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Sir John Graham Kerr's *A Gallery of Memories*

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ABSTRACT

A Gallery of Memories is a previously unpublished memoir by John Graham Kerr (JGK). In this contribution we provide the memoir itself, preceded by an editorial introduction, which describes the source of the manuscript and gives some information on how it has been edited. It also gives a brief account of JGK's family, publications and career. *A Gallery of Memories* is in four parts. First, *Early Years, 1869-1892*, covers JGK's upbringing, including his studies as a medical student at the University of Edinburgh, his first expedition to the Gran Chaco region of South America (1889-91), and his subsequent decision to switch his studies to natural sciences at the University of Cambridge. The second part, *Cambridge, 1892-1902*, covers his undergraduate studies, then his employment as a demonstrator, including the second more successful Gran Chaco expedition (1896-7) in the company of J.S. Budgett, aimed at collecting embryological specimens of the lungfish *Lepidosiren paradoxa* and the beginning of his researches on this material. Part three, *Glasgow, 1902-1935*, describes his appointment to the Regius Chair of Natural History, then Zoology, at the University of Glasgow, and gives an account of his career and interactions there over three decades. The final part, *Westminster, 1935-1950*, gives an account of JGK's election as Member of Parliament for the Scottish Universities, his resignation from the University of Glasgow, and his experiences in Parliament, including the main issues he attempted to influence, such as military camouflage. We have added an Appendix that provides notes aimed at contextualising many of the people, events and topics covered in the *Gallery*.

EDITORIAL INTRODUCTION

A Gallery of Memories was written by John Graham Kerr (JGK) during his final years, following his resignation from Parliament, and after the completion of the book on his Gran Chaco adventures (Kerr, 1950). He died on 21st April 1957. The source of the typescript of the *Gallery* in the University's possession is a donation in November 1993 made by Elizabeth Gordon of Crieff, sister to Agnes "Nora" Miller, long-time zoology lecturer in the University, who died in 1994. Agnes had asked that her sister donate the bound typescript, dated 1967, to the University's Archives, stating that only three copies are in existence. In another letter of 1965, she states that the typescript was possibly generated by a Mrs Jarrad, working from JGK's hand-written manuscript. A digital version of the typescript was made at Professor Keith Vickerman's request by Lorna Kennedy in 2003. The University also possesses some pages from an earlier typescript annotated in JGK's hand, indicating changes both major and minor made to his original version. We have not included here any text he deleted, but future scholars may wish to examine them.

Correspondence in the University's possession shows that JGK's widow, Lady Isobel Kerr, made considerable efforts to find a publisher for the *Gallery* in 1965, eight years after JGK's death. We have the letters she received, but not those she sent. Her main adviser was Edward Hindle, JGK's successor as Regius Professor at Glasgow. JGK's usual publisher, Macmillan, rejected the work on the grounds of its being too specialised. Lady Kerr turned to Harold MacMillan, recently retired as Prime Minister and back at the family firm, but he politely turned it down too. Hindle suggested some editing and some possible Scottish publishers. Lady Kerr tried for some high-level support. She wondered about Lord Todd, probably Scotland's most famous scientist of the time: Nobel Laureate for his work on the biochemistry of nucleotides. She approached another Nobel Laureate, the physicist George Thomson who, as a boy in Cambridge, had listened to JGK's tales of his South American adventures. The correspondence ends with Hindle and Thomson planning to discuss edits. Lady Kerr died in 1966, which may account for the apparent cessation of efforts to find a publisher for the *Gallery*. From this account, it is clear that the family hoped for the *Gallery* to be published. It seems appropriate, therefore, that this intention has been met in the year of the centenary of the opening of the Zoology building which, since a naming ceremony in 1995, has been called the Graham Kerr building (Fig. 1).

In editing the typescript, we have retained the original text except where there are obvious minor errors. We have also made some punctuation and typeface amendments, e.g. use of italics for species and book names, as is now conventional. To provide context for modern readers, we have added a large number of notes, shown as superscript numbers in the text, and listed in full in the Appendix. JGK mentions a large number of people, mainly scientists and politicians, and we have provided notes on most of them. In a few cases, where the people are really well known, we have not felt the

Fig. 1. Plaque commemorating the naming of the Zoology Building as the Graham Kerr Building, May 1995.

need for such a note: Charles Darwin and Winston Churchill, for example. The source for most of these notes has been the online resource Wikipedia. The *Gallery* lacks illustrations, and we have felt it appropriate to add some that help illuminate the text. The *Gallery* also lacks some details that readers might wish to know about, particularly information on his family (mentioned only a few times), the books he wrote, and the honours awarded to him. We summarise these below.

Unless credited otherwise, all images are courtesy of the University of Glasgow School of Biodiversity, One Health and Veterinary Medicine.

Family

JGK's first marriage, at Grange Parish Church, Edinburgh, on 7th July 1903 (about a year after his appointment to the Regius Chair at Glasgow) was to Elizabeth Mary Kerr, a cousin and daughter of the Kerrs of Greenhill Terrace, Edinburgh. They had two sons, Adam and Ronald, and a daughter, Isobel. Elizabeth died after a long illness in 1934. JGK then, in 1936, married Isobel Clapperton (nee MacIndoe), widow of his friend Alan Clapperton who had been Secretary to the University Court. JGK's son Adam attended the building naming ceremony in 1995 and unveiled a plaque. He died in 1998. Information on the family came to Maggie Reilly through correspondence with Adam's son Alistair.

Books and archives

In addition to the Gran Chaco book and a short book on reproduction and heredity, both of which are mentioned in the text and notes, JGK wrote:

A Primer of Zoology (1912), Dent, London.

Volume 2 of an intended three volume *Textbook of Embryology*, published by Macmillan & Co. Volume 1, on the Invertebrates, by E.W. MacBride appeared in 1914. JGK's Volume 2, on the Vertebrates, but not mammals, was published in 1919. The mammal volume was to be written by Richard Assheton, but he died before it could be completed, and was never published.

Zoology for Medical Students (1921),

Macmillan & Co., London. For much of his time at the University of Glasgow, medical students were the main focus of his teaching. This volume is based on his lecture course, which was mainly on comparative morphology, but with additional emphasis on parasites of medical importance, and their transmission.

Evolution (1926), Macmillan & Co., London. JGK was a strong proponent of Darwin and evolution. This book provided an up-to-date account of the state of the theory and the evidence for it.

Introduction to Zoology (1926), an eighty-page book in the Benn Sixpenny Library series. As recounted in the *Gallery*, JGK was an enthusiastic participant in popular education.

Hindle's (1958) obituary of JGK provides a bibliography listing 74 published papers. Three bound volumes of his papers are kept in the Zoology Library, Graham Kerr Building. The University of Glasgow Archives department holds a considerable mass of JGK's letters and other papers.

Career awards

In addition to his roles as Regius Professor of Zoology at the University of Glasgow, and MP for the Scottish Universities, both fully described in the *Gallery*, JGK was elected Fellow of the Royal Society of Edinburgh in 1903, Fellow of the Royal Society in 1909, and was knighted in 1939. He was an Honorary Fellow of Christ's College, Cambridge until his death.

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A GALLERY OF MEMORIES

John Graham Kerr

Early Years, 1869 – 1892

I was born on 18th September, 1869, and spent my childhood years at Rowley Lodge in the parish of Arkley, Hertfordshire. My parents were both from the Scottish borders – my father a retired official of the Education Department of the old East India Company and, as Principal of the Hoogly College, Calcutta, one of the pioneers in the development of Western education in India. His interests were mainly literature and he had published a number of books[1].

My mother was a Graham, one of a large family among whose descendents were Walter Armstrong – in his day a celebrated art critic, author of monographs on various great painters and latterly keeper of the National Gallery of Ireland – and his three sisters who formed the subject of Millais' well-known picture *Hearts are Trumps*[2]. While I was still a small boy the family moved to Scotland, lived for a time in Edinburgh and then moved to Eskbank, a suburb of Dalkeith, some six miles south of Edinburgh. My mother died in 1874 and thereafter my one surviving sister and I remained under the care of our father and his younger sister, Isabella, who kept house for him.

To my father I owe the foundation of my education. He was a man of high principles, a rigid disciplinarian and a born teacher. When I interrupted his literary work with some question he would get up from his writing table, go to one of his book shelves, pick out the appropriate work of reference and hand it to me without saying a word. By doing so he developed in me the habit of going to original sources to solve my difficulties rather than putting my dependence upon mere question and answer. As I grew older he would give me an occasional hour of more formal teaching: Latin – Cornelius Nepos, Virgil, Caesar, Livy and later Horace – and elementary Geometry and Algebra.

My schools and schoolmasters were varied. Of my schoolmasters, two stand out most vividly in my memory. William Young was the parish schoolmaster of Dalkeith, an excellent example of the old Scottish dominie – not contenting himself with pumping his pupils' heads full of mere information, but instilling into them the things that matter so much more in after life – industry, discipline, manners, tidiness of dress and mind, and ambition to succeed. Untrammelled by a rigid code, he was free to concentrate his efforts upon pupils qualified by their natural ability to profit themselves rather than dissipate his energies upon those destined by nature for the humbler tasks of adult life. It was an interesting experience when, after the lapse of half a century three of his contemporary pupils came together again in Glasgow – one Sheriff Principal of Lanarkshire, one Minister of Glasgow Cathedral and one a Professor in the University.

The other schoolmaster who stands out in my memory is David Munn, mathematics master at the Royal High School, Edinburgh. He had the habit of setting his class problems to do at home. One of my failings was an intense dislike of set tasks: I preferred to wander away along by-ways of my own choosing. The natural result was that when called to produce the solution to the preceding day's problem, I had to be ignominiously silent. I did not like being outshone by the other boys on such occasions and I very soon began to develop a facility for producing an extempore solution in such an emergency. This caught the fancy of Munn – able teacher that he was – who instead of punishing me for neglecting my homework actually encouraged my wrong-doing and eventually invited me to go to his house one evening a week to receive free instruction with his own sons. The result of his treatment was that I became devoted to mathematics and came out easily first in my last year at school. From the Royal High School I proceeded to the University of Edinburgh. I had no cut and dried scheme for my future career. My father had for a time the idea of my entering the Indian Civil Service, but on consulting the Rector of the High School as to the probability of my succeeding in the competitive examination, he was told that 'he could do it perfectly well if he worked seriously for it but that is just what he will not do'. So the idea of the I.C.S. was given up.
My father, while primarily a literary man, had naturally, as one time editor of Bacon's *Novum Organum*, intense interest in the modern developments of science and the result was that my first University studies were in various branches of science: Higher Mathematics, Physics, Geology, Botany and Zoology. It was Geology which gripped my interest most strongly – structural Geology with the dissected volcano of Arthur's Seat and its many other manifestations in the Edinburgh neighbourhood, and palaeontology; many a Saturday I devoted to collecting fossil fishes and the brachiopods of the limestone of Joppa and elsewhere.

Then there came Botany and Zoology. The Botany lectures of these days were held during the summer session in the Royal Botanic Gardens on the north side of Edinburgh at the hour of 8.0 a.m. This involved an early morning walk of 7 or 8 miles; getting up at 4.30 to cook my breakfast, a start at 5 o'clock and arrival at the Gardens soon after 7 a.m. with a good interval for rest and cooling down before the lecture began. Later my father provided a mount so that I arrived in better condition. I attended these elementary lectures on Botany for three consecutive sessions. In the first two of these, 1886 and 1887, the Professor was Alexander Dickson[3], an old-fashioned morphologist who drew fascinating comparisons between the flowering plant with its leaves, and the sertularian zoophyte[4] with its polyps. For his first lecture, the lecture table bore a wonderful display of flowering plants in full bloom. After each day's lecture we had a couple of hours practical work, partly in the laboratory and partly in the gardens. This was looked after by two assistants, Patrick Geddes[5] and J.M. Macfarlane[6], both excellent teachers, in very different ways. I got into the way of evading Pat Geddes as much as possible – he was too apt to branch out into politics and sociology. Macfarlane kept to Botany and was a magnificent teacher, whether in studies of the structure of flowering plants in the laboratory, or in field Botany on our Saturday excursions into the country.

My third session in Botany was marked by great changes due to the advent of a new Professor – Isaac Bayley Balfour[7] – fresh from the Sherardian Chair at Oxford and full of the latest developments of botanical science in Germany, then the great centre of that science, apart from the section dealing with the classification of flowering plants in which England, with the Royal Gardens at Kew under the Hookers[8], remained supreme. The course in Botany under Bayley Balfour widened out greatly, particularly into plant physiology and into the lower forms of plant life such as algae and fungi. The excursions remained as before, for the new professor was a first rate field botanist. After Balfour's first year, both of the old assistants disappeared and were succeeded by younger men of up-to-date training. The Curator of the Gardens also retired, but the younger members of the Gardens staff were greatly stimulated under the vivifying influence of the new professor.

After the morning's work at the Botanic Gardens came the walk up to the Old University buildings, a hurried lunch of a glass of milk and a scone, and then the afternoon at Zoology – lecture and practical class in which we dissected and examined various types of the

animal kingdom. The class of Geology, like that of Botany, included Saturday excursions – both instructive and enjoyable – for Professor James Geikie[9] was not only a field geologist of great distinction but also an excellent raconteur with an ample sense of humour.

The time had arrived when it was necessary for me to decide on a programme, and knowing my interest in natural history, my father advised me to take the first year of the medical course, after which I should be able to decide on my future studies. During these early years at the University, the great majority of those attending the classes of Botany and Zoology were medicals, and as a result of their companionship, I also began to look forward to qualifying in medicine. Accordingly I took up two new subjects, being both occupied by teachers of great distinction: William Turner and William Rutherford[10]. Both in lecture room and dissecting room, the teaching of Turner and his unusually able junior staff was of a very high order. Turner was in these days the chief authority on the comparative anatomy of the placenta, and short courses on this subject and on other aspects of comparative anatomy provided a great treat for a little group of students who were keen enough to attend classes which did not count for any examinations. Rutherford was not, as was Turner, a distinguished researcher, but on the other hand he was a master of the technique of lecturing: a great part of each afternoon he would devote to preparing his lecture for the next day, incidentally covering his blackboard with beautifully coloured and instructive diagrams.

In later years at Cambridge I was made to realise by contrast the importance of lecture technique which in Edinburgh in these days was at a remarkably high level – due I daresay in part to the fact that Scottish University teaching differed from that of the English Universities by being almost entirely by lecture rather than tutorial or practical; and perhaps also in part to the fact that the Professor's emoluments, consisting of his students' fees, were proportional to the number of students attracted to his class. Edinburgh was the one place in my experience where I encountered a teacher that might almost be accused of teaching too well: This was P.G. Tait[11], Professor of Natural Philosophy – a master of Mathematical Physics who gained fame in circles other than academic by providing the simple explanation of why in some of his son Freddie's best golf drives the ball, instead of describing the usual parabola, described a curve concave upwards before dropping vertically to earth. As taught by Tait in my first attendance at his lectures the phenomena of mathematical physics appeared so simple and obvious as to require no special attention and it was only when confronted with the horrors of his examination papers that I was made to realise that I must take his course again and work at it seriously. He did in fact teach too well: he made things too clear. It was a lesson which I never forgot during my own teaching career later on.

Already during my school-days I had become an enthusiastic field naturalist. My earlier holidays were regularly spent at the farm of Castlemains, at the base of the Lammermoors, and close to the Goblin Ha' of Walter Scott's *Marmion*[12], where a brother-in-law bred Border Leicester sheep. In later years I came across one of my first letters to my father: 'Dear Papa, I have caught a trout. Please excuse more as I am going fishing.' A year or two later came the great triumph when, with my little single-barrelled gun, I killed a – surely gigantic – hare in full flight. Fishing, watching birds and other animals, hunting birds' nests, collecting butterflies and beetles, climbing the Lammermoors, exploring the woods and climbing the ruins of Goblin Ha', made each of these holidays a marvellous experience.

Later on came vacations on the west side of Scotland with dredging expeditions to fish up marine creatures from the depths. On one occasion (8th August 1884) while collecting butterflies near Ettrick Bay on the west side of Bute, I had the unforgettable experience of seeing a walrus, surely one of the last occasions of the walrus being seen on the Scottish coast[13]. I felt timid about referring to this observation in later years in view of the fallibility of human memory. However, a few years ago I unearthed an old diary and there I found the incident recorded in such terms as allowed no doubt as to its accuracy: 'August 8th, 1884. In the afternoon we went over to Ettrick Bay. We saw a shoal of porpoises and also a walrus. We got rather a surprise when we saw the head of the latter adorned with large tusks rise in the water quite near us. It soon dived, and we lay quite still expecting it to rise again. This it soon did and we watched it for some time'.

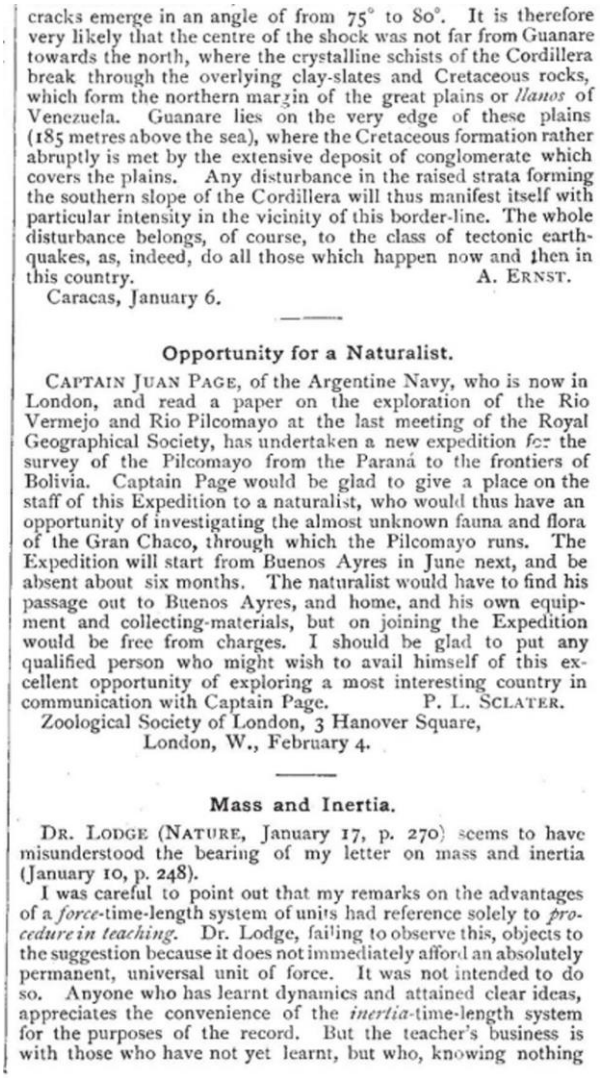
My marine natural history was not limited to the west coast. North easterly gales threw up numbers of squids, sea-mice and other interesting creatures on the sandy beaches of the Firth of Forth between Leith and Joppa, while the rock pools proved to be the home of various rare algae. For a time I collected not only sea-weeds – the algae visible to the naked eye – but also the microscopic diatoms with their beautiful flinty skeletons. Some of the rarest of these I found in the brackish pools near Aberlady. One way and another I acquired a good deal of experience in field natural history apart from my formal courses in zoology in the University. The latter came from the staff of the Natural History Department presided over by Professor J.C. Ewart[14] who was then busy with his remarkable work on the skate, showing how the muscles of the tail, though useless for producing movement, became modified to form an electric organ, useful no doubt as a safeguard against attacks from other fish – for fish are extremely sensitive to electric disturbances.

While attending the various courses in the Natural History Department, I was able to supplement these through the hospitality of Sir John Murray of the Challenger Expedition. Murray had founded the Scottish Marine Station at Granton – on the edge of a large quarry which had been invaded by the sea and converted into a huge aquarium crowded with marine creatures. Murray bade me welcome to the facilities of the marine station and I got much valuable instruction in marine zoology and its laboratory technique from the Director, J.T.

Cunningham[15]. Incidentally, I did not neglect the opportunity of extending my west coast experience of boat sailing for attached to the station was a small Rob Roy canoe in which I made interesting voyages round the islands of the Firth of Forth.

My work in Edinburgh suffered an unexpected break when one day I read in *Nature* (Fig. 2) that the Government of Argentina was arranging an expedition under Captain Juan Page to explore the Rio Pilcomayo and incidentally open navigation to Bolivia from the Paraguay river through the practically unknown region of the Gran Chaco, and that he had at the instance of Dr P.L. Sclater, Secretary of the Zoological Society of London, agreed to allow a properly qualified British naturalist to accompany the expedition[16]. Much of my favourite reading had been on the natural history of South America - Charles Darwin, Waterton, Wallace, Bates[17] - and here seemed to be a marvellous opportunity of penetrating into that realm of romance and incidentally obtaining a valuable addition to my training in Zoology. I was duly appointed naturalist to the Pilcomayo Expedition. The tale has already been told[18], and a few general remarks will suffice here.

The expedition was a failure as regards the main object, but it did give me in my capacity as a naturalist marvellous opportunities for studying the natural history of the Chaco and the customs of a quite unspoilt section of its aboriginal inhabitants - a branch of the nation of Indians known to the Argentines as the Tobas, to the Paraguayans as the Guaycurus, and to the neighbouring races of Indians as the Natokoi. The special interest of the Natokoi of the lower Pilcomayo lay in the fact that their state of constant warfare with their neighbours, whether of the Toba or other races, had kept them isolated and in consequence free from the contaminating influences of other races, whether white or red. The result of this isolation had been that this particular branch of the Natokoi had remained in an extraordinarily primitive stage of communal evolution. They were still in the hunting stage - subsisting entirely on the products of the chase: they had not yet reached the stage of cultivating plants or of keeping domesticated animals: they were still in the wood age, using bows and arrows, and obtaining fire by friction between two pieces of wood. Metal implements were just beginning to make their appearance - an arrow head made from a bit of hoop iron or beaten out fencing wire and capable of being used separately as a knife: or a very occasional axe in place of the heavy wooden paddle-like implement which normally performed the function of an axe in chopping out the soft edible heart of the young palm. In the absence of metal vessels capable of resisting heat, cooking of food was done entirely by broiling or roasting: they had not yet reached the stage of using water for cooking. They had no words for numbers which were expressed by holding up fingers, commencing with the thumb of the left hand, and the normal limit of counting was 5, 6 or in rare cases 7. Time was reckoned in days, moons or years, subject to the numerical limits just mentioned. The time of day was expressed by pointing to the position of the sun -



cracks emerge in an angle of from 75° to 80°. It is therefore very likely that the centre of the shock was not far from Guanare towards the north, where the crystalline schists of the Cordillera break through the overlying clay-slates and Cretaceous rocks, which form the northern margin of the great plains or *llanos* of Venezuela. Guanare lies on the very edge of these plains (185 metres above the sea), where the Cretaceous formation rather abruptly is met by the extensive deposit of conglomerate which covers the plains. Any disturbance in the raised strata forming the southern slope of the Cordillera will thus manifest itself with particular intensity in the vicinity of this border-line. The whole disturbance belongs, of course, to the class of tectonic earthquakes, as, indeed, do all those which happen now and then in this country. A. ERNST.

Caracas, January 6.

Opportunity for a Naturalist.

CAPTAIN JUAN PAGE, of the Argentine Navy, who is now in London, and read a paper on the exploration of the Rio Vermejo and Rio Pilcomayo at the last meeting of the Royal Geographical Society, has undertaken a new expedition for the survey of the Pilcomayo from the Paraná to the frontiers of Bolivia. Captain Page would be glad to give a place on the staff of this Expedition to a naturalist, who would thus have an opportunity of investigating the almost unknown fauna and flora of the Gran Chaco, through which the Pilcomayo runs. The Expedition will start from Buenos Ayres in June next, and be absent about six months. The naturalist would have to find his passage out to Buenos Ayres, and home, and his own equipment and collecting-materials, but on joining the Expedition would be free from charges. I should be glad to put any qualified person who might wish to avail himself of this excellent opportunity of exploring a most interesting country in communication with Captain Page. P. L. SCLATER.

Zoological Society of London, 3 Hanover Square,
London, W., February 4.

Mass and Inertia.

DR. LODGE (NATURE, January 17, p. 270) seems to have misunderstood the bearing of my letter on mass and inertia (January 10, p. 248).

I was careful to point out that my remarks on the advantages of a *force*-time-length system of units had reference solely to *procedure in teaching*. Dr. Lodge, failing to observe this, objects to the suggestion because it does not immediately afford an absolutely permanent, universal unit of force. It was not intended to do so. Anyone who has learnt dynamics and attained clear ideas, appreciates the convenience of the *inertia*-time-length system for the purposes of the record. But the teacher's business is with those who have not yet learnt, but who, knowing nothing

Fig. 2. Letter advertising an "Opportunity for a Naturalist" (*Nature* 39, 341; February 7th 1889).

thus midday was indicated by pointing to the zenith and the behaviour of the hour hand of my watch in acting similarly was attributed to the action of a little spirit which inhabited it. There was as yet no graphic art whether in writing or pictorial. When I first showed my pictures to the Indians, even of animals or trees familiar to them, they failed entirely to recognise a tridimensional object represented on a flat surface though they very soon learned to do so, and were thrilled as I turned over the pages of an illustrated book on natural history. One of the chiefs even got the length of proposing to draw a picture of a man. His portrait of Chinerutaloi - the first picture ever made by a particular race of human beings - is reproduced in my Chaco book[18].

My ambition to be chosen as naturalist to the Pilcomayo expedition had of course nothing to do with these extraordinarily interesting anthropological features of the local Indians. It was due simply to the opportunity it would offer of studying natural history of an unknown region and thereby providing what seemed to me a really essential portion of the education of a professional naturalist. I should have to devote myself to making my

collections and observations of the fauna of the region as extensive as possible. I left Southampton on the 2nd June 1889 in the Lamport and Holt liner *Maskalyne* and reached Buenos Aires on the 29th after a voyage comparatively uneventful but for a violent pampero off Cape Frio on the coast of Brazil. Up to that time I had rather looked forward to enjoying the experience of a real storm at sea, but that feeling perished, never to revive; in that pampero the complete destruction of the smoke room built round the aftermast, and the bending of the bridge stanchions as if they had been made of putty, gave an impressive lesson on the power of waves in a severe storm. The passenger cabin of those days had little comfort, no heating, and the lighting was merely by a single candle hung in gimbals.

We duly arrived at Montevideo on 27th June and there I had one of my first lessons in economics, for near us was anchored a ship laden with Welsh steam coal which was being sold at £1 a ton. The impressive lesson was not that money would pass back into Welsh industry, but rather that once the cargo had been disposed of, there would remain an empty ship ready to be loaded up with food or raw materials for England at greatly reduced freight, an impressive lesson on the balance of exports and imports. From Montevideo we passed onwards over the muddy waters of the Rio de la Plata dotted with numerous floating islands of Camelote (*Pontederia*[19]) which had come down from the warmer regions far to the north. On the morning of the 29th June we anchored in the outer roads of Buenos Aires. The great range of docks and quays of later days were still non-existent and landing was a complicated business - by steam tender, boat and bullock cart.

The four light draught steamships for our expedition - the 'Escuadrilla Pilcomayo y Bermejo' - had been constructed by Messrs Bow, McLachlan & Co. of Paisley and shipped out as separate plates to be put together in Buenos Aires. They were not expected to be ready until the month of December and the delay was most useful in giving me the opportunity of preliminary training of a practical kind in the Natural History of South America - in the Natural History Museum of Buenos Aires presided over by Hermann Burmeister[20], one of the great naturalists of the day; in the swampy region between the city and the river where I was able to wander and watch the bird inhabitants; and above all in a three months sojourn in the heart of the pampas as the guest of Don Benjamin Carbonell, a friend of the Page family. His estancia near the little town of Nueve de Julio was situated in typical pampas country, its slightly undulating surface varied by rush-grown lagoons with a wonderful variety of waterfowl - many species of ducks and grebes, the beautiful black-necked swan and a smaller white swan, herons, including one species with 'dazzle' marking, its dark stripes constituting an extraordinarily effective obliterative colouring among the vertical rushes. The originally treeless pampas had become dotted with plantations round the estancia houses and in these were to be found immigrant forest birds, so that altogether, what with laguna, monte, and open pampas, I was able to get a good foundation training in the ornithology of South America. Mammals too - a couple of species of opossum, and three of armadillo; the coypu - a large water rat miscalled nutria - a name which in correct Spanish belongs to the otter; the biscacha, a large rodent about three times the size of a rabbit which lives in communities or biscacheras, hidden in their burrows during the day but coming out at sundown to feed. When deserted by their regular inhabitants the biscacheras harboured other mammals, a beautiful silver fox, a couple of species of wild cat, a large weasel called huron, and the skunk - which could often be seen taking his leisurely evening stroll, his white tail held aloft as a warning to all to keep their distance.

Of reptiles there were large iguanas and the poisonous snake called Vivora de la Cruz from the cross-shaped markings on its head. It was interesting to see in its habits an indication of the early evolution of the habits of the rattlesnake, for when alarmed and coiled up ready to strike it would vibrate its tail rapidly among the grass stems, making a distinct whirring sound as a warning to the potential enemy.

Of insects, there were the fascinating colonies of gardener ants, their nests low mounds from which radiated clear tracks along which on a warm sunny day could be seen two hurrying streams of ants, those on the homeward stream carrying in their jaws segments cut from the leaves of neighbouring trees. These were carried down into cavities under the ant hill and were there made into beds tended by the gardener individuals, on which were grown threads of fungus which, in response to some unknown treatment, produced tumour-like growths that served as food for the community[21]. Altogether I was able during my three months stay with Don Benjamin to acquire quite considerable qualifications for my duties as naturalist to the Pilcomayo expedition.

It was not until New Year's Day 1890 that our flotilla started on its long journey up the Rivers Parana and Paraguay (Figs. 3 and 4). During our progress northward my pre-Pilcomayo training continued as the fauna became more and more tropical, but it was not confined to matters zoological. Though I was a guest of the expedition and not a paid member of the crew, it was really up to me to do what I could to give a hand in the running of our individual ship, the *Bolivia*. And so it came about that I took my share with the others, a larger share as it happened, for Captain Page very soon discovered that I was knowledgeable about boats and proceeded to give me instruction in the art of river navigation which was his particular speciality. I found it most fascinating, learning to read the surface of the muddy water as expressive of depth, strength and direction of current, snags and other obstacles. I proved an apt pupil and the result was that when we were under way my regular station was at the wheel.

During the early stages the Commander would sit beside me and keep up a continuous commentary upon the water ahead and its indications as to the proper course,

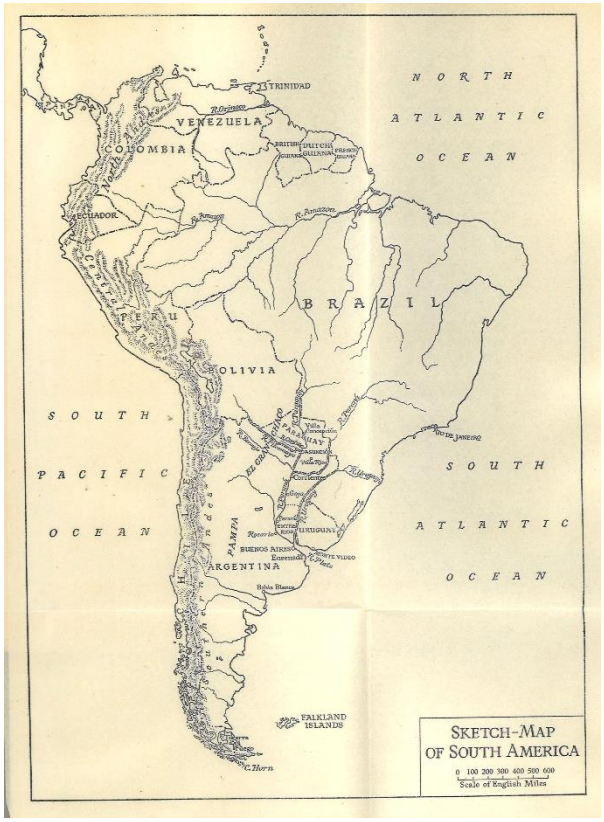


Fig. 3. Map of South America. From Kerr, J.G. (1950). *A Naturalist in the Gran Chaco.* Cambridge University Press, Cambridge.

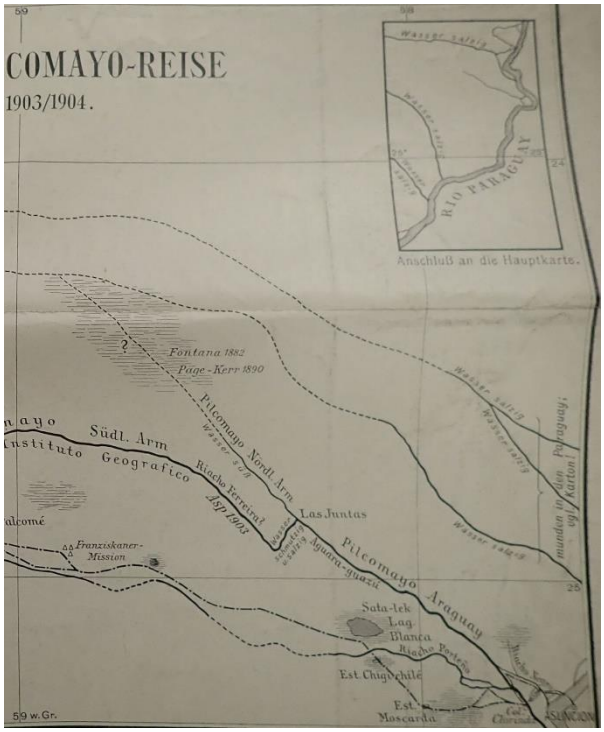


Fig. 4. Detail of map "*Frić Pilcomayo – Reise 1903 1904*" of the Pilcomayo river system, showing the final extent of the Page/Kerr expedition. Image courtesy of University of Glasgow, Archives and Special Collections, John Graham Kerr collection, GB248.

but as time went on he left me more and more to myself in the work of piloting our ship. The climax came when we reached the Rio Bermejo, a tributary of the Paraguay running parallel to the Pilcomayo and at this time in high flood. The Commander decided to turn up into the Bermejo to see how our vessel behaved in its turbulent waters, and the climax of my navigational training came when he entrusted me with the responsibility of navigating the *Bolivia* downstream back to the Paraguay. Throughout the journey which lasted about six and a half hours, in place of the upstream journey of three days, he sat beside me but never uttered a word. At times a swirl of the current would sweep us in towards the bank of hard tosca, contact with which would have meant the end of everything, and I had to edge away from the bank with the greatest care to avoid the stern swinging inwards. At other times a faint ripple would betray the presence of a snag just under the surface. The whole journey required intense concentration and vigilance, and I was a very tired man when at last we shot out into the peaceful waters of the Paraguay.

On 20th January we had reached our up-river base - Barranqueras - on the Chaco bank opposite the city of Corrientes and just below the point of junction of the rivers Paraguay and Parana . A stay at Barranqueras of about a month was occupied in shipping stores on the four vessels and in adjusting their crews. The latter were in the case of the two larger vessels - the *General Paz* and the *Caa Guazu* - ordinary naval crews but in the case of the *Bolivia* they were a mixed lot. Chief Engineer Henderson, an elderly Scot who had sailed with Page in earlier days, second Engineer Cesar, and Italian photographer and Steward, Pool, Carpenter, Higginson, a Scandinavian cook, a negro; ordinary members of the crew, Jack and Smith, negroes, and Kennion an Englishman. Besides these there were on the *Bolivia* Nelson Page, son of the Commander - a midshipman in the Argentine Navy, and myself. At Barranqueras too we were joined by the military contingent - 50 troopers belonging to two regiments of Chaco cavalry with their officers, a particularly tough looking set of men.

