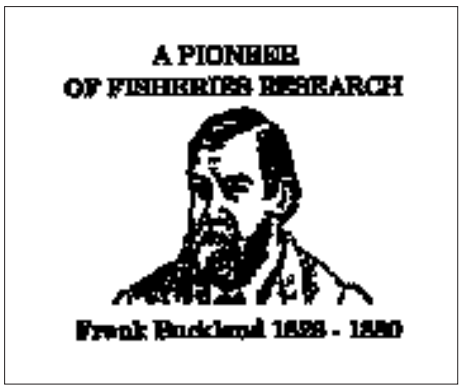
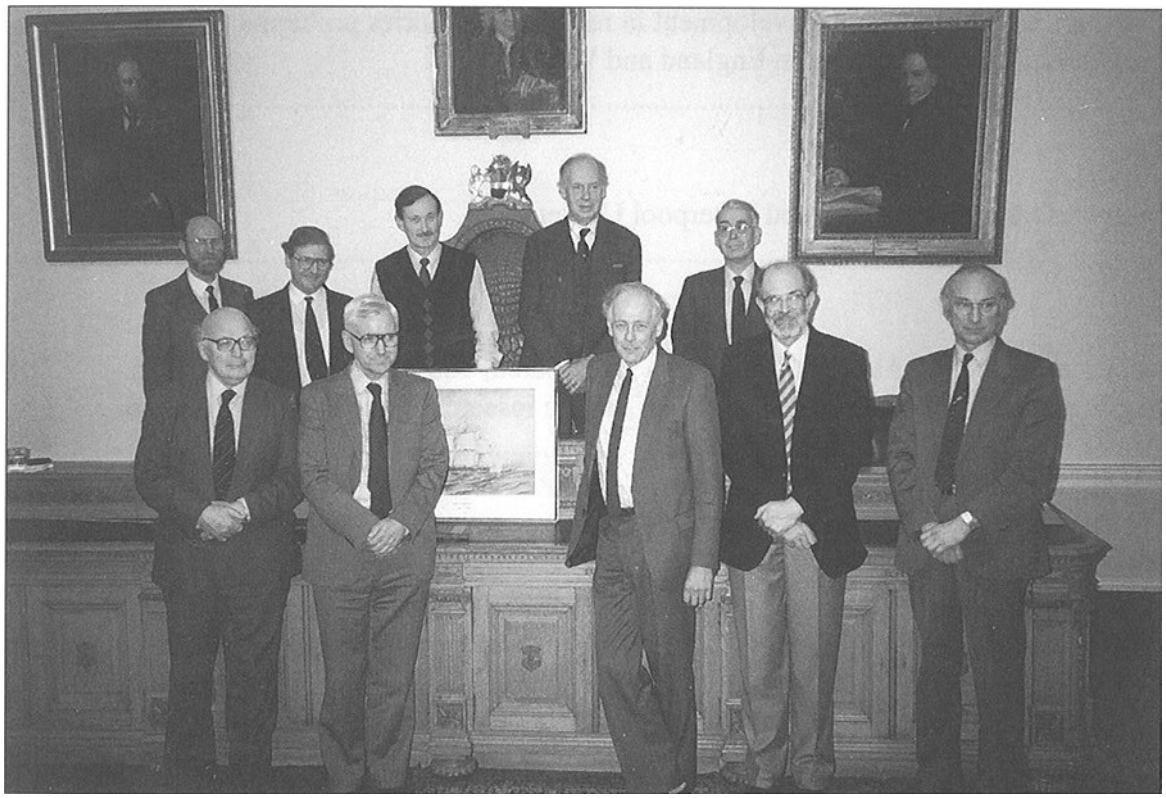


British Marine Science and Meteorology: The history of their development and application to marine fishing problems

Buckland Occasional Papers: No. 2

Contents Page



Speakers at the November 1989 meeting: Back row (from left to right): Ray Gambell, Roger Bailey, Trevor Norton, Arthur Lee, Geoffrey Burgess. Front row: John Gulland, Alan Southward, David Garrod, Jimmy Adams, John Early.

FOREWORD

The first eight of the papers in this book were given at a meeting held in November 1989 that was sponsored by the Buckland Foundation in conjunction with the Challenger Society for Marine Science and the Royal Meteorological Society. Since then the texts by Jens Smed and Dr Christopher Moriarty have appeared and were added because they complement the theme so well and Arthur Lee's book on the History of Fisheries Research in England and Wales has been published.

Furthermore since 1989 there have been great changes in the structure of the Natural Environment Research Council which have affected the the Plymouth Marine Laboratory (pages 61-80), UK government-sponsored research on marine mammals has been largely redirected away from the great whales and more towards the small cetaceans and seals of local domestic interest – a major been change from the heyday of the Discovery Investigations (pages 81-95) – and there has been much discussion of the future structure of government-sponsored fisheries research *per se.* To date the most significant result of this has been the decision to close the Torry Research Station (pages133-140) during 1996 with its work being redistributed between various institutions in Aberdeen and the Central Science Laboratory of the Ministry of Agriculture, Fisheries and Food (MAFF). In short the discussions and debates of the formative years continue with, it has to be said, more or less the same problems at issue.

Finally it is appropriate to note that the plaster casts of fish made by Frank Buckland referred to at various times in Geoffrey Burgess' paper were re-discovered three years ago at the Scottish Fisheries Museum at Anstruther. The bust of Frank Buckland paid for by public subscription is also there. The Buckland Foundation is hoping to set up permanent exhibits to Frank Buckland at the Anstruther Museum and the National Fisheries Heritage Centre in Grimsby.

Alasdair McIntyre
Chairman
The Buckland Foundation
February 1996

FRANK BUCKLAND AND THE BUCKLAND FOUNDATION

Geoffrey Burgess

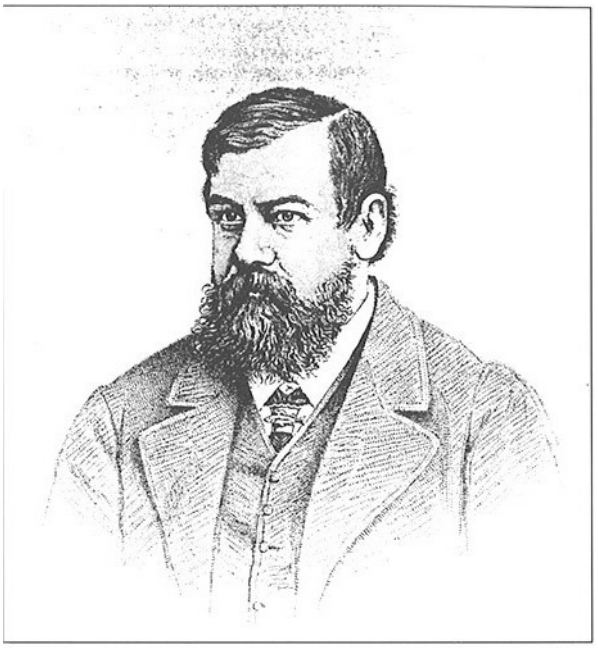


Plate 1. A formal portrait of Frank Buckland.

