OBITUARY NOTICES

OF

FELLOWS DECEASED.

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E. F. W. PFLÜGER, 1829—1910.

EDUARD FRIEDRICH WILHELM PFLÜGER was born at Hanau-on-Main on June 7th, 1829, and died at Bonn in April, 1910, in his eighty-first year. Although his career appears to have been singularly uneventful, it is important as a long record of untiring physiological research. He had few interests outside of the laboratory where he spent the greater part of his active and strenuous life. To those who knew him but slightly, it comes rather as a surprise to hear that he was married and had children (four daughters), for of no one can it be more truly said that he was " wedded to his work."

He originally studied law in Berlin, but he soon went over to medicine; it was while engaged in qualifying himself as a practitioner of this art that he came under the influence of Johannes Müller and Emil du Bois-Reymond, and the work he performed under the direction of these two great masters initiated the series of physiological investigations which has made his name famous.

In 1855 Pflüger obtained his doctorate, three years later (1858) he was "habilitiert," and in 1859 was appointed Professor of Physiology in the University of Bonn, in which chair he succeeded Helmholtz, who was called to Heidelberg. He was still holding this post at the time of his death, for although he was offered the Chair of Physiology at Berlin after du Bois Reymond's death, he declined it; 1878 was the year in which the new Institute of Physiology at Bonn was opened, and the next " red-letter day " in his life was 1909, in which year he celebrated his eightieth birthday and the jubilee of his appointment as Professor. He was elected a Foreign Member of the Royal Society in 1888.

The famous journal of physiology which he founded, and which soon became familiarly known as Pflüger's Archiv, was bound up with Pflüger's life, and it was here that he published nearly all of his work; he was its most voluminous contributor, and 130 volumes had appeared before he died. It rapidly became in Germany the physiological journal which had the largest circulation, and, in consequence, there was never any lack of contributions. Pflüger, however, was a careful editor, and had to reject many of the papers sent in to him. He was exacting in the manner authors set out their matter, and they were bound to obey his rules on such small matters as to the way in which they inserted their references, if they wished to get their papers printed. This untiring diligence lasted to the end, and he was correcting proof sheets as he lay in bed until within a few days of his death.

On the occasion of his jubilee, Nussbaum, one of the most celebrated of Pflüger's former pupils, compiled a complete list, which reached to some hundreds, of the papers Pflüger had written. Some of these are world-famous, but many no doubt had been forgotten even by those whose duty it is to

study current bibliography. What strikes one most on glancing through the long array, is the catholicity of Pflüger's tastes; hardly any corner of the wide physiological field was left untouched; papers on histology, physiological chemistry, physical physiology, metabolism, embryology, psychology, and even philosophy are included, and he seldom touched a subject without illuminating it.

Pflüger is perhaps best known for his epoch-making work on muscle and nerve, and Pflüger's law, as it is called, is familiar even to the junior student. His work on metabolism, where he entered the lists against Voit, of Munich, is equally worthy of his repute, and although no one believes now in the theories of either of these two extremists, Pflüger had the great merit of recognising and of making others recognise the importance of the cell in the changes which food material undergoes before it is ultimately disposed of. The substance glycogen always attracted a peculiar fascination for Pflüger, and the importance of his work in relationship to this material is universally acknowledged. In the later years of his life, his most numerous and his longest monographs dealt with this subject, either from the chemical point of view or from the physiological aspect of its origin and fate.

Pflüger gathered around him a band of younger workers, and conveyed to them much of his own enthusiasm. He set them to work at various subjects in which he was interested, and often important investigations were the result. Much of the work which issued from the Bonn laboratory on the blood-gases was initiated in this way. Many of his pupils and colleagues became his friends and enthusiastic admirers; nevertheless Pflüger could not have been an easy man to get on with; he would not brook any interference with his work and his ideas, and the differences in the laboratory more than once were followed by the appearance of acrimonious articles and the severance of association in work.

The combativeness of Pflüger's nature and his love of polemics constituted a feature which was not wholly admirable in his character. Professor Cyon, however, who has recently written in Pflüger's Archiv an appreciation of his master, is inclined to regard this characteristic as a sign of his strength; he tells us that Pflüger prided himself on his militant attitude, and regarded controversy as the surest means of eliciting the truth on disputed problems. One may also freely admit that although in such disputes Pflüger tenaciously maintained his views, he was not so prejudiced as to continue to hold them when he was convinced of the truth of the opposite opinion. For instance, through a long series of papers, the results of most laborious researches performed even down to details of quantitative analysis by his own hands, he maintained that glycogen does not originate in the body from protein material. Yet in one of his very latest papers he had to surrender this position, because still further work had convinced him he had been wrong.