On 26th February we started northwards up the river Paraguay and after our six day divergence into the Bermejo and a call at Asuncion, the capital of Paraguay, we reached the Pilcomayo on March 12th. That river turned out to be very different from the grandiose accounts which had inspired our expedition. Navigation was difficult from the beginning along its narrow and tortuous channel but there was also a steady diminution of the volume of its water until at last progress was brought to a full stop. Our Commander now developed the bright idea of constructing a series of dams across the river, each of which would raise the water level sufficiently to allow of further progress. In the event, seven of these dams were constructed and made use of, but by the time the seventh had been constructed at the beginning of June, the flow of water had diminished to a mere trickle and this point, Fort Page, turned out to be the final limit of the *Bolivia'*s voyage up the Pilcomayo. The other vessels of the flotilla had been left behind far down stream.

During the voyage up the Pilcomayo my life fell into a regular routine. While we were under way I took my share of the ordinary work of the crew, and then, when we were brought to a stop by the need to cut the next day's supply of fuel, I went ashore and did my natural history work. Particularly interesting was the late afternoon when I would take a canoe and paddle along up river on the outlook for birds and mammals. A female jaguar would be seen pacing along the bank with her kitten, behaving in her movements just like a large cat. A comical family group of carpinchos[22] - these enormously overgrown cavies - would plunge into the river as I approached. Or one might catch a momentary glimpse of a tapir as it dashed off through the undergrowth. A little creek would open into the river and pushing the canoe through it I would find myself in a wide lagoon, its waters bearing a floating carpet of *Pistia*[23] and *Pontederia*[19], or in places of the great floating leaves of the gigantic water lily *Victoria regia*[24]. And pacing about on this floating carpet would be a troop of jacanas, those beautifully somewhat rail-like birds with enormously elongated toes and claws, and they would suddenly stop their movements and stay for a few seconds motionless with their beautiful lemon-yellow wings stretched vertically upwards.

A fascinating discovery was made when, in the narrowing river, our decks became littered with lichen-covered twigs broken off from overhanging trees as the high upper works of the *Bolivia* brushed up against them: for a large part of the litter turned out not to be lichen-covered twigs but living animals coloured and fashioned into the most perfect semblance of the lichens among which they lived. There existed in fact in the upper branches of the forest trees a whole fauna - lizards, snakes, tree-frogs, scorpions, spiders, praying mantis, locusts, beetles, ants - all showing this marvellous camouflage.

One night during my watch - before we got into Indian territory - a slight sound attracted my attention and looking up I saw a jaguar looking in the moonlight of enormous size, coming in great bounds, attracted by two sheep we had grazing close by. The sheep dashed past me and all I could do was to clap my hands and dash towards the advancing jaguar, which startled it so much that it at once turned and fled - as I myself did equally hurriedly to the safety of the *Bolivia*. Another night, the normal pitch of blackness of the forest was replaced by a ghostly greenish light caused by phosphorescent micro-organisms on the decaying leaves.

The nine months between our arrival at Fort Page in the middle of June and our departure on 28th February 1891 was the really fateful period of our expedition. We were made to realise that we were in Indian territory, for a column of smoke would appear in the distance now in one direction, now in another, but there was no sign of an Indian or even Indian trails. And the fact of their keeping out of sight strengthened our expectation of their not being friendly. The dragging out of the expedition far beyond the time of anticipated arrival at Bolivia and civilization meant that the stores of provisions approached vanishing point and rations had to be reduced to starvation level. A hungry man is an angry man and temper on board was not helped by the realisation that the Commander's mess, comprising himself, his second in Command Zorilla and his son Nelson Page had their own private cache of provisions under the flooring of the Commander's cabin. Mere grumbles developed into really dangerous disaffection and feelings against the Pages, more especially against Nelson, became thoroughly poisoned.

Apart from food troubles there was much illness, and towards the end of June, Zorilla was dispatched down river to expedite the sending of a relief party with provisions. Higginson the carpenter had constructed an excellent canoe and Zorilla took with him as crew Cesar the second engineer and Agustin. With them also departed the doctor of the expedition, Luigi Vignoli, who, weakened by illness and inadequate nourishment, seemed clearly doomed unless he could get away into civilised conditions. He did not get away for he was put ashore and left to his own devices. Late in the afternoon we were astonished by his re-appearance, and abject spectacle, dripping wet, covered with mud, without a coat and with only shreds of stockings on his feet, almost *in extremis*. After a bit he was able to tell us his lamentable story of how the canoe party a few miles down stream from the *Bolivia* had simply dumped him ashore and abandoned him to his fate. We did our best for him but after some five weeks of suffering he died on 8th September and we buried him on the edge of the monte close by.

Meanwhile the Commander too had been going steadily downhill. On 20th July he departed in our one remaining canoe with three men. He died on 8th August, nineteen days after leaving us. The men, fearful of the fate that would be theirs if they arrived at Puerto Pilcomayo and simply reported the death of Captain Page, decided that they must at all costs get his body down to the mouth of the river where it could be examined and death declared to be from natural causes. It was a grim voyage of four nights and three days with the rapidly decomposing body. On arrival the canoe had simply to be buried at once with its contents. It was on 4th October that the news of the Commander's fate reached us, for on that day there arrived a relief expedition of Argentine cavalry who, guided by Jack and Aguirre, two of the men who had accompanied Page, reached the *Bolivia* after a journey of over a month from the Paraguay river. They reported that an earlier expedition had started off to relieve us some months earlier, but nothing had been heard of it and it was feared that it had met with disaster.

Zorilla, they reported, had safely reached the Paraguay but, finding the revolution of 1890 in progress, had departed down river for Buenos Aires, reporting that he had left the remains of the Page expedition dying of scurvy. He also reported that Dr Vignoli had gone mad on the journey down the Pilcomayo, had jumped ashore and had been devoured by a tiger. The ship's company of the *Bolivia* were, not unnaturally, impressed by the extraordinarily well-fed appearance of their rescuers.

The magnificent fat bullocks they brought with them showed every prospect of bringing our own company back to normal, though we found our first meals too rich for enjoyment. The new conditions meant much more than the relief of the food stringencies. What one felt much more at the time was the sudden relief from the continuous strain of constant watchfulness against the danger of Indian attack. It was a delightful contrast now that the responsibility was transferred to the military sentries. On October 5th, Nelson Page departed with a corporal and six men of the relief party to proceed to Buenos Aires for orders. With him also departed two members of our crew - Aguirre and the negro, Jack. Command of the *Bolivia* was entrusted to old Henderson the engineer, until Nelson's return.

On September 18th, my twentieth birthday, came our first sight of the wild Indians. I had gone down river for a short distance to do some washing and returning to the ship, I was hailed by Nelson to come aboard at once as there were Indians about. Two had suddenly appeared a short distance off and had waved their bows and arrows in sign of friendship and had then disappeared apparently to fetch their comrades. Nelson was up on top of the wheelhouse at the Maxim gun and all the others were at their stations. Presently the Indians re-appeared, this time twelve in all. Then one of them, evidently the leader, stepped forward and in the dead silence that ensued, said in Guarami 'We want Pineapple Head'. Our captain made nothing of it but one of our men pointed at me. There was no barber on our little ship and my hair, by nature thick with curls that stood out strong and stiff round my head, evidently reminded the Indian of a pineapple with its bristles. As they still seemed friendly, Nelson and I went ashore to establish contact with them (Fig. 5). Their language was of course quite unknown but a useful beginning was made by their repeating over and over again two words of Spanish *Amigo* and *Tabaco*. One of them who, as we learned later, was the most powerful cacique or chief in the region, had a good knowledge of Guarami, the language of Paraguay, in addition to a smattering of Spanish. He explained that he was a great lover of Cristianos, very unlike the neighbouring cacique upstream who was *muy bravo*.

Fig. 5. The expedition's first meeting with the Natokoi people: JGK is at the middle right back, hatless. From Kerr, J.G. (1950). *A Naturalist in the Gran Chaco.* Cambridge University Press, Cambridge.

The Indians stayed with us three days, in friendly intercourse, retiring at night to the neighbouring monte, and bartered with us some deer skins and ostrich feathers and, better still, food, some thirty guinea pigs and the flesh of three cierbos. When they left, with many protestations of friendship, they promised to return next moon with their brothers. Knowing as we did the treacherous reputation of the Toba Indians and their hatred of the whites, we could not help wondering whether their visit had not really been one of reconnaissance and their return would be to exterminate our small party.

It was about a week after our reinforcement by the relief party that we again became aware of Indians in the vicinity but they did not show themselves openly until just before sundown on October 13th when a number approached the "Bolivia", among whom we recognised some of our visitors of the month before. There was no trouble and from that time onwards we had Indians with us practically continuously during the hours of daylight, watching all our doings, as we did theirs. I busied myself in acquiring a working knowledge of their language and eventually came the great day when Cacique Yordaik announced that some of his men wanted me to join them in a hunting expedition. I duly did so, reflecting that had they had any desire to harm me there would have been endless opportunities during my solitary collecting rambles. That first hunting expedition was in search of the ostrich (*Rhea*) or manik[25]. Our little party, three Indians with their bows and arrows and myself with my rifle, made its way at a swinging pace to the north-westward, to the country of the manik - open grassland dotted with ant hills. We were in single file led by Chimaki who later became my most intimate friend among the Natokoi, I following next behind him, and the two other Indians bringing up the rear. Arrived in the manik country Chimaki and I separated from the others and after a bit Chimaki, peering intently to the left, indicated a manik. To me it was quite invisible. Chimaki became more and more excited and presently started to run round in a circle of about thirty yards radius, excitedly pointing to its centre. At last I became aware that one of the apparent ant hills was surmounted by the slender neck and head of a manik, which as it rose to its full height and started to flee, was brought down by my rifle bullet. It was a male bird and the nest close by contained thirty eggs - the male *Rhea* attending to the incubation of the eggs forsaken by his numerous harem. Preparations were at once made for a meal. Chinerataloi produced his fire drill and soon had a fire lighted. The feathers were pulled out and tied together in a bunch. Part of one leg was put to roast. Breaking open the eggs at one end showed to my disappointment well developed chicks but these were fished out, the eggs stood up vertically round the fire to cook and the remains of the yolk duly consumed. After our meal, a short rest, and then I gave the word 'Koluk' - let us go. The unused eggs and the eatable parts of the ostrich were packed in string bags and off we set on our return journey to the camp where we were received with much acclaim.

During the remaining months on the Pilcomayo, my days were normally spent in the company of Indians, wandering about, hunting the various kinds of game, and above all getting to know them more and more intimately. In our earlier days it would happen that every now and then, an Indian would remind me that so many moons ago I killed such and such an animal at a particular spot, and it became borne in upon me that in my supposedly solitary wanderings I had been under the constant surveillance of an invisible Indian spy. I began to realise too that here was the explanation of the attitude of the Indians to myself, so entirely different from their attitude to the other members of the expedition. They had learned that my doings were dominated by my interest in wild animals as were their own. A fellow feeling made us wondrous kind.

The Natokoi were a fine-looking race the men tall and lean, many of them over six feet, their skin sunburning to a dark coppery red, their dark hair cut short a little above shoulder level and often as a fringe over the forehead. All hairs on the face and body were pulled out and absence of eyelashes and eyebrows gave an at first somewhat unpleasant impression. They were particular about their personal appearance and spent much time combing their hair. On ceremonial occasions, as when meeting strangers - friendly or hostile - they painted their faces, a broad band of red urucu across the upper part of the face and narrow black lines along the ridge of the nose and radiating from the mouth. One day early in our companionship, I was summoned by Yordaik to have my face painted and the ceremony was watched with much approbation by the Indians gathered round. I felt that now my inauguration into their communal life was complete. Favourite personal ornaments were white ostrich plumes on the head, and necklaces of rectangular pieces of shell of the freshwater mussel, with the pearly lining outside and showing up well against their dark skins.

The women were also slenderly built, their difference in stature from the men much more pronounced than in European races, their garment like that of the men - a rug worn round the waist and extending down nearly to the knees but of skin instead of woven fabric. They wore necklaces too but composed of overlapping discs about the size of a shirt button, cut from the shells of a large snail *Bulimus*, or, more rarely, of small berries. They did not paint their faces. They were tattooed, the operation performed by an old woman puncturing the skin with a plant spine, and rubbing in charcoal. It was usually done in two instalments, two lines down the ridge of the nose at puberty, and the remainder of the pattern - obliquely intersecting lines covering the cheeks and chin - after the first sexual adventure.

The "tribes" among the Natokoi were not rigid: they were merely groups of individuals clustering round a particular chief or cacique and designated as the 'men of so and so'. The cacique was merely an individual recognised as of outstanding ability, the number of his adherents varying with his reputation. As his power dwindled his followers would drift away. He had no actual command over his men: it was not a case of their obeying orders from him but rather or their realising that he was a wise guide. There had not yet come into existence among the Natokoi the division of power - so unusual among Indian races - between the cacique - concerned with practical affairs - war and the chase, and the 'witch doctor' concerned with the supernatural beings that were held responsible for misfortunes of all kinds.

The upbringing of the Indian boy consisted simply of what we should nowadays call education in citizenship, training to play his part efficiently as a member of the community. The young boy with his toy bow and arrow hunted birds and other small game and in doing so learned far more than merely how to shoot accurately with his arrow; he developed his powers of observation and his powers of rapidly and accurately interpreting the meaning of what he observed. As he became adolescent he associated with the grown-ups, developed his powers further and accumulated a store of knowledge of the local environment: its topography, its plant and animal inhabitants, and the neighbouring tribes, friendly or hostile. The end result was that the average Indian would put an average European to shame both in his powers as an observer and in his condition of constant mental alertness ready for instant reaction to any unexpected emergency.

I had been brought up to think of Red Indians as beings of the utmost solemnity and taciturnity and so it came as a real surprise to realise that so far as the Natokoi were concerned this idea was accurate only as concerned their behaviour in the presence of strangers: in the absence of strangers it was completely different. They were then often quite gay and lightsome. They had a good sense of humour and enjoyed a joke, practical or otherwise.

The Natokoi had no fixed settlements. The encampment at any one spot lasted only as long as it was a profitable centre for hunting and fishing. They had no permanent shelters, no huts or tents. At night the Indian would divest himself of his garment, spreading it on the ground and sleep on it without any covering. In heavy rain he would squat with it over his head. In a storm he would shelter in the lee of a mat or niyik composed of giant rushes and strung up between two bushes. When, towards the end of the expedition I made my way to Paraguay with a small party of Natokoi, it was interesting to notice that when for the first time they saw a house they exclaimed *niyik pok* - big mat.

In their migrations from one camping ground to another they proceeded as always in Indian file, one behind the other, with toes slightly turned in so as to feel the pathway if hidden by darkness or under water: in front, the cacique and older men, then the younger men, each one carrying only his weapons. Behind them the women and children, the women heavily laden. Slung on the back of each by a cord passing over the forehead was a large skin bag containing various stores, on the top of this a roll of dried cierbohide or niyik and several earthenware water vessels with their cord slings. On the

top of all was frequently a little child astride on its mothers neck. Altogether an enormous burden. And in addition she would be steadying her steps with the heavy 'paddle' of cascaranda, often over six feet in length and normally used as an axe or spade.

Whenever possible the route would be along the margin of the monte or forest, into the recesses of which the women would vanish on the threat of attack, while the men remained hidden just within the margin ready to meet the enemy. The new encampment would be sited close by the forest margin and convenient for water supply. A characteristic sight was the departure of the women each evening escorted by one or two men to fetch the supply of drinking water for the night.

The Indians of course do not wash. Their bare skins are kept clean by vital processes just like those of wild animals. The year 1890-91 was, as it happened, unusually dry and the Indians noticed me performing a strange ritual when we came to a pool of water, dipping my hands into it and rubbing them together. Presently, Yordaik felt that he must take over this ritual, so he filled a guinea pig skin with water, took a mouthful from it, squirted the water over my outstretched hands and rubbed them between his own. Though they did not wash, they delighted in bathing during the hot season when their camp happened to be near a deep pool in the river bed. They were magnificent swimmers and used to enjoy the joke of pulling me under water. I had practiced holding my breath for long periods and rather astonished them by disappearing under water and remaining submerged while I made strange sounds by forcing air out between my tightly closed lips.

The normal working day of the Indian commenced before dawn when he started off for his hunting ground - the margin of swamp or *estero* - the haunt of the large deer or cierbo, the edge of the monte - haunt of the beautiful smaller deer, *guazu vira,* and the piglike peccary, the open savannah or palmar - haunt of the *Rhea* and the camp deer[26]. It was fascinating to observe the skill of the Indian in detecting the trail of a wild animal, recognising not only its species but the approximate age of the trail by the extent to which the displaced vegetation had regained its natural position.

What I think impressed me most of all was the tracking down to its nest of a honey-collecting wasp[27]. My Indian companion would point up into the air and exclaim '*Katik'*. I would look in the direction indicated and see nothing or at most some flylike insect. He not only recognised it as *Katik* but - far more astonishing - he was able to judge from some minute peculiarity in its flight whether it was or was not laden with honey. In the latter event he paid no further attention to it but in the former, he knew it was homeward bound to the nest, and he noted the direction of its flight, followed it, keeping a careful look out for any of its companions bound in the same direction and invariably succeeded in finding the nest, a spherical papery structure a foot or so in diameter fixed in the branches of a tree. He would then proceed to light a fire on the windward side of the nest at such a distance that the rising column of smoke swept round the nest. The wasps very soon emerged and flew away to a neighbouring tree and when the nest was completely deserted he climbed up, detached it from its supports and brought it down. Breaking it open we had a great feed upon the honey, but a special delicacy was the large and plump grub of a beetle which was an unusual guest in the wasps' nest. It was cool and juicy and went off in one's mouth with a plop like a ripe gooseberry.

During my wanderings with the Indians I had the opportunity of learning more of their social customs. The correct time for a visiting party to arrive was just before sundown. They approach in single file, the men in front. They are invited to sit down. The do so in a circle, the visiting cacique beside his host. For a long time not a word is spoken. The visitors attend to their toilet, comb their hair, arrange their headdress, paint their faces and when all is well conversation begins, at first purely formal. 'We have come from the West'. 'You have come from the West'. 'There is much water'. 'There is much water'. 'We fought the men of so and so'.'You fought the men of so and so'. And so it goes on, the host politely repeating verbatim each announcement of his guest.

One time I proceeded with Yordaik to pay a call on Yokoidyi and his men. On our arrival at their camp they spread skins on the ground for me to sit upon. The two caciques squatted down besides me, and the tribesmen in a circle. Then an immense gourd holding at least a gallon and a half of luktaga - a kind of mead made from honey or from the chewed-up fruits of a Chaco locust bean - was placed on the ground in front of Yoikoidyi who handed out the drink in a small gourd, first to me and then to the others, going round the circle clockwise - which suggests there may be something very ancient and ancestral in our own way of passing round wine at table. In spite of the quantity of luktaga in the large gourd it had to be replenished so as to give each man about a pint. That was sufficient to make the Indians very talkative, denouncing in particular their enemies and mine, the Nimka, and their intention of utterly annihilating them.

When a party of strangers visiting an Indian encampment includes women, they come in separately one by one after the men, their hostesses running out to meet them and relieve them of their burdens. They then disappear from view, the women remaining apart from the men on such ceremonial occasions, as indeed during the greater part of their ordinary lives except when the tribe is on the move. Polygamy was the rule among the Natokoi - young wives being added one after the other till there might be as many as four or five. They had a high standard of fidelity to their husbands and divergence from this met with severe corporal punishment administered by the other women.

While I kept happy by the continuous interest of my life, others were less fortunate. Service in the Chaco regiments of the Argentine army was in many cases a punishment for previous crime and was subject to harsh

and rigid discipline. The prolonged period of comparative idleness encouraged the always present spirit of disaffection and on 19th January the unpleasant discovery was made of a plot among the troopers to get rid of the rest of us and secure freedom by flight into non-Argentine territory. It was essential to act at once and give the alarm to the Argentine authorities. This could be done only by sending a personal messenger and it was realised that I, from my experience with the Indians, was the most likely person to succeed in getting through the country of hostile Mushcui and reach the military post at Puerto Pilcomayo. When I sounded my friend Chimakyi about coming with me he agreed enthusiastically and on the morning of the 22nd we departed, ostensibly on a hunting expedition. A few leagues downstream we were joined by six other Indians, every one of whom I would have chosen without hesitation as being especially competent in any trouble we might have. The chief Chimakyi and another Indian even accompanied me to the hotel in Asuncion and slept the night outside my bedroom door. The tale of that journey has already been told in my *Naturalist in the Gran Chaco*[18] and all I need say here is that after six days' journey through very difficult country, we duly reached Paraguay.

Six days in Asuncion were busily occupied in the purchase of supplies, including bullocks to take back to the *Bolivia*. One day I took a boat down to Puerto Pilcomayo, the Argentine military post at the mouth of the Pilcomayo, and reported on the trouble amongst the military contingent at the *Bolivia*. I was given a fresh lot of cavalry to form an escort and duly arrived back at the *Bolivia* to find that, as I had anticipated, the disaffected troops of our original relief party had been on their best behaviour after I had managed to slip away.

The Government was so pleased with my services and also by being the first white man to have established friendly relations with the Indians that they offered me a large tract of land to continue work amongst them. My friends among the Indians had an alternative plan that I should become their chieftain or leader. A wigwam had been prepared for me and two of their young women promised to be my companions. However, in Paraguay I had bad news of my father's failing health and felt unable to accept this offer, and remained with the *Bolivia* only long enough to get my collections safely packed up. On March 15th I started on my homeward journey, taking with me as much as could be transported on five mules and leaving the rest on board the *Bolivia* with instructions as to its eventual transport to Edinburgh[28].

On my return from the Gran Chaco I settled down to resume my medical studies in Edinburgh. In the autumn took place the death of my father, and during the winter session I resumed my university studies and attended classes in Pathology and Surgery. But my attention wandered. I was elected President of the newly formed Darwinian Society, one of the series of short-lived students' societies devoted to Natural History. Then there was the task of working through my collections of bird skins from the Pilcomayo, the one fragment of my zoological collections which I had been able to bring home. As the session advanced, I became more and more decided to quit finally the curriculum in medicine and devote myself to training as a professional zoologist.

In the Autumn of 1892 there came to the British Association meeting in Edinburgh, Edwin Ray Lankester[29], the leading naturalist of the day. He stayed at Inverleith House with Professor Bayley Balfour[7] who, ever interested in my future career, arranged tête-à-tête breakfast with Lankester at which I could get his advice. That advice was quite definite: first, that I should complete my medical curriculum and thereby become a member of what he described as 'the strongest trades-union in the country', and thereafter come to him in Oxford for my special training as a professional zoologist. I was duly grateful to Lankester for his advice, though the sequence of subsequent events was not in accordance with it.

On the Saturday of the meeting I took a little party for a walk across the Pentland Hills - P.L. Sclater, his son W.L. Sclater, and young Charles Dalrymple of Newhailes. Philip Lutley Sclater[30], Secretary of the Zoological Society of London, whose autocratic ways had earned for him the nickname of 'Emperor Philip' and who had been more responsible than any other single individual for raising the Society with its Zoological Gardens from a comparatively obscure position, was one of the leading figures among the British scientists of his day. He had been responsible for my being chosen as naturalist to the Pilcomayo Expedition and he continued in subsequent years to be my ever-watchful adviser and guide. He and Isaac Bayley Balfour earned from me a debt of gratitude which could never be repaid.

Half-way across the Pentlands, Sclater called a halt and said: 'Now we shall decide the fate of Pilcomayo', his sobriquet for myself. His son Willie - also a professional zoologist - although trained at Oxford had had some experience of teaching at Cambridge and his advice was that I should go to Cambridge and to Christ's - the college of Charles Darwin - where I should have the advantage of having Arthur Shipley[31] as my tutor. This wise advice decided the matter in my mind. I wrote at once to the Master of Christ's and in view of my unusual circumstances he agreed to my immediate admission to the college.

My objective being an Honours degree in Zoology, the first hurdle to be surmounted was the Previous Examinations or 'Little Go' which would involve my return to subjects neglected since my schooldays. The Little Go at that time was divided into two parts: I, Classical - including one of the gospels in the original Greek - and II, Mathematical, with a paper on Paley's Evidences[32]. As Part I would clearly require a good deal of brushing up of my very inadequate classical training, I decided to concentrate for the moment on Part II and rid of it before the beginning of the October term. I accordingly proceeded to Cambridge in September,

1892, and was up in college for the period of the examination and duly got rid of Part II. Preparation for Part I turned out to be a great nuisance as it involved attendance at college lectures on classics when I should have been able to devote my whole time to the University course in elementary biology and it eventually required a threat by the college authorities to deprive me of a provisionally awarded scholarship unless I passed the examination at the very next opportunity. When the pass list appeared I found my name included in the Third Class instead of the minimal necessary Fourth.

Cambridge, 1892 – 1902

My previous experience in Edinburgh and South America made me appreciate to the full my life as an undergraduate at Cambridge. My new comrades, coming for the most part from the great public schools of England, differed considerably from my fellow students in Edinburgh. However, we got on well together. I liked them and they appeared to enjoy my strange tales of South America. I was elected to the two chief college clubs, both of which unfortunately met on Saturday evenings, so I had to make the choice between them. Of the two, I chose the Shakespeare Society - the activities of whose eleven undergraduate members consisted of the reading of Shakespeare's plays, rather than the Apostles, the activities of whose members lay along more lively lines.

Games as always had for me little appeal (apart from rowing) but this soon turned out to be impossible at Cambridge owing to the afternoon hours being demanded for work in the laboratories. So athletics of any kind took no place in my undergraduate life at Cambridge. Of the Christ's undergraduates of my time, the one who became a conspicuous world figure later on was Jan C. Smuts[33]. The Christ's community at the time naturally failed entirely to realize that they had among them one destined to become a great figure in world history. Smuts showed no interest in undergraduate communal activities and concentrated entirely on his work for the Law Tripos in which he duly got his First Class in both Parts (1894).

Apart from undergraduates, I found myself welcomed in Cambridge by many of the senior people. My old Edinburgh teacher, Isaac Bayley Balfour[7], who had previously been Sherardian Professor at Oxford, was particularly kind in giving me introductions to many of his personal friends. Then one week-end during my first term, there came over from Oxford E.B. Tylor[34], author of *Primitive Culture*, and the great pioneer of modern ethnographical science. He had heard of the Pilcomayo expedition and came at once to question me about my experiences among the Chaco Indians. There was to be a gathering on the Sunday evening in Dr Henry Jackson's[35] rooms in Trinity where Tylor was staying and he kindly insisted on my coming to it. The hardly breathable smoke-laden atmosphere of the crowded rooms nearly proved too much for me and Tylor had to take me out and walk me up and down in the fresh air for a bit before my faculties were fully restored. However, it was a great experience to meet and converse with many of those already well known to me by name, and destined later on to become intimate personal friends. The particular occasion of that evening was a meeting of the *ad eundem* club, composed of Oxford and Cambridge dons who dined together once a term in one or other university alternately. Following subsequent Cambridge meetings of the club, Henry Jackson got into the way of asking me to Sunday breakfast where the little company was always composed of persons specially interested in anthropology - including James G. Frazer[36] - to become famous later through *The Golden Bough*.

Another meeting place was Magdalene College on Sunday evenings where Alfred Newton[37], Professor of Zoology, was at home to Cambridge naturalists whether senior or junior. It happened one evening that two friends standing by me, Evans[38], the author of *Birds* in the Cambridge Natural History, and Somerville[39] - in his day Professor of Agriculture, first at Cambridge and later at Oxford - were reminiscing about one of Alexander Dickson's botanical excursions to Gordon Moss in Berwickshire and incidentally mentioned one the students having collected three live adders. I was able to confess that I was that student.

In October 1893 I was elected a member of the Cambridge University Natural Science Club which met regularly on Saturday evenings during term time and after refreshment in the form of coffee and "whales" (otherwise sardines) on toast proceeded to hear a paper by a member on some scientific subject followed by discussion. The Club was somewhat select as to its undergraduate membership and limited to twelve. Amongst these there were included from time to time a large proportion of those who achieved later a distinguished position in the world of science. Among my own contemporaries for example were such botanists as Seward, Burkhill, Keeble, Willis, Tansley and V.H. Blackman[40,41].

Although not a physicist, it fell to my lot to propose Rutherford[42] for membership as I had got to know him intimately at the house of J.J. Thomson[43]. I was a little anxious about his candidature, for he had of course not yet made himself famous and he was a new type of candidate - aiming not at the Cambridge Honours degree by way of the Natural Science Tripos, but at the just inaugurated research degree. However, all was well and he was duly elected on May 2nd 1896. He reminded me in after years that his first meeting happened to be in my rooms at the height of a bitter war over the proposed expulsion of a member who had failed to do his duty in the way of communicating a paper and regrettably was able to quote verbatim a sentence in which I endeavoured to score off a member on the opposite side.

Another privilege that came my way as an undergraduate was my election as an Associate of the Ray Club. This club, though founded (1837) in honour of the great naturalist John Ray[44], was not restricted in its membership to naturalists in the ordinary sense. Its

membership of twelve included during my associateship Sir George Stokes[45] and Professor J.J. Thomson, physicist. The object of the club was stated to be 'the cultivation of Natural Sciences by means of friendly intercourse and mutual instruction'. There were twelve meetings in the year, held in members' rooms, and the host of the evening was enjoined that it was expedient 'to bring some subject of scientific interest under the consideration of the members'. Members of the University *in statu pupillari* were eligible for election as Associates - limited to six in number. Associates had the privilege - greatly valued - of attending all the meetings of the club. The only other Cambridge Societies I joined during my undergraduate period were the Union Society which was useful as an ordinary club and the University Cruising Club which I joined in 1895 soon after its foundation.

Throughout my Cambridge days, however, I kept in touch with the Zoological Society of London, and in 1928, I was elected a member of the Zoological Club which in those days dined at the Café Royal before the scientific meeting of the Society at 3 Hanover Square. These dinners left many interesting memories - of W.H. Hudson[46] in the days before he became a famous author, of Harry Johnston[47] and his bandolier from the Semliki forest of striped skin supposed to be that of a new species of zebra (*Equus johnstoni*) but which turned out to be an entirely new type of animal, the okapi.

A student of science coming to Cambridge from the University of Edinburgh could not fail to be struck by the fundamental difference in the technique of teaching in the two schools. In Edinburgh the lecture was all important, in Cambridge it ranked as of comparatively little importance as compared with practical and tutorial instruction. In Cambridge I encountered no lecturer comparable with Tait or Rutherford. Michael Foster[48] delivered his lectures on Physiology in a dull monotonous tone of voice, rhythmically shifting a row of coloured chalks on the palm of his left hand. He was clear enough and one did feel as the lecture proceeded that one was absorbing something of the subject, until there came his favourite concluding sentence: 'However, the time is not yet ripe to dogmatise' - an effective means of quenching the dawning interest of the elementary student. It was only after passing beyond the elementary phase that one realised that this type of lecture with its monotony, its hesitancy, its uncertainty, its freedom from dogmatic assertion, though less captivating at the time, provided a far sounder foundation for a scientific career.

The Cambridge school of Zoology in those days was outstanding among the zoological schools of the world, its standing being comparable with that the of the Cavendish Laboratory in the realm of Physics. Its personnel included Alfred Newton, Professor, Adam Sedgwick, Reader in Animal Morphology, Bateson, Gadow, Harmer, Hickson - all of the Fellows of the Royal Society, each one of them of outstanding reputation as a researcher, a teacher or a personality[49,50].

The rise of the Cambridge school to this position had been an aftermath of the work of Charles Darwin in forcing upon the attention of the world the fact of evolution and in adding important arguments that a main causal factor in bringing about evolutionary progress was the natural selection of favourable variations. The intense interest aroused by Darwin's work stimulated scientific enquiry along three main lines to test its validity: First, the actual evidence of evolution; second, the facts of variation; third, the struggle for existence among wild creatures living under natural conditions, and the weight to be attached to it as bringing about the 'survival of the fittest'. Of these three lines of enquiry, the first two were specially adapted to a university with its museum and laboratory equipment, and it was accordingly along these lines that the Cambridge school of Zoology had developed. It followed that the general spirit of the Cambridge school was morphological - the study of the structure of animals - their comparative anatomy and embryology - for therein lay the actual facts demonstrating the evolutionary progress of the various types of animal.

In the decades succeeding the publication of *The Origin of Species* there had accordingly emanated from Cambridge an immense amount of research in animal morphology. Such importance had been assumed by this section of zoological science that in 1882 a special Chair in Animal Morphology was founded, supplementary to the Chair of Zoology but provided with full laboratory equipment. The first and only occupant of the Chair was Francis Maitland Balfour[51], brother of Arthur James Balfour, the statesman, and himself one of the chief pioneers in the subject of vertebrate embryology. After the premature death of Balfour the teaching post in vertebrate morphology was continued as a Readership occupied by Adam Sedgwick. The Tripos courses in elementary Zoology were given by Sedgwick, the Professor confining himself to a few lectures upon Evolution given at the unpleasant hour of one o'clock to a handful of students. A special feature of Sedgwick's course was that several meetings were devoted to the practical study of the developmental stages of the bird, each student opening for himself the hen's egg at various stages and examining the contained embryo. Nothing I had encountered in Edinburgh gripped the interest of students in the way that this did.

The Natural Sciences Tripos consisted of written and practical examination on each of the main subdivisions of Natural Science. It consisted of two parts of which Part I was compulsory. The fate of the candidate was decided by the aggregate of his marks and it was customary to take three or four individual subjects. It had to be taken not later than the end of the third year. Part II, which had to be taken before the end of the fourth year, was all-important to anyone looking forward to a professional career in science and I decided to take my Part I at the end of my second year so as to leave two years free to prepare for Part II. With an eye to the aggregate marks determining the result of Part I, I decided to offer four subjects - Zoology, Physiology, Geology, Botany. But I soon deserted Geology. The

local geology of the Cambridge countryside seemed to me intolerably dull after my experience of Edinburgh with its wonderful variety of structure, its dissected volcanoes and its fascinating fossil fish.

An important factor in my zoological education came from an unexpected incursion into original research during the time that I was working for my Tripos. Sedgwick had received from a missionary a number of specimens of the pearly nautilus[52]. The empty shells were familiar, being constantly thrown up on the shores of the Indian Ocean, but the complete animal was extremely rare and the investigation of the few known specimens had shown it to be of great scientific interest and importance. Sedgwick handed over his specimens to me to see what I could make of them. They had been packed in sawdust moistened with rum but in spite of this crude method of preservation their condition was good enough for ordinary dissection.

They turned out to be peculiarly favourable material for a beginner's first research, for not only was the morphology of *Nautilus* of great importance owing to its being a modern survivor of those ancient molluscs that were the evolutionary ancestors of our modern cuttlefish, but also owing to the very small bulk of the previous literature on the subject the tiresome task of working through that literature was reduced to a minimum[53]. I found the work extraordinarily interesting, and - in addition to providing important new knowledge of the morphology of *Nautilus* and the cuttlefish group of molluscs - it inspired my determination to concentrate my future research so far as possible upon those archaic, relatively primitive, types of animal life which have come down to the present day comparatively unchanged since the early days of geological history.