Plate 2. Frank Buckland in working clothes circa 1875. He is holding an oyster breeding tile and an oyster shell.

FRANK BUCKLAND AND THE BUCKLAND FOUNDATION

Geoffrey Burgess

Frank Buckland was a well-known Victorian naturalist and entertaining author with an engaging manner and an original and humane outlook on the world (Plates 1 and 2). In many respects his views were surprisingly modern and he did not, for example, enjoy killing wild life for sport: "All I beg on behalf of the wild birds" he once wrote, "is not to shoot them; leave the gun at home and take the opera glasses and watch their habits" [1]. His active period spanned less than twenty years, from the early 1860s to his death in 1880 at the age of 54, but in this relatively short time he established a national reputation and enjoyed the sort of following nowadays associated with television personalities or pop stars. People would flock to hear him lecture. A specially chartered train once took 400 of them from London to Brighton to hear him talk about the aquarium and its inhabitants[2].

His popularity and importance can be judged by the fact that after his death, a large and influential committee was formed " ... to perpetuate by a substantial memorial the services which he has rendered to the study of natural history and fish culture ... " [3]. This committee included the Dukes of Beaufort and St Albans, the Marquis of Bute and was later joined by HRH Prince Christian. Buckland's memory lingered on and ten years after his death it was reported in a letter to *The Times* that the last of his pets, a rhesus monkey called 'Tiny the Second', was still alive but feeble, whilst his grey parrot with exceptional conversational powers had recently fallen off its perch and expired [4]. Some of his most popular works were reprinted in this century and a selection even appeared in 1948.

Buckland maintained a prodigious output and probably worked a regular 14-hour day, except on Sundays, and it is therefore not surprising that his writings sometimes show signs of haste. Nevertheless, the best of them deserve to be better known than they are today. His style was original, informative, entertaining and direct, full of interesting and detailed observations about animals, but never condescending or embroidered with the saccharine phrases and poetic quotations which make so many Victorian popular natural history books difficult to read. His style has often been emulated but never surpassed.

He has an even greater claim to be remembered however, for his contribution to fisheries research and administration. He developed his own fisheries museum in South Kensington which was, in effect, a forerunner of the Science Museum, he was appointed Inspector of Salmon Fisheries for England and Wales in 1867, and he sat on at least seven official committees of enquiry of Royal Commissions, all concerned with particular aspects of the fisheries, between 1871 and his death. He never let slip any opportunity to make his countrymen aware of the importance of the fisheries and their problems. In his will he left his Museum to the nation and set aside a sum of money for the eventual establishment of a Professorship of Economic Fish Culture; this latter scheme has been administered from the outset by the Buckland Foundation which was set up by the High Court for this purpose.

This account is not primarily a biography of Buckland; that has been attempted elsewhere by the present author and also by Bompas [2, 5]. It tries to set out the main formative factors in his life which help to explain some of his attitudes and actions, to show his influence on the development of fisheries science and administration, and to review the history of his legacy, namely the Buckland Foundation, to the present generation.

The task is not entirely straightforward because his activities were so widespread and only some of them have direct relevance to the fisheries. For the last thirteen years of his life he did three main, regular jobs. He edited the natural history columns of *Land and Water*, a weekly journal he helped to found, he attended his museum in South Kensington and spent much time collecting and preparing specimens for it, and he fulfilled his duties as Inspector of Salmon Fisheries for England and Wales. In addition he served from time to time on various official enquiries and maintained an enormous correspondence with landowners and others on problems ranging from fish hatching to river pollution, from the humane treatment of pigs at market to the need to teach natural history to children. All manner of people would ask his advice: at the request of the Queen, Prince Christian wrote for help because "There is a plague of frogs at Frogmore ..." [(2)]. Buckland himself did not distinguish between his various activities. Some of his letters to correspondents in *Land and Water* were written on official notepaper from the Salmon Inspectors' office, whilst others concerned with official business were written privately from his own house, underlining that here was a man pursuing a very full life actively dedicated, as he saw it, to the service of his fellow men.

The key to much that he did is in his background and upbringing in a country which was undergoing rapid change, where new technology was altering traditional communities and methods of working, but where successive Governments, at least in the first four decades of the nineteenth century, had neither the desire nor the knowledge to intervene to improve conditions for the most vulnerable in the community. Where the Government did intervene it sometimes made things worse, not better.

After the end of the Napoleonic Wars there was general economic depression and a lowering of prices and wages. Farming became less profitable and, at least in south-east England, there was great deprivation amongst agricultural workers leading to riots when ricks were burned and machinery destroyed. Frank Buckland's father, of whom more will be said later, put off a visit to London in November 1830, where he wanted to vote for Herschel as President of the Royal Society, because his in-laws who lived in Abingdon felt threatened. Frank's uncle was sworn in as a special constable and helped to maintain order by galloping round the countryside, bringing prisoners to Oxford gaol [(6)]. This event occurred when Frank was four years old and was an early manifestation of the continuing social unrest and political instability, sometimes leading to civil disorder, which marked the first years of Queen Victoria's reign. The first forty years of Buckland's life coincided with the period when various working class movements were actively developing, when the country was shaken by the Chartist agitation, and when arguments about parliamentary reform were at their most vehement. The Reform Act passed in 1867 marked the end of this period.

Social ferment was only one aspect of great change; in 1815 most Englishmen depended on agriculture for their livelihood, either directly or through ancillary trades, but by 1820 half were living under urban conditions. This was partly because of movements in population, partly because of rising numbers through slow improvements in public health leading to lower infant mortality and great longevity, and partly through Irish immigration, the effects of which varied in different parts of the country. The population of Britain as a whole doubled between 1815, when it was 13 million, and 1871 [(7)]. "Some towns expanded during the early nineteenth century at rates that would bring a cold sweat to the brows of twentieth century housing committees" [(8)]. Manchester and Salford, taken together, increased by 47% between 1821 and 1831, Bradford by 78% and West Bromwich by 60% in the same period and West Bromwich went on to increase by a further 70% in the following decade.

There was great national concern about the conditions of the poorest sections of the community living in the growing industrial towns and cities, particularly following the publication in 1842 of Edwin Chadwick's Report 'Sanitary Condition of the Labouring Population of Great Britain'.

This revealed much more than the extent of overcrowding and squalor, for it also indicated that considerable sections of the labouring poor were not only inadequately fed; they were starving. The existence of such communities not only threatened political stability but also the health of the entire population.