As the years of life advance, very few escape that conservatism and distrust of new ideas that mark the veteran thinker. Perhaps Pflüger had as little of this failing as any other man of the same age, but it was nevertheless there.

His attack on the neuron doctrine, and more recently on the work of Emil Fischer, are cases in point. Those interested in the knowledge of protein chemistry, which had its inception in Fischer's remarkable work, are hoping that by a continuation of that work one of the most difficult of biochemical questions will shortly be solved. The paper from Pflüger's versatile pen is certainly entitled to the fullest respect and consideration, but we must remember that Pflüger many years ago had a theory of protein constitution which is now of historical interest only; his views on the work of Fischer, Abderhalden and their disciples are therefore not unexpectedly pessimistic, for he doubts whether their gigantic array of experiments brings us any nearer to a solution of the problem. Pflüger adopted as the only certain test for a protein its capacity to maintain life and enter into the composition of protoplasm. If such a definition is accepted, gelatin, protamines, the whole of the poisonous proteins, the proteoses and polypeptides must be excluded from the protein family. This definition strikes one as too narrow and too biological; it is quite possible that members of a group may possess chemical characters in common which justify the use of a general name, and yet they may have a very different physiological action. This is admitted for substances of which the chemical constitution is known, and it is no great stretch of the imagination to conceive the same to be true of substances which, like the proteins, are still in chemical darkness.

But an obituary notice is not the place for a discussion of difficulties of this kind. Much of what Pflüger did will certainly stand the severest of all tests, that of time, and his name will be handed down as one of the giants of his era. His courage and love of truth, his devotion to science, made him an example which may well be imitated, and the scientific men of this country will unite with the whole world in mourning with Germany the loss of one of her greatest sons.

W. D. H.

WILLIAM HENRY DALLINGER, 1842—1909.

WILLIAM HENRY DALLINGER, the son of an artist and engraver, was born at Devonport on July 5, 1842. As a boy he had leanings towards natural science and at one time had thoughts of becoming a medical student; but the deep piety of his nature prevailed and, after a brief training at Richmond Theological College, he entered the Wesleyan ministry in 1861, and for the next twenty years "travelled in the circuits" of Faversham, Cardiff, Bristol, and Liverpool. At the last-named city he remained for twelve years. During these years he not only kept up his interest in Natural Science, but taught himself German, Greek, and Hebrew.

In 1880 Dallinger was appointed Governor and Principal of Wesley College, Sheffield, where he did much to develop the modern side of the school. There he remained until 1888, when the Wesleyan Conference, in recognition of the great interest and value of his scientific work, allowed him to retain the status and privileges of a minister without pastoral charge, only retaining his position as a member of the "Legal Hundred." On leaving Sheffield, Mr. and Mrs. Dallinger—he married Emma, daughter of David Goldsmith, of Bury St. Edmunds, and had one son—were presented with some plate and a handsome sum of money, which he characteristically spent in microscopes and other scientific instruments.

During his tenure of the Principalship of Wesley College, Dallinger was four times elected President of the Royal Microscopical Society, in 1884–5–6 and 7. Although living 160 miles from London, he was constant in his attendance at meetings both of the Council and of the Society, and in order in no way to allow these meetings to interfere with his work at Sheffield he was in the habit of returning by the early newspaper train the morning after the Meeting. His devotion to the Society and the tact he showed in the Chair were warmly commented on by Dr. Glaisher, Prof. Jeffrey Bell, and Mr. Crisp on his retirement in 1888. So great was his interest in the Society that shortly after resigning the Presidency he allowed himself to be nominated Joint Secretary, and for some years he continued to labour whole-heartedly for its welfare. In 1890, 1891, and 1892 he was President of the Quekett Microscopical Club.

After leaving Sheffield, Dallinger devoted much of his time to lecturing. He was for many years senior Lecturer of the Gilchrist Educational Trust. He first lectured for the Trust in 1879 and continued without a break until the spring of 1909. During the thirty years he gave about 450 lectures in different towns in the country for the Gilchrist Trustees. The titles of some of his most popular lectures were as follows:—

"An Hour with the Modern Microscope," "Carnivorous Plants," "Contrasts in Nature—the Infinitely Great and the Infinitely Small," "Evolution as Illustrated in the Minutest Forms of Life," "Spiders: Their Work and Their

Wisdom," "Ants," "Wasps," "The Pond and its Minute Inhabitants." In 1887 he was chosen to deliver the seventeenth Fernley Lecture, the Lectureship being a Wesleyan foundation. The lectures are delivered at the annual Conference. Dallinger took as his subject "The Creator, and what we may know of the Method of Creation." As a lecturer Dallinger was very successful: he had a vivid descriptive style and a remarkable ability in illustrating both verbally and by drawings his subject matter. He spared no pains to make his matter attractive and even painted his own lantern slides; in this his remarkable artistic gifts were apparent.

