James Wallis M-Levdi

OBITUARY NOTICE

James Walter McLeod

2 January 1887—11 March 1978

PLATE XV

It has been a privilege and a great education to me to act as co-ordinator of this obituary. If all of Professor J. W. McLeod's many colleagues and collaborators had contributed we could well have written a full-length biography. Eventually I chose major contributions from just three of these. Professor K. Zinnemann who was closely associated with him throughout most of his time in Leeds, Sir James Howie who had presented him for his honorary LL.D. in Glasgow in 1961 and whose contribution covered a wide span of his career, and Dr J. C. Gould who has written an account of McLeod's post-retirement years in Edinburgh.

I first met McLeod when I was a student in Liverpool and he was my external examiner in the final bacteriology oral. I can certainly confirm James Howie's account of his examining technique.

A few years later, first as a member of Alan Downie's department and later in the City Laboratory with D. T. Robinson, I got to know McLeod as a "neighbour" and occasional collaborator with our laboratories. During this period—the last years of diphtheria in Liverpool—I worked with Robinson and so gained a continuing interest in diphtheria. This later led to the idea of holding a symposium on diphtheria when the Pathological Society met in Sheffield in 1970. Naturally J. W. McLeod was invited to be the opening speaker and it was a great pleasure to everyone there to hear the master once more talking on the subject to which he had contributed so much. It was, moreover, clear that he was not simply contributing an historical view; he was also well aware of the situation at that time both in regard to the residual areas of disease and to such matters as phage typing of gravis strains in Eastern Europe.

Towards the end of 1977 I was probably the last member of the Society to see him, then into his nineties, some few months before his death.

I am most grateful to our principal contributors and to all his friends and colleagues who sent me reminiscences of him. As I read their contributions and studied his own extensive writings, I became more and more impressed not only with McLeod's quite remarkable contributions to bacteriology but also with all the personal qualities that made him such a whole man. I hope that, incomplete as a brief obituary must be, it will succeed in conveying this sense of The Man.

M. G. McENTEGART

Professor Zinnemann's contribution.

With the death of James Walter McLeod at the age of 91 a long line of pathologists and bacteriologists who received their training in Glasgow under Robert Muir and subsequently attained positions of eminence in the pathological disciplines of the English-speaking world is nearing its end.

J. W. McLeod was born on 2 January 1887 in Dumbarton. His schooling was in Scotland and in Switzerland. In 1908 he graduated from the University of Glasgow with commendation. The following year he was appointed Coats Scholar and subsequently Carnegie Scholar in Robert Muir's department. His early work was under the guidance of Carl Browning who remained a lifelong friend. He was appointed assistant lecturer at Charing Cross Hospital in 1912 which post he held until 1914 when he joined the RAMC. He was promoted Captain in charge of a mobile laboratory and not only had a distinguished career in a military sense but also published papers on the problems of infection in the trenches.

In 1919 he came to Leeds as Lecturer in Bacteriology at the invitation of Matthew Stewart—another pupil of Muir—who was then head of the Department of Pathology and Bacteriology. When the chair of bacteriology in Leeds was established in 1922 he became its first occupant, a position he held with distinction until his retirement in 1952.

As Professor of Bacteriology, McLeod followed the Muir tradition and ruled his department in a paternalistic yet very easy-going way, mainly by setting an example. His loyalty to all his staff, domestic, clerical, technical and academic, earned him their devotion, which continued even during the 26 years after his retirement from the Leeds chair when he had become an almost legendary figure.

The bacteriological diagnostic service of the General Infirmary was always provided by his department. Indeed, despite his great commitment to research, he regarded the diagnostic service as "the most useful service we can give" and as the firm foundation of the department. Many of his researches started from observations made during diagnostic procedures. Thus the long series of papers on bacterial respiration originated from attempts to explain the cultural behaviour of clostridia isolated from war wounds. Both the application of the oxidase reaction to the cultural diagnosis of gonorrhoea and the discovery of the three main biotypes of *Corynebacterium diphtheriae* arose from attempts to overcome the difficulties and uncertainties of diagnosis by direct microscopy.

His earlier researches were done mostly alone or with one collaborator. As the staff of the department and the scope of research grew so the number of collaborators became greater until teams had to be formed for verification of the working hypotheses on the identification of gonococci and *C. diphtheriae* subtypes. He himself always wrote the first draft of papers that were the result of collaborative efforts. These accounts were lucid, logical, precise and without unnecessary words or sentences. Although he accepted amendments by his collaborators without much argument, these were rarely necessary. From about 1928 onwards McLeod nearly always insisted on the names of authors in collaborative efforts appearing in alphabetical order. This scrupulous fairness

may have been responsible for the fact that his name was not as widely known abroad as he deserved.

It is strange that a man who could express himself so clearly in papers never overcame peculiarities of speech. It was not that he suffered from any impediment but the ending of words and sentences seemed to trail off into the region of the inaudible. This, combined with a strong Glasgow-Kelvinside accent, made it difficult for students, even of Scottish origin, to follow his lectures, particularly when these were amply peppered with slides of tables and graphs, and delivered in the lecture theatre of the Algernon Firth Institute, which suffered from bad acoustics and worse ventilation. In conversation, new members of staff often had to ask twice for a repeat of key sentences. He seemed to be aware of other people's difficulties in following his speech and patiently responded to such requests without being at all disturbed. Students held him in high regard despite their difficulties with his lectures. This was due to his personal charm and kindness, extraordinary good looks, approachability, easy ways with young people, absolute fairness, devotion to sports, and great sense of humour.