Although much has been written about the food supply of this country during the last century, there is insufficient detailed statistical information to give a clear picture of food consumption across the population classes. At the most it is possible only to show average consumption of commodities. Drummond and Wilbraham, in their classic work 'The Englishman's Food' [9], give contemporary anecdotal information about food quality and supply, information which can be supported by other accounts of the time, and it is clear that for many of the very poor, meat and other animal protein foods were occasional luxuries.

There is perhaps evidence of a decline in meat consumption over the first 50 years of the nineteenth century during most of which period all meat was home produced, since there was a prohibition on the importation of livestock until 1842 [10]. Before the advent of the railways meat supply depended on droving, that is the slow driving of herds and flocks over long distances to pastures in the vicinity of the centres of consumption where they were fattened before slaughter [11]. Even after importation was permitted and railway transport became general, there were continuing problems with imported animals which even in 1880 made up, together with preserved meat, only one-sixth of the total meat consumption [10]. Other factors also affected meat supply. Exotic animal diseases were introduced with imported animals; foot and mouth disease (1839) and pleuropneumonia (1840) became endemic with serious effects on home production whilst rinderpest was introduced through Hull from the Baltic in 1865. It was finally eradicated in 1867 by which time some 400,000 cattle had died or been slaughtered [11]. The outbreak of rinderpest incidentally gave rise to the establishment of the Government Veterinary Service.

Throughout Frank Buckland's early years, therefore, there were considerable problems of food supply and particularly meat supply, and some of these continued throughout his life. Other supply problems almost vanished with the development of railway transport which had enormous effects on society and indeed made possible the development of large urban areas. The Act authorising the Stockton and Darlington Railway was passed in 1821 and the line was opened for traffic in 1825. By 1840 most of the main trunk routes had been opened and by 1850 the total mileage of lines was about 5000 [12].

If the technical changes and their social and political consequences provide one key to the understanding of the development of the Victorian fishery industry and Buckland's contribution to its advance, his family background and upbringing provide the other. He had enormous affection for this mother but his formidable father, William Buckland DD FRS, he held in admiration which almost amounted to reverence. In some respects he modelled his own interests and attitudes on those of his father, who inculcated in his son his own burning desire to be useful in promoting the welfare of his less fortunate countrymen.

William Buckland was the first Professor of Geology and Mineralogy in the University of Oxford, Canon of Christ Church, and an influential member of the scientific establishment of his day. He was 41 years old when he married and Francis Trevelyan, his first child, was born almost exactly a year later on December 17, 1826. His wife was herself a competent geologist and before marriage provided Cuvier with some of the illustrations of fossils for his published work. They had nine children of whom four died in infancy and are buried in Christ Church Cathedral, Oxford.

The Buckland household was a happy one and the parents enlightened. The house in Tom Quad was like a geological museum with books, papers and geological specimens covering every flat surface. The children were encouraged to take an interest in the natural world. Eminent visitors were frequent and the children were encouraged to meet them and talk to them. Dr Buckland numbered Sir Robert Peel, Humboldt, Liebig and Sir Joseph Banks, for many years President of the Royal Society, amongst his friends. When Banks died, Dr Buckland caused *Banksia* roses to be planted in his memory in the grounds of Christ Church.

Dr Buckland was by no means merely a clever academic. He had long been concerned about the agricultural depression and believed that the solution to many of the problems of agriculture was to increase the level of production by applying science more effectively. In 1840 he purchased land at Marsh Gibbon, a mile or two to the east of Bicester, so as to be able to conduct his own experiments on husbandry and drainage. That year also saw the publication of the English edition of Liebig's influential work 'Organic Chemistry in its application to Agriculture and Physiology', translated by a mutual friend, Lyon Playfair. A year or two later, so it is reported, Buckland displayed in the Ashmolean Museum a turnip a yard in circumference as a proof of his success in growing a crop where formerly there was only waste land [(6)]. The author possesses a letter written by Dr Buckland in November 1843 to an unidentified Scottish correspondent. "Will you send me 2 or 3 more lists of the Members of your Farmers Society for promoting Chemical Analysis of Things Agricultural. If you can make it act as a check to the sellers of artificial Manures against adulteration that alone would be an inestimable gain. A Consulting Land Doctor who could for Fees prescribe what should be done to improve soils submitted to him would supply one of the greatest desiderata of our time".

His advice was much in demand. He was a member of the Royal Society Committee which chose the granite for the 'new' London Bridge and was consulted by Peel on how to control potato blight. He helped to form the Oxford Gas Company, and was for many years its Chairman, and he promoted plans for water supply and sewerage in that city. He was the first President of the British Association, a major force in the foundation of the School of Mines, now part of Imperial College, and a founder of the Zoological Society of London. When Louis Agassiz, the eminent Swiss ichthyologist, visited Britain in 1844, he and William Buckland travelled to the Duke of Buccleugh's estate on the River Nith to talk to his head keeper, John Shaw, who was doing original research on salmon hatching [(6)]. Agassiz was doing related work on trout, but Shaw's main finding was to prove that parr are young salmon, not a separate species [(13)].

Buckland was a first-class field geologist. He and a friend were riding towards London one very dark night and were getting lost. He dismounted, took up a handful of earth and smelt it. "Uxbridge" he said[(6)]. He was eccentric in a harmless way and there are many stories about him. He always carried a capacious blue bag into which he put his specimens and from which, at the most unlikely times and places, he would produce objects and give discourses about them. He was an excellent lecturer with a gift for easy and amusing exposition and a sense of the dramatic which Charles Darwin felt was verging on buffoonery. He had no sense of self importance and, unlike some other scientists of his day, was generous in acknowledging the achievements of others. He would talk with anyone as an equal, and no job was too humble for him. He was once discovered by a visitor on his hands and knees with a dustpan and brush cleaning out the ashes from a stove, while his maidservant stood by [(14)].

He become Dean of Westminster in 1845 and was shortly afterwards inducted to the living at Islip near Oxford, bequeathed by Edward the Confessor to the Abbot of Westminster. Here the family would spend the summer and autumn months. The Dean built a cottage at the end of the large old

tithe barn, one room of which was fitted up for the recreation of the village lads. He also organised a night school three times a week at which some of the family were required to be present to give lectures. Shortly after his move to the Deanery at Westminster, he and two of his daughters were struck down by typhoid. On his recovery he took swift action to introduce a piped water supply[6]. His declining years were clouded by mental breakdown, now known to have been caused by a tubercular infection of the neck vertebrae, and he expired in Frank's arms in 1856, aged 73. He is buried with his wife in the churchyard at Islip.