Some of his more important scientific articles are mentioned below. The great service he did to students by editing and partly re-writing Carpenter's book on "The Microscope" is worthy of record.

Dallinger was elected a Fellow of the Royal Society in 1880, and received the degrees of LL.D. from Victoria University, Toronto, in 1884; D.Sc. from Dublin in 1892; and D.C.L. from Durham in 1896. A striking photograph of him is published in the 'Journal of the Royal Microscopical Society,' 1909.

The original contributions made to Science by Dr. Dallinger were almost entirely confined to the investigation of certain flagellates. In conjunction with his friend, the late Dr. J. Drysdale, of Liverpool, he succeeded in working out the life-history of many of the minuter forms and of making considerable advances in our knowledge of the processes of decomposition of organic matter, and of the degree to which unicellular animals can survive great changes in the temperature of their environment. The dominant feature of the work of Dallinger and his colleague Dr. Drysdale was untiring patience and unwearied application combined with a profound knowledge and mastery over all the technique of the microscope. By using a binocular, one individual flagellate could pass from the vision of one observer to that of the other and thus on one occasion a motionless zygote was continuously watched for thirty-six hours until it burst into a cloud of swarm spores; on another occasion Dallinger watched the same protozoon for a continuous period of nine hours. By such persistent observation the life-histories of several of the flagellates hitherto most incompletely known were worked out. The papers in which the joint authors recorded the observations are characterised by a singular modesty and simplicity of language. The simple organisms investigated were not overwhelmed with long classical designations. *Dallingeria drysdalei* (S. Kent) was to them "the hooked monad," *Polytoma uvella* (Ehrb.) "the acorn monad," *Tetramitus rostratus* (Pertz) "the calycine monad," and so on.

Dallinger and Drysdale contributed important facts bearing on the theory of "abiogenesis." With great manipulative skill and under the most rigorous conditions they were able to show that though the temperature of boiling water is fatal to flagellates in an active state, the spores of these animals can resist a much higher temperature without suffering harm. For these minute spores can sustain a heat up to 268° F. in water, and even up to 300° F. or higher if in a dry state. The demonstration of these remarkable powers of

resistance showed that organic solutions, which had been thought to be sterile because they had been boiled, often contained living spores which had survived the heat and were capable of starting fresh colonies of flagellates. In connection with this part of his scientific researches was the remarkable series of experiments by means of which he was able to habituate successive generations of *Dallingeria drysdalei* and other forms to gradually increasing higher temperatures. From a temperature of 60° F. at which these flagellates normally live, he gradually raised the solution to that of 158° F. At this heat, which is at once fatal to the normal animals not habituated to high temperatures, the animals lived and multiplied, differing from the original stock chiefly in the marked vacuolation of the protoplasm. He felt that these experiments weighed against the position Weismann had taken up on the non-inheritance of acquired characters, and argument did not shake him. He was intensely preoccupied in his work and gave his contemporaries the impression of profound earnestness in all he undertook, combined with a little absence of business method. Before leaving this short record of Dallinger's contributions to the advancement of learning it is well to recall the honest and the truly scientific spirit which animated both his researches and his writings. This is admirably expressed in his own words:—"Let *truth* come from whence it may, and point never so grimly to where it may, he would be recreant to science who would for one moment hesitate to receive it. But no less false is it to the foundation principles of true science, to accept as true, what must constitute the roots of vast generalisations, except on evidence which no future scrutiny or analysis can shake."*

A. E. S.

* 'Jour. of the Roy. Mic. Soc.,' vol. 3, pt. 1, p. 16 (1880).

THOMAS WILLIAM BRIDGE, 1848—1909.

THOMAS WILLIAM BRIDGE, the eldest son of the late Thomas Bridge, was born in Birmingham on November 5, 1848.* He received his early education at the Moseley School, and later attended science classes at the Midland Institute in Birmingham. In November, 1869, he became private assistant to Mr. J. W. Clark, then Superintendent of the University Museum of Zoology at Cambridge, and now Registrar of the University. He did not matriculate until 1871 and he entered Trinity College as a Foundation Scholar in 1873. A Demonstratorship of Comparative Anatomy having been established in the University in the latter year, Bridge was nominated to the post by the late Prof. Newton, his duties consisting in conducting a practical class in Comparative Anatomy, in addition to his work in the Museum. We are informed in the Annual Report of the Museums and Lecture Rooms Syndicate for 1873 that his class was well attended and that his pupils derived much profit from his instruction.