McLeod combined, to an extraordinary degree, a rational scientific approach to many aspects of life with deep religiousness and a belief in the literal truth of the Bible. The only time, apart from occasional illness, he was known to have missed Sunday morning service was when, during a necessary call at the department before church service, his two eldest children released a monkey from its cage in the animal house. It took the combined efforts of the chief animal technician and members of the McLeod family until well after Sunday lunchtime before they recaptured the agile primate. It never occurred to him that his children did their best to delay capture and thus to avoid what was, for them, a long and dull sermon.

Though not directly due to his religious belief, McLeod's strict teetotalism had its roots in a pledge given as a boy to an aunt of his, which he would not knowingly break. The taste of any alcoholic beverage was therefore completely unknown to him despite some signs that he might have found it not unpleasant. This is suggested by the fact that Mrs M. J. Stewart's (sherry) trifle was one of McLeod's favourite puddings, which he always found superior to the one made by his wife. At the Stewarts' dinner parties he never failed to ask for a second helping "particularly of the juice from the bottom of the dish"; this request was made in all innocence and none of the friends involved ever betrayed the secret of the "Stewart recipe".

In the thirties he became increasingly concerned by the growth of authoritarian regimes of all colours on the continent of Europe. The chronic shortage of good applicants for posts in bacteriology even then gave him the opportunity to appoint refugees from political and racial persecution and at one time there were three such members on his academic staff.

At the start of the second World War it was a matter of genuine regret to him that his application for active service with the RAMC was rejected on the grounds that his expertise could be of greater use in the Yorkshire Region. This, plus fire watching in his street and in the university, was not enough for him. He volunteered for the Home Guard, which he took very seriously, and

for civilian service in Leeds railway station where he swept floors, washed dishes and served soldiers passing through with food that his wife had cooked. After such a full night session he went home for a shave, a cold bath and his ration of breakfast before going to the department on time.

In common with many others during the war, the department was much understaffed both academically and technically. J. W. McLeod had always taken part of the hospital diagnostic work and now he took on an equal share with the remaining staff. Despite all this he and his staff managed to publish 10 papers during the 5½ years. Four of these papers were a follow-up of his work on the biotypes of *C. diphtheriae*. The first of these entitled "The morbid anatomy of gravis, intermedius and mitis diphtheria" was a collaborative effort with the pathologist J. W. Orr and the infectious-diseases clinician Hester E. de C. Woodcock. Post-mortem and histological findings in 51 fatal cases supported the hypothesis that gravis and intermedius infections caused deeper membranes in the fauces, penetrated more deeply into the tissues of the inflamed parts with greater involvement of the tonsils and surrounding tissues of the neck, and were significantly more often recoverable from lung tissues; *C. diphtheriae mitis* infections tended to develop a pseudomembranous membrane that might reach into the lower air passages.

The next collaborative effort, published in 1940, was "Laboratory diagnosis of diphtheria" and this compared the relative value of different tellurite media then in use in Britain and in Germany, all used in combination with the traditional Löffler serum medium; the comparisons had been going on at intervals for ten years. As a result of these studies he recommended that examination of Löffler's medium and one of the tellurite media should be carried out if the greatest number of positive results was to be obtained. In general, tellurite media gave at least 10% more positive results and, in addition, were less likely to miss the most severe cases—gravis infections with short bacilli largely without any or only one polar granule. The paper contained numerous practical hints on diagnostic procedures that are not normally found in text or bench books.

During the war, in spite of the extra burden imposed by obligatory and voluntary civilian duties and severe staff shortages, McLeod managed to publish one of his most valuable papers, setting out criteria for distinguishing the three main biotypes of *C. diphtheria*. In this he also discussed all aspects of the biotypes including stability, antigenic grouping, and relation to clinical severity, to carrier rates and to epidemic diphtheria. This authoritative survey was based on reports of over 25 000 cases published in papers originating in Europe, South Africa, Australia and the USA, and contained 215 references. If diphtheria ever returns to Europe or North America this is the paper that will have to be consulted by microbiologists with little or no experience of the disease.

In collaboration with D. T. Robinson and A. W. Downie in Liverpool, McLeod studied a mysterious case of post-operative tetanus. From this it appeared most likely that the infection had come from dust from garden soil outside the operating suite, having been blown in through an open window and on to the lamp above the operating table. *Clostridium tetani* was grown from

the soil as well as from the dust. It is tempting to think that this short paper may have helped towards the introduction of clean-air ventilation into operating theatres.

Post-war circumstances were probably responsible for the relative paucity of research publications in which McLeod was directly involved. A number of these were extensions of much earlier work. The special circumstances of the times were the impending retirement from the deanship of M. J. Stewart who had held this post for many years and in that capacity had greatly influenced the development of, and co-operation between, the medical school and the independent teaching hospital. Stewart's declared intention to retire from the deanship two years before reaching the university's age limit coincided with the introduction of the National Health Service and the growing dependence of universities, and thus of medical schools, on government grants via the University Grants Committee which posed an implied threat to the universities' independence. This dual threat to customary conduct of affairs and common interests created divisions not only within the Leeds Medical School and the General Infirmary but also between the two institutions.

Although a faithful attender at meetings of Senate and of the Board of Medicine, McLeod never seemed to have any ambitions to play a leading part in medical politics beyond the interests of his own department. However, his personal qualities of human understanding, tolerance and scrupulous fairness made him the obvious choice of the Board of Medicine for the deanship. He took up this challenge, devoted much time to conducting the board's greatly increased business and was most successful in keeping the peace between the factions which the introduction of far-reaching changes was bound to create. A man less well endowed with a splendid physique and stamina might not have managed the research output of McLeod during this final period at Leeds.