Like his father, Frank was educated at Winchester where the curriculum was devoted almost entirely to the two classical languages, though some mathematics was also taught. Some years after Frank left the school, the headmaster, Dr Moberly, introduced the novel idea of a course of ten or twelve lectures given annually by competent scientist to all the boys regardless of age. He believed that after such a course a boy would be able to appreciate "the last discoveries and the present state of the sciences" though he said, in giving evidence to the Clarendon Commission in 1862, that their remembrance of scientific facts would resemble " ... the sort of recollection that ladies are apt to have of something they learned at school, they know there is a good deal to be said about it, but they forget what it is". Dr Moberley was in fact anti-scientific and saw no place for science in the regular curriculum at Winchester. "An amateur of science is the better for knowing the elements of it, and every man of liberal education is the better for not being ignorant of any thing, but compared with other things a scientific fact, either as conveyed by a lecturer, or as reproduced in examination, is a fact which produces nothing in a boy's mind. It is simply a barren fact, which he remembers or does not remember for a time, and which after a time becomes confused with other facts and is forgotten. It leads to nothing. It does not germinate, it is a perfectly unfruitful fact" [15,16].

It is significant that in a published comment on the period of Dr Moberly's headmastership, which covered a period of thirty-one years from 1835 to 1866, Frank Buckland is mentioned as virtually the only scientific man of note to come out of Winchester "... unless a few eminent doctors be added"[17].

The mathematics taught were probably of the simplest kind and perhaps largely confined to Euclid. Frank left school scarcely capable of undertaking the simplest calculations, a disability he carried through life. When he travelled, he would carry sovereigns in twists of paper, each containing ten coins, to enable him to account for his expenditure [2]. Otherwise, he would get someone else to do the work for him. For example, he wished to know how many eggs were present in the roe of a carp which he had acquired. He gave the figure as 2,059,759 adding "I can guarantee the accuracy of the weighing, and also the calculations, which were made for me by Mr Thomas, a professional accountant" [1]. He is said to have regarded the last figure as of equal importance with that of the first.

He left school in 1844 and went up to Oxford where he graduated in 1848. He was a moderate student, though he absorbed enough to be able to recite long passages in Latin when the fit moved him, and he would say that if he could not understand an Act of Parliament he found it helpful to translate it into Latin. Throughout his period at Oxford he continued his favourite pastime of studying animals. Furthermore he visited the Liebig family in Giessen and attended some of the Professor's lectures. An interesting letter has survived giving an account of the laboratory and the way students were trained; it is now in the possession of the Buckland Trustees [18].

In 1848 he entered St George's Hospital to train as a surgeon under Mr Caesar Hawkins, but also spent a short time in Paris in 1849 studying anatomy. The laws in France relating to the use of bodies for surgical training were less restrictive than in Britain and there was at that time also an

increase in the supply caused by a cholera outbreak. He took his MRCS in 1851 but after only a year as House Surgeon, resigned in 1852.

Surgery had been his chosen career from his later school days, though whether it was intended that he should practice as a surgeon or merely undergo the training is not clear. Certainly it was the recognised route into the biological sciences in the earlier part of the nineteenth century. Richard Owen, Charles Darwin and T. H. Huxley all attended courses on surgery though not all completed them; Charles Darwin in particular was repelled by the savage cruelty and insensitivity to the pain of others required of its practitioners at that time. It is impossible to know whether Buckland was similarly affected but his interest in surgery as a means of livelihood seems to have waned after he left St George's. Perhaps this was partly because he was now responsible for running the family household at Islip, where his invalid father remained from 1850 until his death. Furthermore he was maintaining Hannah Papps, whom he probably first met in 1850 and whom he married in 1863, and by whom in 1851 he had a son, Francis John. His father and his son both died in 1856 and he had no further children [(2)].

In August 1854 he was gazetted Assistant Surgeon to the Second Life Guards and resigned his commission in April 1863. This period was an important one for it saw the development of his interests in natural history, the strengthening of his journalistic ability, and the focusing of his attention on the fisheries. The duties of an Assistant Surgeon were not onerous and allowed time for outside activities. He had begun to contribute articles on popular natural history to *Bentley's Miscellany* and *St James' Medley* in 1852. He subsequently collected together and edited what he had written and it was published as 'Curiosities of Natural History' in 1857. It was an immediate success, being reprinted fifteen times before he died in 1880, and led to an invitation to write regularly for *The Field*. The discipline of writing regularly and of keeping deadlines was a valuable one for him but probably of even greater help was that this contract brought him into the circle of experts who were professional journalists who depended on the pen for their livelihood.

The 'Curiosities of Natural History', later known as the First Series since it was followed by three more volumes, is an entertaining miscellany of anecdotes about animals told with a fresh and unsophisticated charm which is the hallmark of all his best writing. There is no particular order or logic about the arrangement of the material which is more like a fireside chat than a work of natural history, and this is a main attraction of the work. He was also beginning to be in demand as a lecturer. He had begun to develop his lecturing technique under his father's tutelage at Islip and he also talked to a working men's club which his mother was attempting to establish in Westminster. He was probably most at ease, and most successful, before a general audience where his engaging manner, amusing turn of phrase, and general desire to please were seen at their best.

Buckland also became the energetic secretary of the Acclimatisation Society, established in 1860, whose objectives were to utilise plants and animals in places where they were unknown before. The Society had many influential members but many of the schemes proposed now seem bizarre if not fantastic and their critics said so at the time. It must be conceded however that many of their objectives have been achieved over the intervening years, though in ways not then available, and in support of this view it is only necessary to point to the agricultural and horticultural crops now regarded as commonplace but unknown to the Victorians. Acclimatisation was also one of the original objectives of the Zoological Society of London which Dr Buckland helped to found. Frank Buckland and his friends were motivated by the knowledge that people needed food and they believed that their skills and enthusiasm could help their countrymen. He once referred to "... the great object of my life, viz., the increase of food for the people" [(19)].

One objective of the Society was to improve the freshwater fisheries of Britain and to introduce new species from abroad. It is through this activity that Buckland became concerned with fisheries. It was already well known at the beginning of the nineteenth century that ripe fish could be manipulated to yield eggs and milt and that fertilised eggs could be kept under protected conditions so that fry could be reared to a size that appeared to be suitable for release to the wild. Sir Humphry Davy, himself a keen fisherman, had commended the idea in his somewhat stilted work *Salmonia*, first published in 1828. Dr Buckland's interest in John Shaw's experiments has been noted and others were making similar studies, particularly in France where the Government from the early 1850s had been sponsoring work on artificial spawning. The engineer in charge, Monsieur J. Coumes, was widely regarded as the leading expert on the subject. Buckland experimented with perch spawn early in 1861 and later that year and in 1862 he was involved with others in running hatching apparatus at Hampton on the Thames. When Monsieur Coumes visited England, the Hampton apparatus was shown to him by Buckland who, in 1863, arranged a display of fish hatching in the windows of *The Field* offices in the Strand. This created a sensation and he was asked to lecture on the subject to the Royal Institution. He was by nature a showman and had learnt from his father the value of dramatic illustration in a lecture. He was fortunate in having the assistance of Professor Tyndall who, by means of electric light, presumably an arc light, produced a magnified image of the little living fish on a screen. The lecture was a great success and was later published as a book[20]. It is a breezy account of what was already well known, extended with contributions from others, many of whom were correspondents of *The Field*. Another and more workmanlike book also published in 1863 called *Fish Culture* was written by Francis, the fishing expert on *The Field* staff [21]. Francis resented Buckland's uninvited entry into a subject to which he had devoted much effort and in which he felt that he had considerable expertise. Although attempts were made to patch up their differences, these surfaced in a public row in the columns of *The Field* in 1864 and led to Buckland leaving it to become a major force in establishing a highly successful rival publication, *Land and Water*, which first appeared in 1865.