The small group of students proceeding to Part II of the Tripos attended special courses dealing with particular groups of animals which were given by Harmer, Hickson, Shipley and Gadow. These courses were really admirable. In after life I often wondered whether anywhere in the world the student of Zoology was given training in all the main groups of the animal kingdom in any way comparable with that given to Cambridge Part II students of those days. A great character among our Part II teachers was Dr Hans Gadow who on three mornings a week delivered with great enthusiasm a lecture on the morphology of vertebrates, punctuated occasionally by the sound of bursting buttons from his rather tight-fitting garments. He had been an officer of the Prussian Guard and his manners were not always of the best. The feelings of J.J. Lister were ruffled one day as he sat in the Balfour library busily performing his duties as honorary librarian when he heard himself referred to (to some German visitors) as that slug (Nacktschnecke). However, Gadow taught us admirably and on an occasional Saturday would take us up to London for a few hours at the Zoo or the Natural History Museum.

He lived in a little house in Chesterton Road and there he kept a number of unusual pets. After my return from the Gran Chaco in 1897 he appealed to me to obtain a living escuerso (*Ceratophrys*)[54], an Argentine toad which commonly eats frogs but occasionally devours chickens. So I appealed to a friend on the Pampa and in due course heard from him that he had obtained a couple of live escuersos and had entrusted them to the purser of one of the mail steamships to bring over to England. Eventually the packet reached me in Cambridge by parcel post, so I took it to Chesterton Road before opening it. When it was opened there was revealed in its interior not two but one - very replete-looking - escuerso which was christened Juanita and lived happily for some years. Still another South American pet was Maria - one of the huge toads called by the misleading name *Bufo marinus*[55]. One long vacation Gadow went away for a holiday and deposited her for safety along in the animal house belonging to the Department of Physiology. Unfortunately, it happened one day that a student of Physiology about to prepare a nerve-muscle preparation proceeded down to the animal house to obtain a suitable frog for the purpose. To his joy her perceived there a magnificent specimen of unparalleled dimensions, and he was in the midst of his vivisection when there came along one of the lecturers of Physiology who shrieked out, 'Why! good God! that's Maria'. The student wisely fled away home but he did not escape communications fully expressive of Dr Gadow's sentiments.

Our two chief teachers on invertebrates were Sidney Harmer (later Sir Sidney and Director of the British Museum (Nat. Hist.))[56] and Arthur Shipley (later Sir Arthur and Master of Christ's College). Each was officially Lecturer on the Advanced Morphology of Invertebrates but each did much additional work for the University. Harmer was Keeper of the University Museum of Zoology and was in many ways an ideal Keeper. To him the contents of the museum were sacred: everything was labelled and catalogued with the greatest care: and every precaution taken to see that conditions attaching to any particular gift were duly fulfilled. Shipley, in addition to many other duties, acted as Tutor in Natural Science in Christ's College and I found him an ideal tutor, ever ready to help when called upon but never fussy and interfering.

My undergraduate career came to an end with the May term 1896 when I was lucky enough to obtain my 'First' in Part II (Zoology). I was now ready to start a programme of research which had been gradually forming in my mind. The bit of zoological science which had specially excited my interest was the evolutionary history of vertebrate animals and particularly of the various organs constituting their bodies. The facts out of which this history was built up were the facts of structure of the vertebrate body - in the adult and during the developmental stages - in other words, the comparative anatomy and comparative embryology of vertebrates. But during my student period I had been not merely gripped by the interest of these departments of zoological science. I had also been deeply impressed by their deficiencies. Our knowledge of comparative anatomy was practically confined to those forms of animal life still existing at the present day. Geology was

unable to disclose any information except regarding skeletons composed of mineral material. All the important living tissues of the animal were composed of organic material perishable in their nature and incapable of being preserved in fossils. Palaeontology, in fact, so far as concerned vertebrates, was merely palaeosteology.

Working at Cambridge, so intimately linked with the modern evolutionary philosophy of Charles Darwin, and where an important part of the foundations of vertebrate embryology had been laid by Francis Balfour, it was not surprising that I became inspired with the idea of devoting myself to the study of evolutionary embryology. It had, however, become borne in upon me during my reading for the Tripos that the existing science of vertebrate embryology suffered from a fundamental defect inasmuch as it was based upon facts gathered from readily available types of vertebrates such as the fowl and rabbit, and to a lesser extent frog and elasmobranch fishes such as skates and rays. Such old-fashioned vertebrates as *Polypterus*, *Lepidosiren* and *Protopterus*[57], types which had admittedly come down comparatively unchanged from remote geological times, were entirely unknown so far as concerned the early stages of their development. It seemed to me that the general principles of vertebrate morphology could not be regarded as firmly established so long as they ignored the embryology of these archaic types which still survived in remote parts of the world.

And so it was that I decided to devote my research activities towards dispelling this ignorance and determining to what extent the newly acquired knowledge confirmed or modified the current ideas of vertebrate morphology. Of the three archaic types mentioned one, namely *Lepidosiren*, was known as an inhabitant of the Amazon region but a German collector had recently obtained specimens from Chaco Indians on the banks of the Paraguay river. In view of my familiarity with the Gran Chaco and its somewhat difficult conditions I decided to give *Lepidosiren* precedence over the African *Polypterus* and *Protopterus* and make a special expedition to the Gran Chaco to tackle the *Lepidosiren* problem as soon as I got rid of the Tripos.

Having got together my necessary complicated equipment, I sailed from Southampton on August 7th 1896 accompanied by my friend John S. Budgett[58] (Fig. 6) of Trinity College. The full tale of that expedition and its adventures while worrying out the habits and life-history of *Lepidosiren* and transporting the priceless material to Cambridge has already been told in detail in *A Naturalist in the Gran Chaco* so I will now content myself with a brief summary. The site of my *Lepidosiren* work was again in the Gran Chaco, but among a different nation of Indians known as the Lenguas, a name surviving from former days when, in addition to their ear discs, they wore a similar disc in the lower lip, causing it to hang down like a tongue (Spanish *lengua*). Among the Natokoi and other Indian races of the Chaco they were known as the Mushcui and I had

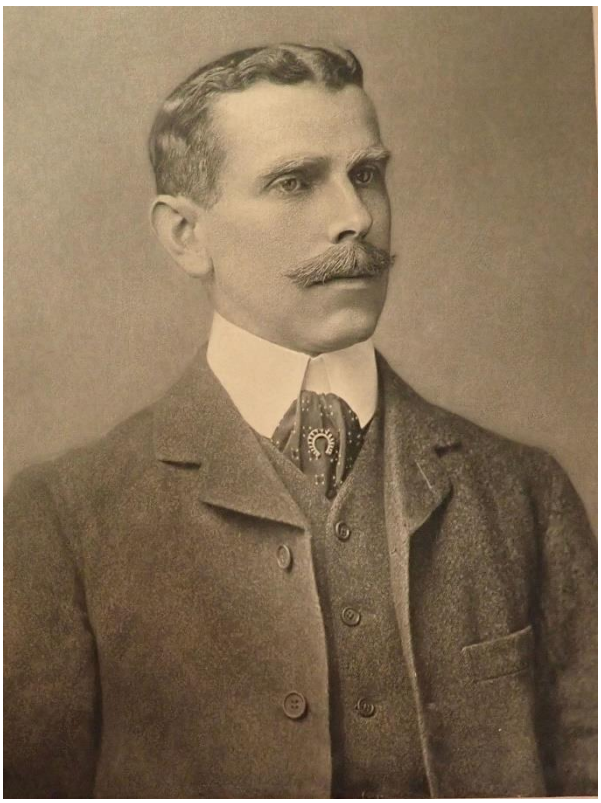


Fig. 6. John Samuel Budgett. From Kerr, J.G. (1907). *The Work of John Samuel Budgett*. Cambridge University Press, Cambridge.

memories - regarding which I had to be discreetly silent - of the active hostility between them and my friends of the Pilcomayo.

Although in their general features typical red men, the Lenguas showed differences in detail from the Natokoi of the Pilcomayo. When in 'full dress' the face was painted red with urucu but without the superimposed black lines of the Natokoi: and the women were without the tattooing customary among Natokoi. They had advanced from the stage of having merely the cacique at the head of the tribe. There was now a 'witch-doctor' - outstanding in his knowledge of the environment - material and spiritual, of the animals and plants of the region, and of the evil spirits responsible for misfortunes of all kinds. There was a good deal of infanticide. A child born after the death of the father was killed. An infant whose mother died was buried alive with her. At other times an infant's death would be decided by the witch-doctor who killed it by a blow on the back of the neck. Personal names among the Lenguas were nicknames descriptive of some personal peculiarity - usually unfavourable and - no doubt in view of this - a man's name was never mentioned in his hearing. My own name Oyankintimgyethlnaapkatik – 'Pineapple head' - I learned indirectly through a missionary friend.

On this expedition my original plan was to make our way to the country of the Natokoi and there settle down to search the swamps for *Lepidosiren*. However, on our way up the Parana I foregathered with a fellow Scot named Graham who told me he was going as a recruit to

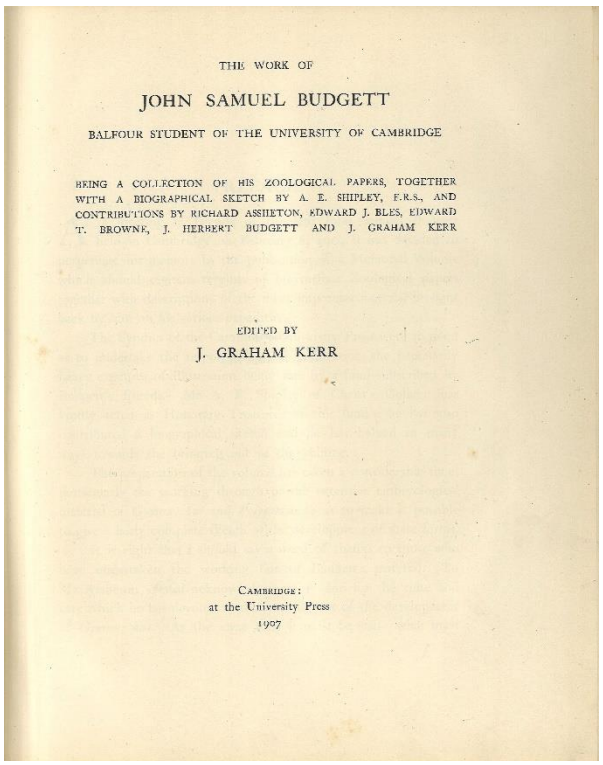
the South American Mission's station in the Chaco under W.B. Grubb. I at once pricked up my ears at hearing this name for I remembered that in a note published by a collector for the Hamburg museum and chronicling having got specimens of *Lepidosiren* from Indians on the Paraguay river he had mentioned his indebtedness to 'mein Freund Grubb'. So I at once decided that our first objective should be to interview Mr Grubb. We found the base of the Grubb mission on the Chaco bank of the Paraguay River opposite the town of Conception, some two hundred miles north of the Pilcomayo. Grubb was himself absent on leave in England but his colleague, Mr John Hay, told me that the main mission station was located at Waikthlatingmayalwa in the interior of the Chaco among a set of Indians known as the Paisiaptó or Black food people, owing to a staple article in their diet being a dark coloured fish called loalach and obviously *Lepidosiren*. I was able to arrange with the missionaries to provide us with board and lodging at Waikthlatingmayalwa and transport thither by bullock cart with our impediments. A week's journey through country very much like that of the Pilcomayo region brought us to Waikthlatingmayalwa where we were welcomed by the two resident missionaries, Andrew Pride and R.J. Hunt. A party of Indians close by were cooking their supper of *Lepidosiren* and one of them brought me some on a plate so that I had the distinction of being the first zoologist to eat this sacred creature.

The carts with our equipment arrived a week later - Budgett and I had ridden on ahead with an Indian guide - and we at once proceeded to rig up a laboratory under the veranda of the mission station. There followed four months intensive work - wading about in the neighbouring swamp, studying the habits of *Lepidosiren*, discovering burrows at the bottom of the swamp in which the eggs were laid, collecting the eggs and keeping them in aquaria so as to secure a complete series of all stages in the life-history, preserving the eggs and larvae by different methods, and finally storing them in hundreds of glass tubes.

While I was busy with *Lepidosiren*, Budgett proceeded with his work for Part II of the Tripos, supplementing his reading by dissection and other practical work on the varied types of animal obtainable in the neighbourhood. He also concentrated on a special study of the numerous species of frogs and toads and of the curious modifications of their spawning habitats which enable them to cope with climatic difficulties caused by prolonged drought with only very short intervening periods with water available for the tadpole stage. This formed the first bits of research in Budgett's tragic career, ending in his death from black-water fever when, after four expeditions to tropical Africa, he had at last succeeded in his quest for the developmental stages of *Polypterus*. The rainy season - the onset of which determined the spawning of *Lepidosiren* - commencing most opportunely just at the time of our arrival at Waikthlatingmayalwa - turned out to be a particularly severe one, the waters of the swamp spreading round the mission station which came to be situated upon an island of ever-diminishing extent. About the middle of February we decided to make an attempt to transport the developmental material of *Lepidosiren* to Paraguay. We started on 18th February - on foot, for the horses had all died of the epidemic disease *Mal de Caderas*[59] - the precious *Lepidosiren* material in a bullock cart - and after a week's very laborious travelling over country, most of which was still under a few inches of water and covered with the matted rank growth of the rainy season - we reached the River Paraguay.

We stored our material in Villa Concepción and then commenced a delightful month's holiday in Paraguay along with Mr Hunt. Our base was the little town of Villa Rica where we found the great topic of conversation was the collapse of the Socialistic experiment of 'New Australia'[60] which had started under such favourable auspices with a grant from the Government of nearly 600 square miles of some of the finest land in the country. The human material too was of the most suitable kind, most of the colonists being countrymen from the back blocks of Australia with experience of the kind of activities required to make the Paraguayan experiment a success. It was pathetic to hear at first hand from individual colonists their account of the collapse. 'Lane (the Leader) did the thinking: the colonists did the work'. 'Everyone wanted to be schoolmaster, none to be scavenger'. The one activity that really prospered was the holding of meetings with interminable debates.

From Villa Rica we made an interesting little expedition to the small town of Caa Guazú, a couple of days' journey to the northward, involving a seven leagues' ride through luxuriant virgin forest with hardly any signs of animal life except when the track crossed a little rivulet running through a sunny open glade. Here there were myriads of butterflies, endless in their variety. In the memoir of Budgett published after his death[61] (Fig. 7) there is quoted his account of the show of butterflies in one of these valleys. When he dismounted to let his horse drink 'the air seemed filled with the flapping of flimsy wings'.'Twenty-five were perched upon me at one moment, six upon my gun-barrel, my horse too was pretty well covered while a great *Morpho*[62] had alighted on his forelock'. Towards the end of our month in Paraguay, I became anxious to get back to Waikthlatingmayalwa as the dry season would now be well advanced and the conditions suitable for studying the dry season habits of *Lepidosiren*, so I pushed on ahead of Budgett and Hunt. My journey was unfortunately interrupted by a severe attack of malaria and it was not until 25th April that I was able to make a fresh start from Concepción accompanied by Budgett who had overtaken me, and Grubb who had returned from his leave in England. With fresh horses and dry country, the journey from the Paraguay River to Waikthlatingmayalwa took us only three days. Great expanses of swamp, where there had been five feet of water, had now only a few inches or were completely dry, and the lungfish had burrowed down into the mud in preparation for their wait until the advent of the next



THE WORK OF

JOHN SAMUEL BUDGETT

BALFOUR STUDENT OF THE UNIVERSITY OF CAMBRIDGE

BEING A COLLECTION OF HIS ZOOLOGICAL PAPERS, TOGETHER WITH A BIOGRAPHICAL SKETCH BY A. E. SHIPLEY, F.R.S., AND CONTRIBUTIONS BY RICHARD ASSHETON, EDWARD J. BLES, EDWARD T. BROWNE, J. HERBERT BUDGETT AND J. GRAHAM KERR

EDITED BY

J. GRAHAM KERR

CAMBRIDGE:
at the University Press
1907

Fig. 7. Cover of Budgett memorial volume. From Kerr, J.G. (1907). *The Work of John Samuel Budgett.* Cambridge University Press, Cambridge.

rainy season, breathing by a passage kept open in the gradually drying mud and subsisting on the fat stored up in their bodies during their period of activity.

We passed four busy weeks at Waikthlatingmayalwa digging up lungfish, preserving them in alcohol or formalin and soldering them up in zinc tubes which I had constructed in Paraguay, making injections of the blood-vessels, carrying on further observations on their habitats. In the interval we explored neighbouring parts of the Chaco inaccessible during the wet season and increased our knowledge of its general natural history. We finally left Waikthlatingmayalwa on 25th May and arrived at Buenos Aires on 13th June. As we had three weeks before our steamship was due to sail, we travelled South first to Bahai Blanca to spend a few days with friends who had an estancia in the neighbourhood. It was snowing heavily and we found the change from the warmth of Paraguay somewhat trying.

Thence to visit another old friend of Mate Grande days, Don Arturo Currie, who managed an estancia on the banks of the Quequen River. I had heard from him at Cambridge of his having found some fossil bones exposed on the banks of the neighbouring river, so, as the Museum of Zoology was completely devoid of specimens of the giant sloths[63], glyptodons[64], etc., belonging to the wonderful extinct fauna of the Pampa, I had begged Currie to do his best to get a representative set of these fossil bones for me to carry off when I visited him. He had got together quite a good collection and we were able to make considerable additions to it during our few days' visit. We spent a day packing the bones into boxes for our transport and were able to get them safely to Cambridge. After our return to Buenos Aires we made a little trip across the river to the Banda Oriental - Uruguay - to visit another old Mate Grande friend Walby. At dinner he astonished me by remarking that he had my old host, Don Benjamin Carbonnel, the once wealthy estanciero. working for him as a peon. He asked him to come in after dinner and it was indeed a shock to see him a complete wreck of what he had been as I had known him seven years previously, with his shrunken frame, his shambling movements and his timorous accents; the loud voice and the shocking language alike gone.

Arriving at Cambridge there came the task of unpacking the large mass of *Lepidosiren*, I imagine the most extensive set of embryological material of any particular vertebrate that had ever been got together. Everything was in perfect order and I must confess of feeling rather proud that, in spite of the rough handling during transport, there turned out to be not a single breakage among the many hundreds of fragile glass specimen tubes when I unpacked them at Cambridge (Fig. 8). Many congratulations were given to me on the wonderful good fortune which had enabled me to collect and preserve amid the remote tropical swamps of the Chaco one of the most complete series of developmental stages that had ever been obtained of any vertebrate, and to get it in perfect condition for investigation by up-to-date technical methods in the Cambridge laboratory. It meant that I had now to settle down to research that must last for several years.

Fig. 8. Jars of *Lepidosiren paradoxa* embryonic specimens, collected by JGK, and now in the Hunterian Museum collections.

I had already received word from Sedgwick that I was to be appointed Demonstrator in Animal Morphology, which meant that I was to be Head of the Junior staff in the Zoological - or as it was then called the Morphological - laboratory, and senior assistant to Adam Sedgwick. As colleagues in my teaching work I had Joseph Lister - nephew of the great pioneer of modern surgery, and Stanley Gardiner[65] who later became Professor of Zoology. My five years of teaching in Cambridge gave me invaluable experience, the more so owing to Sedgwick's time being much occupied by other duties, he had just been appointed Tutor of Trinity and in addition he was busily engaged in writing his great text-book of Zoology[66]. A result of these other demands on the time of my chief was that the main responsibility for the day-to-day running of the

department rested upon my shoulders.

While I had long realised how important it is for the quality of teaching in science that the teacher should be in close touch with research, I now began to realise how immensely the researcher is benefitted by having also to teach. There is nothing so effective in developing clarity of though as having to 'get across' facts and ideas to ignorant pupils. On February 9th 1898, there came to me in the laboratory a startling and wholly unexpected message - that I had just been elected a Fellow of Christ's and that I was to go at once to the College for the ceremony of admission. This marked the beginning of a delightful five years of residence in College. I was allocated a set of rooms on the first floor of Staircase B of the Fellow's Building. They had been vacated by their previous occupant early in the long vacation and on investigating with my pen-knife their linen-fold panelling covered with hideous yellow paint, I found it to be undoubtedly of oak, so I took the responsibility of engaging a firm of experts to remove the paint. This disclosed the beautiful dark oak panelling as it exists today, bearing the date 1644. There was a small grate surrounded by brilliant blue tiles and the removal of these disclosed the existence of the basal part of a carved stone jamb on one side, just sufficient to enable Messrs Rattee & Kett to provide a stone fireplace, much as it must have been originally.

Life as a Fellow of Christ's was very pleasant and stimulating: early breakfast in one's room, departure for the day's work in the laboratory, three hours' teaching; and then research up to about six o'clock. Dinner in Hall and then the Combination room until 9.15, commencing always with the Loyal Toast- uninterrupted since the days of the Stuarts. This record was unfortunately broken at the death of Queen Victoria, the announcement of which came while we were actually at dinner, and the presiding Fellow did not like the idea of drinking 'The Queen is dead, long live the King'. It was the duty of the junior Fellow to act as 'Nib' and keep the wine accounts. This was complicated by the fact that the unit of currency for the payment of bets or fines was a bottle of port. If a member incautiously remarked 'I'll bet so-and-so', without specifying a bottle of port, he was at once subjected to a fine. All such fines and bets had to be entered by Nib in the wine book, to remain there until cancelled by the Fellow responsible standing the particular amount of port as a contribution to the evening's wine. As the old wine books had been carefully preserved, it was interesting to see in them reflections of contemporary history - to read for example of bets upon the probable doings of Napoleon Bonaparte.

After dinner talk in the Combination room was always stimulating. "Shop" was strictly taboo - which I sometimes regretted for to myself the most interesting thing to listen to was the talk of someone about his own speciality, of which he knew more than other people. However, it had to be admitted that it would have tended to dim the sparkle of conversation among a set of able people. And such were undoubtedly the Fellows of Christ's. The Master was John Peile[67], a scholar of great distinction whose speciality was Comparative Philology. His ambition was to be the founder of a great school in this subject, and the rather embittered expression which his face was apt to assume in his leisure moments was commonly attributed to a painful experience he was said to have undergone. Each October term he had given a course of lectures on his special subject and at each inaugural lecture he was wont to scrutinise his audience in the search for someone who might betray by his expression possibilities in the direction of the school that was to be. Year after year, however, the scrutiny was in vain, until at long last he did descry a young man of obvious intelligence who seemed to be following the lecture with the greatest intentness. The lecture came to an end and the Master was gratified to see the young man staying behind to speak to him. What he was reputed to have said was 'Oh, please, Sir, I know this lecture isn't Algebra but is it Palley?'

Besides the Master the society included men of outstanding distinction in varied departments of learning: J.A. Sharkey, a Latinist of high repute; E.W. Hobson - later Sadlerian Professor of Pure Mathematics; W.W. Skeat, Professor of Anglo-Saxon; A.E. Shipley, that kindest of Tutors, a distinguished zoologist and later Master of the College; T.C. Fitzpatrick, physicist and later President of Queen's in succession to another Fellow of Christ's, F.H. Chase, later Bishop of Ely; Armitage Robinson, Norrisian Professor of Divinity and later Dean of Westminster; and Francis Darwin, Reader in Botany and son of Charles Darwin who himself had been, like John Milton in his day, a member of the College though never a Fellow. In a company illuminated by such a galaxy, with occasional visitors from other colleges or from Oxford or London, there were few topics that failed to arouse interesting discussions and it may be imagined what a pleasant ending such Combination room talk provided to a day spent in the specialized work of the laboratory.

Apart from my laboratory and college life, many of my most cherished memories centre round the homes of various Cambridge residents - above all those of J.J. Thomson, Professor of Experimental Physics, and C.S. Roy[68], Professor of Pathology. They were married to the twin daughters of Sir George Paget, F.R.S., a former Regius Professor of Physics, and in each of their households I was treated as if I were a member of the family. In the Thomson household was a delightful small boy, George, who used to amuse himself rigging boats or playing with Indian bows and arrows or fire drill. He was destined to be later on the famous Nobel prizeman, a leader in the world of Physics and Master of Corpus[69].

Another household of which I have pleasant memories was that of Francis Darwin[70] where I often used to dine. One of these dinners during my undergraduate days stands out in my memory. On my walk to his house, Wychfield, I was joined by another Christ's undergraduate, J.G. McCall, a cousin of James Frazer,

later of *The Golden Bough*[36], and at that time regarded as one of the confirmed bachelors of Cambridge. He gave me a bit of information which enabled me to explode a bomb among the large party of Dons and their ladies at Wychfield. When a suitable lull came in the conversation at dinner, I asked my hostess if she had heard the latest news of Mr J.G. Frazer of Trinity. 'No! Whatever is it?' 'He is going to be married.' Shrieks of 'Whoever to?' 'To the authoress of the Badminton volume on Dancing.' A stunned silence followed the reflection that she was in all probability a member of a *corps de ballet*. How very different when the reality became known to all who later on enjoyed acquaintance with the able and formidable Lady Frazer.

In those days Cambridge degrees were not open to women, although both Girton and Newnham were flourishing teaching establishments served by University lecturers. At Newnham the leading personality was Mrs Sidgwick, sister of Arthur and Francis Balfour. Her husband, Professor Henry Sidgwick[71], took a prominent part in University affairs. Like his brother-in-law, A.J. Balfour, he was appreciative of the fact that in public speaking a certain hesitancy increases the effect. On one famous occasion a celebrated German professor, invited after dinner to say something about his general impressions of England and its people, mentioned that one of the things that had struck him particularly was the apparent absence of what in Germany they called the 'gelehrte Klasse'. Sidgwick, commenting on his speech, remarked that the Herr Professor was mistaken in thinking we had no gelehrte Klasse in England. We had them but we did not call them gelehrte Klasse: we called them p-p-prigs.

My own chief, Adam Sedgwick, was strongly antipathetic to women students. One day I remember in the elementary practical class, Sedgwick was sitting down in the place of an undergraduate examining his dissections under a lens when he was approached from behind by Brocket, the laboratory attendant, accompanied by a Newnhamite. After coughing respectfully to attract Sedgwick's attention he said, 'Oh, please, Sir, Miss So-and-so of Newnham would like to speak to you.' 'Tell Miss So-and-so to go to the devil,' said Sedgwick without raising his head from the dissection, whereupon Brocket turned to the young person and said to her, 'Mr Sedgwick says will you please go to Mr Shipley.' When strong pressure was put on Sedgwick to modify his attitude he refused to do so, except to the extent of raising no objection to my accepting an invitation from Newnham to start a class for women students: this I did, but it had to be in premises other than the University department.

For the sake of my own research work, I had made a point of refusing to undertake private coaching and in agreeing to give a regular course of lectures and laboratory work in Zoology for students of Girton and Newnham, I stipulated that the arrangement should last only until I had found one of my pupils to be of a standard justifying my handing over the teaching to her. Such a one turned up in the person of Miss Igerna Sollas[72], daughter of the Oxford Professor of Geology. She proved an excellent teacher and also researcher.

My Cambridge memories are not confined to the academic terms. In the vacations, I was able to do a little sailing. For several reasons a little party of us chartered a 42-ton schooner from a Clare friend, J.A. Whish, and starting from the Thames cruised down Channel as far as Falmouth or Helford River. Our party was scientific but not biological, the others, E.H. Griffiths and F.H. Neville of Sidney, and the Earl of Berkeley, being all physicists. An earlier cruise, during my undergraduate days, was in the summer of 1895 when there came an invitation from my friend Hardy of Caius (later Sir William B. Hardy[73] - a pioneer in the chemistry of colloids, and Chairman of the Development Commission's Advisory Committee on Fishery Research) to join his 12-ton cutter yacht *Raven* at Kiel for the opening of the Kiel canal and form one of his crew in the voyage back to England.

Proceeding by rail to Hamburg, I crossed over to the Klosterthor station, filled with a struggling mass of people all bound for Kiel, and filling up a rapid succession of trains as quickly as they could be brought up to the platform. Into my own compartment I was accompanied by thirteen Germans with their impedimenta, and the journey to Kiel, lasting four hours over its proper time, in an atmosphere complicated by the smoke of thirteen cigars and the aroma of Schnapps, oranges and worse, was very unpleasant. At Kiel the hotels were all packed but I managed to get a room in a back street for the night. The *Raven* turned up a day later and anchored near the mouth of Kiel fjord. I spent the day pleasantly in a cruise around the fleets of the various naval powers in the steamer *Freia*, ensconcing myself undetected in one of the ship's boats from which I had an excellent view undisturbed by the crowds on deck. The Kaiser steamed along the lines of the fleet in his yacht *Hohenzollern* and it was aggravating to hear him greeted by each ship with the strains of our National Anthem - in those days regarded by the Prussians as theirs. In the evening the ships of each squadron in turn were outlined with coloured lights and there were magnificent displays of fireworks.

On Saturday, after shopping with Hardy and Brindley - the other member of his crew - I took up my abode on the *Raven*, from which on Sunday we had a magnificent view of the races of the Kiel Yacht Club, sailed in a strong wind which caused a good many broken spars and masts. On Monday a strong gale all day from the northwest gave us a good tossing and entailed constant watchfulness and the putting out of a second anchor as we were off a lee shore. On Tuesday morning the British squadron departed so we rigged up a tiny ensign on a boathook and saluted the flagship as she passed, our salute being duly returned. By the way, a strange incident occurred during the Kiel week which roused considerable talk at the time, in as much as daylight one morning showed that the French squadron had disappeared: it had sailed during the night without bidding its hosts farewell. Later on I learned privately

what lay behind this remarkable incident. It appeared that the Kaiser, when being shown over our Flagship, was allowed to try his hand at moving one of the turrets with its pair of big guns and he entertained himself by training them on the French flagship. As his every movement was being watched from the latter, this peculiar joke on the part of the Emperor was duly noted and stiffly replied to by the French Admiral's unannounced departure.

Early on Wednesday morning, 26th June, we entered the lock at Holtenau and spent the entire day in traversing the canal - reaching its further end about midnight. Our tug had four yachts in tow, all returning home from the Kiel celebrations, two of them English and one German, which latter was a nuisance through its violent sheering about, so we lengthened our hawser so as to drop astern and get out of his way. It was a bitterly cold day and a rather wearisome journey, though we could not but be impressed by the canal as a bit of engineering and by the magnificent railway bridges spanning it. Next day we explored the little town of Brunsbüttel, did some shopping, ate an excellent dinner, and about 6 p.m. emerged through the lock into the River Elbe. There we found a tremendous current and with it a favouring breeze: we rapidly made our way down stream and about 10 p.m. anchored just below the Cuxhaven lights. There followed three days of complicated navigation along the chain of islands bordering the North German coast - later the scene of Erskine Childers' famous story, *The Riddle of the Sands* [74]- during which my usual position was in the bows, heaving the lead and singing out the depths to Hardy at the tiller, while Brindley aloft in the rigging kept a lookout ahead.

Navigation was further complicated by very unsettled weather. During the first week in July it was so bad that we remained at anchor in the lee of the island of Ameland. On Friday the 4th, we spent a pleasant afternoon ashore having tea at a quaint little inn, the landlady in our honour putting on her best, including the beautiful gold headdress handed down from generation to generation and still to be seen in certain out-of-the-way parts of the Netherlands. After tea we walked out to the lighthouse and were shown over it - a climb of 200 feet. Far out to sea, we could view through the telescope an English 28-rater on her way back from Kiel. The keeper invited us into his house where we sat and talked, then back to the village and on board about 10 p.m. On the Saturday night, while cruising along outside Texel island on our way towards Niewe Diep, the Dutch naval port, we recognised while still far out to sea the strains of the music hall song 'Her golden hair was hanging down her back'[75] and on getting into port we found they proceeded from a steam organ here for the annual fair. The festivities centred in a circus of real ponies. They were mounted by bluejackets. At a particular bar the ponies started to walk, at another trot, at another to canter, at another stopped dead and the bluejackets fell off. The steam organ, the ponies and the bluejackets continued their activities all day without a pause and when we sailed on Monday morning, the strains of the steam organ followed us out to sea. From Niewe Diep we had a fine sail to Smith's Knoll lightship then round the coast into the Wash. A violent north-easterly gale necessitated our anchoring in the lee of a sandbank. Our anchor carried away during the night but we fortunately missed going ashore and when daylight came we were able to enter the port of King's Lynn and take the train to Cambridge. On other pleasant though less eventful cruises I sailed with Edmund Paget in his cutter *Cynthia* on the east coast and down the Channel and with the Roys on the Clyde and the Norfolk Broads.

One long vacation of my undergraduate period, that of 1894, I passed in the then delightful little university town of Jena, mainly to improve my knowledge of German, but also to get an idea of the workings of the zoological department of a German university. I stayed in the house of Frau Zeiss, a name already famous in connection with the manufacture of optical instruments. I was already familiar with the binocular eyepiece invented by Professor Abbé[76] as applied to the microscope but now I found the Zeiss works busily engaged in turning out field-glasses on the same principle. I was allowed to experiment with one and would dearly like to have carried it off. The firm had, however, been strictly prohibited from parting with any until the armed forces were completely equipped and this was not yet the case, so I had to wait several months before my wish was gratified. My days in Jena passed pleasantly and quickly. A.W. Rogers[77], a fellow undergraduate of Christ's - later a F.R.S. and Director of the Geological Survey of S. Africa - had accompanied me. We lodged in different parts of the town but Rogers joined me for an hour in the forenoon for German conversation under the auspices of Fraulein Zeiss and accompanied by three schoolgirl boarders. Our labours were often lightened by merriment caused by misunderstandings - not always involuntary - of German words or expressions.

Apart from our studies of the German language, we frequented scientific departments of the University devoted to our particular subjects. I naturally attended the lectures of Ernst Haeckel[78] who was then Professor of Zoology. His lectures were very characteristic. Heralded by his clattering down the stone staircase with a noise suggesting that he was coming down on a tea tray, he dashed at the blackboard with a lump of chalk in his right hand, writing a furious accompaniment to a torrent of words which continued almost without break until he dashed out of the room again at the end of the lecture. My most profitable time in Jena arose from a cordial invitation from Fürbringer[79], the Professor of Anatomy. The Department of Anatomy in a German university was not, as in an English one, restricted to the anatomy of man. The details of human anatomy as required by students of medicine were attended to by a special lecturer. In point of fact Fürbringer's position in the world of science rested upon his great work upon the anatomy of birds. As co-workers in his department were a number of other leaders or prospective leaders in the morphological side of zoological science; including Semon[80] and Braus[81] who were busily investigating the embryological material of the Australian lungfish

Ceratodus which the former had collected in Queensland.

I was treated with the greatest of kindness and allowed to potter about in the laboratory - reading German textbooks, examining the departmental collection of microscopic preparations, and above all inhaling the atmosphere of a very live university department. By comparison with Cambridge, two features impressed me particularly; one favourable - the far higher pressure of work all day long - the other unfavourable - the more proprietorial interest of the researcher in his own work. In the Cambridge laboratory everyone left his work scattered about, open to inspection by anyone; in Jena he locked it up when he left the laboratory.

After working hours Rogers and I would take a walk up one of the hills that surrounded Jena and have tea at the restaurant invariably to be found at its summit - Schweizerhöhe or the Fuchsthurm - overlooking the beautiful valley of the Saale. After dinner we usually adjourned to Die Sonne and drank beer while we listened to the music of Wagner. Jena - in close proximity to Weimar - was naturally dominated in those days by the music of Wagner and Liszt. Certain evenings we spent with the Naturwissenschaftliche Verein - the students' science club - and were inducted into the ways and laws of the Kneipe or Bierabend, ending usually in the small hours with a visit to a cellar in which was prepared a soothing and seductive Knickerbein - a glass of dark liqueur on which floated the yolk of an egg.