Amongst the publications of these five years there is a survey of "Smear and culture diagnosis in gonorrhoea" in the *British Journal of Venereal Diseases*, and a "Survey of the epidemiology of diphtheria in North-West Europe and North America in the period 1920-46". The collection of data and construction of 21 graphs for this latter paper was a very time-consuming task which occupied most of McLeod's evenings for two years. It showed fairly clearly that when and where sharp spikes of the incidence of diphtheria occurred and typing of *C. diphtheriae* strains was carried out, the *gravis* type was responsible for the increase.

With the slow decline of the incidence of diphtheria, atypical strains began to appear that either had not been recognised earlier or had not attracted sufficient attention. Non-virulent *gravis* strains appeared, amounting to 4% of starch-fermenting strains isolated. With D. T. Robinson, McLeod investigated the phenomenon and published the results in 1948. The paper is valuable in showing how slight differences in technique may result in discrepancies in the finer differentiation between atypical strains and those of the three main types and in establishing when virulence tests of *gravis* strains were justified.

It was a matter of considerable surprise to him and his staff that sucrose-fermenting *mitis* strains, as described by Martin Frobisher Jnr, should not only

exist but be toxigenic. But McLeod hardly managed to hide his irritation when Frobisher with associates, as well as Galbraith, both obviously misunderstanding that "type *intermedius*" referred to severity of the disease and not to colony size, described a *C. diphtheriae minimus* type. Irritation was the greater because Frobisher, as well as Galbraith, had visited McLeod's department during the later stages of the war to become acquainted with all aspects of his work. The tension thus created was resolved by a publication that is little known in Britain because it appeared in the Public Health Reports of the US. In it Johnstone and McLeod acknowledged the existence of (rare) virulent, starch-fermenting *mitis* strains and demonstrated that Frobisher's "*minimus*" were classical *intermedius* strains whilst Galbraith's "*minimus*" strains were non-virulent diphtheroids.

McLeod took great interest in and devoted much time to the Medical Research Council's first investigation into the prevention of whooping cough by vaccination. Characteristically, he was not content to make a contribution as head of one of the multi-laboratory participants but stimulated members of his staff to look into the comparative diagnostic value of the Bordet-Gengou and other media; this resulted in a report by a departmental team with him as a member, and further papers from his department after his retirement. During his last two years before retirement he was involved in two studies of growth and respiration of *Leptospira*, triggered by a routine finding of a pure culture of *Leptospira* as the cause of abacterial cystitis.

On his retirement in 1952, members of the university and of the consultant staff of the General Infirmary at Leeds combined to mark his successful 31 years as holder of the Brotherton Chair and four years as Dean of the Medical School by commissioning from Jacob Epstein a bronze of McLeod's fine head; the bronze head is now in the entrance of the library of the new medical school.

After his retirement the staff of the Leeds Department could not imagine how he could remain inactive in the large and lonely shepherd's cottage in the Lammermoor hills near Duns to which he and his wife retired. However, life there provided its own occupation because the only amenity available was running water! For illumination they had to rely on oil lamps, for heating, largely on wood which he chopped up; much time was spent on decorating and making the place habitable. They seemed to be happily occupied thus for little more than a year when suddenly Jean McLeod died of a cerebral haemorrhage. Walter McLeod was lost without her and went to live in Edinburgh, there trying to get over his loss by steeping himself in research work on behalf of the Scottish Hospitals Endowments Research Trust. One most happy outcome of this period of research in Edinburgh was his meeting with his second wife Joyce, a co-author in some of his papers and devoted companion during his remaining 20 years in Edinburgh.

K. ZINNEMANN

Sir James Howie contributes the following recollections.

James Walter, as he was known to his friends, was a great microbiologist

and a great character. As with great characters, remarkable legends as well as verifiable facts accumulated around him. It was my good fortune to have many personal meetings with McLeod and to present him in 1961 for his honorary LL.D. at Glasgow University. In preparing the promotion speech I had much help from his family and friends and so collected many of the legends as well as the facts I could confirm. Both facts and legends are of equal importance in showing how McLeod's friends saw him; so I do not hesitate to include both in this memoir.

In 1932-33, I worked at the bench and sink where McLeod did his classical studies on streptococcal haemolysins in 1910-11. I also worked with streptococcal haemolysins; and when I spoke to McLeod on the subject he asked: "And do you wash out your own tubes, as I did?" I confirmed that I did because the routine wash was not enough to guarantee perfect cleaning. But McLeod insisted that the real merit of cleaning his own tubes was that it gave him a pause in which to plan his next experiment. "My thoughts grew as I washed", he said, "just as a gardener's grow when he is weeding".

He was in every way a big man, handsome in appearance and generous in spirit. I well remember his being challenged at a meeting of the Pathological Society by a sharp and persistent critic of less than average height. Would McLeod not reconsider the terms *gravis*, *mitis*, and *intermedius*? Nature did not arrange living creatures in such a disciplined and repeatable way as these terms implied. "Would not 1, 2, and 3 be better labels for the three types of diphtheria bacilli?" The answer was a firm but polite negative. The critic persisted. Again the answer was negative—more firmly so, but still polite. The critic had a third go. At that time McLeod's bulldog expression appeared in all its glory; and Carl Browning whispered: "Don't you think the bulldog wants to grab the terrier by the neck?"

Epstein was obviously the sculptor to do justice to so fine and so firm a face. Unhappily, McLeod was recovering from a broken forearm at the time of the sittings, and perhaps the hopes and expectations of his friends and admirers were not fully realised in Epstein's work, which is nevertheless a fine tribute.