Buckland also set up fish hatching apparatus in the Science and Art Department in the South Kensington Museum, a demonstration which created great interest which he maintained by his contributions to *The Field* and subsequently *Land and Water*. He began to collect eggs for shipment in ice to the Antipodes. There was a desire amongst the colonists to see salmon and trout in Australian and New Zealand lakes and rivers and he played a part in what were eventually successful attempts to introduce trout, though whether the eggs he himself collected were the progenitors of the present stocks is doubtful [2]. His contribution was however formally recognised in 1868 by the presentation to him of a silver claret jug by the New Zealand Government.

The hatching apparatus at South Kensington became the nucleus round which he developed a Museum of Economic Fish Culture, the contents of which was mostly provided by Buckland at his own expense, though the authorities paid him a personal fee as 'Scientific Referee on Fish Culture' [2]. No complete record of its contents now exists, if it ever did, but it probably was not arranged according to any systematic scheme of classification then in use. The objective of the museum was for it to be "... an educational means of informing the public, not only as to the Natural History of Fish, but also as to their commercial uses, and as to the development of the fisheries of this country"[22]. It certainly contained a fine collection of plaster casts of fish, prepared by Buckland himself but usually coloured by an artist. He taught himself to make casts and seems to have been very good at it; taxidermists find fish particularly difficult to prepare and few are successful in making convincing preparations of them. Casting in plaster is a recognised alternative.

Much of Buckland's effort was concentrated in 1865 and 1866 on his Museum and launching *Land and Water* to which, every week for the next fifteen years, he made considerable contributions. One

can only wonder at the energy and mental toughness of the man. A major shareholder in the new journal was William Joshua Ffennell, one of the two Inspectors under the Salmon Fisheries Act of 1861. The other Inspector was Frederick Eden. Perhaps it was from Ffennell, or from an old college friend at the Treasury, that Buckland learned that Eden was ailing and likely to resign his post. Such posts were still filled by patronage and Buckland took steps to make sure that his name would be considered for the vacancy; he was appointed Salmon Inspector (England and Wales) in February 1867.

He was an excellent choice. His background and upbringing made him acceptable to wealthy landowners, many of whom he already knew, he was acquainted with many of the public figures of the day and moved in their circles, as shown for instance by his membership of the Athenaeum, and he was already fully conversant with the major problems of the salmon fisheries. Indeed, he had accompanied the Inspectors on some of their inspections, which was an additional, but unforeseen, advantage because Ffennell died suddenly in March 1867. His death was a great loss. He was about 68 years old and had spent much of his life studying the salmon. Buckland suddenly found himself in an official position where he was required to give the Government of the day his expert advice. His new colleague was Spencer Walpole, son of the then Home Secretary, an efficient administrator and good colleague but with no pretensions to any technical background.

Buckland's appointment marks the beginning of the period, which ended with his death, when he made his most important contributions to fisheries matters, though his literary work continued unabated and his new job gave him additional opportunities of adding to his museum. The Inspectors' duties involved detailed examination of rivers to advise, for example, on the effectiveness of salmon passes and the nature of obstructions to the passage of fish, and the provision of advice to local Boards of Conservation set up under the Act of 1865. Buckland was much concerned about pollution of water, as had been his father. His views have a remarkably modern ring about them.

In the Sixth Annual Report of The Inspectors of Salmon Fisheries (England and Wales), his first, he asked what was a reasonable cost for dealing with pollution [23]. In the Ninth Report (1870) he said "A great cry is made against weirs which obstruct fish. A greater cry should more properly be established against those which deter or kill the fish by noxious materials which they pour into public waters for their private use and benefit". He also advocated the double system of leading sewage into one set of sewers and surface water into another [24].

In later reports he was more vehement. "In England and Wales, as well as in Scotland, manufacturers of all kinds of materials, from paper down to stockings, seem to think that rivers are convenient channels kindly given to them by nature to carry away at little or no cost the refuse of their works". Later in the same report, the Twelfth (1873), "It is, therefore, most lamentable to think that at the present time when there are so many mouths to feed, and so many markets comparatively salmonless, manufacturers and mine owners, who form a relatively small proportion of Her Majesty's subjects, should be allowed to inflict directly and indirectly such a vast evil on the public in general. The above-mentioned individuals and companies reap no inconsiderable profits from their individual operations, but while endeavouring to increase their own profits, they treat with indifference the welfare of the public, and an important source of food not only to themselves, but to the public in general"[25]. In 1875 he took up again the question of sewage pollution of rivers and said "I ... warn the authorities who have command of the sewers that the enemy is always there, and only awaits time and opportunity to spring from his lair in the form of widespread disease" [19].

He believed that new techniques would be needed to treat polluted water. As early as 1867 he had suggested that a chemist should study how polluted water might be purified[23] and in 1873, in the

columns of *Land and Water*. he proposed the holding of an anti-pollution congress: "How to purify the water is a question not yet determined" [26]. The Rivers Pollution Commission claimed in 1874 that in most cases efficient remedies existed but in either event it is clear that the laws enabling control of pollution to be exercised were not being applied.

In 1863 a Royal Commission was appointed to "enquire into the Sea Fisheries of the United Kingdom". Its terms of reference were wide because sea fisheries legislation was recognised to be in confusion and the intention was to provide a more rational approach to control of the fisheries. The three Commissioners included Thomas Henry Huxley and their Minutes of Evidence, giving answers to nearly 62,000 questions, and providing information about almost every fishing station round the coasts, paint a remarkably detailed picture of the fisheries at the time and the way they had grown within living memory[27]. They also provide a graphic background to Buckland's work.

At the beginning of the nineteenth century the sea fisheries were largely concerned with the capture of fish for preservation by the traditional means of salting, smoking or drying. Fresh fish was supplied locally, or further afield to those who could afford to pay for transport, but this was only a small proportion of the total catch. Traditional methods of preservation demand great care if they are to be successful and are suitable only for certain species. Salting and drying, for example, is appropriate only for cod and ling and similar species with a low fat content in the flesh; herring can be preserved with salt but must be kept in airtight barrels to exclude air, or must be heavily smoked, to prevent rancidity which would otherwise rapidly make the products inedible. Traditional fisheries must therefore be seen as a unity, catching methods and shore operations being closely integrated and the catching methods employed, such as lining or drifting, being highly specific. Where fish is caught for the fresh fish market however the requirement is for variety and this is where trawling is particularly useful.

