not a question of picking out what suited him ; on the contrary there was hardly a point—be it the homologies of the germinal layers, the occurrence of some obscure feature like Reissner's fibre, or some Silurian fossil, which he did not take often infinite pains to examine into. Frequently he enlisted friendly help, as in the case of the digestive properties of the lamprey's skin.

"This is not the place to discuss the strong and weak points of his hypothesis that vertebrates are descended from some Crustacean-like ancestor, *i.e.* from some vaguely reconstructable stock of which the palæozoic Trilobites, King crabs and Scorpions are the only known representatives on the invertebrate side, and he bridged the gulf between them and the vertebrates by the Silurian Ostracoderms, of whose internal organisation the larvæ of the Lampreys, before their marvellous changes into the present adult forms, seemed to afford a clue. The gulf was great indeed, but his planned bridges were not more hazily sketched than those which pretend to connect the vertebrates either separately or conjointly with Amphioxus, Tunicates, Balanoglossus, etc., with worms and even with Echinoderms. Especially the various worm-theories he considered as no solution of the problem, since they would carry the connection so far back as to merge almost into the beginning of the Metazoa, amounting to no recognisable origin. He on the contrary believed that 'each higher group of animals has arisen in succession from the highest race developed up to that time.'

"Further, as the leading motif of the whole course of this solution he discerned the orderly sequence in the development of the central nervous system, in which no break of continuity can possibly have occurred. The brain and nerves afford the fundamental homologies; the organs which they innervate may fall into line in a surprising way, but they are not the essential comparisons, *e.g.* a new gut may be formed, as in the transforming Ammocœtes. 'The secret of evolutionary success is the development of a superior brain.'

"The immediate starting point of Gaskell's investigations on the origin of vertebrates was the recognition of the close similarity in structure and function of the different parts of the vertebrate brain with those of Arthropods. The segmental character of the vertebrate central nervous system, so clear to the physiologist, and long before insisted upon by most anatomists, had lost weight for the morphologists, clearly because the C.N.S. appears embryonically as a single unsegmented tube. Here then was the next question forced upon Gaskell's attention. Cannot the two opposing views be reconciled by the suggestion that the vertebrate C.N.S. consists of two parts, closely entangled, viz., a segmental nervous system on the same plan as that of the Arthropods, which is outside and has surrounded an epithelial tubular structure?

"This idea explained at once the remarkable non-nervous epithelial parts of the tube, which become so conspicuous as we descend the vertebrate phylum, and every part of this tube bears the same resemblance to various parts of the C.N.S. as the dorsal stomach and intestine of an Arthropod. As a crowning of his conception the pineal eyes fit into the right place of the scheme; and the resemblances become greater and more numerous on the one hand in Ammocœtes, as was to be expected in the lowest available vertebrate, and on the other in Limulus, the King crab. In short, there was now a provisional working hypothesis, obtained by a direct logical process from the consideration of the vertebrate nervous system.

"After this working explanation of the tubular nature of the C.N.S. the next step was the enquiry into the nature of the cranial nerves and, therefore, the double segmentation of the vertebrate body in the head region. Now he was in the midst of the most complex and abstruse problem of morphology, involving every organic system. The resemblances between Arthropods and vertebrates—with Limulus and Ammocœtes as the champions—are indeed numerous and in many cases perplexingly close. Of course, the more Gaskell became absorbed by his research, the more resemblances he saw, many of which are in all probability mere coincidences, or even erroneous. With great intuition and ingenuity he connected them, and in some of the most important cases his argumentation as to their being homologous structures has remained intact. He knew that if but a few are true homologies, his case would be proven, according to all the accepted canons of the theory of descent, and all the rest could be waived aside as incidental convergences, due to correlations, the possible laws of which we are now only just beginning to speculate about. Hence he felt it necessary to defend, so to speak, his whole extended line; not that the yielding of some point would mean a disastrous breach, but because of the lack of criterion to know which of his many points might prove one of his best assets, viz., an absolute homologue.

"On the other hand he felt justified in assuming as most unlikely that representatives of two fundamentally different phyla should have produced so very many close resemblances, so close in function, structure, and relative position as to make it impossible to show them up as heterogenous. He was also fully aware of it that our time-honoured conception of homologies versus analogies and their application to phylogeny are under reconsideration. It is a blow to the comparative anatomist and to the constructor of pedigrees, but all the more interesting since it shows that it is life, function, adaptation, and inheritance, which shape the material, and this being Gaskell's standpoint of view he skilfully worked with the tools of the morphologist as a physiologist. Be his genial hypothesis, elaborate enough for a theory, right or wrong, he has discovered and elucidated many a feature both in vertebrates and invertebrates which without his tireless work would remain still neglected and unexplained.