In 1950, McLeod submitted a manuscript to the *Journal of Pathology and Bacteriology*—obviously a major work, drawing together many aspects of his work on diphtheria. It came to me as one of the two assistant editors who worked at that time under the rule of Matthew Stewart. Clearly McLeod's manuscript was so valuable and important that its acceptance was never in doubt. But several passages seemed to convey more than one possible meaning; and I asked Matthew Stewart what was to be done. I could not see myself editing McLeod! But M.J.S. had no hesitation. "He'll not be upset if you question him about what he really wants to say. He's accustomed to that. If his war-time notices giving orders to his fire-watchers had been sent out without editing, the party would never have mobilised at one time or place!"

As an examiner of undergraduates he was fair and generous; but his approach worried W. J. Tulloch, who was at one time his external examiner. Tulloch told me: "Here was this majestic Scotsman asking nervous Sassenach boys quite difficult questions in a dialect they doubtfully understood—and

almost certainly could not hear properly, for he had closed his eyes and addressed his questions to the ceiling. I was extremely worried about what my duty was until I realised that he was not only asking these difficult questions but also answering them ”.

Physically, mentally and morally he was a fit man who enjoyed his strength and used it wisely. When he was on his way home from one Pathological Society meeting his late night train went no further than York. Friends who had travelled home by car realised what must have happened and set out early on Sunday morning to bring him home, because they well knew that nothing would stop him from walking. They met him on the outskirts of Leeds, for he had walked through the night in order to be in time for church.

I understand, although I have no details or confirmation, that he resigned from a favourite golf club because it refused to admit a guest on grounds of race. The report is certainly credible but the person who gave it to me is no longer here to be asked for details.

One story remains from his days in Glasgow in the pre-1914 period—perhaps the golden era of Robert Muir’s famous department of pathology, of which he was proud to be a member. In that department at that time the lights never went out. As Browning became busier he worked later and later; as McLeod became busier he came to work earlier and earlier. Inevitably, the day came when Browning, homeward bound, greeted McLeod coming in to get on with the day’s work. “Good-night, McLeod ” said Browning cheerfully, “Good-morning Browning”, said McLeod sternly, conveying more than a hint that work had a higher moral value if done early rather than late.

This aspect of McLeod is illustrated by the following note from Colin Beattie. There were two apparently contradictory, but really complementary, aspects of McLeod’s character: one was his sincerity, his devotion to his presbyterian faith (with all its practices and prohibitions, notably the proper observation of the Sabbath) and hence his apparent austerity. The other was his generosity of heart, his friendliness, his kindness. As he grew older the apparent austerity lessened, the ever present kindness became more obvious.

It was not strange that one of his good friends should have been the late W. J. Tulloch, as devout a Roman Catholic as McLeod was a Presbyterian. Tulloch used to recount a story told by McLeod against himself which illustrates both sides of his character. One dismal Sunday of torrential rain he and one of his children were walking into the centre of Leeds. They were cold, wet and miserable. Tram cars sped past, lit up, their passengers dry, warm and happy. The child looked up and asked “Daddy, are all these people going to Hell?” This was a poser, for, as McLeod said, “in common humanity I couldn’t say ‘Yes’ and, if I said ‘No’,—why were we walking?”.

Dr J. C. Gould takes up the story.

Walter McLeod came to work in the Department of Surgery in Edinburgh University not long after he retired from the chair in Leeds in 1952. Professor James Learmonth was agreeable to his being attached to the surgical unit in

the Wilkie Laboratories, and McLeod rapidly became interested in a number of microbiological problems associated with the surgical units in the Royal Infirmary of Edinburgh, more particularly that of urinary-tract infection when it followed catheterisation. For several years he worked assiduously to examine the sources and routes of these infections and instituted a number of somewhat rigorous procedures to reduce contamination. It was at this time that I first came into close contact with McLeod, because pseudomonads were common in these infections as they are now, and I had developed an interest in the phage typing of these organisms. McLeod himself was concerned with their antigenic structure as a means of identifying them and we spent several years together working on the use of both of these methods in studying the epidemiology of pseudomonas infections.

When Sir James Learmonth retired from the chair, the re-organisation of the Department of Surgery resulted in McLeod moving to Edenhall Hospital where space was made available for him to construct another laboratory funded from several sources, including the Royal Society. Here he continued to work, mainly on the problems of urinary-tract infection, and the presence of the paraplegic unit in Edenhall Hospital provided him with a great deal of first-hand material. He was able to reduce the rate at which these unfortunate patients become infected and to ameliorate their condition when, inevitably, infection did take place, and he was very proud of one patient with permanent catheterisation in whom he had prevented bacteriological contamination and infection for several months. The methods that McLeod used involved very strict attention to asepsis and the liberal use of antiseptics of various kinds, representing techniques that he had been brought up with in the early days of applied bacteriology and during his association with the giants of bacteriology, in Britain and on the continent of Europe. Perhaps sufficient attention has not been paid to this aspect of his work, although it must be admitted that his procedures were perhaps rather too time-consuming and rigorous to gain general acceptance in the rush of modern times.

Eventually further changes in the administration of Edenhall Hospital once again left McLeod without a base and, although in his mid-seventies, he was physically and mentally so active that he clearly could not give up work. Accordingly, it was with great pleasure that I was able to offer accommodation in the Central Microbiological Laboratories for McLeod and the technical staff that he maintained through his research grants, and he was able to continue his investigations on the control of urinary-tract infection, and to commence a number of other investigations more suited to purely laboratory work. Amongst these was a study of the production of toxins from coagulase-positive and coagulase-negative staphylococci, and some of this work was reported to the Pathological Society at its meetings. During all this time he maintained an active interest in scientific work going on in Edinburgh and elsewhere, attended many meetings, and participated by presenting papers and joining in discussion. He also contributed much to my own department as a source of information, a living contact with the past, and a wise counsellor on many problems affecting members of staff. The staff themselves greatly appreciated his presence and he

was a much respected figure. We were as sad as he was when, after a major operation and nearing his 90th year, he found himself unable to return to work in the laboratory. This severed a long and fruitful association with microbiology and its application to the management and treatment of patients.