A different type of diversion from our laboratory studies was afforded by the students' duels - more correctly Mensur, the German term Duell being restricted to the settlement of questions of personal honour, whereas in the Mensur the two antagonists are merely representatives of rival student clubs. Of these, there were in Jena three categories, the Corps, the Burschenschaft and the Landsmannschaft. Our more intimate friends belonged to the Burschenschaft 'Germania', and its Mensurs were with representatives of the rival Burschenschafts 'Teutonia' and 'Arminia'. The Mensur was held in a large first-floor room in a country inn a couple of miles from Jena. As we approached it about 8 a.m., our ears were greeted by the clash of swords and the occasional shout. We found the proceedings in full swing. Each Burschenschaft was represented by a team of four: the principal, a friend of the principal, a second and a doctor with his equipment. The weapons used were light swords, unpointed and with razor-sharp edge. The two contestants had the front of the body, throat and right arm protected by thick padding and their eyes by goggles. The seconds wore similar protection on their right arm and head. At the commencement of the Mensur the two principals took up their position one sword-length apart, the right arm of each supported by his friend, and the second stationed on the principal's left. At the word to commence the friend withdrew his support, the principals crossed swords and at a second word went at it hammer and tongs, showing very pretty sword play, entirely from the wrist, and of course entirely different from fencing with foil or épée. After about four or six cuts and parries, the seconds struck up the opponents' swords while their friends seized and supported their right arms to give them a rest.

So the Mensur went on, round after round, at first in rapid succession, later with longer intervals, with increasing weakness from fatigue and loss of blood. In the absence of serious wounds each pair was supposed to fight for fifteen minutes. In point of fact, the first contest lasted nearly an hour: others were much shorter: one no longer than three minutes when it was terminated by a neat cut slicing off the flesh from one side of the head with the greater part of the ear, necessitating immediate surgical attention. In any case the fifteen minutes was interrupted at half time for a five minute rest. The two doctors were on watch throughout, ready to stop proceedings the moment a bad cut necessitated their attention. The Mensur seemed a strange substitute for the relaxations of English undergraduates but it had its points: its training in quickness of hand and eye, in indifference to pain, and insubordination of personal interest to that of the Burschenschaft. One learned to understand how the much-scarred face one so often saw in Germany in those days was appreciated as a certificate of the hard training its bearer had been through.

Glasgow, 1902 – 1935

In the year 1901 I began to hear rumours of an impending vacancy in the Chair of Natural History in the University of Glasgow. I had regarded that as the ideal setting for my life's work ever since I had decided to devote my life to Zoology. In the first place, its proximity to the Firth of Clyde, where I had spent so many of my pre-Cambridge days dredging and tow-netting, offered a marvellous vista for research work on marine zoology. In the second place, the Glasgow Chair of Natural History had been occupied since the year 1866 by a geologist, and his successor would have the fascinating task of creating an up-to-date Department of Zoology from the very beginning, untrammelled by grooves worn by his predecessor. At the same time, I had to realise that, apart from its personal appeal to myself, the Glasgow Professorship with its relatively high emoluments and its long summer holidays, was generally regarded by professional zoologists as one of the most attractive in the country and the vacancy would certainly mean a large field of candidates. Nevertheless I decided to have a try for it in spite of my comparatively junior status, so I proceeded to draw up a letter of application and collect testimonials. It was not until well on in the summer of 1902 that I gathered that the appointment was imminent, and on July 29th I forwarded my application to Lord Balfour of Burleigh[82], Secretary for Scotland, the Minister responsible for advising the King regarding Regius appointments in Scotland.

On Saturday, 2nd August, a letter arrived from Lord Balfour suggesting a personal interview on the following Friday. During that interview it became obvious that Lord Balfour, in accordance with his

reputation, had taken a keen personal interest in the forthcoming appointment and he seemed to know all about my previous career including my early morning walk from Dalkeith to the Botanic Gardens, Edinburgh, to attend the 8.0 a.m. Botany class, my two expeditions to the Gran Chaco, and my time at Cambridge. However, he put me through a searching examination which unfortunately brought out a violent divergence of opinion on certain fishery matters. He became quite heated, kept the Duke of Sutherland waiting ten minutes in the corridor, and when at last Lord Balfour bade me a rather stiff farewell, I felt that I had better give up all thought of Glasgow possibilities. It was therefore a most unexpected surprise when I learned on the following Wednesday that my name had been sent to the King. Absolute secrecy was imposed upon me until the official announcement of the appointment in the newspapers, and there ensued a somewhat difficult period during which I had to keep my secret inviolate even to my nearest friends and relations, and benignly accept the condolences of those who had heard definitely that the appointment had gone elsewhere. After the King's approval had been given, I had a delightful letter from Lord Balfour conveying his good wishes and assuring me that a warm welcome awaited me in Glasgow - above all from F.O. Bower[83], Professor of Botany, the subject most closely linked with my own.

The public announcement on 19th August brought me a flood of congratulations and good wishes - some of the letters betraying a little surprise that so important a professorship should have been entrusted to one so young and comparatively inexperienced. Answering these and winding up my Cambridge affairs kept me busily occupied for the next week or two. A pleasant incident was the offer by E.J. Bles[84], a Cambridge zoologist a good deal senior to myself and with very wide knowledge of the subject, to accompany me to Glasgow as my demonstrator. My appointment at Glasgow was from 1st October, 1902, and since the period of my appointment as Demonstrator at Cambridge expired at midnight on 30th September, I had no period of unemployment.

Passing through Glasgow on my way to Lamlash, where I proposed to spend a quiet month working on my first term's course of lectures, I took the opportunity of making reconnaissance of my future department. There was, of course, no zoological laboratory. The eastern half of the lower hall of the Hunterian Museum - know in later years as the Hunter Hall - had been used for what little practical work had been done, but it had no scientific equipment. Its floor was littered with geological debris: its entry was by wooden steps through one of the windows. A startling discovery came when I examined some old furniture which had been carried out into the quadrangle preparatory to being broken up. Amongst this was a decrepit chest of drawers, and pulling out the drawers I found the bottom of each studded with insects with old dusty labels, so I told the Master of Works, who was showing me around, that this chest of drawers must on no account be destroyed, but must be carried back into the shelter of the department to await my taking over at the beginning of October. I may say that my examination of the labels in these drawers showed that here was the long lost Hunterian Collection of insects which had been worked through, arranged and labelled by the great entomological pioneer, Johann Christian Fabricius[85], and which contained over 200 of the original type specimens on which Fabricius had based his definitions of species. Such type specimens of Fabricius - and of other early entomologists also contained in the Hunterian Collection - were of course irreplaceable and priceless in value. Their original descriptions were still extant in the published works of Fabricius but the actual specimens had disappeared and it was a great discovery to find them still in existence. It was pleasant too that my first adventure in Glasgow was to save them from destruction. Later on they were submitted to skilled examination by Dr R.A. Staig[86] and their descriptions brought up to date[87] (Fig. 9).

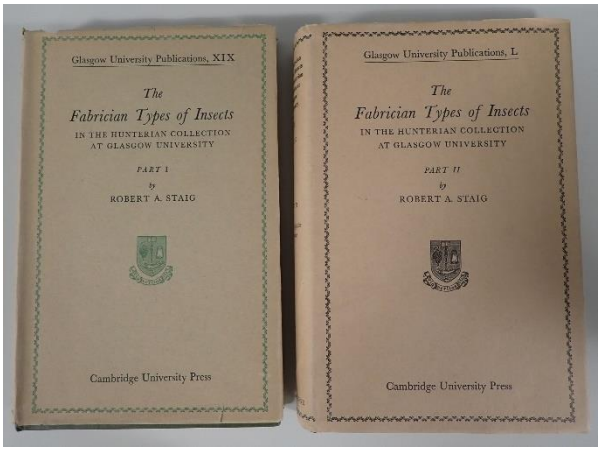


Fig. 9. Covers of R.A. Staig's two volumes on the Fabrician insect specimens in the Hunterian Museum collections.

My time in Lamlash was busily occupied in planning my first term's course at Glasgow. The great majority of my students would be entrants to the curriculum in Medicine, so I was determined to model my course in such a way as to make it provide as sound as possible a foundation for later subjects in the curriculum. To achieve this I decided to break adrift from the type of course in Elementary Biology customary in other medical schools. It was usual to commence the animal section of such courses with the dissection of a vertebrate such as a rabbit. This type of course, when first introduced by T.H. Huxley[88], had marked a great advance, but I learned when teaching it at Cambridge to appreciate its fundamental defect as a means of starting the ignorant beginner on a curriculum concerned with the human being. In its main features of structure and function, a rabbit is a creature of very much the same grade of complexity as man, whereas the proper introduction of the elementary student to the study of animal life would surely be by way of an animal organism of the least possible complexity. Pre-eminent among such creatures is the little protozoon, *Amoeba proteus*. The adoption of *Amoeba* as the first animal to be studied by the elementary student would clearly involve practical difficulties - training in microscopic

techniques, the obtaining of *Amoeba* in quantity, and in the actual teaching, but I decided that none of these difficulties was insuperable.

The main conclusions I came to in planning my course were: first, that it should commence with a concentrated study of *Amoeba* to make the student familiar with the structure and functions of a typical animal cell; second, that in my survey of the animal kingdom I should so far as possible confine myself to those of its members that illustrate important principles and to those which are of particular importance to medical science; and third, that I should leave the teaching of the special anatomy and physiology of the mammal to the University departments of Anatomy and Physiology, where it could be done properly instead of by a hurried scramble through the anatomy and physiology of the rabbit in the short time available in the course of Zoology. The carrying into effect of my plans would necessitate the provision of expensive new microscopical equipment and I had to take the drastic step of refusing to start my practical class - compulsory by Ordinance on all students of medicine - until this was provided. Happily, the Principal of the University, Dr Herbert Story[89], played up excellently: the money was obtained from a special fund, and the new practical class was duly held after a delay of only one term. My departure from what was customary in other medical schools found little favour among my zoological colleagues. How absurd, they suggested, that elementary students with no knowledge of microscopic technique should be entrusted with valuable high-power microscopes and still more valuable - it might be irreplaceable - microscopic specimens. As a matter of fact, experience showed that the Glasgow students reacted splendidly to the responsibility placed upon them, and the cases of serious damage to microscopes of specimens during my thirty-three years of office were exceedingly few. It was delightful to witness the thrill of excitement of students as they watched, say, living trypanosomes wriggling about in still living blood. I was to have the strange experience later on of medical men who had been though my course urging its extension in spite of the limitation in length of the medical curriculum.

While the main teaching of the courses in Zoology had to be carried out in lecture room (Fig. 10) and laboratory, a necessary supplement was a museum for the display of specimens of importance other than those studied in the laboratory. A teaching museum had to be created. It is true there existed the great Hunterian Museum - the collections bequeathed 'to the Principal and Professors of the University of Glasgow' by William Hunter[90]. My four predecessors in the Chair of Natural History had each in turn occupied the post of Keeper of the Hunterian Museum, but such an additional responsibility seemed quite out of the question for me in view of the task lying ahead. I therefore proposed to the Museum Committee - a body composed of the Professors of Natural History, Anatomy and Geology along with two representatives of the University Court and the Principal as Convenor - that the Keepership of the Hunterian Museum should be replaced by

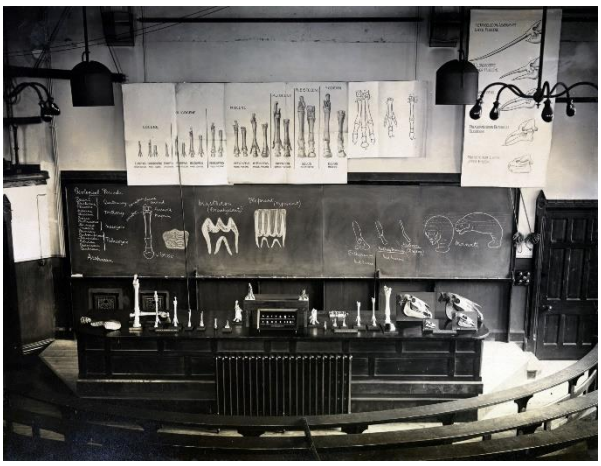


Fig. 10. Original Zoology lecture theatre in Glasgow University's Gilbert Scott building, ready for JGK to lecture on mammalian limb skeletal anatomy. Image courtesy of University of Glasgow Archives & Special Collections, John Graham Kerr collection, GB248 DC6/1230/4).

Honorary Curatorship. This was agreed to and approved by the University Court and I became Honorary Curator of the zoological collections. These included the Hunterian Collection of Insects, valuable type specimens of corals, and the valuable Waddell Collection of bird skins from Tibet[91]. The zoological exhibition cases were filled with stuffed birds and mammals - a large proportion of them in very bad condition, and obviously of little value for teaching purposes.

To create an adequate teaching museum of Zoology would involve the expenditure of much money and much skilled labour. As regards the former, there were no university funds available but a beginning was made when a local body - the Bellahouston Trustees[92] - agreed to make a grant of £500 conditionally on the University Court providing a similar sum. The Court agreed to do so and my first measure was to instal specially designed exhibition cases of steel fitted with internal electric lighting and dust filters to safeguard against the grimy Glasgow atmosphere. I had also the good fortune to recruit to my staff an enthusiastic and highly qualified expert in museum technique - R.A. Staig[86].

The development of the teaching museum provided perhaps the most fascinating part of my work in Glasgow. I started with pronounced personal views moulded by my previous experience. I had long felt that museums in general suffered by the crowding of their exhibits. An isolated specimen on a shelf by itself at once attracts attention: a crowded series of specimens is apt to be passed by. I therefore made a rule to restrict the exhibited specimens to the few that conveyed some definite lesson. The mass of the museum collection should not occupy the valuable and restricted exhibition space, but be stowed away in store cabinets. This applied more particularly to fragmentary fossils. To demonstrate the characteristic features of the skeleton of an extinct vertebrate, the effective method would be to exhibit not isolated fragments but rather a reproduction of the most

perfect known specimen when that could be obtained by purchase or exchange.

My experience of tropical nature had caused me to develop a particularly keen interest in the colouration of animals – usually adaptive as an aid or obstacle to their recognition, though sometimes of no obvious biological significance – as in the case of various animals inhabiting the depths of the ocean where no daylight penetrates but which nevertheless show brilliant colours when brought into daylight. Apart from their personal interest to myself, it was obvious that the colours and colour patterns of animals provided material of much value in the teaching of natural history and therefore demanded special attention for their display in a teaching museum. The two main requisites would be: first, lighting – adequate for display while safeguarded against the bleaching induced by prolonged exposure to intense daylight, the disastrous effect of which I had seen in other museums; and second, a background suitable to show up the colouring to the greatest advantage. Much experimentation convinced me that dead black was on the whole the most effective background, and the most perfect black was provided by the finest quality of black silk velvet. This was expensive, so its use was restricted to the showcases of comparatively small dimensions, while the larger exhibition cases were provided with a background of the most perfect obtainable matt black varnish.

The Bellahouston grant made it possible to proceed slowly with the museum programme, but by 1911 it was exhausted and the problem was how to finance the continuation of the work. Fortunately the then Principal, Sir Donald MacAlister[93], who regularly presided over meetings of the Museums Committee and was keenly interested in my development of a teaching museum, agreed to include in a forthcoming appeal to Government for an increase in the Annual Grant to the University, an additional sum for museum expenditure. The appeal was successful and on 25th June, 1913, the University Court agreed to the allocation of £1600 of the new grant to museum purposes. On February 4th, 1914, the Finance Committee agreed to its allocation in detail: cases and furniture £600, Zoology £500, Geology £250 plus £150 for a new Curatorship, Archaeology and Anatomy £100. As the whole incentive to the new grant had come from the needs of Zoology, I did not view with enthusiasm the diversion of a large proportion to the Department of Geology but I thought it wise to refrain from making difficulties – more especially as the amount allocated to cases and furniture must obviously go in great part to Zoology in view of the high cost of the specially designed steel cases. These cases with their walls and shelves of glass were practically air-tight, the unavoidable slight exchange of air between interior and exterior taking place through a filter of cotton wool so as to block effectively the entrance of dust with the in-draught. Their lighting was provided by tubular electric lights enclosed within the cases so as to avoid the view of their contents being interfered with by reflection from the front of the case. The lighting of each individual case was controlled by a switch so as to avoid wastage of electricity when the case was not in actual use.

The main purpose of the teaching museum was the exhibition, properly displayed and labelled, of such members of the animal kingdom as were of special importance from either the purely scientific or the practical point of view. The acquisition of these involved getting into touch with dealers, naturalists and museums – it might be in some distant part of the world. Although a large proportion had to be obtained by purchase, others were got by exchange and my unique material of stages in the life history of archaic vertebrates such as dipnoan and ganoid fishes had, of course, a very high exchange value. Some of the most interesting acquisitions were specimens of parasitic animals of medical importance which came as gifts from former students. Museum developments were naturally interfered with by the First World War but at least one specimen of great value came as a result of the outbreak of war. This was a magnificent skeleton of a gorilla which had been prepared in Paris for the German government by the great expert of that time in the preparation of bony skeletons. This patriotic Frenchman let me know of his readiness to do a deal over this skeleton and it reached Glasgow in due course. (Fig. 11) The active growth and development of the teaching museum together with great increase in the number of students made more and more urgent the problem of adequate accommodation of the Zoology Department as a whole. The accommodation so far had been ridiculously inadequate. On 22nd September, 1912, I had a special interview with the University Court to emphasise the impossible conditions under which the work of the department was being carried on. The Court were most sympathetic and I was authorised to discuss possibilities with the eminent architect, Sir John Burnet[94]. It was obvious that the complicated needs of up-to-date teaching and research demanded an entirely new building adapted to those needs, and it was further clear that the building should be remote from the roadways bounding the University grounds to ensure freedom from the risk of high-power microscope work being interfered with by vibration caused by the passing of nearby electric trams. It was further important that it should have open ground to the north so as to ensure steady northern light for dissecting and microscope work. In May, 1914, the general idea was approved by the University Court; the new Zoology building to lie on the southern side of a wide western quadrangle with the existing Natural Philosophy building on its eastern side and the contemplated Chemistry building on its northern side.

The working out of detailed plans went steadily ahead, the accommodation for research and practical classes being concentrated along the north front and special precautions being taken to secure good lighting for the back benches in the large rooms required for the elementary practical class by carrying its windows right up through the full height of the building. It was an era of great development in the technique of cinematographic and other methods of projection, and the Glasgow department made full use of these. A

Fig. 11. Skeletons of an orangutan (left) and gorilla (right) in the Hunterian Museum: the gorilla skeleton was purchased by JGK.

powerful projection apparatus by Zeiss was installed capable of showing on the screen not merely ordinary lantern slides, but microscopic preparations under a magnification of many thousands of diameters so as to display clearly the peculiarities of minute microbes or the details of tissues as shown in microscopic sections of more complex animals. An important adjunct was the episcopic arrangement for displaying on the screen opaque objects such as corals or shells, or drawings or book illustrations.

In the design of the new building there was included a full-size projection chamber for cinematograph films. It happened that this coincided in the time with an immense growth of the cinema industry and I was able to obtain from Messrs Pathé at comparatively small cost a full size projection apparatus of a type which they were replacing by one better suited for the hard wear of public cinema. By gift and purchase a fine collection of films were got together including the Rockefeller[95] films detailing with the fights against malaria and hookworm disease. It became at once obvious that the cinema provided a splendid addition to the technique of zoological teaching, but practical experience brought out its weakness as compared with the old-fashioned method of wall diagrams or drawings on the blackboard, the hurried view of the moving film being admirable so far as it concerned gripping the interest of the student, but on the other hand, a comparative failure so far as it concerned impressing details upon the memory.

Accordingly, my teaching method reverted to the use of diagrams, more especially drawings on the blackboard during the lecture, while cinema was restricted to Saturday forenoons. Though the attendance then was voluntary, the students very soon began to understand that it was well worth while from its effect in livening up the picture of complicated details at which they had laboriously worked during the week. In one section of the subject, that dealing with animal movement such as the flight of birds, the cinema – more especially 'slow motion' films – retained its place in primary teaching.

When interested in the use of ordinary lantern slides, my thoughts naturally turned towards the possibility of stereoscopic projection and I thought out a new method, making use of carbon process in which printing on a film of gelatine sensitive with bichromate results in a picture expressed in relief by varying thickness of the gelatine film. To make the picture visible it has be to dyed, and it seemed to me that to obtain a stereoscopic picture on the screen all that was necessary would be to stain, say, the right eye picture green and the left one red, to superimpose two pictures on the glass lantern slide, and then to view the blurred result on the screen through spectacles, the right eye green and the left red. The viewer would then see the right hand (green) picture though his right eye and the left hand (red) picture though his left eye and the result would be a perfect stereoscopic picture. I proceeded to test my idea experimentally and found it worked perfectly and felt much set up. But alas! I discovered that I had been forestalled in Germany and Messrs Lilienthal of Düsseldorf sent me an album of stereoscopic landscape pictures prepared on this principle with accompanying spectacles of red and green gelatine.

A small detail that I found useful in my lecture room teaching was to have two pointers – the one matt black for use with ordinary diagrams, the other white for use with lantern projections – the pointer itself disappearing from view and its black shadow being used in its stead. In the general planning of the new lecture room it was necessary to bear in mind the importance of the entire audience having a clear view of illustrative specimens placed on the lecture table and in accordance with this, I arranged with the architect that the benches should be concentrically curved and that the upward slope of the floor should increase in steepness towards the back of the room. In connexion with these arrangements, the steel framework to support the floor presented an impressively complicated appearance before it was covered in by the wooden flooring.

The planning of the new museum building was dominated by its primarily teaching function. An ordinary public museum has to be adapted for indefinite

growth as its collections increase in size. Not so a teaching museum, which should be restricted in size if it is to remain effective in stimulating the keenness of the student. It has to keep in touch with the teaching of the day, specimens which have become less important being weeded out to make way for others whose importance has increased. It was decided to place the museum at the south-west corner of the new building: one storeyed, the day lighting to come from the roof. Experience of the destructive effect of intense daylight in other museums enjoined that this must be guarded against. To do this, each roof light was divided into a number of vertical cells, their depth being just sufficient to exclude direct rays from the sun when at its greatest altitude in midsummer. Each cell was painted white, the result being a soft diffused light in the interior of the museum. Artificial general lighting was given by 'day-light' lamps of the pattern used in up-to-date business premises, but the really important lighting from the practical point of view was that of the individual cases by the tubular lights inside the cases.

An important detail, as in all museums, was that of labelling. The two faults to guard against were in the first place too great detail, which would encourage the student to cram up a superficial knowledge from the labels and discourage the more important work of lecture room and laboratory, and in the second place illegibility when not strongly illuminated. The latter difficulty necessitated much experimentation. White lettering on a black background was obviously better than the usual black on white, but many trials failed to discover a white pigment that could be depended upon to retain its brilliance in the Glasgow atmosphere. Eventually it became clear that the most perfect labelling was by using bookbinders' gold leaf on a matt black background and this was finally adopted. The labels were printed with ordinary printer's ink on matt black paper and the gold leaf, applied immediately, adhered strongly to the letter, the non-adherent portions of leaf being carefully dusted off when the ink was dry.

This new technique in museum labelling involved me some years later in an amusing controversy with H.M. Stationary Office which had been asked to adopt my method by one of the great public museums. If the application were granted, the Office replied, it would be repeated by all the other museums and the expense would be enormous. Evidence that the cost was very small owing to the extreme thinness of the pure gold leaf used by bookbinders produced no effect, but as there could be no denial of the outstanding degree of visibility of the gold label, it was agreed that the museum in question could have its labels printed in 'gold ink'. When it was pointed out that the so-called gold ink was really not gold and that the brilliance of labels printed with it would soon tarnish, it was agreed that six copies of each label would be printed so that there would be five in reserve! Another complication had to do with the artificial heating of the museum which was liable to undergo violent changes of temperature and this in turn, by causing changes in volume of the fluid contained in museum jars, brought about both loss in volume and diminution of the strength of the preservative fluid when alcoholic. To avoid this waste, it was decided to instal thermostatic control. In addition to the museum itself there were included in the plan rooms for printing and other technical work, ample cellarage accommodation, animal houses, an aquarium room, and library in which I installed my private collection of zoological publications to form a departmental library.

I had learned to appreciate, both at Cambridge and during my earlier years in Glasgow, the difficulty of ensuring that students make full use of the museum, so in planning the arrangements of the new building, I devised a means of entrapping them into involuntary visits to the museum. This was done by arranging a wide communicating door between the museum and the large elementary laboratory. This door alone was opened at the hour of commencement of the practical classes, so that all students had to enter through the museum. Those who arrived a little before the hour had to wait in the museum and quite naturally a large proportion became interested in what was to be seen there and tended to develop the museum habit. As I thought it a part of my duty to encourage interest in the natural history of our own country apart from formal teaching I did my best to get together an index collection of our British birds and mammals and this was arranged along the west side of the museum.

I have given an idea of the planning of the new Department of Zoology, but its translation into stone and lime was prevented by the First World War. It was not until March 1919 that the Court decided to go ahead. Early in 1921 came final approval of the detailed plans. In July of that year the foundations were laid and by midsummer 1923 I was able to envisage moving into the occupation of lecture and practical class rooms at the beginning of the Winter session. I interviewed the contractor who promised that it would be ready by the end of August. I said 'You can have till the end of September but I will count on its being ready then as my first lecture will be on October 8'. On 7th October I looked into the lecture room: there were no benches. I reminded the contractor that I was going to lecture tomorrow. 'Quite impossible!' However, I proceeded to my lecture room at 9 a.m. on that morning and found the room well filled, the students all seated on the floor, with anticipatory grins on their faces. I gave no indication of noticing anything unusual and proceeded with my normal introductory lecture on *Amoeba*, to which they were most attentive. However, I stopped five minutes before the usual time and made a few remarks on the subject of contractors. They were, I said, an unhappy race: no one seemed to appreciate them; and I suggested that anyone with access to a telephone might ring them up (I wrote their telephone number on the blackboard where it remained all through the week). That would let them know there was at least some interest in their work and it would give them the heart to carry on. I gathered that the students played up admirably and that the contractor's telephones were kept ringing from morning to night. That they were duly encouraged to get on with their work seemed to be evidenced by the high pressure

at which they now strove to get the benches completed. Although several months had to elapse before its fittings were complete, the museum itself was finished very soon after the rest of the building, and proved a great architectural success both as regards suitability for its purpose and artistic beauty. It formed a wonderful setting for the Rectorial luncheon[96] on 12th December.

The Professorship of Natural History to which I was appointed in 1902 may be said to have originated in the Lectureship in Natural History founded in 1803. In 1807 the Lecturer, Lockhart Muirhead[97], who had previously been University Librarian, was given the task of superintending the packing and transmission to Glasgow of the great collections formed by William Hunter, brother of John Hunter who had founded the Hunterian Museum in London. In the same year (23rd March 1807), a royal warrant was issued appointing Muirhead Professor of Natural History and Keeper of the Museum. The creation of this, the first Regius Professorship in the University, without previous consultation with the University authorities, was the cause of considerable excitement and it was not until December 1808 that Muirhead was formally recognised. One clause in the royal warrant of my appointment caused me great regret. 'If and when a separate Chair or Lectureship of Geology should be founded in the said University, the said Professor shall cease the teaching of Geology and the Professorship of Natural History shall be styled the Professorship of Zoology'. The objectionable phrase was that enjoining the change in title of the Chair, for, apart from the fact that 'Natural History' was in ordinary use as the equivalent of zoology, the old title had been continued in the case of the corresponding Chairs of the other three Scottish universities in spite of the fact that the teaching of Botany and Geology took place in separate departments[98].

Throughout the planning of my courses in Glasgow, as of the building which was to house the department, I took the view that the Professor's duties were concerned with zoology in the broadest sense as the basic science of animal life. Specialised sections came under the responsibility of the independent Agricultural and Veterinary Colleges and that arrangement I regarded as excellent. At the same time there was no getting over the fact that the great majority of the students passing through the Department of Zoology did so *en route* to a Degree in Medicine. It was accordingly a primary responsibility of the department to provide a sure foundation upon which could be built the more specialised courses of the medical curriculum. In planning my class for the first term of the academic year, I tried to bear in mind that while adequate as a general introductory course in zoology, it must have special regard to the claims of the medical students. In accordance with this I endeavoured, so far as possible, to make use of animal types that were of special importance to medical science, such as parasites and pathogenic microbes.

I had further to bear in mind that a large proportion of the students coming straight from school had had no training whatever in observational science. It was therefore a further responsibility of my department to do what it could in the way of training the powers of observation. In view of this the course should be on the whole morphological – dealing with facts of structure that can be observed and recorded by being drawn in the student's notebook. Incidentally, such work would involve training in the technique of dissection and microscopic observations – both essential in later stages of the curriculum. In view of the short time available (50 meetings of the class) it was impossible to include theoretical aspects of Zoology such as evolution, heredity, variation and so on. However, I arranged to make available a set of special lectures on these at hours which did not clash with those of the ordinary class and which would be freely available to present or past students.

When the day arrived for my first lecture, the Principal proposed to be present to introduce me formally to my students, but from my knowledge of Scottish students I decided to tackle my first contact with them independently. It was in some trepidation that I entered the crowded classroom. There was a little disturbance at first as they "tried it on" with their new Professor but it very soon died down, those who had come mainly for fun slipped away by the door at the back of the room, and those who remained listened with rapt attention. And so it remained during my 33 years of office, my students formed a perfect audience, not a sound unless I perpetrated some 'howler' when at once shuffling on the floor emphasized the fact that they were following every word. In pre-war years their capacity for making a noise showed itself in community singing – sounding as if it would lift the roof off but ceasing at once as I stepped on to the dais. I was indeed extraordinarily fortunate throughout in my relations with my students: and my keenness to teach was amply reciprocated by their keenness to learn.

University teaching extended through the three academic terms – the first two being grouped together as the winter session. The introductory course in Zoology occupied the first term – lectures one-hour daily Monday to Friday, practical classes two hours daily. During the other two terms, some advanced courses were given on various sections of the animal kingdom. Attempts were made to get me to attenuate the elementary course by reducing the number of meetings per week, leaving the full number to be made up in the second term. To do this would have made it easier for the teaching staff by reducing the extreme pressure during the first term, but I held out against it as keeping the pressure lighter during the second and third terms made it easier for the staff to find time for research. I still held to the view that being a researcher made a better teacher and that being a teacher made a better researcher.

The efficient running of a large university department is in great part dependent upon its junior staff and in this I was extraordinarily fortunate. In the early days E.J. Bles, who accompanied me from Cambridge, and for a short

time W.F. Lanchester[99], gave me most devoted assistance. Bles had not only a profound knowledge of the literature of Zoology but was an able teacher and researcher. His one failing – from which I was not entirely free myself – was that he was apt to lose interest in a particular bit of research when once it was completed. He had much less interest in seeing that his results were published and made available to others.

W.E. Agar[100] of King's College, Cambridge, had attracted my attention during my last year as Demonstrator and I was fortunate in inducing him to come to Glasgow. He achieved classical research on the reproductive cells of *Lepidosiren*, followed it up by a long series of investigations bearing on heredity and genetics, and eventually left Glasgow to occupy with much distinction the Chair of Zoology at Melbourne. My own personal interest throughout my career as a zoologist had continued to lean towards 'primitive' or archaic types of animal life: creatures that had lagged behind in their evolutionary progress. It was natural then that the Protozoa[101], the least advanced of all the existing sections of the animal kingdom, should play an important part in both teaching and research in my department.

Charles H.G. Martin[102] concentrated on a particularly obscure section of the Protozoa – the Acinetaria – and added greatly to our knowledge of them. His brilliant research career was cut short by his untimely death during the First World War. A similar end came to J.S. Dunkerly[103] who had recovered sufficiently from a severe wound to resume his research work but only to die a few months after his appointment to the Zoology Chair in Manchester through a flare up of the infection of his old war wound.

Apart from its actual teaching staff the Glasgow department was associated with two dramatic developments in the history of protozoology. Muriel Robertson[104], who commenced her research career in the department, specialised in the study of parasitic Protozoa and was able in a stay of several months of Mpumu in Uganda, to do much to complete the imperfectly known life history of the trypanosome which causes sleeping sickness. She had the distinction at a later period in her career of being the first woman zoologist to be elected to the Fellowship of the Royal Society (Fig. 12).

The other somewhat dramatic occurrence had to do with teaching. My course commenced with the detailed study of *Amoeba*. During pre-war years the most reliable purveyor of live amoebas was one Thomas Bolton of Birmingham who became latterly dependent on a son for the collection of the amoebas. Young Bolton's departure for the war meant an immediate slump in the supply of amoebas and the practical work of my class threatened to be entirely held up. It had happened that among the former students of my department who had greatly distinguished themselves were three nuns of the order of Notre Dame. They had developed a remarkable science department at their training college at Dowanhill,

Fig. 12. Muriel Robertson F.R.S. (Photo: Department of Zoology Archives/University of Glasgow)

Glasgow, and I appealed to them for help in this emergency. I asked them to make a special study of the haunts of *Amoeba* in the neighbourhood of Glasgow, to find out what were the conditions under which they flourished so that knowing these they might be able to run an 'amoeba farm' and keep a constant supply of amoebas which would be always available to the meet the teaching needs of our department. They took up this task with enthusiasm and with complete success, so that for each day on which we were doing *Amoeba* in the practical class, instead of the few small specimens we were accustomed to get from Thomas Bolton, we were able to have available hundreds of large healthy amoebae whenever they were required. Soon after the end of the war an exhibit of a Notre Dame culture of *Amoeba* was shown at a soirée of the Royal Society in London and excited much attention. Sir Ray Lankester, looking down at a culture through a binocular microscope, said it was like looking down on a meadow with cattle grazing.

Dr Monica Taylor[105] (Sister Monica S.N.D.) who had played the chief part in working out the conditions favourable to the life of *Amoeba* developed methods of rearing and cultivating them which became widely adopted in university departments all over the world. In her own department they played a great part in her long series of pioneer researches upon the life history of different species of *Amoeba*. Certain species of the genus *Amoeba* have taken to a parasitic mode of life, one being responsible for amoebic dysentery in man, and another member of the University department, Dr

Margaret W. Jepps[106], played an important part in the advancement of knowledge of this and other parasitic amoebae.

In 1923 came an important recruit to the staff, G.S. Carter[107] of Caius College, afterwards Fellow of Corpus College, Cambridge. He made an expedition into my old haunts in the Gran Chaco and made a very valuable study of the conditions affecting life in the great swamps of that region. In addition to his general studies, he made important additions to scientific knowledge of the special arrangements for breathing air which enable the fish of these swamps to cope with dry season conditions when gill breathing becomes impossible. Other members of the junior staff who carried out research work of interest were R.A. Staig who concentrated upon the study of the Hunterian collection of insects and Miss A.E. Miller[108] whose work on the lower vertebrates included a study of the evidences that the curious little fossil *Palaeospondylus* of supposed lamprey affinities was in actual fact more nearly allied to the lungfish of the primitive vertebrates.

Apart from the formal duties of the University Professor to teach his own students there lay the further though informal duty to do his best to spread interest in, and knowledge of, his subject in the community outside. I was given plenty of opportunity to this by the frequent invitations that came to me to address Natural History[109] and other Societies in Glasgow, Greenock, Paisley and other centres. The opportunity of organising such work on a more extended scale arose when in the autumn of 1920 a letter came to the University Court announcing that the Workers' Educational Association was about to start a branch in Glasgow. On my advice it was decided not merely to let the letter lie on the table but to send a message of good wishes and to agree to the invitation to appoint a representative on the local committee. I was appointed and became Vice-Chairman of the Glasgow W.E.A. My period in that office was most interesting and in spite of the strongly socialistic views of my colleagues I managed to maintain an atmosphere quite free from party politics until the appointment to a Glasgow Chair of Professor Lindsay[110] (later Master of Balliol) who felt how wrong it was to abstain from doing everything possible to further the cause of socialism.