The evidence submitted to the Royal Commission underlined the importance of the railways in developing the fresh fish industry by carrying catches to the large and developing urban areas. There had been a steady increase in trawling, mainly from the 1840s and in those places where this had occurred, the livelihood of the traditional line fishermen was being seriously affected. One example will suffice: on 2 October 1863 Mr Tanton Fell gave evidence at Flamborough, Yorkshire. He said that the catches made by the line fishermen were greatly diminished whereas twenty years previously "A boat would get 58 or 60 stone of cod, haddock and other fish. They would average that each boat". He was then asked "and what will the average be now each boat?" ".... we have very few caught now at all. Sometimes a boat will go out and only get 2 or 3 stone" [27]. The same story was repeated all along the North Sea coast by the traditional line fishermen whilst the trawlers to a man claimed that their catches were continuing to rise. The reasons were partly that the trawlers fished through the lines which were thus damaged or lost, and partly no doubt that because of greatly increased levels of exploitation, catches per unit of effort were falling. The liners may also have been forced to move on to grounds which were less productive but because of rocks, wrecks or other potential snags were not suitable for trawling. There was no doubt that the fisheries as a whole were continuing to grow at a rapid rate. Trawlers were increasing in numbers and becoming larger and new technology was also making them more productive. The use of ice and, mainly after Buckland's death, the employment of steam, extended still further the possibilities of exploiting more distant grounds.

The Royal Commission reported in 1865. It recommended that " ... all Acts of Parliament which profess to regulate, or restrict, the modes of fishing pursued in the open sea be repealed; and that unrestricted freedom of fishing be permitted hereafter" [27]. For the future, the fisheries should be allowed to develop with only the minimum of Government interference to prevent needless friction

between different groups of fishermen. Huxley had formed a view, which he appears to have held for the remainder of his life, that " ... the supply of fish in the deep sea was practically inexhaustible ... " [28]; this was based on the ingenuous and mechanistic argument that the numbers of eggs produced by commercially important spawning fish in the sea were so large that the effects of man's fishing activities were insignificant. It is perhaps surprising that a scientist of Huxley's stature did not recognise that such an argument is seriously flawed because it depends on unwarranted assumptions about factors affecting the recruitment of young fish, the relationship of fishing mortality to mortality from other causes, and the distribution in space and time of spawning stocks, all matters on which at the time there was profound ignorance.

There is in fact some evidence in the answers to the Commissioners' questions that some fisheries were being overexploited, but it is easy to see how this was overlooked especially since it was impossible from the information then available to distinguish the effects on yield of rising catching effort, the development of faster vessels and new techniques for getting fish to market, and exploitation of new fishing grounds. The Commissioners did not even know the composition of the fleet and were concerned about the complete lack of such basic information: "We think it a matter of great importance that fishery statistics should be systematically collected" they observed [27].

The Commissioners' recommendations led to the repeal of much ancient and inappropriate legislation but the need was not identified for what are nowadays recognised as two essential pre-requisites for the proper control of sea fisheries, namely an effective administrative organisation within government, supported by a permanent body of scientists able to provide professional advice on how a common resource can best be exploited for the common good. These two aspects both bear on Buckland's contribution to fisheries administration and management.

In Scotland administrative arrangements were in fact tolerably effective, partly because they had developed over a long period, at least from 1808 when Parliament appointed Commissioners for the Herring Fisheries, but also because the fisheries in Scotland were of relatively greater importance than in England. In England and Wales the sea fisheries administration was muddled and ineffective. The Home Office was responsible for all aspects of the salmon and freshwater fisheries; Buckland and his colleague Spencer Walpole occupied premises in Old Palace Yard, Westminster, where most of the departmental responsibilities were fulfilled. Although the arrangements nowadays appear to have been needlessly bureaucratic, the system seems to have worked reasonably well and was perhaps appropriate for its time.

In so far as any department was responsible for the economically much more important sea fisheries, these duties lay with the Board of Trade. Attention was mainly directed to safety of navigation and the preservation of good order amongst crews. The Board at that time had no field supervisory staff or central fisheries office [29], and appears to have been structurally unsuited to, and probably incapable of, developing and implementing policies for the sea fisheries.

When problems with the sea fisheries arose, as they not infrequently did, Government relied upon whatever advice it could obtain from Buckland and Walpole, often through an administrative device which today seems strange when used for this purpose, namely of establishing a Royal Commission or Committee of Enquiry; this may have been occasioned by the fact that both men worked for the Home Office whilst sea fisheries were the responsibility of the Board of Trade. As a result, reports by Buckland and Walpole were received by Parliament and the possibly awkward situation of Civil Servants in one department reporting to another department was avoided. There may however have been other reasons for the adoption of these clumsy procedures.

It was widely recognised that some reorganisation of departmental responsibilities was needed, and in 1870 a Parliamentary Select Committee recommended that the Home Office responsibilities for salmon and freshwater fisheries should be transferred to the Board of Trade "... until, at least, the fisheries of the country are thought to be sufficiently developed to justify the establishment of a separate department". The Committee failed to address the crucial question of what the proper function of a fisheries administration should be. Although Buckland welcomed the idea of unification, whilst prudently adding that he was personally happy in the Home Office, he added " ... it is a question whether the development of the Department should not rather *precede* the development of fisheries than follow it" [30]. Unification under the Board of Trade did not take place until 1886 when field staff were appointed, but for a number of reasons the arrangements were unsatisfactory and responsibilities for the commercial fisheries, apart from matters concerned with safety and navigation, were transferred to the Board of Agriculture in 1903 [29].

So much for the administrative tangles which involved Buckland during his lifetime and to some extent his successors also. Administrators and politicians were slow to recognise that there was hardly any reliable statistical information about the sea fisheries, and that knowledge about the biology of the commercial species was grossly deficient. Many of the questions about possible overfishing could have been answered, or at the very least critical investigations could have been designed, if there had been regular collection of properly authenticated fishery statistics over a period of years. The advice of the 1863 Royal Commission that statistics should be collected was ignored; it was repeated by Buckland and Walpole in their Royal Commission Report on the Sea Fisheries of England and Wales (1878-9). It was repeated again by at least two other Royal Commissions but the scheme introduced in 1885 seems to have been stimulated by a paper given by HRH the Duke of Edinburgh at the Great International Fisheries Exhibition of 1883, three years after Buckland's death. It was not the fault of the Duke of Edinburgh that the scheme that was introduced was so ineptly conceived that the official statistics for the period up to 1906, when the basis of the present system was first introduced, are virtually worthless[29].

Nobody today would question the need for reliable statistics as the essential foundation for any attempt to understand and regulate a commercial fishery, but this recognition was remarkably slow to develop. Buckland was in advance of his time in seeing the need for both reliable statistics and a knowledge of the biology of commercial species of fish, though perhaps this is not surprising since he was repeatedly called upon to advise on matters which had never been studied and where little reliable information of any kind was available.