Throughout his long and dedicated life J. W. McLeod not only inspired the respect and admiration of those who knew him but also won their affection. Alan Lendrum comments on the very high regard in which W. J. Tulloch held him and it was interesting to hear from Charles Whelan that J. W. McLeod was, in particular, proud of the obituary that he wrote for Tulloch in 1968, and spent weeks in the university library in his determination to get all the facts right. J. W. McLeod ended that obituary with the words "He was one of the great men of his generation". How better to end his?

We are grateful to the editor of the *Journal of General Microbiology* for permission to reproduce the photograph that appeared to mark the occasion of Professor McLeod's 82nd birthday.

BIBLIOGRAPHY

Studies of the streptococci and streptococcal infections

- MCLEOD, J. W. 1912. On the haemolysin produced by pathogenic streptococci and on the existence of anti-haemolysin in the sera of normal and immunised animals. *J. Path. Bact.*, **16**, 321.
- MCLEOD, J. W. AND MCNEE, J. W. 1912. On the anaemia produced by the injection of the haemolysin obtained from streptococci and on the question of natural and acquired immunity to streptolysin. *J. Path. Bact.*, **17**, 524.
- MCLEOD, J. W. 1914. On the value of antistreptococcal sera. *Lancet*, **2**, 837.
- MCLEOD, J. W. 1915. Criteria of virulence amongst streptococci, with some remarks on streptococcal leucocidin. *J. Path. Bact.*, **19**, 392.
- AMEUILLE, P. AND MCLEOD, J. W. 1916. Le fonctionnement rénal chez les troupes en campagne et ses rapports avec les néphrites de guerre. *Bull. Acad. Méd.*, 3rd series, **76**, 103.
- MCLEOD, J. W. 1921. Streptococcus classification. *Br. med. J.*, **2**, 791.
- CHANNON, H. A. AND MCLEOD, J. W. 1929. On the importance of *thermolabile* streptococcal toxin, with special reference to its cytolytic effect on leucocytes. *J. Path. Bact.*, **32**, 283.
- MCLEOD, J. W. 1929. The streptococci of the human body, *also* Streptococci readily secreting a filterable haemolysin. In *A system of bacteriology in relation to medicine*, Medical Research Council, *London*, vol. 2, p. 30 and vol. 2, p. 44.
- MCLEOD, J. W. 1929. The pneumococcus: pathogenic action. *Ibid*, p. 177.
- ABDALLA, N. W. AND MCLEOD, J. W. 1939. The antigenic properties of streptolysin. *Br. J. exp. Path.*, **20**, 245.

Studies on bacterial respiration with special reference to production of catalase, hydrogen peroxide and oxidising ferments and reducing activities, and the bearing of these on the phenomenon of anaerobic growth

- MCLEOD, J. W. AND GORDON, J. 1922. On the production of peroxides by pneumococci and other bacteria. *J. Path. Bact.*, **25**, 139.
- MCLEOD, J. W. AND GORDON, J. 1922. Production of hydrogen peroxide by bacteria. *Biochem. J.*, **16**, 499.
- MCLEOD, J. W., GORDON, J. AND PYRAH, L. N. Further observations on peroxide formation by bacteria. *J. Path. Bact.*, **26**, 127.

- MCLEOD, J. W. AND GORDON, J. 1923. Catalase production and sensitiveness to hydrogen peroxide amongst bacteria: with a scheme of classification based on these properties. *J. Path. Bact.*, **26**, 326.
- MCLEOD, J. W. AND GORDON, J. 1923. The problem of intolerance of oxygen by anaerobic bacteria. *J. Path. Bact.*, **26**, 332.
- MCLEOD, J. W. AND GORDON, J. 1925. The relations between the reducing powers of bacteria and their capacity for forming peroxide. *J. Path. Bact.*, **28**, 155.
- MCLEOD, J. W. AND GORDON, J. 1925. Further indirect evidence that anaerobes tend to produce peroxide in the presence of oxygen. *J. Path. Bact.*, **28**, 147.
- GORDON, J. AND MCLEOD, J. W. 1928. The practical application of the direct oxidase reaction in bacteriology. *J. Path. Bact.*, **31**, 185.
- MCLEOD, J. W. 1928. Bacterial oxidations and reductions. In *The newer knowledge of Bacteriology and Immunology*. Edited by E. O. Jordan and I. S. Falk, *Chicago*, p. 211.
- ELLINGWORTH, S., MCLEOD, J. W. AND GORDON, J. 1929. Further observations on the oxidation by bacteria of compounds of the para-phenylene diamine series. *J. Path. Bact.*, **32**, 173.
- MCLEOD, J. W. 1930. Variations in the periods of exposure to air and oxygen necessary to kill anaerobic bacteria. *Acta path. et microbiol. scand.*, **20**, suppl. iii, 255.
- MCLEOD, J. W. 1930. Bacterial respiration. In *A system of bacteriology in relation to medicine*, Medical Research Council, *London*, vol. 1, p. 263.
- MCLEOD, J. W. 1931. Methods of observing the reducing and oxidizing actions of bacteria. *Ibid.*, vol. 9, p. 157.
- FILDES, P. AND MCLEOD, J. W. 1931. The reduction of dyes: indicators of oxidation-reduction potential. *Ibid.*, vol. 9, p. 160.
- MCLEOD, J. W. 1931. Recognition of special oxidizing mechanisms. *Ibid.*, vol. 9, p. 162.
- HOLMAN, R. A. AND MCLEOD, J. W. 1953. Observations on Schales' reaction for hydrogen peroxide, with special reference to its use in complex solutions containing sugar and peptone. *Brit. J. exp. Path.*, **34**, 191.
- GORDON, J., HOLMAN, R. A. AND MCLEOD, J. W. 1953. Further observations on the production of hydrogen peroxide by anaerobic bacteria. *J. Path. Bact.*, **66**, 527.