One of the chief moves in the W.E.A.'s work for which I was responsible was the inauguration of a scheme of popular lectures on Saturday afternoons. I opened this with a group of four lectures on evolution. At the first lecture the room was packed and there were as many again outside. At the next committee meeting there were strong complaints and the very unfair criticism was made that the room was "crowded by wealthy women in furs". However, I promised to do what I could to secure better accommodation for the next lecture. All was well for we were given the Bute Hall, specially fitted with blackboard and project apparatus for the occasion. At the close of the first lecture I was asked if I would be willing to answer questions, to which I replied, by all means, but would it not be better to save up questions until the end of the course when I would be willing to give an extra Saturday afternoon for a 'heckling' meeting. This duly took place on January 16th in the large hall of the Technical College, which again was crammed. I had an entertaining couple of hours answering questions, some of them skilfully designed to entrap me in matters of religion and politics. One of the former I evaded by explaining that I would as soon think of kicking away the crutch of a cripple as of saying anything calculated to weaken anyone's religious faith. I think everyone enjoyed that heckling meeting and I could not help noticing the mountain of silver contributions which it brought to the W.E.A. funds.

Another set of popular lectures was arranged in response to an appeal from a London body emphasising the spread of public interest in the subject of sex and heredity, and the urgent need of popular information on these subjects that could be trusted as scientifically reliable. It was suggested that I might give a short course of public lectures to meet this need. I felt much sympathy with this appeal but suggested that the influence of such a course would be such increased by its being shared by Bower, Professor of Botany, and Dr W.E. Agar of my department. The idea materialised in the winter of 1917-19 in a set of six lectures: two by Bower on the vegetation kingdom, two by myself on the process of reproduction in the animal kingdom and two by Agar on the phenomena of heredity. The lectures attracted crowded and keenly interested audiences in one of the large halls of the city and a year later were published in the form of a small book[111].

A compliment which I much appreciated was being chosen to be President of the Zoology section at the 1926 Meeting of the British Association for the Advancement of Science, which promised to be of unusual importance in view of its place of meeting being Oxford and its President the Prince of Wales. I decided to break away from tradition in the matter of my presidential address. In place of the customary exposition of some particular section of Zoological Science, I decided to devote my address to a more general subject, the training of the citizen as viewed from a standpoint of the evolutionist. In primitive man, still exposed to the full pressure of the struggle for existence, a main part of his education consisted in the training of his powers of observation and in the power of quick and accurate interpretation of what he observed. His continued existence depended – apart from physical health and strength – upon these powers and on his constant mental alertness. With later evolutionary developments came printing, newspapers, the electrical telegraph, the cinema, facilitating the broadcast diffusion of ideas and tending to transfer leadership to the glib writer or talker – even though devoid of other and much more important qualifications. I urged the importance of infusing the ordinary school curriculum with a modicum of science, commencing with practical physics – unequalled as a means of training in accurate observation and proceeding to biology, more especially its general ideas rather than information regarding details. My Oxford address excited such interest and was widely reported in the world's press. I was greatly pleased by the general

accuracy of the reports. It was obvious that they were in great part based upon actual perusal of the printed text of the address.

At the British Medical Association's meeting in Glasgow in 1922, I was invited to deliver the popular lecture and chose as my title 'The Physician: Naturalist, Teacher, Benefactor'. Other addresses of general interest delivered to the Royal Philosophical Society of Glasgow dealt with 'Science and Education' (1919), 'Science, the new Philosophy' (1924), and 'Citizenship' (1926). The address on Science, the new Philosophy seemed to excite special interest from its emphasising the fact that the universe in which we exist is one of black darkness and absolute silence. The whole world of colour with its endless variety and beauty, whether in nature or in art, was a mere figment of our own mentality resting on the fact that we had a particular sense organ - the eye – capable of transforming periodic disturbances in the something-or-other, which used to be called the ether, into sensory impressions. And so also with the world of sound – the hum of insects, the songs of birds, music – again a figment of our own mentality resting on the fact that we had a special organ of hearing capable of transforming waves of compression of matter into sensory impressions.

In 1929 came an interesting invitation – to undertake a new adventure on the part of the B.B.C. in the form of a set of six lectures on zoology. These lectures entitled 'Links in the Chain of Life' were broadcast from Glasgow in January and February 1930. Broadcasting in those days was complicated by the absence of individual stations capable of nationwide transmission, which necessitated simultaneous broadcast from a number of different centres. It was a curious experience sitting in a dark room in Blythswood Square watching the appearance of lights indicating the linking up of the various centres until there came the final signal for me to start talking. It was also a strange experience in those days to lecture to an invisible audience especially for one like myself so accustomed to keep in touch with the audience with careful watch over their expressions. However, the shoals of appreciative letters I received indicated that my broadcast had been well worth while, and that the rather forbidding introduction to my audience as 'Professor Graham Kerr – The Worker' had not resulted in a universal switch-off!

In all these extra addresses and lectures I did my best to provide a worthy extension of my teaching beyond the ranks of my ordinary university students. An attractive feature of a teaching post in Natural History is that the extent and variety of the subject provides opportunity for interesting work during vacation periods. During my tenure of the Glasgow Professorship I made full use of this facility.

It is one of the interesting facts of Natural History that many animals, instead of passing through their early stages in the seclusion of an egg-shell or within the body of the mother, lead a free existence as larvae. These larval stages frequently live a quite different kind of life from the adult and in accordance with this they may be utterly unlike the parents in appearance and structure: for example, creatures that when adult lead a completely sedentary existence, such as many shellfish, swim about freely during their young stages. These larvae – often microscopic in size – with their endless variety and frequent beauty of form provide a fascinating subject of study.

Although much of the pioneering work upon such larval forms had been done at Cambridge, the ordinary student in that university was given little opportunity to see for himself the various types of larvae with which he had become familiar through lectures or textbooks. That omission I resolved to correct at Glasgow, which meant that I had to set about getting together as complete as possible a collection of typical larvae, preserved by the most perfect methods for study by students. Such larvae, usually microscopic in size, constitute the main part of the plankton or drifting fauna of the sea and my first step was to find a sea area not too far distant in which the conditions were as favourable as possible to the life of plankton. Inspection of charts of the west coast of Scotland disclosed an apparently ideal locality in Loch Sween – a sea loch opening off the Sound of Jura with its strong tidal currents, extending in a north-northeast direction for some miles, and dividing into a number of branches which, with their great variety of coast line and bottom, might be expected to harbour a most varied fauna. This expectation turned out to be fully justified and Loch Sween became the scene of many vacations' work (Figs. 13 and 14).

The unusually small volume of fresh water flowing into the loch permitted the salinity of its waters to remain remarkably constant. It was only after a heavy downpour of rain that a thin layer of lesser salinity could be detected over the surface of practically pure ocean water. The temperature of the water also remained remarkably constant, apart from the surface layer. The frequent changes in water level presented a puzzle, for I failed entirely to correlate them with the three obvious factors, the tidal level outside in the Sound of Jura, the prevailing wind, and the barometric pressure. I found myself forced to the conclusion the there must exist, in addition to changes due to these factors, a slow oscillation of the water from end to end of the loch similar to the "seiches" known to occur in many freshwater lakes – the narrow entrance to the loch with the strong tidal currents running past it caused the water to behave as if it were completely enclosed. The bottom of the loch was covered for the most part by very fine mud but the longest branch – Kyle Scotnish – was sufficiently narrow near its mouth to cause a strong current which prevented the deposition of mud at this point which as a consequence had its own and specially rich fauna.

Although the water of the loch was at all times clear, its precise degree of transparency did show considerable variations from time to time. Normally, the transparency or otherwise of sea or river water depends upon the amount of mud suspended in it, but here in

Fig. 13. View of Loch Sween, in the days when JGK frequently visited the area. (Photo: Department of Zoology Archives/University of Glasgow)

Fig. 14. JGK at Loch Sween, collecting specimens on the rocky shore. (Photo: Department of Zoology Archives/University of Glasgow)

Loch Sween the conditioning factor was quite otherwise, namely, the greater or less abundance of minute – microscopic – living organisms.

Each of the various environments in the loch had its own characteristic and luxuriant fauna: the muddy bottom with sea-pens (*Pennatula* and *Virgularia*)[112] and its own meadows of sea grass (*Zostera*) with their small purple sea-urchins and their creeping molluscs such as *Philine* and *Acera*, the latter at times to be seen flitting through the water like sea-butterflies: the rocky southeast bank of Kyle Scotnish with its great nudibranchs (*Doris* and *Facelina*) and sea-urchins (*Echinus esculentus*), those strange worms, *Chaetopterus* and *Phoronis*, and an occasional lobster. By far the most interesting part of the fauna to me, however, was the plankton, ranging from large jelly-fish a foot or more in diameter down through innumerable grades of microscopic organisms – some of them plantlike such as the diatoms which, during the hours of daylight, keep up a continuous supply of the oxygen required by their animal companions. Conspicuous members of the plankton were a wonderful variety of those larvae which, as already mentioned, were my special quest. It was a really astonishing spectacle when examining under the microscope the catch of the tow-net to see there, almost jostling one another, practically every one of the varied forms of larvae which I learned at Cambridge to be familiar with in lecture and textbook diagrams. It was fascinating sometimes to watch them under the binocular microscope, e.g. the larvae of the ordinary acorn-shell or barnacle which covered the rocks near high water mark everywhere. Its larvae were to be seen cruising about in the water until eventually, as the end of larval life approached, there developed a pair of glands at the front end which secreted a sticky cement. Now when the larva blundered against a solid surface it tended to stick: and when endeavouring to free itself, looking absurdly like a human being walking along adhesive mud. Soon, however, its efforts failed and it remained fixed, gradually to undergo the changes which converted it into the familiar barnacle.

The rich plankton of Loch Sween was of interest apart from its constituent members, for it is the plankton that provides the food on which a great variety of marine animals subsist. Herring and mackerel possess in their gill openings a special apparatus to strain off the plankton from the water as it passes through them. Whales have a different straining apparatus in the frayed out edges of the plates of whalebone that hang down from the roof of the mouth. The fat of the whale, the highly nutritious flesh of the herring, are alike derived from the plankton on which they feed. So also with shellfish such as mussels and oysters. In successive visits to Loch Sween I planted out mussels at various rocky points adjacent to favourite picnic sites and they flourished and multiplied, providing delicate fare for our picnic. As regards oysters, the once considerable oyster population evidenced by the plentiful dead shells, had practically died out except in the small arm of the loch known as Linnhe Mhurich, but in the early years of the century, one could still find an occasional large oyster in the main arm of the loch and these gave an apparent clue to the cause of the oyster population dying out, in the fact that they were partially buried in mud. I came to the conclusion that the increasing deposit of very fine mud in recent years, whatever its cause, had tended to smother the oysters. And in view of the richness of Loch Sween in plankton, I felt that the oyster population might be restored again by planting imported young oysters on supports above the mud level. Such considerations naturally directed my thoughts towards possible developments of plankton research of economic importance. Why should not, for example, the Marine Biological Station at Millport take as its main interest the study of the Clyde plankton in relation to the all-important herring fishery?

When, for example, a local herring fishery such as that of Loch Fyne fell upon evil days, might not that well be due to local poverty in plankton, the herring having betaken themselves to localities in which the plankton was abundant? And I hoped, too, that one day attention would be paid to the development of means by which special concentrations of plankton could be located and followed with a view to its extraction from the sea water to serve as food for man.

Apart from its marine fauna the Loch Sween

neighbourhood was a naturalist's paradise and I made fruitless attempts to have it made a nature reserve[113]. However, in later years something in this direction was done when the greater part of the region was taken over by the Forestry Commission. In addition to my long vacation sojourns I used in pre-war years to take a party of senior students to Loch Sween at Easter and sometimes at Christmas, and in the early summer I made an occasional short stay with some of my junior staff. In later years my pioneer work on the natural history of Loch Sween was greatly extended by others, more especially by J.A. Kitching[114] and by members of the staff of the Millport Marine Station.

Loch Sween was not only marvellous as a centre for scientific work: it was equally so for a summer holiday. Its sheltered waters provided ideal conditions in which my young family[115] could learn the management of boats. Oib peninsula with its dense wood, the Fairy Isles with their many creeks, the varied scenery of hill and dale, the shore of the Sound of Jura, provided an infinity of delightful sports for holiday picnics. As a purely holiday centre the only serious rival to Loch Sween was the island of Colonsay, one of the Inner Hebrides, an island which for its size possessed a variety –hill and dale, sea cliffs and sandy shores, sand dunes and peat bogs – unequalled by any of the other islands. There I spent many long vacation holidays, especially when my family were in their early 'teens'. To them it was the great period of the year, the one period when we were together. We had great times, moving off for the day regardless of weather, camping in some spot comparatively sheltered according to the direction of the wind, and making a fire of driftwood. The children learned the various dodges of out-of-door-life – how to make their fire in pouring rain, how to extract the best shelter among the heather on a bare hillside, how to time the boiling of an egg when no watch was available by using a pendulum made of a stone and a bit of string. Then there was always the fascinating natural history of the island; the searching for rare plants, the luxuriant flora of the peat bogs with their rich crimson parterres of the three species of sundew (*Drosera*)[116].

When our picnic spot happened to be at the south end of the island there was the particular delight of watching the seals which during the period of low water rested from their fishing activities on the rocks between Colonsay and Oronsay. Counting them one day, we found 130 visible from one spot. As the tide rose it was amusing to witness their apparently ancestral dislike of the rising waters, curving their head and hinder ends upwards into a crescent as if to delay getting completely wet until the very last moment. Then they would slither off the rock and depart for their fishing grounds. If we happened to be afloat in the boat during this period the seals would bob up and inspect us with a most comical expression.

In the evenings we commonly fished for saiths and lythe[117], trailing lines with fly or spoon bait, and at such times we were apt to be accompanied by two seals, one on each quarter, who found it a convenient method of doing their own fishing - to pick off the fish that we had hooked. Once or twice the seal itself got hooked which meant the loss of our cast. The grey seal was not so numerous as its smaller relative[118], but a pair were usually to be found at the east end of Oronsay. One time we watched an exciting struggle between the male and an enormous skate which he had grabbed by the root of its tail. The struggle lasted quite a long time, the skate beating the seal with its side fins, but eventually it was terminated by the seal cleverly shifting its grip to the under side of the body of the skate and tearing it open. The grey seal produced its young in the spring and they spent much of their early life lying on isolated rocks where the children enjoyed giving them a friendly caress.

One of our troubles during earlier years at Colonsay was the absence of a suitable small boat. Eventually I had to refuse to take our usual farm-house, Garvard, unless the farmer, Mr MacNeill, undertook to obtain a satisfactory boat. In due course came the announcement that he had been to Oban and secured a boat of the most admirable kind. So on arriving at Garvard the first thing I did was to accompany Mr MacNeill and one of his men to inspect the boat. Its appearance did not inspire confidence. However, we got it launched and proceeded to hoist the sail. There was a fair sailing breeze blowing, but we had hardly got under way when there was a sound of rending of timbers, the mast and sail came down and an open split in the timbers flooded the boat with water. Fortunately the depth was only two or three feet and we were able to wade ashore. So next morning I walked in to the post office and telegraphed to my colleague, Professor J.H. Teacher[119], an appeal to do his best to secure a good sailing dinghy and send it off to us by the Colonsay steamer. Before night-fall the reply came that he had secured a 'Kilcreggan Imp', a 12-ft. centreboard sailing dinghy which had misbehaved by capsizing with its owner, a local minister. She, the *Curlew*, proved a most excellent boat and served us well for several seasons until replaced by a new boat of the same design. Rather a shock came when I first navigated the *Curlew* out on the west side of the island. The sea was calm except for the normal big Atlantic swell and as I drifted quietly along I was suddenly startled by the appearance of a sharp pinnacle of rock, on to the summit of which the boat very nearly subsided. This experience taught me the lesson that the west side of the island was no place for a small boat unless navigated by one with thorough local knowledge. On the eastern side of the island, however, we made great use of the boat, fishing, pottering about and collecting the small animals of the plankton with a fine tow-net, but we found the plankton was poor indeed in comparison with that of Loch Sween. The outlook from Colonsay provided a marvellous panorama – to the westward the open Atlantic with, on a clear day, Dubh Artach lighthouse[120], sixteen miles to the north-west, then clockwise, Iona, Mull, the mountains of Morven and Glencoe, the mainland of Argyll, the islands of Jura and Islay. Especially towards sundown, one could see these beautiful soft colour effects, surely unsurpassed anywhere in the world - the pearly grey sea with the wonderful purple of the Jura

mountains. One evening, to complete the effect, the setting sun shining on a shower of rain between us and Jura added a perfect rainbow to the normal scheme of colour.

It was not at Colonsay but further north that my wife and I had the good fortune to see the 'green ray'[121]: not the slight green flush familiar to travellers at sea as the sun dips down below the horizon but the green ray which forms a centre for Highland legend. It was one evening in June 1933, when staying with Sir Hector Cameron[122] near Morar, that we were sitting on the terrace watching the brilliant setting sun about to disappear behind the Cuillins. There had just taken place one of the periodical correspondences in *The Times* in which the physicists explained it all simply in terms of refractions of light of different wavelengths, and I said to my wife, 'Now is the time to see the green ray'. As the last of the sun's disc disappeared behind the dark Cullins there appeared as it were a veritable explosion of the most intense emerald green – an experience never to be forgotten and sufficient to inspire any amount of legend. But now came the point of scientific importance. Just as the explosion occurred, my wife exclaimed: 'It moved as I moved my eyes'. It had happened that she was shifting her line of vision at the precise moment of the green flash, and the fact that the flash seemed to move with it demonstrated beyond question that the green ray as we saw it was no mere physical phenomenon but a subjective sensation. Our eyes had been flooded with the intense reddish yellow light of the sun and the sudden switching off of this caused the sensory impression to swing over to green, the opposite or complementary colour.

The natural history of Colonsay was very different from that of Loch Sween. The plankton was normally nothing like so rich, though on occasion one was made aware of the fact that a local concentration of plankton was slowly drifting past the island by the sea birds and porpoises feeding upon the fish which accompanied the plankton. Occasionally, too, especially after long continued south-west winds, there arrived visitors from distant warmer seas – including the sea snail *Janthina*, with its beautiful violet-coloured shell, and *Velella*, a relation of the Portuguese man o' war[123].

There was a great variety of birds, especially sea- birds. The predominant duck was naturally the eider – it used to be called the Colonsay-duck, and in August one would see many broods of these – sadly diminishing in size as the season went on – for there were many predatory black-backed gulls. On occasions skuas could be seen bullying other gulls and terns to disgorge their food and swooping down on it before it reached the water. On the sandy shores were flocks of little ring-necked plovers and dunlins – and the children were delighted to see the perfect camouflage of their eggs, and of the young chicks as they flattened themselves down upon the gravel as we approached. It was instructive, too, as these waders rose into the air and swung round in a curve to alight a little further along the shore, to observe how they vanished as they turned their white under surface towards us, telling us incidentally, as do all fish-eating birds, that white is the proper coloration, to diminish conspicuousness of war aeroplanes against a background of sky. Another lesson in camouflage was taught us by the turnstone as it picked its way among the rocks, its body rendered almost invisible by its 'dazzle' markings – a patchwork of violently contrasting pigments.

It was during one of our Colonsay sojourns that the First World war broke out. I had gone down to the port at Scalasaig to await a friend's yacht which was to pick me up, when a telegram arrived intimating that the cruise was off owing to the uncertainty of the situation, and presently news arrived of the outbreak of war. Colonsay was pleasantly remote from the major operations of the war, but there developed a good deal of submarine activity away to the westward – much infested by German submarines whose activities were betrayed to us by the sound of distant gunfire or the explosion of a torpedo or mine. Several mines drifted ashore on Colonsay and one or two exploded without doing any damage. One day towards the end of the war we had a fine view of a cruiser dashing past, close inshore on the eastern side of the island, clearly intent on business and I was glad to see she was camouflaged, in dazzle paint, though not very effectively, but as always she showed no sign of countershading[124].

A good deal of war debris was washed up on the western shores of Colonsay – a life raft, miscellaneous wreckage, and cargo materials such as crude rubber and barrels of oil. An exciseman travelling with me one time to Colonsay told how on a recent occasion when many barrels of oil came ashore, the islanders had been most helpful in handing over the barrels to the authorities, but what a shock they had received on learning later that amongst the barrels of oil they had unwittingly surrendered a barrel of good Scotch whisky.

Just at the outbreak of the war in 1914, I was puzzled by the behaviour of a large steam yacht distinctly visible through my binoculars and apparently anchored in the open close to the south-east tip of the island of Mull. Gales blew and high seas raged and she seemed to remain quite unperturbed at her strange anchorage. It was only a few weeks later when returning from Colonsay to Oban that I discovered the mysterious 'yacht' to be the hospital ship *Maine*, presented by the U.S. Government, which had run ashore on a rock near the entrance to Loch Buie and remained there immovably fixed.

Looking back over my long tenure of the Glasgow Professorship, I never fail to be impressed by my extraordinary good fortune. My main task, that of creating a modern Department of Zoology in place of the old Department of Natural History, so long controlled by Professors who were geologists rather than naturalists in the ordinary sense of the term, was one of fascinating interest. I was helped in my task throughout by that remarkable series of loyal and able helpers, and I had the further good fortune that the central twenty-

two years of my Professorship came in the academic reign of Principal Sir Donald MacAlister, unrivalled as a University administrator and always to be relied upon for sympathetic consideration of my difficulties.

The one cloud which overshadowed my early years in Glasgow arose out of a most unfortunate misunderstanding. In my interview with Lord Balfour, I had emphasized that to me one of the great attractions of the Glasgow Professorship was the prospect which it afforded of carrying on my earlier interest in the marine biology of the Clyde, and in my official letter of application I foreshadowed the hope that Glasgow, with its proximity to the Clyde 'and with the Marine Laboratory at Millport', might become one of the chief national centres of zoological research. Unfortunately, my strongest local rival for the Chair, Dr James F. Gemmill[125], was also pre-eminent among the supporters of the Millport Station at which he had carried out a long series of important pieces of original research. The mention of my own prospective interest in the Station was immediately pounced upon as indicating the intention on the part of the Cambridge invader of doing his best to annex the Millport Laboratory to his own department in the University. In point of fact, I was of the opinion that it was to the interest alike of the University department and of the Millport Station that their relations should be those of friendly alliance but completely independent. If brought into the University organisation the Station would be in competition with other University departments for already inadequate financial resources. However, it needed the passage of many years and the advent of a dominant new factor before the evil working of this misunderstanding came to an end.

The origin of the Millport Marine Station had been due to Sir John Murray of the Challenger Expedition who, in connection with certain researches supplementary to those of that Expedition, had brought round to the Clyde his floating barge laboratory, *The Ark*. After the completion of his work, he decided that *The Ark* should remain on the Clyde as a centre for marine biological research, and with this end in view he placed her at the disposal of a committee of persons interested in natural history, headed by David Robertson[126] – a Glasgow business man and enthusiastic amateur naturalist who had made important contributions to our knowledge of the marine fauna of the Clyde. *The Ark* was wrecked by a gale in 1900 but she had proved so attractive both to researchers and to casual visitors that the committee had already decided that the good work must by expanded by erecting a permanent laboratory building ashore. Funds were collected, a site was provided by the Marquess of Bute[127], and the new Marine Station was opened by Sir John Murray in 1897. Unfortunately, divergences of opinion soon began to show themselves in the governing body as to what should be regarded as the main objective of the Station, one section – including most of the University representatives - placing the furtherance of biological research first in order of importance, the other giving priority to educational activities – formal through vacation classes to teachers in training, informal, by encouraging visitors to the aquarium and museum collections.

At the time of my appointment in 1902, this division of opinion was already marked by somewhat violent personal feelings, which I as a newcomer naturally wanted to see die down. The unfortunate misunderstanding already alluded to served, however, merely to exacerbate them and they reached a head when the Annual Meeting of subscribers in 1907 passed a resolution forbidding the staff to carry on with the admirable work on which they were engaged – a 'Biological Survey of the Clyde Sea Area'[128]. This complete *volte face* from the intentions of John Murray when he initiated the research centre at Millport led to the resignation of the chief officers of the Association together with the majority of its biological members, and a little later the scientific superintendent of the Station.

The upheaval at Millport involved severe interference with the practical facilities available to the University Department of Zoology but this was mitigated by the sympathy and generosity of the Marquess of Bute who purchased the aquarium building at Rothesay[129], fitted it out as a laboratory, and placed a properly qualified biologist in charge. During the next few years the Rothesay laboratory under its successive heads provided the centre at which the Glasgow students gained their practical experience of Marine Zoology. It was so successful that Lord Bute planned to erect and endow a fine new Marine Station within his own grounds at Mount Stewart, but his plan was brought to an abrupt end by the shock he received as a witness before the Sankey Commission[130] which seemed to imperil his whole financial future. While reluctantly abandoning his plans of a Mount Stewart marine station, Lord Bute agreed to my suggested foundation of a 'Bute Marine Biological Committee', with himself as Chairman and a purely *ex officio* membership, to receive and hold sums of money for the furtherance of marine biological study in the Clyde region. Safeguarded by its constitution against interference by personal animosities, this new committee might be trusted to wield a good influence for the future. In point of fact it did so until at long last the Millport Station was brought back into harmony with the aim of its founder. The first promise of this came through Sir John Murray himself. We frequently dined together as members of the Royal Society of Edinburgh Dining Club and I did not conceal from him my view that the only hope for the Station lay in the possibility of his taking it over. Eventually on 13th February, 1914, he took me to see his friend, Mr Laurence Pullar[131], who had shared financial responsibility with him in connexion with the survey of Scottish lakes. It was agreed that they should proceed together to Millport to make a preliminary inspection before entering on negotiations for taking over the Station. Alas! on 10th March, a week before the proposed date of their visit, Murray's life was brought to an end by a motor crash.

The actual dawn of brighter times for the Station came after the end of the war when my old friend and yachting skipper, W.B. Hardy, got me included in the personnel

of the committee appointed under his Chairmanship 'to advise the Development Commissioners on the character and scope of the research required for the development and improvement of the fisheries of the United Kingdom'. A special sub-committee under the Chairman and including myself was appointed to consider the question of grants in aid to research institutions, and this sub-committee at once proceeded to get into touch with the Millport authorities. After full enquiry they expressed their desire to see there 'a biological station staffed and equipped to deal adequately with areas of such great interest to the zoologist and to fisheries as are the Clyde area and the sea off the west coast of Scotland', and their willingness to recommend a grant in aid sufficient to make possible the development of such a Station. The essential condition that the affairs of the Millport Station should be put under the control of a strong executive committee working in harmony with the scientific staffs of Glasgow and the other Scottish universities was at once agreed to, and grants were recommended to recondition the Station and its equipment, to provide two research vessels, one of the fishing boat type, the other in the form of a motor barge capable of working in the fjord-like sea lochs such as Loch Sween, and to appoint a scientific staff. The Station would require the appointment as Director of 'a Scientific man fully trained and with a high capacity for research', but this would have to wait. In the meantime two Glasgow University graduates were appointed, Miss Sheina Marshall[132] as naturalist and Mr A.P. Orr[133] as biochemist. It need only be added that in succeeding years, with the continued interest of the Fishery Research Committee under its successive chairmen, Sir W.B. Hardy, Professor E.W. MacBride[134] and myself, the Millport Station continued to flourish and to justify itself by its important contributions to the advancement of marine biology[135]. At the same time, its relations with my department in the University remained friendly and to the mutual advantage of both. And what remained of personal feeling among members of the staff was driven underground and deprived of serious effect.

Apart from the Millport complication, my personal relations throughout my Glasgow period were without a cloud. Academic society – devoid of the College life of Cambridge – was, of course, very different, but the existence of the Professors' Square with its 13 houses allocated to the Principal and 12 Senior Chairs ensured a nucleus of almost family intimacy. Although the Chair of Natural History was not one of these, I was fortunately able to rent the house which had been inhabited by the late Professor of Medicine, his successor preferring to retain his more centrally placed residence in the city.

A matter of great significance to myself and my department was the appointment as Principal in 1907 of Donald MacAlister whose quite outstanding ability I had learned to appreciate at Cambridge. His principalship lasted until 1929 and throughout that long period he never failed in his understanding, sympathy and helpfulness towards my efforts in developing my department. He was too strong a man to be universally popular but he certainly earned an incalculable debt of gratitude from the University of Glasgow. Perhaps his greatest service was his bringing together into co-operative friendship with the University, the City and the important extra-mural educational bodies, the Royal Technical College and the Medical School of the Royal Infirmary. More impressive, perhaps, to the general public, were the remarkable tributes he received from wealthy citizens of Glasgow in the form of endowments for new Professorships in the University. Of the 57 Chairs of the University at the time of my retiral in 1935 no less than 22 dated from Principal MacAlister's period of office. My own appointment came just after the revolution in University administration brought about by the Universities (Scotland) Act of 1889 and the Ordinances of the Commissioners appointed under that Act. Up to that date the *Senatus academicus* – the body of Professors – had been the supreme governing body of the University. The individual Professor was practically an autocrat in his own department and his remuneration consisted of the fees paid by the students. This arrangement involved as natural consequences on the one hand the high development of lecture technique and its capacity for attracting students, but on the other hand discouragement of expensive practical and laboratory activities which had to be paid for out of the Professor's own pocket. In placing the remuneration of the Professors on a fixed salary basis and freeing them from the payment of salaries of assistants and expenditure on laboratory equipment, the 1889 Act freed the Scottish Universities from what had been a fatal obstacle to their advance as centres of scientific teaching and research.

The strongly marked individuality among the Professors encouraged by the pre-1889 conditions had by no means disappeared during my early years in Glasgow**.** Amongst the Professors there were several real 'characters'. John Ferguson[136], Professor of Chemistry, though little interested in modern developments of his science, was one of the greatest authorities on alchemy. He had a long beard and the tale was told how at a University dance his partner in a waltz felt her back hair coming down and pinned it up, only to find at the end of the dance that she had pinned up her partner's beard. He was our most knowledgeable Professor in the matter of food and drink and used to give admirable little dinner parties. Walking back with F.O. Bower from the last of these, I remarked to Bower that I thought Ferguson in particularly good form. Bower did not agree: had I not noticed a most serious symptom – that he had begun to pour one of the wines into the wrong glass? And sure enough he was dead within a week. Poor Ferguson was given a dreadful time by his students who made his lecture- room a regular pandemonium. His lecture at 10 a.m. came between my lecture at 9 and my practical class at 11 and every now and then I would see his students streaming along towards my department at half time, having deserted his lecture-room *en masse.*

Another great character was James Moir[137], Professor of Conveyancing, who had the reputation of never having been known to speak well of anyone. I was glad to be

able to vouch for having myself heard him speak well of someone - Sir Thomas McCall Anderson[138], who had just died.'Well! They may say what they like about Tom Anderson but more than once I have known him to say or do a thing that I could not see what advantage it would be to him'. That, however, appeared to be the summit of his appreciation of anyone. I remember being startled at a Senate meeting when on someone proposing the Reverend Professor James Cooper[139] as our representative at the General Assembly of the Church of Scotland, Moir rose to his full height and commented, 'A most improper person', though it could never have occurred to any other member of the Senate to think of Cooper otherwise than as the very soul of propriety.

My most intimate friend among my fellow Professors was Frederick Orpen Bower, Professor of Botany. He did not give himself airs and I often felt that Glasgow did not always realize the fact that Bower was one of the greatest botanists of his time. To myself he was the most loyal and helpful of colleagues. A colleague whom I saw a good deal of was William Macewen[140], Regius Professor of Surgery and the greatest of Lister's successors in the Glasgow school. Tall and with a well trimmed beard, he was a distinguished looking figure, especially when in court dress as a member of the King's household. Macewen had a habit of coming into my demonstrations to the elementary class. Two incidents stand out in my memory. The first was when he examined one of the early Levaditi[141] preparations of the spirochaete of syphilis and expressed his entire disbelief in its being the cause of that disease. The other was one day during the First World War when I noticed a man in naval uniform sitting down at one of the microscopes and studying the preparation under it. I did not look at him or his uniform particularly and took him to be some merchant skipper who had wandered into the department. However, after a bit I went to speak to him. He looked up and then I recognised Macewen disguised by the absence of his beard and his Rear-Admiral's uniform.

The hard work of early years in Glasgow was lightened by the charming hospitality accorded to my wife and myself by the residents in the west end of Glasgow. The dinners of those days had many guests and many courses, and the leaders of Glasgow business and professional life laid themselves out to do their very best to entertain their university guests. If the level of the talk was not quite up to that of Cambridge high tables, it showed on the other hand as mere conversation a much wider knowledge and much greater appreciation of the importance of public affairs. The great private dinner parties of those early years came to an end with the First World War. Thereafter, lunching and dining arrangements were mainly of a public nature. I was a frequent guest at the Lord Provost's weekly luncheon, and at big public dinners I was often called upon to propose the toast of the evening. I remember, one speech which went down particularly well when, in proposing the Corporation, I spoke of Glasgow as the Secret City – differing from St Petersburg, the Secret City of Hugh Walpole's book[142], in that Glasgow's secret activities were those of its trade incorporations and family associations which distributed their funds in secret help to those in trouble.

As a rule, my laboratory work extended over Saturday and Sunday, but there came an occasional week-end with friends in the country. Outstanding among these were week-ends at Ardgowan with Sir Hugh and Lady Alice Shaw-Stewart[143] and at Lochside with Mr & Mrs A.E.C. Clapperton[144]. In addition Alan Clapperton, then Secretary of the University Court, was a sympathetic listener and could be depended upon for friendly advice when occasional difficulties arose. Most important of all my personal relationships were of course those with my students. With them there was never a breath of discord. It was an understood thing that we all – students, Professors and junior staff – worked at high pressure during class hours. From my class room in pre-war years there emanated a deafening roar of community singing which ceased as if cut off by a switch when I entered the room at 9.03 a.m. and was succeeded by absolute silence during the fifty minutes of lecture. It was to me a personal delight – which lasted throughout my thirty-three years – to lecture to Glasgow students with their concentrated attention, their mental alertness and their sense of humour.

During the peaceful first decade of the century there still lingered in my mind the signs I had learned to appreciate in Jena 1894 and Kiel 1895 of a coming attack by Germany, so I was particularly interested when the scheme of an Officer's Training Corps in the universities of the country was inaugurated in 1909. I became a member of the Military Education Committee – a body composed of members of Senate together with the Commanding Officers of local units of the Territorial Army, which was to be responsible for setting up and supervising our unit of the O.T.C. Owing to the serious illness and prolonged convalescence of the chairman of the committee, D.J. Medley[145], Professor of Modern History, I had to act as chairman for the first year and a half. This meant a lot of hard work as, while purely military details were attended to by the excellent adjutant, Captain A.N.E. Browne, H.L.I., I was responsible for the business arrangements. These included clothing the unit, complicated by the fact that we had no money in hand. However, I assumed that the army contractors who provided uniforms adjusted their estimates in the knowledge of the precise dates on which the government grants would be available, and so remained unmoved by their fervent appeals for immediate payment of their bills. When my accounts for the first year were made up, I was worried by a discrepancy of a few shillings between credit and debit and it was only after many hours' work that I was able to trace down the discrepancy to the orderly room clerk having included an item in a petty cash total as well as putting it down separately. After the accounts had been sent in, there ensued a considerable correspondence with the auditor, closing abruptly with a letter from me:

Sir,
In response to your enquiry of date …. As

to whether item X is or is not included in the
total under heading Y, I have the honour to inform
you that item X amounting to £50 odd is not included
under the total Y amounting to £4 odd.
I have the honour to be,
Sir,
Your obedient servant

Soon after I happened to meet Lord Haldane[146], who was Secretary of State for War at this time, and he much enjoyed my tale.