It has been a recurrent problem with fisheries legislation from early times that it has frequently been drawn up without regard to, or knowledge of, the biology of the species in question and with no understanding of the probable effects of the legislation when implemented. Although the 1863 Royal Commission had recognised part of the difficulty and had recommended the repeal of old statutes, it had not recognised the need for research. Even Huxley did not apparently identify such a need at the time. Indeed, the approach of the Commissioners seems nowadays to have been remarkably incurious. For example, it was repeatedly claimed by witnesses that trawl nets were frequently found to be full of spawn. The Commissioners do not appear to have asked whether this was true or, if it was, to what species of fish the spawn belonged though it would have been an easy matter to have asked a competent naturalist to have investigated the reports. It is perhaps more understandable that the Commissioners were apparently unaware of the work of G. O. Sars, published in Norway during the period the Commission sat, showing that cod produced pelagic eggs and larvae.

Buckland was perhaps the first permanent Government servant with a biological background who was called upon as a regular part of his job to provide fisheries advice, but he had no access to scientists with the skills or facilities to undertake appropriate investigations. It is at first sight puzzling that fisheries science began in Britain only a century ago, more or less contemporaneously in England with the foundation of the Plymouth Laboratory, and in Scotland with the work of W. C. M'Intosh and the reconstituted Fishery Board for Scotland. Agricultural research can be traced at least to the eighteenth century when inspired amateurs undertook pioneering studies on their estates and farms. Government employed Humphry Davy in the early part of the nineteenth century to advise on the application of chemistry to agriculture and the first agricultural research establishment in the UK and one of the first in the world, was formally opened in 1843, though Lawes and Gilbert had begun their classic experiments some years previously. Dr Buckland's purchase of land at Marsh Gibbon in 1840 has already been mentioned.

The spirit of investigation and scientific enterprise was widespread, and marine science and biology generally developed rapidly, particularly after the end of the Napoleonic Wars. Government gave imaginative and remarkable support by not only allowing naturalists such as Edward Forbes, Charles Darwin, T. H. Huxley and J. D. Hooker to accompany Royal Navy survey ships to distant parts of the world, but also allowed the Hydrographer to the Navy to make available the *LIGHTNING, PORCUPINE*, and finally the *CHALLENGER* for basic oceanographic research, though it should be noted that there was also a strong commercial interest in the ocean floor because of problems encountered in laying and maintaining submarine cables.

In spite therefore of considerable activity in other related areas of scientific endeavour, the pursuit of fisheries studies during Buckland's lifetime was strangely lacking. Ichthyologists, whether amateurs like Yarrell, Couch or Francis Day, or professionals like Gunther or J. E. Gray, were interested almost exclusively in fish structure and classification. Even Edmund Holdsworth's classic account of the methods of fishing and the boats employed, which arose from his work as Secretary to the 1863 Royal Commission, contains little mention of fisheries problems and in any case is not concerned with biological questions [31]. Buckland's voice remains the only one consistently calling for research into fishery problems, publicising the activities of the industry, drawing attention to the national importance of fish in the diet, and acting as a focus for those in the industry and elsewhere who were interested and concerned about its proper commercial development.

Even at the time of his appointment as Inspector of Salmon Fisheries he had identified the need for research. In August 1867 he wrote in *Land and Water*, in response to a letter from a correspondent, "What objection can be reasonably argued against the employment of revenue cruisers for the accommodation of naturalists, appointed by Government ... in order that they make a thoroughly practical examination of the dark and mysterious habits of food fishes. The trawl and the tow net, we firmly believe, if judiciously and persistently employed over an extended area of the sea, by men able to identify what the nets drag up and entangle, would do more to bring to light what is now hidden and unknown than all the evidence collected by the Sea Fisheries Commission. <u>It is a Government question</u>, and not one of private or individual research. We feel confident that the time is not far distant when properly-equipped naturalists will be sent by Government to investigate the habits of deep sea fish and moreover, we predict that aquaria must be established ere long at one or more stations along our coastline, wherein the larger food-fishes, together with the edible molluscs, may be easily watched from day to day, and their manners and customs investigated"[32].

Unfortunately most people engaged in fishing were not conscious of the need for any research and would probably have not been interested in it even if the need had been drawn to their attention. There was no equivalent of the large landowner who from natural curiosity would finance his own

investigations of agricultural procedures, nor were there large commercial interests equivalent to those which stimulated Government to send ships of the Royal Navy to chart the ocean highways. Only Government could have provided the resources and direction which would have enabled appropriate fisheries research to be done but the policy of non-interference was in a sense self-reinforcing; no requirement for statistical and other information about the sea fisheries was recognised, and in the absence of such information the need for research was also unrecognised. Buckland was influential in helping to change views, but he did not live to see Government begin to fund fisheries research.

One must be careful not to claim too much for his views on the funding of fisheries research. The idea of using an aquarium as a centre for the study of sea fish is probably as close as he ever got to the concept of a laboratory dedicated to scientific investigations. His approach to problems was essentially a practical one and he occasionally indicated some contempt for theoretical and basic scientific research. He could not accept the concept of evolution which he fiercely opposed on religious grounds though he never set down his objections in any reasoned way.

He also appears to have felt that the resources devoted to the *CHALLENGER* expedition could have been better applied to fisheries research nearer home. "The natural conditions of the bottom of this great North Sea is (sic) in a scientific sense less well known than the deserts of Sahara. Yet ... (it) is practically more important than the revelations made at a vast expense to the country of the abyssal depths of far distant oceans," he wrote in 1880 [33].

Although he knew many of the leading scientists of the day, and some, for example Sir Richard Owen, were old family friends, it was rather to practical men that he turned when he needed help, information or advice on fisheries questions. He himself was at his best in the field, commenting on a fish hatchery, helping to net spawning trout, or examining the operation of a salmon ladder from the point of view of the fish itself. He had a wide circle of friends in and around London, but he developed and maintained an even wider range of contacts through the columns of *Land and Water*. He acted as a focal point for all matters concerned with freshwater and marine fisheries and people from all over the United Kingdom, recognising his interest, wrote to him and sent him specimens and in time were infected by his enthusiasm. His last published work, the *Natural History of British Fishes* [33], gives a good idea of the extent to which he depended on his correspondents for information. The contribution of this array of amateur naturalists to the development of fisheries research in the United Kingdom during the early years deserves to be recognised.

Many confined themselves to reporting a single, chance observation or to sending an interesting specimen, but others continued to make contributions over many years. One such outstanding person was Matthias Dunn (1830-1901) of Mevagissey " ... who throughout a long and busy life ... perseveringly and very fruitfully applied himself to the careful study of the habits and life histories of the denizens of the waters near his home ..." [34]. Dunn was from a fishing family and had practical experience of most methods of fishing. He was a man of considerable character and intelligence but he also owed much to Jonathan Couch of Polperro. He sent specimens to Buckland for his Museum, and was also in frequent correspondence with him, but his contacts ranged more widely. He helped Spence Bate and Saville Kent, both well known in their time, and when Francis Day was completing his monumental treatise *Fishes of Great Britain and Ireland* he sent the manuscript to Dunn for his comments [35]. Unfortunately, apart from the fact that he published a number of original papers and other articles, mostly in journals of local scientific societies, and played a part in the early history of the Plymouth Laboratory, not a great deal is known about him.