Studies of *Corynebacterium diphtheriae*; its variations in culture and their significance in relation to the severity of the disease and its epidemiological prevalence

- ANDERSON, J. S., HAPPOLD, F. C., MCLEOD, J. W. AND THOMSON, J. G. 1931. On the existence of two forms of diphtheria bacillus—*B. diphtheriae gravis* and *B. diphtheriae mitis*—and a new medium for their differentiation and for the bacteriological diagnosis of diphtheria. *J. Path. Bact.*, **34**, 667.
- ANDERSON, J. S., COOPER, K. E., HAPPOLD, F. C. AND MCLEOD, J. W. 1933. Starch fermentation by the "gravis" type of diphtheria. *Lancet*, **1**, 293.
- ANDERSON, J. S., COOPER, K. E., HAPPOLD, F. C. AND MCLEOD, J. W. 1933. Incidence and correlation with clinical severity of *gravis*, *mitis* and *intermediate* types of diphtheria bacillus in a series of 500 cases at Leeds. *J. Path. Bact.*, **36**, 169.
- LEETE, H. M., MCLEOD, J. W. AND MORRISON, A. C. 1933. Diphtheria in Hull and its relation to bacteriological type. *Lancet*, **2**, 1141.
- MCLEOD, J. W. 1935. Bacteriological diagnosis of diphtheria. *Lancet*, **2**, 250.
- MCLEOD, J. W. 1935. Recent observations on the bacteriology of diphtheria. *Univ. Leeds Med. Soc. Mag.*, **5**, 2, 26.
- COOPER, K. E., HAPPOLD, F. C., MCLEOD, J. W., WOODCOCK, H. E. DE C., ANDERSON, J. S., ELLIOT, W. M., LEETE, H. M., SAUNDERS, J. C. AND WARREN, S. H. 1936. Review of the observations which have accumulated with regard to the significance of diphtheria types in the last four years (1931–1935). *Proc. R. Soc. Med.*, **29**, 1029.
- MCLEOD, J. W., ORR, J. W. AND WOODCOCK, H. E. DE C. 1939. The morbid anatomy of *gravis*, *intermedius* and *mitis* diphtheria; observations on a series of 51 post-mortem examinations. *J. Path. Bact.*, **48**, 99.

- COOPER, K. E., HAPPOLD, F. C., JOHNSTONE, K. I., MCLEOD, J. W., WOODCOCK, H. E. DE C. AND ZINNEBANN, K. S. 1940. Laboratory diagnosis of diphtheria—comparative values of various media. *Lancet*, **1**, 865.
- MCLEOD, J. W. 1943. The types *mitis*, *intermedius* and *gravis* of *Corynebacterium diphtheriae*. *Bact. Rev.*, **7**, 1.
- MCLEOD, J. W. 1944. Tipos de cultivo y bacilo difterico – *gravis*, *mitis* e *intermedius* – y su significado en la epidemiologia de la enfermedad. *Prensa med. Argentina*, **31**, 543.
- MCLEOD, J. W. AND ROBINSON, D. T. 1948. Virulence of *gravis* strains of *Corynebacterium diphtheriae*. *Lancet*, **1**, 97.
- JOHNSTONE, K. I. AND MCLEOD, J. W. 1949. Nomenclature of strains of *C. diphtheriae*. *Publ. Hlth Rep.*, Wash., **64**, 1181.
- MCLEOD, J. W. 1950. A survey of the epidemiology of diphtheria in north-west Europe and North America in the period 1920–1946. *J. Path. Bact.*, **62**, 137.
- MCLEOD, J. W. 1964. Diphtheria. In *Encyclopaedia Britannica*, Chicago, vol. **7**, p. 470.

Observations on bacterial metabolism and nutrition

- MCLEOD, J. W. AND WYON, G. A. 1921. The supposed importance of vitamins in promoting bacterial growth. *J. Path. Bact.*, **24**, 205.
- WYON, G. A. AND MCLEOD, J. W. 1923. Preliminary note on inhibition of bacterial growth by amino-acids. *J. Hyg.*, Camb., **21**, 376.
- MCLEOD, J. W. AND GORDON, J. 1924. The production of organic compounds of sulphur in bacterial cultures with special reference to glutathione. *Biochem. J.*, **18**, 937.
- GORDON, J. AND MCLEOD, J. W. 1926. Inhibition of bacterial growth by some amino-acids and its bearing on the use of tryptic digests as culture media. *J. Path. Bact.*, **29**, 13.
- MCLEOD, J. W., WHEATLEY, B. AND PHELON, H. V. 1927. On some of the unexplained difficulties met with in cultivating the gonococcus; the part played by the amino-acids. *Br. J. exp. Path.*, **8**, 25.
- PHELON, H. V., DUTHIE, G. M. AND MCLEOD, J. W. 1927. The rapid death of the meningococcus and gonococcus in oxygenated cultures; the part played by the development of an unduly alkaline reaction. *J. Path. Bact.*, **30**, 133.