After graduating by means of the Natural Sciences Tripos (1875), Bridge spent six months at the Zoological Station at Naples. The outcome of this visit was the paper on the "Pori abdominales of Vertebrata." Returning to Cambridge, he again took up his duties as Demonstrator, and was engaged as before in teaching and curatorial work. The Cambridge Museum still possesses many admirable dissections, particularly osteological preparations of Fishes, which were prepared by him at this time and earlier.

In February, 1879, he was appointed, in succession to Dr. Leith Adams, F.R.S., to the Professorship of Zoology in the Royal College of Science for Ireland, vacating it a year later on his election to the Chair of Biology at Mason College, Birmingham, then just about to be opened. In 1882 he became the first Professor of Zoology in Mason College on the division of Biology into Zoology and Botany; and with the development of that institution into a University in 1900 he became Mason Professor of Zoology, a position he held until his death.

From 1880 onwards, as in his early life, Bridge's interests were entirely in Birmingham. His official duties naturally occupied a large proportion of his time, and his connection with a young and expanding institution rendered these claims so exacting as to give him but little leisure for research. It was no doubt mainly owing to this cause that the period between 1878 and 1888 was unproductive of scientific results. But he took a full share during that time in the organising work incidental to the growth of Mason College, acting as Secretary to the Academic Board in 1884—1886, and in later years occupying successively the Vice-chair and the Chair of that body.

* For many of the facts and dates recorded in this notice the writer is indebted to Miss Bridge and to an article contributed to the 'Birmingham Post' by Prof. J. H. Poynting, F.R.S.

To his professorial work he throughout gave the utmost devotion. He was an excellent lecturer, and took special interest in the practical work carried on by his students.

Bridge was closely connected with the Birmingham Natural History Society and Philosophical Society, of both of which he filled the office of Vice-President, becoming the first President of the amalgamated Societies in 1894. He proceeded to the degree of Sc.D. (Cambridge) in 1896, and became a Fellow of the Royal Society in 1903. The degree of M.Sc. was conferred on him by the new University of Birmingham in 1901.

Bridge's scientific work all lay within a narrow compass. He was essentially a Morphologist, and his original papers refer to Fishes, especially to those which are usually regarded as occupying a low place in the Piscine series. He was thus particularly attracted to the "Ganoids" (a name which is now used in a somewhat more restricted sense than that in which he was accustomed to use it), to the Dipnoi and to the Siluroids, *Osteoglossum* and *Notopterus* among the Teleostei. "Let it be distinctly understood that the only sound foundation for scientific ichthyology is a profound *comparative* anatomy, and especially osteology of all the genera." These words, by Dr. T. Gill,* well express what may be supposed to have been Bridge's guiding motive throughout his work, which was always a judicious mixture of description and comparison of the structure of well-selected forms of Fishes.

During his residence at Cambridge he took up, jointly with his friend Mr. A. C. Haddon, the study of the remarkable relations that exist between the air-bladder and the auditory organ in the Siluridæ, as in certain other families of Teleostei which are grouped together as Ostariophysi. This resulted in a paper published in the 'Proceedings of the Royal Society' in 1889 and in a voluminous memoir which appeared in the 'Philosophical Transactions' in 1893. It was unfortunate, for various reasons, that the publication of this Memoir had been so long delayed.

The anatomical relations which form the subject of this joint paper are of no little interest. They were first described in 1820 by Weber, who showed that in the Siluridæ and Cyprinidæ a short chain of bones intervenes, on either side, between the anterior part of the air-bladder and the auditory organ, and regarded the air-bladder as thus accessory to the function of hearing. Bridge and Haddon, depending to a considerable extent on a part which had been purchased of Dr. Bleeker's well-known collection of East Indian Fishes, added greatly to our knowledge of the "Weberian ossicles" in the Siluridæ. No less than 100 species, referred to 51 genera, were examined. The view that the fishes possessing these ossicles are related to one another was fully confirmed, since the agreement throughout the Ostariophysi in regard to the ossicles is too detailed to permit of explanation on any other theory. The Weberian mechanism includes modifications of the auditory organ, of the air-bladder, and of the anterior part of the vertebral column. The axial skeleton in this

* 'Science' (N.S.), vol. 21, 1905, p. 661.

region has probably given rise to the ossicles, the homologies of which are carefully considered. A well-reasoned discussion of their functions follows.