"His book, "The Origin of Vertebrates," published in 1908, has made little impression. Partly it is to a great extent a reprint of numerous previous papers and series of essays, partly because, instead of pleading, he did not present his views and the long chain of argumentation in an easy manner. Lastly the idea of our descent from 'some Crustacean-like ancestor' was so subversive of all the other rival hypotheses (one of which if assumed to be right implies that all the others are wrong) that the unbiassed reader expects at least a clearly summarising explanation why Gaskell considered the older hypotheses not only insufficient but wrong.

"He did not choose this line. He had too noble a character, the respecting admiration of his many friends, ever ready to defend his own, willing to give

in to sound argument, but not to be suppressed. 'By their fruits you shall know them.'—H. F. G."

In reviewing Gaskell's work one cannot fail to be struck with the carefulness and accuracy of his observations. But the bent of his mind lay in the direction of generalisation. A fact once definitely ascertained was never viewed by him as an isolated phenomenon, it was used as a basis for formulating some general rule. If he sometimes generalised too hastily, it was but the defect of his virtue. The value of his work was widely recognised. He was awarded a Royal Medal of the Royal Society in 1889, and at various times was the recipient of honours both at home and abroad.

One or two further events of his life and some personal characteristics remain to be mentioned. In 1878 he proceeded to the Degree of M.D. by Thesis, but he did not at any time practise medicine. Two or three years after this he began a life-long part in the advanced teaching of Physiology in the University. His subjects were those on which he had himself worked, viz., the heart, the nervous mechanism of respiration, the sympathetic system, and, at a later date, the origin of vertebrates. In 1883 he was appointed University Lecturer. His style was incisive, and he spoke on controversial points with a half-suppressed enthusiasm which was eminently infectious.

In 1888 he left Grantchester and took up his residence in Cambridge. In the following year he was elected a Fellow of Trinity Hall, and was appointed Prælector in Natural Science in the College. Living in a town was not to his liking, and in 1893 he built a house—The Uplands—on a hill-top in Great Shelford, opposite that on which perched Michael Foster's house. Here he remained for the rest of his life.

Gaskell attended but little the Congresses of Scientific Associations, though he did not altogether shun them. He was President of Section I of the British Association in 1896 at Liverpool, and attended the meetings of the Association in Canada in 1897, and in South Africa in 1905, and took the opportunity of seeing a good deal of these countries. He was present also at one or two of the earlier triennial meetings of the International Congress of Physiologists. He did not take much interest in the ordinary business of the University, but he served on the University Council (1907–1910), and if any broad question came before the Senate he was fairly certain to be found on the Placet side. When there was real need of his services he did not grudge them. He served on the Royal Commission on Vivisection which was appointed in 1906, and the final report of which was not issued till 1912; and he was a member of the Mosely Commission on Education in America.

As an undergraduate he rowed in the May races, played cricket and racquets, and frequented the bathing sheds. Later on he enjoyed an occasional set of lawn tennis, but, in general, active exercise did not greatly attract him. In recreation, as, indeed, in work, he took throughout life a somewhat leisurely course. He liked both work and play,

but not to the stage of exhaustion. For some years he spent part of the Long Vacation yachting and fishing with his brother. His hobby was gardening. He converted a large part of his 15 acres of sloping hillside at Shelford into a charming terraced garden, the early summer display of which was the occasion of an annual reception to Cambridge residents. He was always glad to receive physiologists visiting Cambridge, and his bluff, hearty greeting left no doubt of their welcome. In the evening he liked a game of whist or bridge, and after college feasts he was amongst the first to settle down to a rubber.

In the year preceding his death he was a little troubled about his health, but his customary course of life was hardly affected. He was writing a small volume on the 'Involuntary Nervous System,' and on September 3 revised the last sheets. Early on the following morning he had cerebral hæmorrhage, and died on September 7 without recovering consciousness.

J. N. L.

JOSEPH REYNOLDS GREEN, 1848–1914.