Investigations into the mechanism of sulphonamide action

- MCLEOD, J. W. 1939. Experimental evidence of the value of *p*-aminobenzene-sulphonamide and related substances in controlling bacterial infections. *Univ. Leeds Med. Soc. Mag.*, **9**, 143.
- BURTON, H., MCLEOD, J. W., MCLEOD, T. S. AND MAYR-HARTING, A. 1940. On the relationships between the respiratory activities of bacteria and their sensitiveness to sulphanilamide, *p*-hydroxylamino and *p*-nitrobenzenesulphonamide. *Brit. J. exp. Path.*, **21**, 288.
- GORDON, J. AND MCLEOD, J. W. 1941. Relative value of sulphonamides and antisera in experimental gas gangrene. *Lancet*, **1**, 407.
- BURTON, H., MCLEOD, J. W., MAYR-HARTING, A. AND WALKER, N. 1942. Development of colours from sulphonamides (*p*-nitrobenzene-sulphonamide) under bacterial action and the bearing of such phenomena on the theory of the bacteriostatic and bactericidal activities of the sulphonamides. *J. Path. Bact.*, **54**, 407.
- MCLEOD, J. W., MAYR-HARTING, A. AND WALKER, N. 1944. The influence of access of free oxygen on the action of antiseptics with special reference to the sulphonamides. *J. Path. Bact.*, **56**, 377.
- MCLEOD, J. W., MAYR-HARTING, A. AND WALKER, N. 1944. Observations on the bactericidal and bacteriostatic actions of *p*-aminobenzene-sulphonamide and *p*-hydroxylaminobenzene-sulphonamide, with special reference to their suppression by *p*-aminobenzoic acid. *Brit. J. exp. Path.*, **25**, 27.

- WALKER, N., PHILIP, R. P., SMYTH, M. W. AND MCLEOD, J. W. 1947. Observations on the prevention of bacterial growth by sulphonamides, with special reference to the Harper and Cawston effect. *J. Path. Bact.*, **59**, 631.

Studies on spirochaetes and leptospira

- MCLEOD, J. W. AND SOGA, A. R. B. 1914. A simplified method for the cultivation, in fluid media containing coagulable albumin, of bacteria requiring anaerobic conditions, notably the pathogenic spirochaetes. *J. Path. Bact.*, **19**, 210.
- WATSON, G. W., MCLEOD, J. W. AND STEWART, M. J. 1935. Fatal case of leptospiral jaundice of obscure origin. *Br. med. J.*, **1**, 639.
- CZEKALOWSKI, J. W., MCLEOD, J. W. AND RODICAN, J. 1953. The growth and respiration of leptospira in solid or semi-solid media with special reference to Dinger's phenomenon. *Brit. J. exp. Path.*, **34**, 588.
- CZEKALOWSKI, J. W. AND MCLEOD, J. W. 1954. Detailed description of a leptospira obtained in pure culture from the urine in a case of abacterial cystitis. *J. Path. Bact.*, **67**, 43.
- CZEKALOWSKI, J. W., MCLEOD, J. W. AND RODICAN, J. 1954. Observations on the nutrition of leptospira based on the development of Dinger's phenomenon. *J. gen. Microbiol.*, **10**, 199.

Papers on whooping cough and the *H. pertussis*

- SUGARE, H. AND MCLEOD, J. W. 1929. The bacteriological diagnosis of whooping cough. *Lancet*, **2**, 165.
- DAWSON, B., FARNWORTH, E. H., MCLEOD, J. W. AND NICHOLSON, D. E. 1951. Observations on the value of the Bordet-Gengou medium for the cultivation of *Haemophilus pertussis*. *J. gen. Microbiol.*, **5**, 408.
- BEDSON, S. P., COCKBURN, W. C., CONYBEARE, E. T., CRUICKSHANK, R., DOWNIE, A. W., HILL, A. BRADFORD, KENDRICK, P. L., KNOWELDEN, J., MCLEOD, J. W., PARISH, H. J., STANDFAST, A. F. B., WILSON, G. S. AND EVANS, D. G.; also 10 medical officers of health, 11 field workers, MCLEOD, J. W. and 9 other laboratory workers, 1951. The prevention of whooping cough by vaccination. A Medical Research Council Investigation. *Br. med. J.*, **1**, 1464.

Contributions to bacteriological technique

- MCLEOD, J. W. 1913. A method for plate culture of anaerobic bacteria. *J. Path. Bact.*, **17**, 454.
- MCLEOD, J. W. AND BEVAN-BROWN, R. E. 1918. The technique of blood culture. *J. Path. Bact.*, **22**, 74.
- MCLEOD, J. W. 1919. Observations on the cultivation of typhoid and paratyphoid bacilli from the stools, with special reference to the brilliant green enrichment method. *J. Hyg., Camb.*, **18**, 260.
- MCLEOD, J. W. AND RITCHIE, A. G. 1920. The serum reaction in bacillary dysentery. Observations on agglutination, with special reference to the use of freshly prepared bacillary emulsions. *J. Path. Bact.*, **23**, 217.
- MCLEOD, J. W., COATES, J. C., HAPPOLD, F. C., PRIESTLEY, D. P. AND WHEATLEY, B. 1934. Cultivation of the gonococcus as a method in the diagnosis of gonorrhoea with special reference to the oxidase reaction and to the value of air reinforced in its carbon dioxide content. *J. Path. Bact.*, **39**, 221.
- GORDON, J. AND MCLEOD, J. W. 1940. A simple and rapid method of distinguishing *Cl. novyi* (*B. oedematiens*) from other bacteria associated with gas gangrene. *J. Path. Bact.*, **50**, 167.
- MCLEOD, J. W. 1947. Smear and culture diagnosis in gonorrhoea. *Br. J. v. vener. Dis.*, **23**, 53.