In view of the restrictions on expenditure of government money to definite authorised headings I felt it was desirable to have a private fund for expenses that were expedient though not admissible under the authorised headings and a number of friends were good enough to become annual subscribers to this. The O.T.C. was a great success, and a gratifying experience was to notice its educational effect, apart from its training in military technique – the discipline, quick and accurate reaction to the word of command, and the general alertness instilled on the parade ground bringing with them corresponding changes in mental activity.

The Department of Zoology received the full shock of the actual outbreak of war in August 1914. All members of the staff – teaching and technical – who were of military age departed on war service, as did also a large proportion of the students. This involved the recruitment of temporary members of the staff to take the place of those who had left. It involved also a large increase in the number of women students, and following on this the infusion of women members into the teaching staff. As a teacher of medical students, I had to remain at my University post and my war activities were restricted to the selection of candidates for commissions, to my – in great part fruitless – efforts to get war camouflage put on a proper scientific footing, and to joining the local volunteers. The volunteers in their early months were without uniform and their only distinguishing mark was a brassard with the red letters G.R. signifying Georgius Rex. Not unnaturally they came to be known flippantly as the Gorgeous Wrecks. Their evenings were devoted to elementary military training, and their Saturday afternoons to route marches. I got my First Class certificate as instructor in musketry and became quite keen on that line of work. In my squad I had a skilled engineer and got him to prepare a greatly enlarged wooden model of the breech mechanism of the P14 rifle which was served out to the corps. This model was most helpful as an aid to musketry instruction.

During the later years of the war, I was one of those detailed for night duty at the docks – often of interest owing to the danger of spying activities by the crews of foreign vessels. Occasionally, when dealing with Spanish-speaking seamen who threatened to give trouble, I found that scraps of opprobrious language learned in South America were peculiarly effective. An interesting experience when I was in command of the guard at Meadowbank was the arrival of the Russian cruiser Askold with her five funnels which some years earlier had proved of so great psychological value in raising the prestige of Russia and lowering that of Britain in the Persian Gulf. At this period the crew had already seized control of the ship, though the officers were still alive and allowed to move about in apparent freedom.

Another interesting experience was when I noticed a ship, the figures on which indicated that her draught was much greater than what I knew to be the depth of the water at that particular spot. Further scrutiny disclosed other misleading features about her and she became clearly one of the notorious 'Q-boats', ordinary merchant ships disguised so as to entice hostile submarines within reach of their guns. At an earlier period in the war, other merchant ships in the docks had been conspicuous from their strange tripod masts intended to give them when seen in distant view the appearance of formidable battle cruisers. By far the most interesting, however, to myself personally was the arrival of ships camouflaged by paint, as I had been responsible for the initiation of that form of camouflage by my memorandum circulated to the Fleet in November 1914. I will defer saying anything more on this depressing topic until I come to the Second World War.

My period in the volunteers came to an end when – in order that I might take a more direct part in the Officers' Training Corps during the difficult period at the end of the war – I was given a junior commission in the Territorial Army (unattached). In December 1918 I was put through a course with the Grenadiers at Chelsea Barracks – somewhat trying as the course was arranged for serving officers back from various fronts and accordingly adapted to the capacity of younger men with active service experience.

Apart from my teaching work and the administration of my large department, I did my best to avoid unnecessary outside entanglements. However, there were many which were unavoidable. Amongst these were the continuing responsibilities of the Faculties of Science and Medicine, of each of which I was an *ex officio* member. Then I had eight years' membership of the University Court including the period of the First World War, with its innumerable problems of detail such as the presence of persons of German blood or sympathies on the teaching body, the question of insuring or not insuring the University against possible damage by enemy action and so on.

During the later years of my Professorship came other interesting responsibilities following on my election to the Board of Management of three important Glasgow institutions - the Royal Infirmary, the Royal Technical College and the Anderson College. Of these, the first was of particular interest – for it was in the Royal Infirmary of Glasgow that Joseph Lister[147] – at that time Professor in the University – laid the foundation of modern surgery. I was brought into immediate contact with the Infirmary's activities by being a member not merely of its governing body but also of its medical committee. Work at the Technical College, with its very

highly qualified teaching staff and the large body of students attending its evening classes after their day's work in factory or shipyard, was again of absorbing interest and I occupied latterly the position of Convener of the committee controlling training and navigation. The Anderson College of those days was the main extra-mural school of medicine and my position as Governor brought many interesting problems bearing upon both its own teaching activities and their relation to those of the University.

Holding as I did the King's Commission as Regius Professor, I preferred to abstain from taking any active part in party politics. That did not mean that I was without party sympathies. I naturally agreed that our country's prosperity was ultimately dependent upon labour but it seemed to me preposterous that the word labour should be used by politicians as if it did not include brain labour – as expressed in invention, administration and management – as well as manual labour, and it appeared to me ridiculous not to admit the overwhelming importance of the former. The excellent handiwork of that one time employee of the University of Glasgow, James Watt[148], was surely of quite insignificant importance in comparison with his bit of brain work which invented the idea of separating the condenser from the cylinder, thus making the steam engine an economically practicable instrument – and incidentally providing the impetus for the Industrial Revolution. And it seemed to me beyond question that the one of the two dominant political parties which had the surest grasp of the needs and claims of labour in the broader sense was that which went under the name Tory, the more modern Conservative, or the less misleading Unionist.

My resolve to keep apart from open participation in party activities persisted until January 1924 with its announcement that Mr Ramsay MacDonald[149], head of the Labour Party, was now Prime Minister. This news was to me so alarming that I at once got into touch with the Secretary of the Hillhead Unionist Association and asked him to enrol me as a member. I duly attended meetings, did my duty as member of the Executive Committee and was chosen as a representative on the General Committee of the Glasgow Unionist Association – comprising the local Unionist Associations of the fifteen parliamentary divisions of Glasgow. A few months later – in November – there happened an incident which was to influence my whole subsequent career. I was rung up by Sir Archibald Craig, one of the leaders of Unionist politics in Glasgow, who said he had been authorised to ask me a question to which he hoped I would not answer 'No' without careful consideration. The question was would I allow my name to be proposed for the Vice-Chairmanship of the Glasgow Association. My answer was that if the suggestion was really serious – which I ventured to doubt – I did not see how I could possibly refuse. My nomination followed in due course, and on 3lst January 1925, I was formally elected.

Owing to the ill-health of the Chairman, Sir Archibald Craig, I found myself almost immediately entangled in the task of presiding over meetings of the General Committee. At first there was a little trouble. It seemed, no doubt, strange that a comparative outsider should have been chosen instead of one of the many members who had years of experience in handling the Association's affairs. However, matters soon settled down and there ensued five years of absorbing interest, two as Vice-Chairman and three – after the death of Sir Archibald Craig – as Chairman. I was fairly successful in discharging the duties of these posts but I have never failed to attribute my success in great part to the fact that I had by my side that marvellously efficient Secretary, Lewis (later Sir Lewis) Shedden[151]. Beginning as office-boy, Shedden had spent his whole working life in the service of the Association. He knew everyone and was equally at home conversing with a Duchess or a 'shawl lady'. He had a remarkable memory and it was a treat to drive round with him to meetings of the Divisional Associations and listen to his continuous ripple of recollections associated with the various streets and those who in time gone by had dwelt therein.

It was my custom on the afternoon before each committee meeting to go down to the office and go carefully over the details of the agenda and consider as to whom I should invite to speak on each item. The result of this careful preparation was that the business of the meeting went through so smoothly and expeditiously as to win the approval of those present, apart from the small minority who always felt aggrieved by their so obviously pre-eminent claims to take part in debate being passed over. Apart from the ordinary business meetings there was not during the greater part of the year much for the Chairman to do. In January, however, there were held the Annual Meetings of the Divisional Associations, and at these the Chairman of the Glasgow Association was expected to put in an appearance and 'say a few words'. Then followed the Annual Meeting of the Glasgow Association when office bearers for the year were elected and speeches upon the political situation were delivered by some of the Unionist representatives of Glasgow constituencies in Parliament. Now and then some emergency claimed the attention of the Chairman. A vacancy in the parliamentary representation of one of the Divisions brought the responsible task of joining with the divisional committee in its consideration of whom to adopt as the official candidate, and, after this had been settled, of being present at his first meeting with the constituents: as well as, of course, working behind the scenes of his success. On at least on one occasion I found myself in the unpleasant position of having to agree to the withdrawal of official support from a candidate for whom I had a high personal regard but who was unwilling to abstain from the public expression of views conflicting with official statements of party policy.

To myself, accustomed in my scientific career to express my own opinions, however much they conflicted with those of authority, it was peculiarly difficult to speak and act in support of party policy when in conflict with my own personal views. However, I realised that the

working of parliamentary democracy would be quite impossible without the subordination of personal opinions to those decided on by the leaders of the party. Particularly delicate were my duties in cases when discord had broken out among the members of some particular Divisional Association. Complaints would come in as to the deplorable behaviour of a certain section of the members and an appeal would be made to the chairman to put matters right. The Secretary would write and say that I would be glad to hear all about the trouble if they would come to the office at 2 p.m. on a particular day. At 2 p.m. I would be in the Chair and one of the two parties would be ushered in and would take their seats. Then the other party would be brought in and would take their seats, the two lots interchanging glances of the most unfriendly kind. Then, after greeting the company and expressing my regret at hearing of their troubles, I would call upon them in turn to explain to me what was wrong. There would follow prolonged and eloquent denunciation of the enormity of the conduct of those on the other side. On one such occasion it was 6 p.m. before all the steam had been blown off and the pressure down to zero. Then, after expressing my thanks for their patience in giving me such a detailed exposition of their woes and my sympathy with them in their troubles, I would indicate the need of time for careful consideration of their difficulties. And so the company would disperse, the violent feelings of 2 p.m. entirely dissipated and nothing more would be heard of the matter.

After being twice re-elected, my term of office as Chairman of the Glasgow Unionists reached its three-year limit and I looked forward to the end of my political interlude. On February lst 1931 I attended my last Annual Meeting as Chairman of the Glasgow Association and it was pleasant to be once again free to give my whole energies to scientific work. My respite from politics turned out, however, to be merely temporary. Towards the end of October 1932 I had a call from Sir Henry Mechan[151] who said he had been deputed by the Western Divisional Council to express its desire that I should become its Convener – this office bearing a relation to the constituencies of the West of Scotland similar to that which I had already held as Chairman to the fifteen constituencies of Glasgow.

I was duly elected Convener for the year 1933 and re-elected for the following year. My period as Convener was again of great interest and I had again by my side the inimitable Lewis Shedden as Secretary. On 23rd November 1934 I was elected President of the Scottish Unionist Association. The duties of this office, tenable for one year, were relatively light, the detailed business of the Association being carried on by the Eastern and Western Divisional councils.

On occasion there would be a meeting of the Central Council, composed of the two Divisional Councils, and then the President of the Association occupied the Chair. During my year of office the most important meeting of this kind took place to consider the Scottish Housing Bill which brought out strong divergences in opinion between east and west in regard to the Scottish system of Rating. I had to do my best to keep my attitude strictly impartial. An entertaining experience was the delivery during the meeting of no less than 470 telegrams addressed to me personally, urging one side of the case – which I remarked might be interpreted either as showing an overwhelming mass of opinion on that particular side or on the other hand the excellent organisation of its supporters.

On Friday 29th November, I had to preside at the Annual Conference of Scottish Unionists at Dundee. There were present between two and three hundred delegates, and morning and afternoon sittings were devoted to discussion of various Scottish interests, more especially agriculture. This involved several speeches: one moving the adoption of the Annual Report, a second proposing a resolution expressing satisfaction at the Party's victory in the General Election, congratulating Mr Baldwin[152] the Party's leader, and pledging support to the National Government, and a third introducing Mr Baldwin to the great evening meeting of over 3,000 – in the Caird Hall. Apart from these speeches, the day's work involved constant supervision of the general business of the conference. The evening meeting was a great success. In view of threats of serious trouble by the local 'Reds', a force of two hundred stewards was scattered through the hall but there was no trouble whatsoever, only the greatest enthusiasm.

These were the days of university representation in Parliament[153], when it was generally felt that the House of Commons was strengthened by the infusion of a few members whose knowledge and university experience gave weight to their opinions on matters of public importance, but who could not be expected to subject themselves to the rough-and –tumble of an ordinary election.

Within the University of Glasgow, the interests of Unionism had been kept alive over a long series of years by the devoted exertions of a single individual, T.A. Harvie Anderson[154] of Quarter – a prominent Glasgow lawyer who was also well known for his activities as Secretary of the Glasgow Territorial Association. Right up to 1950, when university representation was brought to an end by the Labour Government of the day, Mr Harvie Anderson continued to devote himself to the cause of Unionism in the University of Glasgow and indeed in all the four Scottish universities. Mr Harvie Anderson had been accustomed to summon more or less informal meetings of University Unionists as the occasion arose, but in the winter of 1928-29 the Glasgow University Unionist Association was formally constituted. During the informal period the position of Chairman had been occupied by Sir Hector Cameron[122], Professor of Clinical Surgery, and as his health began to fail, I had acted as his understudy.

At the Annual Meeting of the Glasgow University Unionist Association on 4th February 1931, I was elected Chairman and *ex officio* one of the four representatives on the 'Standing Joint Committee of the

four Scottish Universities'. During my period as Chairman of the Glasgow Unionist Association the question was raised of my becoming a University candidate for Parliament, but I had had no difficulty in repelling any such suggestion. On the one hand, I was very happy in the work of running my University department and on the other hand I failed to see any attraction in subsiding at my age into the back benches of the House of Commons, but in 1934 my first wife died after a long illness, and I was brought to reconsider the possibility of Parliamentary candidature.

Westminster, 1935 – 1950

In 1935 came the elevation of one of the Scottish University members, Mr John Buchan[155], to the House of Lords as Lord Tweedsmuir, and I was at once pressed to consider the question of becoming a candidate in his place. It was pointed out that there was no one in the House of Commons with my experience of university teaching and administration. It was also stressed that in spite of the enormous part played by science in ministering to the health, comfort, and prosperity of our people there was in the House of Commons not a single Fellow of the Royal Society apart from those elected under a special statute, not for eminence in science but for their position as persons capable of furthering the general interests of science. I was assured that, if I were in Parliament, I should find myself being made full use of on committees dealing with matters involving science. I found myself confronted with a difficult problem, involving many factors. There was my university department, the development of which had been my absorbing interest over a period of thirty-three years. There was that wonderful staff of junior colleagues who had played such an all-important part in maintaining its efficiency. To step off into a new parliamentary life would mean severing associations that were very dear to me. And it was the case that my university teaching still constituted my keenest personal interest and also that the perfect silence and discipline in my lecture room seemed to show that I was still able to hold the interest of my students.

Again, there was the financial aspect. I was not a man of independent means and I had to face the fact that my election to Parliament would mean heavy financial sacrifice. There was no age limit to my university Professorship with its salary, at that time £1450[156], supplemented usually by one or more external examinerships. These emoluments I would have to exchange for a pension of £800, plus a Parliamentary salary, at that time £400, of quite uncertain tenure, and I should also be saddled with the expenses entailed by the fact of my parliamentary work being in London. However, after full consideration, I decided to take the plunge. The election campaign of a university candidate was a much less formidable affair than that of an ordinary candidate. There were no open public meetings, only a meeting with members of one's own party in each university centre. The main thing was the preparation of an election address and its circulation among the Scottish university constituents. This latter proved a formidable task as a large proportion of university graduates had not troubled to keep the university register up-to-date in the matter of their postal address.

In view of the near approach of a General Election it was expected by many that my candidature in a by-election would be unopposed. However, the Labour Party decided otherwise, and various possible Labour candidates were mentioned – among them my one-time student, A.J.Cronin[157] for whose literary skills I had great regard. Happily, however, he declined to stand and the Labour candidate actually nominated was Mrs Naomi Mitchison[158], daughter of my old friend Professor John Haldane of Oxford, sister of J.B.S. Haldane – a distinguished biologist, and herself possessing a goodly share of the heritage of mental ability enjoyed by the Haldane family.

The poll in a university election was carried out by voting papers circulated by post, each bearing the names of the candidates in alphabetical order, with spaces in which to indicate by a X to which candidate the vote was given, space for the signature of the voter, and space for the signature of a witness to the authenticity of the voter's signature. The poll extended over five days. Each day voting papers were counted by the Registrar of the particular university, under the watchful scrutiny of a representative of each of the candidates, who examined each voting paper in favour of the opposing candidate on the lookout for anything that might render the vote invalid. In spite of the simplicity of the voting paper and in spite of the voters being persons with a university education, there were no less than 652 spoilt papers! However, the declaration of the total poll – by the Vice-Chancellor of Edinburgh University – was eminently satisfactory, for out of the total votes recorded I had 20,507, while my Labour opponent had only 4,293, giving me a majority of 16,214 – a record majority in the history of Scottish University elections.

I took the first available train to London and on the way had an amusing adventure. At Newcastle there came into my compartment an elderly gentleman who was greeted by the only other occupant as a former colleague in the House of Commons. The two entered into conversation and the main topic consisted of speculation as to the probable result of the Scottish universities by-election. Naturally I intervened and informed them as to what had happened. Thereupon the three of us conversed and there came up the subject of the former Principal of the University of Glasgow, Sir Donald MacAlister, and his extraordinary linguistic ability. I capped the statements of the others by recalling an old yarn I had heard about a meeting of university Principals at which Sir Donald was present and at which an apology for absence was intimated from Principal Viriamu Jones[159] of Cardiff. "What an extraordinary Christian name, if you can call it Christian", remarked one of the assemblage. "Oh! I can tell you about that", said Sir Donald, "Viriamu, of course, is Fijian for William". "How very remarkable that you should tell me that story", said the elderly gentleman (who turned to be Lord Rhayader, formerly Mr Leif Jones[160]). "It's perfectly true! Viriamu Jones

was my brother and he was called after a missionary in Fiji named William whom our father greatly admired but whose name the native Fijians found impossible to pronounce except in the modified form Viriamu".

My introduction to the House of Commons took place next day – 26th June – and as I was the one new member the introduction took place with full ceremonial. Sir Lewis Shedden had come south for the occasion so I gave him lunch at the Athenaeum and we then proceeded to the House. I was shown into the Whips' room where everyone was extremely kind, and one of the Whips coached me up in the details of the ceremonial. I was then taken to a seat under the Gallery, i.e. below the Bar and outside the floor of the House, where I sat and listened to the answers to questions and received greetings from various friends. As questions approached their end I was lined up at the Bar with my two sponsors – on my right Captain Margesson, the Chief Whip[161], and on my left Noel Skelton[162], my colleague in the Scottish universities representation. After the last answer had been given, Mr Speaker stood up and invited Members desiring to take their seats to do so. The Chief Whip growled 'Bow' and we all three bowed, then stepped off, left foot first, took five paces forward and halted. Then again 'Bow' and we bowed simultaneously and again stepped off, left foot first, five paces forward, which brought us up to the table of the House. Here we halted, bowed simultaneously for the third time and then my sponsors slipped away and left me alone at the table. The Clerk of the House – the senior of the three bewigged figures seated at the table in front of the Speaker – rose from his place and demanded from me the blue paper certificate of my election signed by the Clerk of the Crown. Having satisfied himself about this, he deposited the certificate in the box on the table and handed me a testament and a board carrying the words of the Oath of Allegiance. These I duly recited and kissed the book. The Clerk conducted me forward to sign the test roll and then to the Speaker who shook me by the hand. My introduction complete, I retired from the Chamber behind the Speaker's chair and I was delighted to receive my first congratulations from my one-time student, Walter Elliot[163], now Minister of Agriculture and Fisheries.

As luck would have it, a division took place immediately after my admission, so I was introduced to our primitive method of taking a vote by counting members as they passed through the 'Aye' or the 'No' division lobby respectively, which has the advantage of separating the two bodies of – it may be – violently opposed opinion and giving a few minutes for feelings to cool down. After the division I was taken in charge by the Lord Advocate, Douglas Jamieson[164], who showed me round the complicated topography of the House. In the cloakroom I was shown my hat peg, still bearing a loop of tape for the reception of the Member's sword – reminiscent of the day when the sword was an article of ordinary attire but had to be left behind before entering the chamber. Then to the fees office where I was given my book of railway vouchers, with the smiling advice that whereas the ordinary M.P.'s voucher was valid only between London and the chief town in his constituency I, as a Scottish university Member, could travel as I liked between London, Edinburgh, St. Andrews, Aberdeen and Glasgow!

Throughout the afternoon I was constantly receiving greetings of welcome. Ramsay MacDonald was particularly cordial. Neither he nor his son had a vote in the Scottish university constituencies but his son-in-law and daughter had voted for me. Sir John Simon[165], too, was most cordial and Mr James Maxton[166], though the latter briskly repelled my suggestion that no doubt he had voted for me. Altogether I was made to appreciate that atmosphere of personal friendship which is one of the main strengths of the British Parliament of today. It was a little embarrassing throughout the afternoon to find myself under the close scrutiny of police and other officials who have to know by sight all the Members of the House of Commons.

My first session in the House was short. The long vacation extended through August and September, Parliament resuming on 22nd October, only to be prorogued on the 25th in anticipation of the General Election. It soon became obvious that my parliamentary duties demanded residence within easy reach of London. My fiancée and I considered various localities and various available houses and at last were lucky enough to find a house that suited us exactly, at the northern tip of Hertfordshire and only fourteen miles south of Cambridge. The name of the house, Dalny Veed, puzzled us at first but reference to a Russian dictionary showed it to be simply the Russian for 'Distant View' and we learned that the original owner had been in business in St. Petersburg and had recognised a field on the north side of the village of Barley and sloping to the south-east, as providing a perfect site for a dwelling house, which he duly proceeded to build. The house and its three and a half acres of ground were effectively enclosed in a triangle of roads, while the southerly slope suggested great possibilities for my future wife's skill in landscape gardening. We were married in the crypt below St. Stephen's Hall in the Palace of Westminster on 2nd April, 1936 and immediately settled down at Dalny Veed. During the parliamentary session we had to stay in London, but it was a great relief to retire each week-end from the noise and bustle of town.

My resignation of the Glasgow Professorship took effect as from 30th September, 1935, and there came to an end my long period of unbroken friendly relations with the governing body of the University of Glasgow. My only further communication with the University Court was to make over formally to my old department my scientific library, scientific instruments and my zoological collections – the latter of great scientific value, including as they did, not merely those of lungfish made by myself, in the Gran Chaco, but also those of *Polypterus* bequeathed to me by Budgett, of calcareous sponges bequeathed by Minchin[167], the Protozoa bequeathed by C.G. Martin. The severance of relations with the University Court did not, of course, affect my relations with the General Council – the general body of

graduates who had entrusted me with their representation in Parliament.

Nominations for the Scottish university seats in the General Election of 1935 took place on 2nd November – four candidates for three seats. This meant that the poll would be in accord with the principle of proportional representation, each constituent having a single transferable vote. The voting paper carried the names of the candidates in alphabetical order with the instruction to place the numerals etc. opposite the names of the candidates in the order of the voter's preference. The paper had to be signed by the voter in the presence of one witness who certified this by his own signature. The completed voting paper had to be posted to the Registrar of the University to which the voter belonged. I had already had experience in Glasgow of this method of voting in elections to membership of the Provincial Committee for the Training of Teachers and had learned to distrust its reliability in practice as it was found that many voters allocated their votes simply according to the order in which the candidates' names appeared on the printed list. In other words, the vote for a candidate depended not upon his general qualifications, but upon what happened to be the initial letter of his surname.

No doubt a university constituency with its relatively higher standard of education might be expected to show the working of Proportional Representation at its best, but many congratulatory letters received after the declaration of the poll showed the most astonishing and often ludicrous blunders and misunderstandings on the part of the voters. More than one enthusiast expressed the pleasure he had in giving my 'all three' of his votes; two highly placed legal luminaries voting for me succeeded in invalidating one another's voting papers. However, the result of the poll was satisfactory as my 'first preference' votes were 16,214 of which only 8,252 were required to place me at the top of the poll. The election was, however, marked by a deplorable tragedy, Noel Skelton, one of the three successful candidates, dying during the counting of the votes. The seat to which Skelton had been elected was declared vacant. I was placed in a somewhat delicate position in relation to the choice of a candidate for the vacant seat, as I received an urgent appeal to do what I could to facilitate the candidature of Mr Ramsay MacDonald – who as the first Labour Prime Minister had actually been the cause of my entry into party politics. However, the present position was that, while he was now a member of Mr Baldwin's Government as Lord President of the Council, he had failed to secure re-election to his former seat at the General Election. It was put to me that he must be got back into the House of Commons if he were to continue as Lord President, so would I do my best to favour his candidature? Ramsay MacDonald was duly elected and I had the privilege of a few months' friendship with that very interesting personality before his untimely death.

The vacancy caused by Ramsay MacDonald's death was filled by the election on 28th February,1938, of Sir John Anderson[168], an Edinburgh graduate of great distinction who had risen to be head of the Civil Service and thereafter had become a very famous Lieutenant-Governor of Bengal.

It was indeed a strange new world in which I found myself after my election to Parliament. As its very name indicates, Parliament functions by the method of debate, and my experience in the world of science had taught me to be profoundly suspicious of debate as a method of arriving at sound judgments. Eloquence and skill in advocacy were apt to be the determining factors, far outweighing mere statements of fact – however accurate, however carefully marshalled. Again, I had learned to appreciate the pitfalls which lie in the path of those making use of statistical evidence – pitfalls concerned on the one hand with the volume and reliability of the evidence, and on the other with its interpretation. And yet in the House of Commons I found the affairs of the nation being settled or at least ostensibly settled by debate; debate, moreover, in which statistical statements were often accepted as the most convincing arguments. In view of the multiplicity of subjects dealt with by Parliament, in any one of which there were necessarily a very small proportion of the members qualified by intimate personal knowledge, the great majority of speeches had to be spoken to a brief, provided in the case of Ministers by their departmental officials, in the case of backbenchers by a government department, by their Party's central organisation, or by some interested body outside. This 'speaking to a brief' was entirely alien to the methods of science, while on the other hand it is entirely in harmony with the training and day-to-day professional work of the barrister. It seemed to follow that the appropriate source for Members of a debating Parliament was the Bar rather than the laboratory. It was only occasionally that a Member equipped with expert personal knowledge was in a position to intervene effectively in a debate. This applied particularly to problems affecting trade and industry and it seemed to me regrettable that persons who had risen to a position of leadership in such affairs did not contribute a much larger proportion of membership. No doubt this is rendered impossible by the system of universal suffrage where the uneducated voter naturally adheres to the candidate who is least trammelled by knowledge or strict principles in portraying the rosy future which will follow the return of his particular Party to power.

Moreover, there is the regrettable psychological fact that actual knowledge has a paralysing effect upon eloquence. The man-in-the-street knows that Professor So-and-So is looked up to as the leading authority upon some particular subject. He asks him a definite question about that subject. 'What is the real truth about So-and-So?' The great man hums and haws and very likely refuses to commit himself further than to say that on the whole he thinks that at the present moment the balance of probability would appear to be on the side of such-and-such being the case. The questioner is naturally unsatisfied. He meets another man in the street and recounts his experience and he is told, 'You take it from me the real truth is so-and-so', and away he goes

completely satisfied. The fact, of course, is that the comparatively ignorant man, entirely unaware that there is more than one side to a problem, or the fanatic who wilfully ignores all but one, is thereby enabled to reach heights of eloquence that would otherwise be inaccessible.

An entertaining feature of our parliamentary system, which I had not fully appreciated until actually in the House, is the amount of make believe that enters into it. In my early days in Parliament, I was much impressed when a Minister got up and made a statement about some important matter of administration, how he had devoted much time to its consideration and now having considered it in all its aspects he had finally decided to do so-and-so. In time the impressiveness of ministerial statements became much diluted by the realisation that such statements, like the knowledge of facts on which they are based, are the work not of the Minister himself, but of the hard-working civil servants of his departments. Nevertheless, in accordance with the doctrine of ministerial responsibility, the fiction that they are the work of the Minister himself is accepted – and to him is accorded the praise or the blame which they earn. It is a strange system but it works well in ordinary circumstances owing in great part to the high reliability of our Civil Service and I have often wondered how much this is due to our public school system of education, in which the young entrant finds himself in a community of rather older boys in which he is taught to 'play the game' – that wonderful and characteristically British code of personal honour.

As it happened, the period of my membership of the House of Commons turned out to be the most interesting of all the periods of similar length in the whole history of the British Parliament, including as it did the demise of the Crown in 1936, the accession and abdication of Edward VIII, the Coronation of King George VI, a period of extraordinary complexity and difficulty in international affairs, the Second World War, the abandonment of the Indian Empire, and the nationalisation of great industries which had been built up by competitive private enterprise.

To the back-bencher in the House of Commons, more especially to one like myself who had come into it from a so different environment, it was of fascinating interest to watch the turning over of these pages of history, and apart from their historic importance these years have left behind many vivid memories. That dismal day in January 1936 when I watched the funeral procession of George V passing by to the mournful strains of the pipes, the coffin followed on foot by Edward VIII and great national figures of war and peace: the wonderful skill of Stanley Baldwin as he guided the House of Commons and the country during those anxious days of the abdication of King Edward: the marvellous pageantry of King George's coronation in Westminster Abbey: the anxious listening to Neville Chamberlain's latest reports from Germany: the declaration of war: the air-raid warnings and the temporary adjournments of the House on the intimation of 'imminent danger': the transference of sittings to Church House: the sight of what had been the House of Commons after its destruction on 10th May 1941: the punctuation of London life by the sounds of sirens, gunfire and bomb explosions: the strange metamorphosis of tube stations into dormitories: the citizens of London going about their daily work, picking their way amongst heaps of rubble and lines of fire-hose. During the war period I stayed usually in the Athenaeum until the hours of sitting were altered from 11 a.m. to 4 p.m. when it became possible to travel daily by train, subject to delay from bomb craters on the track. One day I spent 8 hours in the train. A break came when on l7th October 1940 I suffered a fracture to my right tibia at Euston Station during an air-raid. After a fortnight in hospital, I was conveyed home by ambulance on 29th October. A bed was rigged up in my library on the ground floor and there I remained peacefully recuperating until the end of January: peacefully apart from the occasional sounds of bombs and gunfire. It was somewhat trying when the sound of a distant bomb was followed by another and another distinctly nearer, rousing speculation on the possibility of one of the series hitting Dalny Veed. Nothing of the kind happened, however, until the evening of 28th November when my nurse was interrupted in her work of tidying me up for the night by a tremendous explosion accompanied by the tinkling of glass and the pouring into the room of a cloud of soot from the chimney. My wife rushed in to see that I was all right and then into the kitchen where a maid had been bowled over by the blast. A crowd of people, members of the Home Guard and others quickly assembled to inspect the damage, Dalny Veed being the first house in the neighbourhood to suffer from any enemy action. Actually, the damage was much less than it might have been, most of the windows were blown out, doors fractured and plaster cracked, and the absence of glass in the windows meant a certain amount of discomfort during the cold winter months when it was impossible to have them repaired.

Incendiary bombs were rather a nuisance. One evening I counted 62 blazing in a straight line along the hillside to the eastward. Another time five dropped in the garden of Dalny Veed, without, however, doing much damage, except that one destroyed a valuable and valued bed of young plants of shrubs, seedlings and cuttings. One was a dud and after it was rendered harmless, I was shocked to find, neatly engraved on its magnesium body the initials, not A.H. the initials of Adolf Hitler but G.K. I told my friends that it was this incident that caused me really to have a down on the Führer. As war went on a considerable number of bombs were sprinkled over the neighbourhood, due in part, I suspected, to the effectiveness of a fake aerodrome constructed close to Dalny Veed with the object of attracting enemy bombers away from a neighbouring aerodrome. In the later stages of the war, we saw to the south an occasional doodle bug (V.l) travelling towards London. A few miles to the South of Dalny Veed was a great American aerodrome with about 4,000 men, and it was a grief to us when we learned one day that the Commanding Officer, a personal friend, had been lost in one of their raids on Germany. He had told us that it was a rule of A.A.F that

Commanding Officers must take part in raids in their regular turn. Though that showed a highly commendable spirit, I wondered if it were really a sound policy to extend equal risks to persons in such key positions.

A complication arose when in 1938 I received a warm invitation from a group of socialists in the University of Glasgow to come and take part in a debate upon the government's foreign policy. From my experience in the House of Commons I had already developed strong objections to all open debates upon our relations with foreign countries. The Secretary of State for Foreign Affairs for the time being, who alone had at his command full knowledge of all the factors concerned, was to a great extent muzzled by that very knowledge. Other Members without these trammels were apt not merely to express entirely misleading opinions, but also to use language liable to cause disastrous reactions on the part of proud and patriotic foreign peoples. Accordingly, I refused absolutely my Glasgow colleagues' invitation and attention was drawn in the local press to this deplorable conduct of a Member of Parliament who refused to discuss an important section of government policy with his constituents. When publishing a justification of my behaviour I expressed the view that a most desirable reform of the procedure of the House of Commons would be to set up an all-Party committee on foreign relations where foreign affairs would be debated in secret so long as any matters of delicacy were at issue.

The dissolution of Parliament in 1945 at once raised the question as to whether or not I should stand again. On the one hand I had become disillusioned regarding my qualifications as a parliamentarian. On the other hand, was the danger that the seat vacated by me might quite possibly be taken by a socialist, while if I stood again there would surely remain a sufficiency of votes from my record poll of ten years earlier to give me a good chance of retaining the seat for my party. I eventually decided to be a candidate once again: when I received the report that on the first count I was at the bottom of the poll I lost interest in the matter, until there came the surprising news that the final count brought me out at the top!

A lesson already driven into my mind during the preceding Parliament was that parliamentary democracy, excellent in many ways as a form of government in normal times, becomes quite impossible in times of great national emergency. During the emergency of the World War, Parliament had no doubt continued to debate and discuss but the actual power had been concentrated in the hands of one man, Winston Churchill, aided in the details of government by his self-chosen advisers. So also in the U.S.A.: its war activities were similarly dominated by a benevolent dictator, Franklin D. Roosevelt, as also in other great powers – Stalin, Hitler, Mussolini. In every case, government was for the period of the emergency, a virtual autocracy.

After the Labour victory of 1945, in spite of the continuance of the national emergency, there was no longer a virtual autocrat at the head of the Cabinet, but the disparity in numbers between the two principal Parties was almost the same as during the preceding decade: 393/189 against 387/154. What made the disparity much more dangerous was that the new government was imbued with socialistic ideals that involved revolutionary changes in those relations between capital, management, and workers, under which our country had attained a position of prosperity and leadership among the nations of the world out of all proportion to its size and population; a position attained mainly through the hard work of citizens of outstanding ability in the fields of commerce, industry and applied science, and retained by continued effort backed by military and naval power. The now predominant party was all out against individual pre-eminence whether in ability, industry or income. Nature's dictum that no two individuals are born exactly equal must be defied: those who seem to be outstanding in ability, industry and earning power must be repressed. The ideal must be the nearest possible approximation to equality for all in the matter of privileges or remuneration. The intellectual ability from which spring great industrial developments or the organisation of great business concerns must on no account be regarded as being on a higher level than the physical ability to do the routine work of an ordinary labourer. I will not discuss the results which must automatically follow government along such lines in the case of an island community dependent for its very existence upon its success in competing in the markets of the world with countries in which private enterprise has full scope. All this will one day be recorded by a future Gibbon[169] when he writes 'The Decline and Fall of the British Empire'!