Joseph Reynolds Green was born at Stowmarket, Suffolk, in 1848. He was destined for a commercial career, and actually entered upon it for some years. But his real bent and capacity were scientific, and all his spare time was given to study, with the result that he took the B.Sc. degree of the University of London in 1880. This seems to have decided him to devote himself entirely to scientific work, and with this object in view he entered Trinity College, Cambridge, as a sizar, in October, 1881. He pursued his studies with such zeal and success that he was elected to a scholarship at Trinity in 1882, and gained a First Class in Part I of the Natural Sciences Tripos in 1883, as also a First Class in Part II the following year, his subjects being Botany and Animal Physiology. His work in the latter subject was carried on under the late Sir Michael Foster, whilst I was responsible for his botanical work. He impressed us both, as a student, not only by his enthusiasm but also and more especially by the singular lucidity of his mind.

Having thus satisfactorily completed his undergraduate career, he at once applied himself to research, both botanical and physiological. His first published contribution to science was a paper on the glands of the Hypericaceæ, which appeared in the Journal of the Linnean Society, 1884. At the same time he was engaged in experiments upon the clotting of blood, which led him to make the important discovery that the process is dependent upon the presence of a calcium salt, more especially the sulphate, which, he concluded

affects either the formation or the activity of thrombin ("On Certain Points connected with the Coagulation of the Blood," 'Journ. Physiol.,' 1887).

Green did not at once decide between the two sciences, which seemed to have equal attractions for him. His appointment in 1885 by Sir Michael Foster as Demonstrator in Animal Physiology, a position that he held with great credit for two years, determined the nature of his work for the time. But even so he continued to pursue more or less botanical research, the results of which were published in two papers read before the Royal Society; the one on the protein constituents of latex ('Proc. Roy. Soc.,' 1886); the other, of greater importance, on the changes in the proteins of the seed which accompany germination ('Phil. Trans.,' 1887) in which he confirmed for the Lupin the discovery by von Gorup-Besanez (1874) of a proteoclastic enzyme in the seed of the Vetch, and amplified it by showing that the protease is tryptic in its action. These papers indicated the direction of his future work.

In 1887 Green was appointed Professor of Botany to the Pharmaceutical Society of Great Britain, and consequently he devoted himself wholly to that science. During the 20 years that he held this office his literary output was voluminous. The first 12 volumes of the 'Annals of Botany' (1888–98) contain a number of papers by him on various points in the biochemistry of plants; and he contributed several articles to the first series (1894–8) of 'Science Progress.' The most important results of his investigations during this period were the following:—The discovery ('Ann. Bot.,' vol. 1, 1888) that the conversion of inulin into sugar (fructose) during the germination of the Jerusalem artichoke is effected by a specific enzyme, inulase; the detection of a fat-splitting enzyme (lipase) in the germinating seed of the castor-oil plant ('Roy. Soc. Proc.,' 1890), a subject to which he returned years afterwards ('Roy. Soc. Proc.,' 1905); the demonstration of the presence and activity of amyloclastic enzymes in the germinating pollen-grain and in the tissue of the style ('Phil. Trans.,' 1894); the analysis of the action of light upon diastase ('Phil. Trans.,' 1897), showing that whereas the red, orange, and blue rays favour the formation of the enzyme, the green, the violet, and especially the ultra-violet rays destroy it, with the striking suggestion that "vegetable structures have a power of absorbing radiant energy which is not connected with the presence and activity of chlorophyll."