Sundry

- COWAN, J., MCLEOD, J. W. AND PATERSON, A. R. 1910. A case of partial heart-block occurring during an attack of acute rheumatism. *Q. Jl. Med.*, **3**, 115.
- FUNK, C. AND MCLEOD, J. W. 1914. The formation of a peptone from caseinogen by the prolonged action of dilute hydrochloric acid in the cold. *Biochem. J.*, **8**, 107.
- MCLEOD, J. W. AND AMEUILLE, A. 1916. The effect of trench warfare on renal function. *Lancet*, **2**, 468.
- TATE, D. L. AND MCLEOD, J. W. 1918. Trench Fever: observations on the condition of the spleen and leucocytes. *Lancet*, **1**, 603.
- TATE, D. L. AND MCLEOD, J. W. 1919. Observations on the condition of the spleen and leucocytes in Trench Fever. *Q. Jl. Med.*, **12**, 1.
- MCLEOD, J. W. AND GOVENLOCK, P. 1921. The production of bactericidins by micro-organisms. *Lancet*, **1**, 900.
- MCLEOD, J. W., RITCHIE, A. G. AND DOTTRIDGE, C. A. 1921. Incidence of infections with Pfeiffer's bacillus before, during and after the 1918 epidemic. *Q. Jl. Med.*, **14**, 327.
- MCLEOD, J. W. 1922. Limitations of bacteriology in its application to public health. *Jl. R. Sanit. Inst.*, **42**, 353.
- ROBINSON, D. T., MCLEOD, J. W. AND DOWNIE, A. W. 1946. Dust in surgical theatres as a possible source of post-operative tetanus. *Lancet*, **1**, 152.
- GORDON, J., MCLEOD, J. W., MAYR-HARTING, ANNA, ORR, J. W. AND ZINNEBANN, K. 1947. The value of antiseptics as prophylactic applications to recent wounds. *J. Hyg., Camb.*, **45**, 297.
- MCLEOD, J. W. 1949. Penicillin. *Univ. Leeds med. Mag.*, **19**: 3, 29.
- CZEKALOWSKI, J. W., DOLBY, D. E., JOHNSTONE, K. I., LATOUCHE, C. J. AND MCLEOD, J. W. 1951. Observations on the destruction of bacteria by a soil amoeba. *J. gen. Microbiol.*, **5**, vii.

Papers published after retirement

- MCLEOD, J. W. 1958. The hospital urine bottle and bedpan as reservoirs of infection by *Pseudomonas pyocyanea*. *Lancet*, **1**, 394.
- MCLEOD, JOYCE A. AND MCLEOD, J. W. 1959. Oscillation of the intraleucocytic granules as a criterion of survival of the leucocyte and of the potency of cytotoxic agents. *J. Path. Bact.*, **77**, 219.
- MCLEOD, J. W. 1959. Urinary infections associated with operations on the bladder with special reference to prostatectomy. *Br. J. Urol.*, **31**, 298.
- GOULD, J. C. AND MCLEOD, J. W. 1960. A study of the use of agglutinating sera and phage lysis in the classification of strains of *Pseudomonas aeruginosa*. *J. Path. Bact.*, **79**, 295.
- MCLEOD, JOYCE A. AND MCLEOD, J. W. 1961. The technique and interpretation of tests for leucocidin with special reference to the value of ethylene diamine tetra-acetic acid (EDTA). *Br. J. exp. Path.*, **42**, 171.
- MCLEOD, JOYCE A. AND MCLEOD, J. W. 1961. The absence of leucotoxic activity in highly purified diphtheria and tetanus toxins (as bearing on the virulence of the bacteria concerned). *Br. J. exp. Path.*, **42**, 179.
- MCLEOD, J. W. AND TAYLOR, Margaret M. 1963. Sterilisation of the skin. The time factor in the action of antiseptics and the possibilities of local applications of antibiotics. *Scot. med. J.*, **8**, 234.
- MCLEOD, J. W. 1963. Thermostable staphylococcal toxin. *J. Path. Bact.*, **86**, 35.
- MCLEOD, J. W., MASON, J. M. AND PILLEY, A. A. 1963. Prophylactic control of infection of the urinary tract consequent on catheterisation. *Lancet*, **1**, 292.
- MCLEOD, J. W., MASON, J. M. AND NEILL, R. W. K. 1965. Survey of the different urinary infections which develop in the paraplegic and their relative significance. *Paraplegia*, **3**, 124.
- BRAUDE, H., FORFAR, J. O., GOULD, J. C. AND MCLEOD, J. W. 1967. Cell and bacterial counts in the urine of normal infants and children. *Br. med. J.*, **4**, 697.

- BRAUDE, H., FORFAR, J. O., GOULD, J. C. AND MCLEOD, J. W. 1967. Diagnosis of urinary tract infection in childhood based on examination of paired non-catheter and catheter specimens of urine. *Br. med. J.*, **4**, 702.

Obituaries

- PAYLING WRIGHT, G., MCLEOD, J. W. AND STEWART, M. J. 1943. Obituary notice of Hedley Duncan Wright, 1891–1942. *J. Path. Bact.*, **55**, 113.
- MCLEOD, J. W. 1956. Obituary notice of Matthew John Stewart. *Lancet*, **2**, 1054.
- MCLEOD, J. W. 1956. Obituary notice of M. J. Stewart. *Br. med. J.*, **2**, 1179.
- MCLEOD, J. W., JOHNSTONE, K. I. AND FOWWEATHER, F. S. 1958. Obituary notice of John Gordon, 1895–1956. *J. Path. Bact.*, **75**, 218.
- MCLEOD, J. W. 1956. Obituary notice of John Gordon. *Br. med. J.*, **1**, 753.
- MCLEOD, J. W. 1958. Obituary notice of John William Mackavoy. *Univ. Leeds med. J.*, **7**: 1, 37.
- MCLEOD, J. W. 1968. Obituary notice of W. J. Tulloch. *J. Path. Bact.*, **95**, 336.
- MCLEOD, J. W. 1971. Obituary notice of Bertha Wheatley. *J. Path.*, **105**, 83.