It is a striking fact, as is pointed out by the authors, that "the presence of a Weberian mechanism is characteristic of nearly all the dominant families of fresh-water Teleostei"; and it might be supposed that its possessors derive "some exceptional advantage therefrom." What that advantage may be is not perfectly certain, in the absence of sufficient experimental evidence. The authors give weighty reasons for believing that the mechanism is not for the appreciation of the small vibrations which are concerned in producing an auditory stimulus, and conclude that it is probably to acquaint the fish, through the auditory organ, with the varying degrees of tension of the gaseous contents of the air-bladder due to variations in the height of the superincumbent column of water. It may be remarked that this manometer-like function of the Weberian mechanism has recently been supported by Thilo, who gives figures* showing the different positions assumed by the ossicles in a Carp with the air-bladder respectively tense and flaccid.

Of Bridge's other special Memoirs it is perhaps unnecessary to speak in detail, since they can hardly appeal to any except Vertebrate Morphologists. They include papers on the Skulls of *Amia*,† *Polypterus*, *Lepidosiren*, and *Osteoglossum*, on the Osteology of *Polyodon*, on the Mesial Fins of Ganoids and Teleosts, and on the Air-bladder and Auditory Organ of *Notopterus*.

Bridge's latest work was his article on Fishes in vol. 7 of 'The Cambridge Natural History,' and to this he devoted his best efforts. The writing of that article gave him the opportunity of putting together and making available for others his wide knowledge of the Morphology of Fishes, though other parts of the subject were by no means neglected. Although some of his statements have been criticised, the chapters contributed by Bridge to this volume are a most valuable summary of a very difficult subject. As one of the editors of the volume in question, the writer of this notice had many opportunities of admiring Bridge's devotion to his work, the trouble he would take to avoid carelessness or inaccuracy, and his keen desire to make his article as good as possible, without thought of any other considerations. He was, perhaps, unduly critical of his own performances, and was not satisfied to publish until he had made himself certain that he had done everything in his power to arrive at a correct result. This attitude of mind and the continued ill-health from which he suffered were no doubt responsible for the fact that his list of published papers is not a long one; though, on the other hand, there is probably nothing which he wrote that will not repay perusal. He was of a reserved nature, and there were not many persons who were admitted to his confidence. But those who knew him had a high respect for his thoroughness and his disinterested singleness of purpose. He died, unmarried, on June 29, 1909.

* 'Zool. Anzeiger,' vol. 32, 1908, p. 781.

† A list of the more important contributions is given at the end of this notice.

List of the Principal Publications of T. W. Bridge.

1. "The Cranial Osteology of *Amia calva*," 'Journ. Anat. and Physiol.,' vol. 11, 1877, p. 605.

2. "On the Osteology of *Polyodon folium*," 'Phil. Trans.,' vol. 169 (for 1878), 1879, p. 683.

3. "Pori abdominales of Vertebrata," 'Journ. Anat. and Physiol.,' vol. 14, 1879, p. 81.

4. "Some Points in the Cranial Anatomy of *Polypterus*," 'Proc. Birmingham Phil. Soc.,' vol. 6, Sessions 1887—88, 1888—89, p. 118.

5. "The Air-bladder in certain Siluroid Fishes," '*t. cit.*, p. 131.

6. (With A. C. Haddon.) "The Air-bladder and Weberian Ossicles in the Siluroid Fishes," 'Roy. Soc. Proc.,' vol. 46, 1890, p. 309; vol. 52, 1893, p. 139; 'Phil. Trans.,' vol. 184, B, 1894, p. 65.

7. "On certain Features in the Skull of *Osteoglossum formosum*," 'Proc. Zool. Soc.,' 1895, p. 302.

8. "The Mesial Fins of Ganoids and Teleosts," 'J. Linn. Soc. (Zool.),' vol. 25, 1896, p. 530.

9. "On the Presence of Ribs in *Polyodon* (*Spatularia*) *folium*," 'Proc. Zool. Soc.,' 1897, p. 722.

10. "On the Morphology of the Skull in the Paraguayan *Lepidosiren* and in other Dipnoids," 'Trans. Zool. Soc.,' vol. 14, 1898, p. 325.

11. "The Air-bladder and its Connection with the Auditory Organ in *Notopterus borneensis*," 'J. Linn. Soc. (Zool.),' vol. 27, 1899—1900, p. 503.

12. Art.: "Fishes" (exclusive of the Systematic Account of Teleostei), 'The Cambridge Natural History,' vol. 7, 1904.

S. F. H.