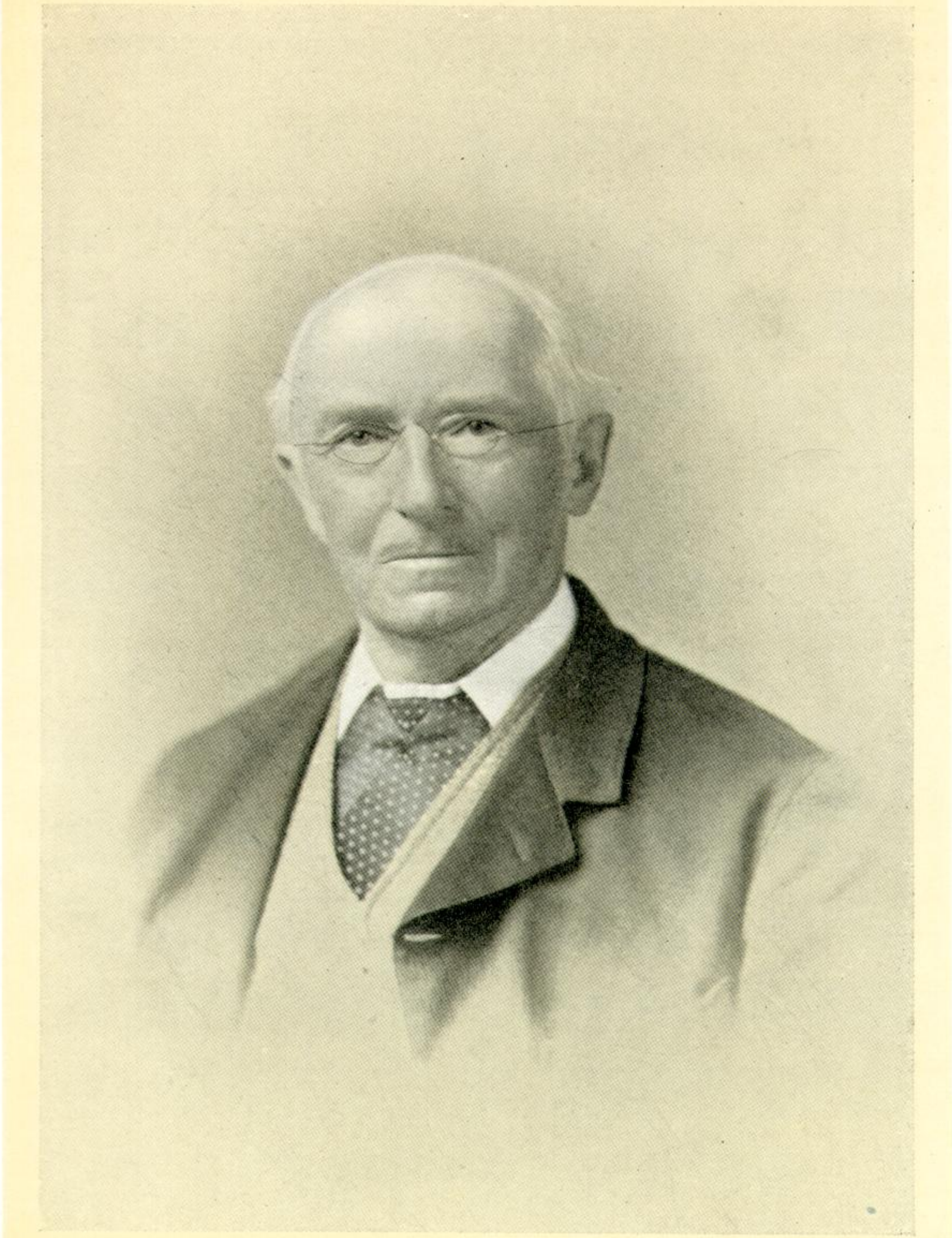
In his later years Green turned his attention mainly to the writing of books, and produced several considerable works, characterised by the lucidity of exposition that he possessed in a high degree. Three of them were text-books: 'A Manual of Botany based upon that of the late R. Bentley' (1895–6), 'An Introduction to Vegetable Physiology' (1900), and 'The Soluble Ferments and Fermentation' (1899). All three went to a second edition, but the third was the most important and successful of them; a German translation of it, by Windisch, was published in 1901. Further, he was commissioned by the delegates of the Clarendon Press, Oxford, to write a continuation of Sachs' 'History of Botany' (1530–1860), to bring the record up to the end

of the nineteenth century—a difficult task, which he performed with a considerable measure of success. He became so interested in work of this kind that he subsequently wrote a history of botany in England, which, unfortunately, has not yet been published.

Owing to failing health Green resigned his Professorship at the Pharmaceutical Society in 1907, and undertook the less onerous duties of the Hartley Lectureship on Vegetable Physiology in the University of Liverpool, a post that he held until his death. His health finally broke down in September, 1913, when he had a stroke, from which he only partially recovered. A second stroke, following an operation, carried him off on June 3, 1914, to the deep regret of his numerous friends, to whom he had endeared himself by the geniality of his disposition and his unfailing scientific enthusiasm.

His merits did not pass unrecognised. He proceeded M.A. at Cambridge in 1888, D.Sc. in 1894; he became a Fellow of the Linnean Society in 1889, and was elected to the Royal Society in 1895. He was President of Section K (Botany) at the Belfast meeting of the British Association in 1902, and was elected, in the same year, Fellow of Downing College, Cambridge.

S. H. V.



ALBERT GUNTHER