My parliamentary career and that of several others came to an end with the abolition of the university franchise by the Attlee government. I had, I confess, no great confidence in its persistence. Among parliamentarians there was always the suspicion that the university representative was apt to be independent minded and liable to speak and vote without due regard to party discipline. And among the outside public there was the feeling that the university seat was liable to be made use of on occasion to provide an easy entrance to Parliament for one who though devoid of university qualifications would be a desirable acquisition to a particular political party. And finally there had come into being in recent years special machinery for dealing with the relations between the universities and government, in the form of the Committee of Vice-Chancellors, which kept under constant review the affairs of the universities and their needs, and the University Grants Committee appointed to keep the government in touch with the needs of the universities and to advise regarding their financial aid.

As regards my own work in Parliament, it was not long before I discovered my mistake in accepting the assurance that I should be given plenty of work on parliamentary committees dealing with scientific matters. In point of fact, nothing of the kind happened. I was invited to take charge of a Bill from the Lords dealing with Scottish matrimonial affairs, and to serve

upon a departmental committee on Local Government in Scotland, with neither of which subjects did I possess any special familiarity. At the same time there were set up many committees dealing with matters in which I had special interest and experience – the training of medical students, the organisation of hospitals and medical schools, the need of bringing our ancient type of school education into relation with citizenship in the world today, the scientific development of fisheries and in general the food resources of the sea, and I would have dearly loved to find myself made use of on such committees. No doubt, apart from formal parliamentary committees, I was able to do a little on informal committees. An invitation came from Sir Francis Fremantle[170] to join the medical committee presided over by himself and later Dr A.B. Howitt[171], the meetings of which were always of interest and, during the pre-war period, of particular importance when its advice was sought on the organisation of hospitals and other medical arrangements for coping with possible war emergencies such as the bombing of London. Then periodical meetings of the university Members were convened and presided over by Sir Ernest Graham-Little[172] and meetings of Members for the discussions of post-war policy by Sir John Wardlaw-Milne[173]. All these three groups, though without the status of formal parliamentary committees, were able to do really useful work and I enjoyed taking part in their activities.

The main duty of a Member of Parliament is – as the word Parliament indicates – to speak, to take part in debate, and for the reasons already given I determined to restrict my speeches to matters to which I happened to have special knowledge: education, health service, fisheries and the commercial exploitation of the food resources of the sea, the construction of a ship canal across mid-Scotland, war camouflage.

Education

In my various speeches and questions dealing with education, I urged that surely the main object of our expenditure on education was training in citizenship – the qualifying to be a worthy citizen in our complicated modern community and that important factors in such training were the development of the powers of observation by eye and ear and the correct interpretation of what is observed, the development of mental alertness, and the development of such qualities as morality, personal honour, discipline, loyalty, manners, cleanliness of person and thought, command of the English language and the ability to express oneself clearly in speaking or writing. Such qualifications were surely of far greater importance in the life of the citizen than mere information, much of it useless, or if not, easily obtainable when required from books or otherwise, and yet the conveyance of mere information on a great variety of subjects and its memorising took up a large portion of the time spent in an ordinary day school. Incidentally, I stressed the transcendant importance of the pre-school period in laying the foundations on which school education must rest, and also the fact that education did not terminate with the end of the school period. The mental development in a boy of 14 when allowed to take part in adult activities in workshop or office was most impressive as compared with what happened if his period in an ordinary day school was extended through the great formative period of 14 – 16. As likely as not these two extra years meant his leaving school completely stale and devoid of all keenness to go on learning.

Health Services

A large part of my speaking was devoted to urging the importance of maintaining the great voluntary hospitals in view of the all-important part they played in the training of the medical students. Under existing conditions, the leaders in medical and surgical practice in the particular area were glad to take wards and to conduct clinical teaching in an honorary capacity. It was of immense benefit to the student to have available not merely the skilled technique of a master of his subject, but also the inspiration to do his best to attain a similar position of leadership with its accompanying honour and material benefits. Under existing conditions, as I had learned during my long experience of medical students, the profession of medicine was successful in attracting the most brilliant type of student. Were this attraction weakened by the disappearance of the great leaders of medical and surgical practice from their teaching activities, these brilliant students would assuredly turn their attention elsewhere – to industry, commerce or professions in which their individual ability would find its due reward, or should they be determined to stick to medicine, would go overseas to other lands in which they could freely compete. In either case they would be lost to our own country, and not merely the profession of medicine, but also the advancement of medical science, in which Britain had played an out-standing part in the past, would suffer a disastrous blow. I reminded the House of some of these advances – the foundation of antiseptic surgery by Lister, the introduction of chloroform as a general anaesthetic by Simpson[174], the invention of vaccination by Jenner[175], the foundation of tropical medicine by Patrick Manson[176].

Fisheries

Outside the House of Commons, when Chairman of the Advisory Committee on Fishery Research, I had been somewhat critical of the generally accepted ideas regarding overfishing and its effect in diminishing the food-fish population of the sea. Although the evidence of this was incontrovertible in the case of flat fish and other bottom frequenting fish, I felt that the possibility of serious fallacy underlay the evidence as regards other food fishes. This fallacy affected especially the evidence provided by the greatly increased catches by trawlers during the immediate post-war period which was interpreted as indicating increase in the fish population during the war period, when the activity of trawlers was greatly diminished. The fallacy underlying this evidence lay in the fact that fish are extremely sensitive to vibrations in the water and in the possibility of their learning to avoid the oncoming trawl through the necessarily great vibrations that it caused in the sea water. There was thus the possibility that the increased catches after the war period were merely expressive of

the fact that the trawls now encountered generations of fish which had not learned by experience to avoid the oncoming trawl. Evidence in favour of this interpretation was provided by the herring industry where the catches – by drift net instead of by trawl – showed no evidence of the herring population having undergone any reduction through human agency. Another aspect of the fisheries problem related to the plankton or drifting fauna of the sea which provides the food of such fish as the herring and mackerel, of the whalebone whales, and of oysters and other shellfish. The seas around our coasts were rich in plankton and therein existed untold amounts of highly nutritious food material, at present entirely untapped by man, except indirectly through the fish and shellfish which subsist upon it. The plankton is not evenly distributed: it shows concentration in particular sea areas or at particular depths. I suggested, without effect, that the government should appoint a committee – whose membership should include not merely marine biologists, but also engineering specialists in the technique of extracting solid particles from liquid – to advise on the possibility of collecting plankton on a commercial scale and making it available for human consumption.

Still another aspect of the fisheries problem was the importance of developing our oyster fisheries. In various other countries oysters were not merely expensive delicacies for the well-to-do, but constituted an important element in the food supply of the ordinary people. The sea lochs of the west of Scotland, with their rich supplies of oyster food in the form of plankton and their freedom from contamination by sewage from large towns, provided ideal localities for the development of oyster fisheries by planting out young oysters above the level of the mud which had played an important part in killing out the once abundant oyster population of these lochs. My speeches on the development of fisheries were not confined to those of Great Britain. The fisheries of our overseas possessions constituted an asset of great potential value, and it was of importance to give every help to their development by the institution of research centres and otherwise.

Forth–Clyde Ship Canal

During my years in Glasgow with frequent journeys to and from Edinburgh, my thoughts had often recurred to the old idea of a ship canal, uniting the Firths of Forth and Clyde and cutting through the barrier formed by Great Britain across one of the great trade routes of the world – between Canada and Northern U.S.A. on the west and Scandinavia and the Baltic on the east. While President of the Royal Philosophical Society of Glasgow, I had arranged a symposium on the subject from which it transpired that, on the one hand, the engineering difficulties were by no means insuperable, and on the other that shipping interests in Scandinavia and Northern Germany were prepared to make use of such a canal provided the rates were reasonable. Accordingly when in April 1942 the ballot assigned to me the opportunity of speaking to a Resolution on the Preservation and Development of Scottish Industry, I decided to emphasise particularly the industrial developments which might be counted upon to follow the construction of a Forth-Clyde ship canal.

My speech on 14th May 1942 sketched the history of the industrial revolution in mid-Scotland which followed the work of that Glasgow University artificer James Watt in making the steam engine economically practicable, and the inauguration of steam navigation by Symington's 'Charlotte Dundas' propelled along the Edinburgh-Glasgow canal by a James Watt engine. I recalled how the 'Charlotte Dundas' was inspected by the American Fulton[177] and how he ordered an engine from Messrs Boulton & Watt and fitted it into the 'Clermont' on the Hudson river – the first American steam-ship. I referred too to important subsequent steps in the development of steam navigation which had taken place in mid-Scotland; the first use of compound engines; the first construction of a sizeable vessel of steel; the first turbine-driven passenger steamship; the first high-pressure steamship engine. So too in other industries, particularly textile and heavy, mid-Scotland had been the seat of many important steps in their development. The location of particular industries was, however, not necessarily permanent: they were apt to migrate to other localities where the conditions were more favourable, as was exemplified by the dying out of the textile industry in the west of Scotland as it developed in Lancashire. A similar fate might be anticipated for the heavy industries which meant so much for the Scottish midlands today. The surest safeguard for the future would lie in the development of a variety of light industries, and such development would surely come about in the region opened to water transport by the Forth-Clyde canal just as it had in the case of the Manchester ship canal.

The main obstacle in the way of constructing the canal was its great cost together with the fact that the return on the expenditure would be indirect – by the new developments of industry in the region traversed by it. It could not be expected to pay a direct dividend for many a day. It followed that there was no possibility of the money being provided by private capitalists: it would have to be provided by the state. 'Great Britain interposes a tremendous obstacle in the path of commerce between the new world on the one hand, and Scandinavia, the Baltic countries and Germany on the other. Ships using the proposed canal would not only save hundreds of miles of steaming and many hours of expenditure of fuel but would also evade the dangers of the Pentland Firth. Such a canal would present an irresistible attraction to commerce'. 'In my mind's eye I see ships travelling, not across the arid deserts of Suez, not through the jungles of Panama, but through a prosperous, happy countryside dotted with garden cities, producing materials which these great ships can carry away, and where these great ships can refuel'.

I urged that the government should make at least a preliminary investigation of the scheme and expressed the hope that the Secretary of State would not leave a blot on the Official Records of Parliament like that of Lord Palmerston[178] who, when answering a question on

the proposed Suez Canal, referred to it as 'One of the many bubble schemes which from time to time have been palmed off upon gullible capitalists'. There was at the moment little reaction to my speech: the value of the canal scheme in terms of votes was insignificant. However, public interest gradually developed. In July 1943, the *Glasgow Herald* reported that 'indifference and even hostility' to the scheme were rapidly disappearing. The proposal was a canal from Grangemouth to a point near Clydebank, a distance of 29 miles. The canal would be at sea level without locks, except the sea-gate at each end, thus evading the difficulty of providing an adequate and reliable supply of fresh water for the working of locks.

Apart from its advantage as a short and safe cut for transatlantic shipping, it would serve to link together ports on our east and west coasts. The export trade, on which our country subsisted, was dependent upon our costs of production being low and competitive, and one of the important factors against this lay in the cost of transport between our manufacturing centres. This would be reduced by the availability of the relatively cheap water transport between centres of production.

The availability of water transport to the Scottish midlands would also be of particular value to the existing heavy industries, for our manufacture of iron and steel had been entirely dependent upon iron and ore, and the canal would bring this ore straight to the blast furnaces close by. In the opposite direction the manufactured steel would be available by cheap water transport to the shipyards of the Clyde. The enormous importance of such a canal in time of war was obvious. On the one hand, it would be free from the dangers of attack vessels which had hitherto to travel between east and west coasts by the long and exposed passage round the north of Scotland, and on the other hand it would provide direct communication between Rosyth and the shipbuilding and repairing yards of the Clyde. In the Upper House, Lord Teviot proposed a resolution in favour of the canal and the Minister of War Transport agreed to appoint a departmental committee to investigate the matter and draw up a confidential report. The scheme had already gained the support of Unionist Scottish M.P.'s and in February 1944 an all-Party meeting passed a resolution in its favour. A Member remarked that it was the first time he had ever known Scottish Members to be unanimous about anything! Matters seemed quite hopeful. For a very brief period, unfortunately. Vested interests became seriously alarmed. Leith would steal trade from Glasgow: Glasgow's competition would ruin Leith; existing transport interests would be seriously injured. The Chairman of the Glasgow Chamber of Commerce denounced it as a 'wild cat's' scheme, the same epithet as had been applied to the Panama Canal. With existing business interests almost unanimously opposed, the position was hopeless, while public interest in Scotland was diverted to the two rival post-war schemes – the development of Prestwick airport and the construction of a road bridge across the Firth of Forth. And so the Forth-Clyde Ship Canal project once again fell asleep.

War Camouflage

The incidence of the Second World War during the period of my membership of the House of Commons gave me the opportunity of returning to my old interest, the utilisation in war camouflage of devices worked out by nature for rendering wild animals less easily recognisable and during the first three years of the war, I bombarded the Ministers concerned with questions drawing attention to the failure to secure adequate accord with scientific principles on the part of the artists who had been placed in control of war camouflage.

The tale had begun with my presence in 1895 at the opening of the Kiel Canal, recognised openly in Germany at the time as a preliminary move towards war with England. For the occasion, there had assembled an immense concourse of warships, each naval power contributing a squadron. What at once excited my interest was the fact that the vessels of Germany and of France were painted in a uniform grey colour – differing in shade in the two cases – obviously meant to have an obliterative function, to make the vessel less easily recognisable at a distance or in faint light. The fact, however, that the ships were painted of a uniform colour betrayed complete ignorance of these methods of obliterative coloration which had been evolved by nature in the course of countless ages for the concealment of wild animals for their enemies of prey, and which had been driven so forcibly on my attention by my observation of wild animals in the tropics of South America. Realising how greatly the obliterative effect of the ships' colouring could be increased by utilising nature's methods, I determined to do my best to secure their utilisation in the painting of our ships in the event of war. I prepared a short memorandum on the subject and on my return to Glasgow after the outbreak of war in 1914, forwarded it to Mr Winston Churchill who was then First Lord of the Admiralty. In due course I received a letter signed by Sir W. Grahame Greene[179], Secretary to the Admiralty, dated December 19th 1914, and saying 'I am commanded by My Lords Commissioners of the Admiralty to convey to you their thanks for the valuable information you have placed at their disposal and to inform you that the data and suggestions contained in your memo. have been communicated confidentially to the Fleet in a General Order'. The exact wording of my memorandum as circulated was as follows:

It is possible to diminish greatly the conspicuousness of ships at a distance by paying attention to the principles which govern the coloration of wild animals and render them so extraordinarily inconspicuous in their natural surroundings.

I Colour

Small animals such as insects, lizards, etc. are in many cases practically invisible when placed against their natural background on account of their tint and colour-pattern identical with that of their background. This principle of protective tinting is, however, of little importance in the case of large animals and it may safely be ignored entirely in regard to large objects such as

ships.

II Compensating Shading
If you take a large object, say a large sphere or ball, and paint it a uniform colour – say a reddish brown – and place behind it a screen painted with exactly the same colour, you will find on going back some distance that the sphere, instead of being inconspicuous, stands out from the background with the greatest distinctness (I assume the experiment is done in the open, with light falling from above – that is to say under natural conditions). The cause of this conspicuousness is that the brilliant lighting of the upper surface of the sphere gives it the appearance of being much lighter than the background, while the shadow causes the under surface to look very much darker. If you repeat this experiment with large animals instead of an artificially painted object, you will find, in many cases that the animal is almost completely invisible at a short distance when placed in front of a background of the same tint as itself. This is due to the fur of the animal being shaded in such a manner as to compensate for the different brightness of illumination on its back and on its belly. The back is darker (sometimes a very dark line runs along the middle of the back), the belly is lighter (often quite white), and the sides of the body are delicately graduated in shade between these two extremes.

This principle of compensating shading should be constantly borne in mind in painting the upper works of the ships. All deep shadows should be picked out in the most brilliant white paint, and where there is a gradually deepening shadow this should be eliminated by gradually shading off the paint from the ordinary grey to pure white. Big guns should remain the ordinary grey along their upper side (only a narrow strip, say 6 inches wide in the case of a 12 inch or 13.5 inch gun) and this should shade off into pure white along their lower surfaces. A neighbouring ship should be asked to advise as the work proceeds until the maximum of 'invisibility' is reached.

III Continuity of Surface
Observation of distant objects, e.g. ships, shows that their visibility depends upon their forming each a continuous spot or blotch standing out against a darker or lighter background. The continuous lines which form the boundaries of the object are the most important in rendering it conspicuous – e.g. in the case of a ship, the straight lines which form the outline of its spars and hull; in the case of an animal, the regular continuity of the outline. To counteract this, it is essential to break up the regularity of outline, and this can easily be effected by strongly contrasting shades. The same applies to the surface generally – a continuous uniform shade renders conspicuousness. This also can be counteracted by breaking up the surface by violently contrasting pigments. A giraffe or zebra or jaguar looks extra-ordinarily conspicuous in a museum, but in nature, when not moving, is wonderfully difficult to pick up, especially in twilight. Ring plovers, turnstones and many other birds and mammals, are rendered extremely difficult to detect, by the outline and surface being broken up by the patches of white.

This same principle should be made use of in painting ships. The outline more particularly should be broken up by patches of white. The masts should have irregularly edged bands of white surrounding them, the width of the bands, whether white or grey, being roughly about the same as the diameter of the mast. (It is important to break up the masts in this way, as doing so will help not merely to make the vessel less conspicuous but will greatly increase the difficulty of accurate range-finding). The bow, stern and upper line of the hull should also be broken up by very large patches of white, and what has been said naturally applies also to turrets and other parts of the upper works, fire control stations, etc., in every case destroy completely the continuity of outline by splashes of white.
(signed) J. Graham Kerr, September 24th 1914

In view of the controversial statements on the subject of camouflage after the close of the 1914-18 war, it is necessary to explain that the artists who were in control of war camouflage from 1917 onwards made use of the term DAZZLE for the breaking up of continuity of surface and outline by patches of strongly contrasting pigments, and the term COUNTERSHADING for what I called compensating shading. Both of these terms were borrowed from Thayer[180].

After the circulation of my 1914 memorandum, I was fairly confident that the painting of our warships would proceed along correct lines, an elementary knowledge of the scientific principles involved having been widely spread amongst service personnel by my very simply worded statement. But alas! My confidence turned out to be misplaced, for along with the memorandum was circulated the ominous note, 'The trial or adoption of the proposals made therein is left to the discretion of Flag Officers, etc. concerned.' There was no suggestion of special officers being appointed to see that the camouflage was properly carried out on an organised system. The natural result was a complete lack of uniformity in carrying out the coloration of the individual ships which varied according to the reaction of the Flag Officers or others concerned. To some, the idea that the colouring to which they were accustomed should be replaced by a ridiculous patchwork seemed simply an outrage. Those who took it more seriously and did endeavour to paint their ships in accordance with the memorandum were apt to fail in particular details such as the scale of the patchwork or the violence of the contrast between the pigmentation of the patches. There seemed also a tendency to forget that the diminution of visibility was of importance not merely as regards the ship as a whole but still more so as to the details of its structure.

The sudden appearance of dazzled warships all over the world in 1914-15 naturally attracted the attention of everyone interested in shipping. There was much talk of it in Glasgow, while private information came to me about the excitement among service people in the Mediterranean and how our troops in Gallipoli were

mystified by the vessels anchored off-shore, the dazzle painting making it difficult to see how individual ships were heading. In Bermuda, during the winter of 1914-15, Abbot H. Thayer, the originator of the terms dazzle and countershading, at once recognised that the camouflaged ships were more or less foozled attempts to carry out coloration in accord with the scientific principles of animal coloration with which he was so familiar. Being strongly pro-British, he decided to offer his services to our government and actually came over to this country to do so. Armed with recommendations from Professor Poulton[181] of Oxford and myself, he endeavoured to get in touch with our authorities but failed entirely. He found them, as he said, surrounded by a quite 'impenetrable net of courtesy'. As time went on it became obvious that the Admiralty's interest in dazzle was fading out in view of the divergent reports on its utility, and I attributed this to the frequency with which the suggestions in my memorandum were not carried out effectively. This in turn made me feel it desirable to supplement my first memorandum by one less abbreviated. Accordingly I sent to the Admiralty in July 1915 a fuller communication (Admiralty No. DO 3126/15) and again in December 1915. In these I expanded the wording of my original memorandum so as to make its meaning still more clear and drive home its contents still more forcibly.

I again emphasized that a uniform coloration was necessarily wrong, as except on very rare occasions it caused the ship to stand out clearly as a continuous blotch or patch and that the only method of correcting this was to break up the continuity of surface and outline into areas of violently contrasting shade or tone. I also met the criticism which had come from the Admiralty in a letter dated 9th July 1915, that 'the strong variations of light and surroundings that are liable to be experienced at sea, render it necessary to modify considerably any theory based upon the analogy of animals', by pointing out that such variations are quite trifling compared with those experienced by a dazzled animal such as a jaguar. I emphasized that the object to be aimed at was not so much complete invisibility of the ship as a whole, as the invisibility of the details of its upper works which on the one hand betray its character and on the other hand by their perspective enable the range taken to judge how the ship is heading, an important matter to the gun layer when aiming at a ship under way. In the matter of such details, I emphasized the particular importance of countershading in the case of guns and torpedo tubes, and in the case of deep shadows which should be diminished so far as possible by the use of brilliant white paint. The importance of scale in the dazzle patchwork was again emphasized, a small scale patchwork becoming at a distance no better than a uniform colouring.

I failed to see any immediate result of these communications: the Admiralty apparently adhered to a decision (letter of 9th July 1915) to use a system of colouring which ignored the dazzle principle. It was not until the autumn of 1917 that a naval friend reported to me that my system of camouflage had reappeared but that it was said to be a new invention by an artist. It was in fact a very distinguished artist, Mr Norman Wilkinson[182], who succeeded in reawakening the Admiralty's interest in dazzle. He was placed in control of camouflage and was allowed to select his own staff of some 40 assistants. Accommodation for experimental work on models was provided by the Royal Academy and camouflage officers were appointed at the various seaports. My 1914 memorandum had to do with the camouflage of ships, but of course the visibility of other things of importance in war is determined by exactly the same factors and I made many attempts to urge this upon the authorities. Already in my letter of 5th December 1915 I had done this as regards guns, armoured cars, uniforms. The flat top of the service cap ignoring scientific principles and reflecting the light formed an ideal target for the enemy marksman in the case of troops lying prone with their heads towards the enemy.

While aeroplanes against a background of sky provided a problem of great difficulty, the construction of the wings of transparent material and the use of brilliant white for the under surface as in sea birds which had to be concealed in flight from their fish prey were recommended. A letter to Mr Lloyd George, dated 28th September 1916, emphasized these recommendations about aeroplanes and in addition urged that special planes for night use should be painted on their lower surfaces with matt black varnish. On clear nights without a background of cloud or haze they would be completely invisible, even when in the beam of a searchlight. The letter of acknowledgement, dated 10th October, informed me that 'its subject matter is forming the basis of detailed investigation'. During the war my various communications on the subject of camouflage were, of course, secret, but after its close I published a general statement on the subject in a letter to *The Times* (May 6th 1919). My letter was followed by an outburst of publicity which must have convinced the general public, knowing nothing of the inner history of the matter, that dazzle was the invention not of nature but of Mr Norman Wilkinson.

Eventually I received a letter from the Admiralty, dated 20th October 1920, saying that 'several claims in respect of dazzle painting, etc., are receiving the consideration of the Royal Commission on Awards to Inventors' and suggesting that I might apply to them. Though I had made it quite clear that what I was interested in was not a pecuniary award but official admission that 'dazzle' was no invention by an artist but simply an application to war camouflage of certain recognised scientific principles, I decided to submit my application. The Commissioners – amongst whom there was no biologist – in their report made no pronouncement on the *origin* of dazzle. On the one hand, the chairman ruled that they were not concerned with the matter of personal controversy (Minutes, p. 106). On the other hand, the evidence given before the Commissioners and duly recorded in the Official Minutes contains statements surely calculated to make their confusion of ideas worse confounded. As regards the term 'dazzle' invented by Thayer and used by him in connection with animal

camouflage long before the war, 'Admiral Greatorex invented the word,' 'the word was chosen for the purpose of contrasting it with camouflage'! As regards the idea of applying dazzle to the coloration of ships, 'the idea suddenly came to him (Mr Norman Wilkinson) on the 26th April 1917, as he sat in a carriage'. No mention of his experience in the Mediterranean during the outburst of dazzle in 1915. The function of dazzle 'has nothing to do with visibility' (page 5). On the other hand the Royal Commission very properly recommended an award to Mr Norman Wilkinson for his work in getting dazzle put into effect on a large scale in 1917. During the period between the wars, public information about war camouflage continued to be dominated by the artists. Mr Norman Wilkinson's article in the *Encyclopedia Britannica*, Fourteenth Edition, 1929, says in regard to the dazzle painting of ships in 1917, 'it embodied entirely new ideas in sea camouflage' and makes no mention of its experimental employment in 1914-15 nor of its biological foundations.

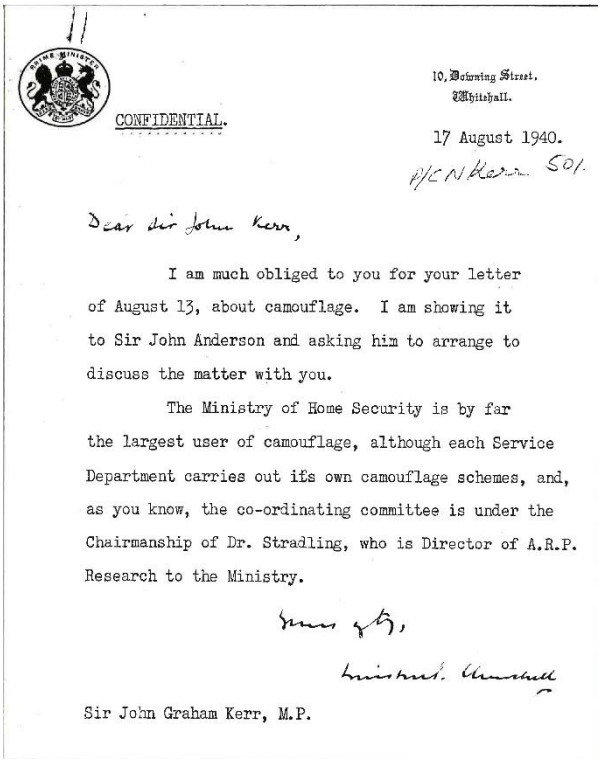
With the approach of World War II, I fondly imagined that I would at long last be able to secure that camouflage should be put under scientific control, but it was not to be, and later it was most frustrating to see in the Malayan campaign the highly successful adoption of my dazzle painting principles by the Japanese. A letter to the Prime Minister in March 1936 served merely to start a tiresome and controversial campaign – involving many letters to Ministers and some 40 questions in the House of Commons – which resolved itself into a practically single-handed conflict between myself as representing the scientific side of camouflage and the artists who remained in official control. As there still continued the official denial that naval dazzle was identical with or had anything to do with what had been set forth and promulgated to the Fleet in 1914, I agreed to allow the publication *verbatim* of my original memorandum (*Nautical Magazine*, July 1940). I should have mentioned that before the actual outbreak of war there had appeared in *The Times* an admirable article – with which I personally had nothing to do – upon camouflage which was obviously written by someone with full command of the scientific principles involved, and might well have been taken as a guide by the officials responsible. Nothing of the kind happened and the artists continued on their way.

Even more to be deplored than the answers to questions in the House – evasive, misleading, or grossly inaccurate – was the consistent barring out of scientists from positions in which they could exert direct influence upon the practical application of camouflage. I was personally barred out from the membership of any camouflage committee; from appearing before any such committee; from interviewing the Prime Minister; from appearing as I requested before the War Cabinet. In view of ineffective efforts in such directions, I concentrated upon trying to infiltrate into the camouflage organisation someone highly qualified in the scientific aspects of camouflage, and had the good fortune to find available one of the chief living authorities upon the camouflage of animals, Dr Hugh Cott[183] of Cambridge (Fig. 15). Dr Cott was already known to the authorities. He had lectured with much acceptance at the Staff College, Camberley, and had also delivered an impressive exposition of the scientific principles of camouflage to Members of Parliament in the Grand Committee Room, Westminster Hall. At the close of this address, he was invited to an interview with Sir Kingsley Wood[184], Minister for Air. An outcome of this was his being entrusted with the task of camouflaging an area containing objects of military importance in one of our chief aerodromes. His work completed, it was flown over by the authorities –military and ministerial – and pronounced unanimously to be extraordinarily effective. At last all seemed 'set fair' and I visualised Cott's immediate incorporation into the service and his skilled technique being made available to the country. Nothing of the kind happened, and on my asking why, there came the astonishing reply that though Cott's work at the aerodrome in question had been excellent, the cost had been too great. This in spite of the fact that he had been practically authorised to use his own judgment as to what was necessary in the way of expenditure. However, Cott was given another chance – the obliterative coloration of an ordinary large, 9.2 inch coastal defence gun! Such an object catches the eye at once, its long cylindrical form standing out conspicuously whatever its surroundings. The effectiveness of the result achieved by Cott was of the same order as that of his former experiment. An airman provided with a vague indication that the gun was situated near a particular railway station failed entirely to find it. Even when the precise location was 'pin-pointed' it was only when the plane came down to 2000 feet that the gun became visible. I was able to show a number of photographs of the gun taken from the air to General Dill[185], C.I.G.S., and to several other highly-placed officers and they were one and all greatly impressed. The General having at last found the gun remarked that he seemed to see right through it.

So again all seemed 'set fair'. Cott had worked out and solved the problem of how a gun ought to be camouflaged to secure the most perfect obliterative effect, and it would obviously be within the capacity of ordinary workmen to paint other guns as exact copies of Cott's gun. As I could see no evidence of this being done, I put a question in the House of Commons (8.1.42) asking the Minister 'whether any steps were taken to secure the immediate extension of this protection to every gun in the service, ashore or afloat; and whether he will inform the House if in the public interest, what obstacles have prevented this from being carried into effect'. The Minister replied, 'I can assure my hon. friend that the Army has taken full advantage of the biological knowledge of the specialist referred to and that no obstacles have been placed in the way of its proper application'. Apart from the mere untruth involved in this answer, it was of course obvious that not a mere lack of obstruction, but actual constructive orders on the part of those in control of camouflage were required.

Fig. 15. Hugh Cott. (Photo: Department of Zoology Archives/University of Glasgow)

I had already, in a speech in the House (23.10.41), drawn attention to the wrongly camouflaged guns in one of H.M. ships and said I had used exactly the same words of criticism of a camouflaged gun on a previous occasion – that particular occasion being in a letter to the Secretary of the Admiralty, dated 18th July 1915! In my speech I made it clear that my attacks on the inefficiency of our war camouflage related entirely to the failure to take full advantage of the potentialities of paint in this connexion. There were, of course, many other methods of misleading the enemy in the matter of objects of military importance – hiding them under an innocent-looking covering; distracting the enemy's attention by providing dummies; eliminating shadows by substituting sloping or vertical walls, and so on. Such types of what might be called structural camouflage had been used most effectively. The supreme advantage of paint as a means of camouflage was its transportability. A covering of vegetation harmonising with the surroundings may form a perfect camouflage for a small ship moored in a creek, or a stationary tank, but a moving object must have a means of camouflage which automatically accompanies it, and such is provided by properly applied paint. Although the immediate reaction to questions in the House as to letters to Ministers was uniformly depressing, there did come about a gradual improvement in service camouflage, especially as regards ships (Fig. 16). The need of violent contrast in the elements of the dazzle patchwork and their being drawn out horizontally rather than vertically, became more and more clearly appreciated. One of the gratifying features was the acceptance at long last of the utility of white as the element in the effective camouflage of ships. I had stressed this in my original memorandum of 1914, but its use was neglected by the artists in charge, and a letter to the First Lord, dated 9th September 1939



10, Downing Street,
Whitehall.

CONFIDENTIAL.

17 August 1940.

H/C N Kerr 501.

Dear Sir John Kerr,

I am much obliged to you for your letter of August 13, about camouflage. I am showing it to Sir John Anderson and asking him to arrange to discuss the matter with you.

The Ministry of Home Security is by far the largest user of camouflage, although each Service Department carries out its own camouflage schemes, and, as you know, the co-ordinating committee is under the Chairmanship of Dr. Stradling, who is Director of A.R.P. Research to the Ministry.

Yours sincerely,

Winston S. Churchill

Sir John Graham Kerr, M.P.

Fig. 16. Letter from Churchill to JGK concerning camouflage. Image courtesy of University of Glasgow Archives & Special Collections, John Graham Kerr collection, GB248 DC 006/501. Reproduced with permission of Curtis Brown, London on behalf of The Estate of Winston S. Churchill © The Estate of Winston S. Churchill.

brought the reply that 'The instructions to ship-owners are that all merchant ships should be painted in an even colour with a matt surface, avoiding light shades, and in particular, white, which shows up very clearly at night' – the actual fact being, of course, that against a background of sea or sky, in normal circumstances, white is the least conspicuous of all colours. A port authority which painted its navigation buoys white instead of red or black would be regarded as insane.

I have told in outline the tale of my efforts to secure that our country's war camouflage should have the advantage of scientific guidance. I have confined myself in the main to naval camouflage but, of course, my efforts extended to land camouflage, the effectiveness of which is ruled by precisely the same set of principles. Aerodrome hangers, oil tanks, buildings, vehicles, aeroplanes, uniforms, all formed the subject from time to time of communications to government departments or of questions in the House of Commons. It was in regard to military camouflage on land that scientific method was at last able to make itself really effective. Cott was eventually given a commission in the Royal Engineers to do camouflage, but instead of being kept at home to influence its central administration, he was sent overseas and became Chief Instructor in Camouflage to the army in North Africa. Soldiers who went through that campaign are well aware how effective its camouflage methods became and what an important part it played in the attainment of victory.

When parliamentary duties no longer made calls on my attention and when the Second World War was over, and lands and seas were free from fear of attack, we made good use of the summer months in travelling abroad and seeing other countries than our own. Our first adventure was Finland where I represented the Royal Society at the Tercentenary Celebrations of the Royal Society of Finland. My wife, in full court dress (as commanded) listened to speeches in languages unknown to us – then one in German, which we could follow and find interesting. The hall was filled by scientists from many countries all decorated with orders and insignia: only the British scientists had nothing of that sort to mark the recognition of their services. Still, undecorated as I was as the representative of the Royal Society – the greatest scientific society in the world – I was given the first place and every possible consideration and token of respect. It was interesting to find amongst the people of importance introduced to us Scottish names, familiar to us – Ramsays – Brown or Brun.

In other years we sailed down the east coast of Africa stopping at Mombasa and Nairobi – Dar-es-Salam and Zanzibar – and at the Cape where we had relations with whom we stayed. Then to Germany where we stayed several times with Sir Brian Robertson[186] (now Lord Robertson) then U.K. High Commissioner of the Allied High Commission in Germany. He had married a cousin of my wife and we were most delightfully at home in their house – in Germany and later in Egypt where he was Commander in Chief of the Middle East Land Forces – with them we came in touch with most interesting people – many of them in important posts in the army or representing it in governments.

A quite important incident gave me pleasure and so I relate it. Lord Mountbatten was a guest while we were with them at Fayid on the Suez Canal – the Robertsons and Lord Mountbatten were to attend an official dinner at Ismailia – they were to leave some time before our dinner hour - however, when we appeared we found the official party still there and waiting for us because Lord Mountbatten would not leave until he had greeted me – he flung his arms round me, hugged me to his heart, saying ‘we are both Honorary Fellows of Christs’ and Christs’ Fellows must be great men for there are only four of us’ and that was true, there were at that time only he and I, Sir Charles Darwin[187] and I think a Bishop.

On those words spoken by that distinguished sailor were tied together the memories of my life early and late, that are never far from me, and on that note of unbroken friendship I bring to an end this picture of my life which I have named *A Gallery of Memories* (Fig.17).

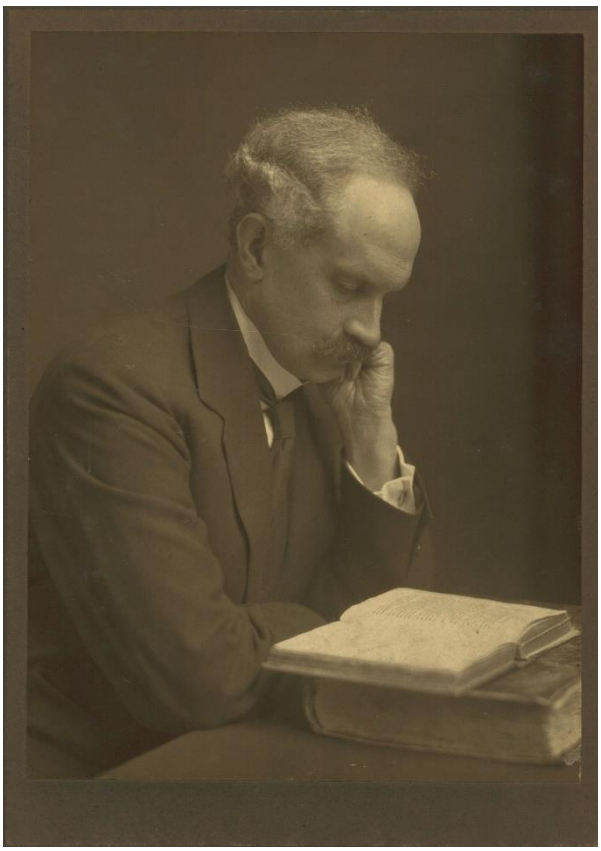


Fig. 17. JGK reading at his desk. (Photo: Department of Zoology Archives/University of Glasgow)

APPENDIX

Notes compiled by the editors

Some individuals are mentioned more than once in the text. For simplicity, we have not generally given a number for every time they are mentioned, only the first.

1. JGK's father James Kerr wrote: *The Domestic Life, Character and Customs of the Natives of India* (1865); *The Land of Ind (or Glimpses of India)* (1873); *Essays on Castism and Sectism* (1879); and *Carlyle as Seen in his Works* (1887).
2. Painted in 1872.
3. Alexander Dickson (1836-1887); Scottish botanist, latterly Professor of Botany at Edinburgh University and keeper of the Royal Botanic Gardens Edinburgh
4. "Zoophyte" is an older term for animals with characteristics similar to those of plants (fixed to the substrate; branching structure) and previously thought to be intermediate between animals and plants. *Sertularia* is a genus of hydroids (phylum Cnidaria).
5. Sir Patrick Geddes (1854-1932) was a botanist, zoologist, geographer and sociologist, remembered now as a pioneer of town planning.
6. J.M. Macfarlane (1853-1943) became Professor of Botany at the University of Pennsylvania and wrote books on evolution.
7. Sir Isaac Bayley Balfour (1853-1922) was Professor of Botany at the University of Glasgow, then Oxford, then Edinburgh, where he also became Regius Keeper of the Royal Botanic Gardens, directing considerable re-organisation.
8. William Jackson Hooker (1785-1865) moved from the University of Glasgow to become first Keeper of the Royal Botanic Gardens at Kew; he was succeeded by his son, Joseph Dalton Hooker (1817-1911), one of Darwin's key supporters.
9. James Geikie (1839-1915) was an authority on the Ice Ages.
10. Sir William Turner (1832-1916), author of the compendious *Atlas of Human Anatomy and Physiology* at age 25, became Professor of Anatomy at Edinburgh, and later University Principal. William Rutherford (1839-1899), Professor of Physiology, Edinburgh, for 25 years. Arthur Conan Doyle's fictional Professor Challenger, in *The Lost World* and other books is said to be partly based on Rutherford.
11. Peter Tait (1831-1901) was a mathematical physicist of high research productivity: he is estimated to have completed a research paper every 44 days on average. He collaborated with Lord Kelvin at the University of Glasgow on a series of textbooks. Denley and Pritchard (1993) reviewed his 13 papers on the paths of spherical projectiles, including golf balls (*The Mathematical Gazette* 77, 298-313).
12. *Marmion: a Tale of Flodden Field* (1808) - a historical romance in verse.
13. In fact, there have been 27 sightings of walrus in U.K. waters over the last 130 years, most recently in 2021.
14. J.C. Ewart (1851-1933) held zoology posts in University College London and Aberdeen University, before Edinburgh. His paper on the skate electric organ was published in the *Philosophical Transactions of the Royal Society, London* 179, 399-416 (1888).
15. Sir John Murray (1841-1914) is recognised as the father of modern oceanography. He served four years as naturalist on *The Challenger* expedition, and later took over directing the publication of its reports (50 volumes, 1896). The Scottish Marine Station, the first of its kind in the U.K., was a floating barge in the drowned tidal quarry of Granton, near the port of Leith. The station moved to Millport on the isle of Cumbrae in the Clyde estuary in 1894, as the base of the Scottish Marine Biological Association. J.T. Cunningham (1859-1935) was known for experiments on flatfish which he thought (incorrectly) demonstrated Lamarckian inheritance.
16. He read the advert in February 1889 at the age of 19, and was hardly "a properly qualified naturalist". But neither was Darwin at 22 when he joined *The Beagle*.
17. In his book, JGK cites Charles Waterton's *Wanderings in South America* (1825), Charles Darwin's *Voyage of the Beagle* (1839) and Henry Walter Bates's *The Naturalist on the River Amazons* (1863). Alfred Russell Wallace's book on South America was *A Narrative of Travels on the Amazon and Rio Negro* (1853).
18. The drawing is on page 138 of Kerr, J.G. (1950). *A Naturalist in the Gran Chaco*. Cambridge University Press.
19. *Pontederia* is a genus of aquatic plants endemic to the Americas.
20. Burmeister (1807-1892) was a German zoologist who spent the latter part of his career in Argentina, establishing the zoological collections of the national museum. He described many new species, especially amphibians and reptiles.
21. Gardener (or leaf-cutter) ants use leaves as nourishment for the highly modified fungi which grow in their nests. The adult ants cut and transport leaves, and keep the nests free of pests and moulds. Ant larvae feed on the fungal hyphae.
22. Spanish common name for the capybara (*Hydrochoerus hydrochaeris*), the largest species of rodent.
23. *Pistia* is a genus of aquatic plants in the arum family (phylum Araceae). Common name, water lettuce.
24. The giant water lily *Victoria regia* is the second largest in the family Nymphaeaceae, with leaves up to thee metres in diameter.

25. IUCN (International Union for Conservation of Nature) recognises three species of *Rhea*, the South American ratites (flightless birds), distantly related to ostriches. In the Chaco, most likely the greater rhea *R. americana*, a little smaller than an emu.
26. There are many species of South American deer, so it is not clear which JGK saw. The Spanish for deer is ciervo, so it is unclear why he gives cierbo.
27. This is most likely one of 16 species in the genus *Brachygastra*, the only kinds of wasps to collect nectar and make a kind of honey in their nests.
28. In his Gran Chaco book, JGK writes that he was able to transport home a limited part of his collections, especially bird skins. A few of these remain extant in the Hunterian Zoology Museum. The birds were reported as Kerr, J.G. (1892). On the avifauna of the lower Pilcomayo. *The Ibis* 4 (6th series), 120-131. The specimens left on *The Bolivia* never reached him.
29. Sir Edwin Ray Lankester (1847-1913); eminent teacher of zoology, researcher mainly on invertebrates. Based at University College London, then Oxford.
30. Philip Lutley Sclater (1829-1913) was a lawyer and zoologist, mainly interested in birds. Secretary of the Zoological Society of London for 42 years, and founder editor of the journal *The Ibis*.
31. Sir Arthur Shipley (1861-1927) was a Cambridge zoologist, tutor in the natural sciences from 1892 and eventually the university's Vice-Chancellor.
32. William Paley (1743-1805) was an English clergyman and philosopher. His *Natural Theology* (or *Evidences for the Existence and Attributes of the Deity*) (1809, published after his death) used the analogy of the watchmaker, taken up later by Richard Dawkins in *The Blind Watchmaker* (1986).
33. Jan C. Smuts (1870-1950); South African statesman, military leader and philosopher. After legal training at Cambridge and London, returned to South Africa in 1894 and became a key figure in the country's politics.
34. Sir Edward Burnett Tylor (1832-1917); an ethnographer who helped define the scope of anthropology. Believed human society underwent evolution from savagery to civilisation.
35. Henry Jackson (1839-1921), scholar of ancient Greek philosophy; became Professor of Greek at Cambridge.
36. Sir James George Frazer (1854-1941); Glasgow-born and educated social anthropologist interested in the origins of myths and religions. Famous for his book *The Golden Bough* (1840).
37. Alfred Newton (1829-1907); Professor of Comparative Anatomy at Cambridge; specialist in ornithology; wrote a four volume *Dictionary of Birds*.
38. Arthur Humble Evans (1855-1943); Cambridge lecturer in English history and economics, but also an ornithologist. Co-edited *The Ibis* with Sclater.
39. Sir William Somerville (1860-1932); Scottish-born and educated Professor of Agriculture, latterly at Oxford.
40. Sir Albert Seward (1863-1941) was particularly active in palaeobotany. Professor of Botany at Cambridge.
41. Sir Arthur Tansley (1871-1955) was a pioneer of ecology: first president of the British Ecological Society and first chair of the Nature Conservancy; Vernon Herbert Blackman (1872-1967) was a British botanist.
42. Lord Ernest Rutherford (1871-1937); New Zealand-born physicist, pioneer of atomic and nuclear physics; Nobel laureate.
43. Sir Joseph John Thomson (1856-1940); physicist, famous for discovering the electron and the existence of isotopes.
44. John Ray (1627-1705); the most prominent English naturalist of the 17th century, a pioneer of taxonomy.
45. Sir George Stokes (1819-1903); Irish-born physicist and mathematician, known for research on fluid mechanics.
46. William Henry Hudson (1841-1922); Anglo-Argentinian natural historian and ornithologist. Prolific writer of nature books, but also of fiction.
47. Sir Henry Hamilton Johnson (1858-1927); African explorer, botanist and colonial administrator. His name is associated with the scientific description of the okapi (*Okapia johnstoni*), a relative of the giraffe.
48. Sir Michael Foster (1836-1907); physiologist at University College London, then Cambridge. Known for teaching and administration rather than research. Secretary to the Royal Society and MP for the University of London. Sideline in the taxonomy of irises.
49. Adam Sedgwick (1854-1913) taught zoology at Cambridge, then Imperial College London. Not to be confused with his uncle of the same name, who taught Darwin geology but never accepted Darwin's ideas on the origin of species.
50. William Bateson (1861-1926) was the first person to use the term genetics, and was a promoter of the ideas of Gregor Mendel on heredity; after his early career at Cambridge, Bateson became Director of the John Innes Horticultural Institution. Hans Friedrich Gadow (1855-1928) was a German zoologist who spent most of his career at Cambridge, specialising in ornithology. Sir Sidney Frederic Harmer (1862-1950) was keeper of the zoology museum in Cambridge, then moved to the Natural History Museum, London.
51. Francis Maitland Balfour (1851-1882); born in Edinburgh, higher education at Cambridge. The leading British comparative and evolutionary embryologist of his time. Tragically died on Mont Blanc, aged 30.
52. The chambered or pearly nautilus (*Nautilus pompilius*) is an oceanic cephalopod, native to the south Pacific. Cephalopods are now divided into two subclasses: Coleoidea - octopuses, squid, cuttlefish; and Nautiloidea - nautilus.
53. Published as Kerr, J.G. (1895). On some points in the anatomy of *Nautilus pompilius*. *Proceedings of the Zoological Society of London* 1895, 664-686.
54. There are eight species of South American horned toads, family Ceratophryidae, two of them native to Argentina: Gadow's specimen was most likely *Ceratophrys ornata* whose females can reach 16.5 cm long.

55. *Bufo marinus* (now *Rhinella marina*), the cane toad. JGK regards the name *marina* as misleading, but cane toads can be found foraging for invertebrate prey on sea shores in the tropics.
56. Now the Natural History Museum (NHM).
57. There are now 11 described species of bichir (genus *Polypterus*). Freshwater, lunged fishes. Now regarded as stem actinopterygians (ray-finned fishes). *Lepidosiren* and *Protopterus* are two of the three genera of extant lungfish (the third is *Neoceratodus*), all lobe-finned fishes in the class Dipnoi.
58. John Samuel Budgett (1872-1904) was still an undergraduate when he accompanied JGK to Argentina in 1896. As well as helping with the *Lepidosiren* work, Budgett researched frogs: Budgett's frog *Lepidobatrachus laevis* (Family Ceratophryidae) is named after him.
59. Mal de caderas is a chronic, sometimes fatal disease of horses, occurring in South America; caused by the blood parasite *Trypanosoma equinum*, transmitted by biting flies.
60. The New Australia Cooperative Settlement Association, led by journalist William Lane, was granted land by the government of Paraguay. Several hundred settlers arrived in 1893 and 1894. Much dissent within the colony led to its dissolution, but those who wished to stay were granted individual plots of land, and around 2,000 descendants now live in Paraguay. Anne Whitehead's *Paradise Mislaid* (1997) gives a full account.
61. Kerr, J.G., editor (1907). *The work of J.S. Budgett*. Cambridge University Press. Contains Budgett's zoological papers, a biographical sketch by Shipley and work by colleagues.
62. The genus *Morpho* includes at least 29 species of large Central and South American butterflies (family Nymphalidae): wingspans up to 20 cm, mostly blue and green on the upper sides.
63. Ground sloths of the genus *Megatherium* were as large as elephants: extinct as a result of human expansion about 12,000 years ago.
64. South American genus of large armadillos, extinct by about 11,000 years ago.
65. John Stanley Gardiner (1872-1945) was a specialist on coral reef biology.
66. Sedgwick's *Student's Textbook of Zoology* was published in three volumes 1998-1909.
67. John Peile (1838-1910) promoted the higher education of women, becoming President of Newnham College, Cambridge.
68. Charles Smart Roy (1854-1897); Scottish-born pathologist.
69. Sir George Paget Thomson (1892-1975); Nobel laureate for discovery of the wave properties of the electron.
70. Sir Francis Darwin (1848-1925); third son of Charles Darwin and Emma Wedgwood. Francis worked with his father on plant movements and insectivorous plants, and edited his father's papers.
71. Henry Sidgwick (1838-1900) was a prominent utilitarian philosopher. Co-founder of Newnham College for women, his wife became its Principal.
72. Igerna Brunhilda Johnson Sollas (1877-1965), known as Hilda, was a zoologist/palaeontologist with wide interests. Published results of work extensively until 1916 when she became a Christian Scientist and gave up actual science.
73. Sir William Bate Hardy (1864-1934); biochemist and physical chemist.
74. Erskine Childers (1870-1922); writer, politician. *The Riddle in the Sands* (1903) was one of the first spy novels, and predicted war with Germany. Childers was executed during the Irish Civil war.
75. Composed in 1894 by Felix McGlenn and Monroe Rosenfeld.
76. Ernst Karl Abbé (1840-1905); German physicist and optical scientist. Working at the Carl Zeiss AG Company in Jena, perfected the optical microscope via a series of innovations in design.
77. Arthur William Rogers (1872-1946).
78. Ernst Haeckel (1934-1918); foremost German zoologist of his time: promoted Darwin's ideas on evolution. Gifted artist. Marine biologist, embryologist, eugenicist. Unlike some others, recognised the contributions of Jewish scientists and artists.
79. Max Fürbringer (1846-1920); German comparative anatomist; devised the first phylogeny of birds based on anatomical features.
80. Richard Wolfgang Semon (1859-1918); German zoologist, with strong Australian links.
81. Hermann Braus (1868-1924); German comparative anatomist; worked on the evolution of the tetrapod limb.
82. Lord Balfour was a Scottish representative peer in the House of Lords and Conservative politician. Served as Secretary of State for Scotland 1895-1903.
83. Frederick Orpen Bower (1885-1925), Regius Professor of Botany at Glasgow until 1925. The Botany building is now named after him (and was built during his tenure).
84. Edward Jeremiah Bles (1864-1926) contributed to the book on Budgett.
85. Johan Christian Fabricius (1745-1808) was a Danish zoologist and student of Linnaeus. The 18th century's foremost entomologist, he named about 10,000 species and established the basis of insect classification. The Fabrician types rescued by JGK remain in the Hunterian Zoology museum to this day. For an account of Fabricius's interactions with William Hunter, see: Hancock, E.G. (2015). The shaping role of Johan Christian Fabricius on William Hunter's insect collection and entomology. In: Hancock, E.G. *et al*. (Editors). *William Hunter's World.* pp. 151-164. Routledge, London.
86. Robert Arnot Staig (1878-1963); Scottish entomologist; acted as curator of the Hunterian Zoology museum.
87. Staig, R.A. (1931-1940, 1931). *The Fabrician Types of Insects in the Hunterian Collection at Glasgow University*. Two volumes, Cambridge University Press.

88. Thomas Henry Huxley (1825-1895); self-taught English biologist and anthropologist. Populariser and defender of Darwin's theories. Had major impact on education, including his role in the Royal Commission (1876-1878) which led to the reform of the Scottish Universities via the Universities (Scotland) Act of 1889. The emphasis of his zoological teaching on comparative anatomy to the exclusion of study of living animals is often criticised.
89. Robert Herbert Story (1835-1907) was a Scottish Church of Scotland minister and divinity academic. Principal of the University of Glasgow 1898-1907.
90. William Hunter (1718-1783); Scottish physician and anatomist. Avid collector of zoological specimens, coins, minerals etc. His collections were bequeathed to the University of Glasgow along with funds to build a museum to house them. The original museum was built to adjoin the old Glasgow College on High Street. Along with the rest of the University, the collections were moved to the Gilmorehill campus in 1870. For a discussion of the original zoological collections and their fate, see: Reilly, M. (2015). William Hunter's zoological collections. In: Hancock, E.G. *et al*. (Editors). *William Hunter's World.* pp. 135-150. Routledge, London.
91. Laurence Austine Waddell (1854-1938); Scottish physician, explorer and linguist. Spent many years in India and developed heterodox ideas on human history. Made a large collection of bird skins, many donated to the Hunterian museum in 1894, and many still in the collection.
92. The Steven family owned the extensive Bellahouston estate on the south-west side of Glasgow during much of the 19th century. On the death of Elizabeth Steven in 1892, a Trust became operational which aimed to use revenues from the estate for charitable, religious and educational purposes in greater Glasgow. The Trust is still active in 2023. £500 in 1903 would be worth about £77,500 in 2023, so, with the University matching the grant, JGK had the equivalent of £155,000 in to-day's money.
93. Sir Donald MacAllister (1854-1934); mathematician, physician and linguist (could speak 19 languages, apparently). Principal, University of Glasgow 1907-1929, then Chancellor.
94. Sir John James Burnet (1857-1938), son of architect John Burnet. J.J. Burnet was responsible for many prominent buildings in Glasgow and London.
95. The Rockefeller Foundation was founded in 1913 with a mission to find solutions to public health problems such as hookworm, malaria and yellow fever.
96. At the four ancient Scottish universities, the rector is elected every few years by the students, and is supposed to represent their interests; the Rector's formal role is to chair the university's governing body, the court. In December 1923, the recently elected Rector was the Conservative politician Frederick Edwin Smith, first Earl of Birkenhead.
97. Lockhart Muirhead (1765-1829) supervised the transfer of Hunter's collections to the University of Glasgow, and was Regius Professor of Natural History 1807-1829.
98. The last person to hold the Chair of Natural History at a Scottish University was D'Arcy Wentworth Thompson, author of *On Growth and Form* (1917) who held the St. Andrews chair 1917-1948.
99. William Forster Lanchester (1875-1953) worked on crustacean diversity.
100. Wilfred Ede Agar (1882-1951) moved to Melbourne in 1919. His work on sperm development in *Lepidosiren* was published in the *Quarterly Journal of Microscopical Science* 57, 1-44 (1911).
101. In JGK's time, the term Protozoa was used for all single-celled heterotrophic organisms, such as *Amoeba*, *Paramecium*, *Euglena* and *Trypanosoma*. Although the term is still used, the taxonomy of these organisms no longer puts them together in a single group.
102. Charles Martin (1881-1930) published a paper on the ciliated organism *Acineta papillifera* in the *Quarterly Journal of Microscopical Science* 53, 351-377 (1909).
103. John Samuel Dunkerly (1881-1930) lectured at Glasgow till 1926, then moved to Manchester as professor. A specialist on flagellate protozoa.
104. Muriel Robertson (1883-1973) was introduced to zoology during her undergraduate years at Glasgow. A Carnegie fellowship then allowed her to do fieldwork in Sri Lanka. The rest of her career was based at the Lister Institute in London where she unravelled the life cycle of the sleeping sickness parasite, *Trypanosoma gambiense*. One of the first women to be elected FRS (1947). Research on trypanosomes returned to Glasgow with the arrival of Keith Vickerman in 1970.
105. Monica Taylor (1877-1968) trained as a teacher in Liverpool, then joined the Sisters of Notre Dame as a nun and was transferred to Glasgow in 1901. With the support of JGK, she was permitted, chaperoned, to take lectures and practical classes in zoology. Awarded Glasgow D.Sc. in 1917.
106. Margaret Jepps was a lecturer 1923-1952. After retirement, she published *The Protozoa, Sarcodina* (1956), Oliver & Boyd, Edinburgh.
107. George Stuart Carter (1893-1969) lectured at Glasgow 1923-1930.
108. Agnes Eleanor ("Nora") Miller (1898-1994) lectured at Glasgow 1924-1963. She was awarded a Ph.D. for her thesis *Studies on Dipnoan Structure* in 1962.
109. JGK interacted with two of Glasgow's learned societies. He gave four lectures to the Natural History Society of Glasgow, all published in the Society's journal: two on the Hunterian zoological collections, and two on marine biological themes. He seems never to have been an office-bearer in the Society. His involvement in the Royal Philosophical Society of Glasgow was more extensive, acting as President 1925-28, and delivering six lectures on a variety of topics, all published in the Society's Proceedings.

110. Alexander Dunlop Lindsay (1879-1952); first Baron Lindsay of Birker. Professor of Moral Philosophy at Glasgow 1922-1924, later Master of Balliol, Vice-Chancellor of the University of Oxford, then first Principal of Keele University.
111. Bower, F.O., Kerr, J.G. & Agar, W.E. (1919). *Lectures on Sex and Heredity, Delivered in Glasgow 1917-18.* MacMillan and Co., London.
112. The marine organisms named in this paragraph are: a) sea pens - colonial cnidarians of the order Pennatulacea, 35 extant genera; b) seagrass - the only flowering plants growing in marine environments, about 60 species; c) *Philine* and *Akera* (or *Acera*) are genera of sea-snails; d) *Doris* and *Facelina* are genera of nudibranch gastropods; sea urchins - many species in the phylum Echinodermata; e) *Chaetopterus* is a marine polychaete, common name parchment worm; f) *Phoronis* are worm-like animals in the phylum Phoronida.
113. JGK would no doubt be delighted to learn that Loch Sween was designated a Marine Protected Area in 2014, with its population of native oysters one of its special features.
114. John Alwyne Kitching (1908-1996); professor of Biology at the University of East Anglia 1963-1974; specialist on rocky shore ecology and barnacles.
115. JGK married Elizabeth Mary in 1903; their children were Adam, Ronald and Isobel. Elizabeth Mary died in 1934. JGK then married a widow, Isabella Dunn Clapperton, in 1936.
116. Common sundew *Drosera rotundifolia*; oblong-leaved sundew *D. intermedia*; great sundew *D. anglica.*
117. Common names of food fish do not always apply to the same species: these both belong to the cod family. Saithe is *Pollachius virens*; lythe is *P. pollachius*.
118. Grey seals *Halichoerus grypus* are larger then common (or harbour) seals *Phoca vitulina.*
119. John Hammond Teacher (1869-1930); St. Mungo Professor of Pathology at Glasgow Royal Infirmary; specialist in reproductive pathology.
120. The Thomas Stevenson-built lighthouse is on an isolated basalt rock, 29 km west of Colonsay, Inner Hebrides.
121. An explanation of the green ray or green flash can be found on Wikipedia.
122. This seems to be an error: Sir Hector Clare Cameron (1843-1928) studied under Lister and progressed to be Professor of Clinical Surgery, University of Glasgow. For this 1933 recollection, perhaps JGK means Sir Hector's son, Hector Charles Cameron (1878-1958), child health specialist at Guy's Hospital, London.
123. *Janthina* is a genus of small pelagic sea snails, floating by means of bubble rafts; *Velella* is a single species of free-floating hydrozoan.
124. JGK's interest in how animals conceal themselves, and its relationship to camouflage techniques in warfare, is a major theme later: see Notes 180 and 183.
125. James Fairlie Gemmill (1867-1926); Ayrshire-born physician and biologist. Lectured at the University of Glasgow in surgery and embryology until 1916. From 1919, Professor of Natural History at University College Dundee. His book on natural history in the poems of Robert Burns was published posthumously (1928).
126. David Robertson (1806-1896); from the age of eight, worked as a herd boy in Ayrshire, but progressed to a medical degree at the University of Glasgow. Studied the fauna and flora of the Isle of Cumbrae, especially the marine life. He died before the opening of the marine station. His second wife Hannah joined him in his researches and, after his death, became a marine biologist in her own right. *The Ark* was towed by Murray's steam-yacht *The Medusa* through the Forth and Clyde canal and then down the Clyde estuary to the Isle of Cumbrae.
127. The third Marquess of Bute (1847-1900); the Crichton-Stuart family are landowners of Arran, Bute and Cumbrae, and, through marriage, of extensive lands in south Wales. The gothic revival style Mount Stuart House was built 1879-1900 at his direction.
128. This work was eventually published as Chumley, J. (1918). *The Fauna of the Clyde Sea Area*. Glasgow University Press. It collated the records of Murray and colleagues from 1884 to 1892. Chumley later joined the Glasgow Zoology staff.
129. The Rothesay Royal Aquarium opened in 1875-6. After its period of use as a laboratory, it became a swimming pool. This was now the fourth Marquess.
130. Sir John Sankey led a commission into the future of the U.K. coal-mining industry, and recommended its nationalisation. This was rejected by the government. Nationalisation would have affected the Marquess's income from the South Wales coalfield.
131. Laurence Pullar (1838-1926); Scottish businessman, geographer and philanthropist. Helped fund the *Challenger* expedition (1872-1876) and also the surveys of Scottish lochs published as Murray, J., Pullar, L. & Chumley, J. (1910). *Bathymetrical Survey of the Scottish Fresh-water Lochs. Volumes 1-6.* Challenger Office, Edinburgh. It covered 562 lochs and took 10 years to complete.
132. Dr Sheina Macalister Marshall (1896-1977) was a zoology graduate of the University of Glasgow. Worked on plankton, especially copepods, at Millport throughout her long career. The second of JGK's female students to be elected FRS (in 1963).
133. Andrew Picken Orr (1898-1962), a chemistry graduate, worked with Sheina Marshall, including joining the Great Barrier Reef expedition (1928-1929) led by Maurice Yonge, later Regius Professor of Zoology at Glasgow.
134. Ernest William MacBride (1866-1940); Irish biologist who specialised in the morphology and evolution of echinoderms.
135. JGK gives a more detailed account of the Millport story in Kerr, J.G. (1949). The Scottish Marine Biological Association. *Notes and Records, the Royal Society Journal of the History of Science* 7, 81-96.

136. John Ferguson (1838-1916) left his huge library (18,000 volumes), much of it on alchemy, to the University as the Ferguson Collection.
137. James Moir (1840-1915); authority on feudal law.
138. Sir Thomas McCall Anderson (1836-1908); Professor of the Practice of Medicine.
139. Cooper (1846-1922); Professor of Ecclesiastical History, served as first chaplain of the University's Officer Training Corps.
140. Sir William Macewen (1848-1924) was one of the most innovative surgeons of his time, using Lister's antiseptic techniques and also the new method of anaesthesia. Pioneer of brain surgery. Served as Surgeon-General to the Royal Navy in World War 1, hence his uniform. Helped found the Erskine Hospital for damaged soldiers.
141. Constantin Levaditi (1874-1953) was a Romanian microbiologist who worked for most of his career at the Intitut Pasteur in Paris. Researcher on viral diseases and on syphilis, including developing a staining method to identify spirochaetes.
142. Sir Hugh Seymour Walpole (1884-1941) was a prolific writer of novels and memoirs. *The Secret City* derived from his experiences working for the British Government in Russia during World War 1; he left just before the revolution.
143. Sir Hugh Shaw-Stewart (1854-1942); Scottish politician, soldier, landowner.
144. Alan Clapperton (1888-1931) trained as a lawyer. On his early death, his widow became JGK's second wife.
145. Dudley Julius Medley (1861-1953); specialist in constitutional history.
146. Sir Richard Burdon Haldane (1856-1928); Scottish philosopher and politician, brother of physiologist J.S. Haldane, and uncle of geneticist J.B.S Haldane. Responsible for major reforms of the army as Secretary of State for War in the Liberal government.
147. First Baron Lister (1827-1912); surgeon best known for pioneering antiseptic techniques, much of his research being done at Glasgow Royal Infirmary.
148. James Watt (1736-1819); Scottish inventor, engineer, chemist; best known for improvements to the steam engine.
149. Ramsay MacDonald (1866-1937); Scottish Labour Party politician, twice Prime Minister in the inter-war years.
150. Sir Lewis Shedden (1870-1941) was Unionist party organiser in Glasgow.
151. Sir Henry Mechan (1856-1943) was an engineer, philanthropist, and champion of public health education. He endowed the University of Glasgow chair named after him.
152. Stanley Baldwin (1867-1947) was U.K. Prime Minister three times in the inter-war years.
153. Since 1603, Parliament included members voted for by graduates of the universities (who therefore could have two votes). The system was abolished in 1950. From 1918-1950, graduates of the four ancient Scottish universities were represented by three MPs.
154. Thomas Alexander Harvie Anderson (1872-1953); a lawyer involved in many aspects of Scottish affairs, including Erskine Hospital.
155. John Buchan (1875-1940); Scottish politician and statesman, best known now for his novels, written in his spare time, the best remembered being *The Thirty-nine Steps.* MP for the Scottish Universities 1927-1935, then appointed Governor General of Canada and ennobled as Lord Tweedsmuir.
156. £1,450 in 1935 is equivalent to about £132,000 in 2023.
157. Archibald Joseph Cronin (1896-1981); Scottish physician and writer. Studied medicine at Glasgow 1914-19. His novel *Country Doctor* was the prototype for the TV series *Dr Finlay's Casebook*.
158. Naomi Mitchison née Haldane (1897-1989); prolific writer of mainly historical novels, and political activist. A biologist early in her career, like others in the family, and two of her children became professors of biological subjects.
159. John Viriamu Jones (1856-1901); Welsh scientist, first Principal of Cardiff University.
160. Leifchild Stratton Leif-Jones, Lord Rhayader (1862-1938); temperance movement leader and Liberal politician.
161. Henry Margesson (1890-1965); first Viscount Margesson; Conservative Politician best known in his role as chief whip.
162. Noel Skelton (1880-1935); Scottish journalist and politician, MP for the Scottish Universities 1931-35.
163. Walter Elliot (1888-1958); Scottish Unionist politician. Studied science, then medicine at the University of Glasgow. Moved to politics after World War 1 and served in several government ministries.
164. Douglas Jamieson (1880-1952); Scottish lawyer and Unionist politician. Left parliament to become a judge as Lord Jamieson.
165. John Allsebrook Simon (1873-1954); first Viscount Simon. Began as a Liberal, but was later a Conservative. He was among only three people to have occupied the three high offices of Home Secretary, Foreign Secretary and Chancellor of the Exchequer (as well as being Lord Chancellor).
166. James Maxton (1885-1946); Scottish socialist politician. MP for Glasgow Bridgeton 1922-46, and leader of the Independent Labour Party.
167. Edward Alfred Minchin (1866-1915); Jodrell Professor of Zoology at University College London. Proved that sponges are not coelenterates, and studied trypanosomes.
168. John Anderson (1882-1958); first Viscount Waverley and MP for the Scottish Universities 1938-1950.
169. Edward Gibbon (1737-1794); English historian and politician: remembered for his massive *The History of the Decline and Fall of the Roman Empire*.
170. Sir Francis Fremantle (1872-1943); physician and Conservative politician.
171. Sir Alfred Bakewell Howitt (1879-1954); physician and Conservative politician.

172. Sir Ernest Graham-Little (1867-1950); dermatologist, and MP for London University 1924-1950.
173. Sir John Wardlaw-Milne (1879-1967); Conservative politician.
174. Sir James Young Simpson (1811-1870); Scottish obstetrician; first physician to demonstrate the anaesthetic properties and use of chloroform.
175. Edward Jenner (1749-1823); pioneer of vaccination.
176. Sir Patrick Manson (1844-1922); Scottish physician and parasitologist. First to demonstrate mosquitoes as vectors of a parasitic infection (filariasis).
177. Robert Fulton (1765-1815); American engineer and inventor. Credited for first commercially successful steamboat in the U.S.A.
178. Palmerston as Prime Minister was worried that the Suez canal would disturb the political balance between Russia, the Ottoman Empire and the U.K.
179. Sir William Grahame Greene (1857-1950); English civil servant; permanent secretary to the Admiralty in World War 1.
180. Abbott Handerson Thayer (1849-1921); American artist, naturalist and teacher, with his son Gerome, published *Concealing Coloration in the Animal Kingdom* (1909). Considered a pioneer of camouflage, though he mistakenly believed all animal coloration has concealment as its function.
181. Sir Edward Bagnall Poulton (1856-1943); English evolutionary biologist; Professor at Oxford; coined the term aposematism (warning coloration), and wrote *The Colours of Animals* (1890).
182. Norman Wilkinson (1878-1971); artist specialising in marine paintings.
183. Hugh Bamford Cott (1900-1987); British zoologist and artist. Worked as lecturer at University of Glasgow (1932-1938), and was awarded D.Sc. by the University for his thesis on frog coloration. Moved to Cambridge 1938, and worked as a camouflage expert in Africa during World War 2. Published *Adaptive Coloration in Animals* (Methuen, 1940) illustrated mainly by his own pen and ink drawings. The full story of Kerr, Wilkinson, Cott and the government's policies on camouflage has been told by Peter Forbes (2009) *Dazzled and Deceived: Mimicry and Camouflage* (Yale University Press, 2009). See also Ruxton, G.D., Allen, W.L., Sherratt, T.N. & Speed, M.P. (2018). *Avoiding Attack: the Evolutionary Ecology of Crypsis, Warning Signs and Mimicry*. (2nd edition). Oxford University Press.
184. Sir Howard Kingsley Wood (1881-1944); Conservative politician, Minister for Air and Chancellor of the Exchequer.
185. Sir John Greer Dill (1881-1944); Chief of the General Staff in World War 2.
186. Lord Robertson (1896-1974) was military governor of Germany after World War 2.
187. Sir Charles Galton Darwin (1887-1962); English physicist; Director of the National Physical Laboratory and Master of Christ's College; worked on the Manhattan Project. Grandson of Charles Darwin.