Buckland was the acknowledged leader of a network of people such as Dunn who were particularly well placed to make original observations. He believed that many fisheries problems could be solved by collecting and collating detailed observations from such people and he sought to make his Museum the recognised centre for the dissemination of information.

Early in 1879, whilst Buckland and Spencer Walpole were preparing their report *Sea Fisheries of England and Wales*, O. T. Olsen of Grimsby, whose name survives in *Olsen's Fisherman's Nautical Almanack*, suggested that masters of North Sea fishing smacks should compete for prizes for the best-kept logs giving details of water temperature, wind, barometric pressure, and the quantity and nature of fish caught. Buckland adopted the idea with enthusiasm and helped to establish a committee to organise a scheme for publicising the competition, collecting the completed logs and marking them, and presenting the prizes. He added to the prize fund from his own pocket and was instrumental in obtaining a contribution of £25 from the Fishmongers' Company.

The purpose of the competition was very much in line with Buckland's own ideas, and was to encourage fishermen to provide information which when systematically considered and organised would help them in their calling. They would " ... be enabled, with much greater accuracy than at present, to predicate the times and places at which the shoals of fish, whether round fish or flat fish, assemble or disperse"[36]. He went on "We also want to know the times and places of the spawning of sea fish. Where do the soles lay their eggs? When and how do the plaice, turbot, brill, halibut, etc., spawn? Do soles' eggs sink or swim? What are the form and dimensions of the young sole just hatched from the egg? We know, moreover, as yet, but very little of the food of these fishes. We want also samples of the surface water itself under peculiar conditions, for instance, what is the meaning of the wonderful white appearance of the sea which took place last autumn in nearly all the waters of the northern coast of England? What is the meaning of the occasional red appearance of the sea for many square miles. Again, how are we to devise a mesh of net that shall let go the small soles and undersized fry of other sea fish, and keep marketable fish only?"

As Garstang pointed out in 1930, however, " ... the notes that a fisherman can make, and the samples he can collect, in the course of his regular work, which is exacting enough, can only touch the fringe of all the many matters that affect the life, growth and movement of sea fishes ... "[37]. The more fully the scheme was carried out, the more difficult it would have been to carry it on and if Buckland had lived he would probably soon have realised that the enterprise would need to be based on a more solid foundation. Nonetheless, this arrangement could have led to a faster development of statistical and scientific investigations of fishery problems than in fact occurred, but the idea died with Buckland.

Buckland's Museum he left to the nation in his will for " ... public instruction and enjoyment ... " [38]. His enthusiasm sustained it during his lifetime and he had great ambitions for it. He once wrote "I ... am trying to make such a Bucklandian fish museum as will be appreciated some of these days. My Father left his museum of Geology to the University of Oxford. It is called the 'Buckland Museum' "[39] and he wrote elsewhere "I only trust my museum at South Kensington may one day become the nucleus of such a museum as we have at the College of Surgeons"[40]. This was a reference to the Hunterian Museum. Buckland's Fish Museum remained on show into this century and was eventually put into store where little of it now remains. Time and the damage sustained as a result of two World Wars have mostly destroyed the collection. Attempts by the South Kensington Museum authorities to find a more suitable home for it were frustrated by the fact that gifts to the Nation are accepted in perpetuity.

The Rt Hon Edward Heneage MP was no doubt echoing a widely held contemporary view when in 1889 he submitted a Memorial asking that the Museum should be transferred to Cleethorpes. He wrote "Frank Buckland stirred up throughout the country an interest in our fisheries, the effects of which survived him, and may be traced both in many local organisations for the cultivation and preservation of fish, and in the remarkable Fishery Exhibitions held in 1881 in Norwich, in 1882 in Edinburgh and in London in 1883" [41].

Buckland was indeed an enthusiastic proponent of fisheries exhibitions but although a number were held in Europe in which he played important parts, there were none in Britain until after his death. The Great International Fisheries Exhibition of 1883 was a particularly impressive affair, supported by the Government. It was housed in specially erected buildings which stood behind the Royal Albert Hall in London and it was opened with much pomp by the Prince of Wales. It aroused great interest and led directly to discussions on the need for marine biological research in the UK. These discussions culminated in the foundation of the Marine Biological Association of the United Kingdom and the building of the Plymouth Laboratory. The Fisheries Laboratory at Lowestoft began as a daughter station of the Plymouth Laboratory but was eventually transferred early in this century to the Board of Agriculture and Fisheries.

In his will Buckland also left a legacy of £5000 for the foundation of a 'Professorship of Economic Fish Culture'. The Trustees were to be the Vice Present of the Committee of Council on Education and the Director and Assistant Director of the South Kensington Museum, but Buckland's widow was to have the use of the interest on the money during her lifetime. She lived to be 91 years old and died in 1920. There were difficulties with the estate which led to legal problems but at her death there were sufficient assets to establish the trust, though it was necessary to apply to the Chancery Court for detailed interpretation of the original provisions. The present scheme came into effect in 1926.

The Buckland Foundation as now constituted has three Trustees, two of whom are appointed by the Secretary of State for Education and Science and one by the Minister of Agriculture, Fisheries and Food. It has been the general practice to appoint the current directors, or their appointed representatives of the Scottish Office Agriculture and Fisheries Department's Marine Laboratory in Aberdeen and the Ministry of Agriculture, Fisheries and Food, Fisheries Laboratory at Lowestoft, who take it in turns to act as Chairman, whilst the third Trustee has been a senior figure from marine science or the fishing industry. The first Trustees were Mr E S Russell, Director of the Lowestoft Laboratory (Chairman), Dr Alexander Bowman, Director of the Aberdeen Marine Laboratory, and Mr Robert Jackson of the British Trawlers' Federation.

Their deliberations in 1926 and 1927 were concerned with drawing up the detailed responsibilities of the Buckland Professor whose duties were set out in the scheme as " ... to deliver lectures at such places in the United Kingdom or Ireland as the Trustees shall from time to time approve ... ". Although some possible names were considered, no appointment was made. It was however provisionally agreed that the " ... lecturer be required to stay for two periods of one week each in some fishing port or ports, by holding informal preliminary conferences and otherwise, and that he be requested to deliver not less than three formal public lectures during each week". In addition it was agreed " ... that the Lecturer be required to prepare and deliver to the Trustees one month in advance the subject matter of his lectures in form for publication" [42].

The Trustees were anxious to ensure that the first Buckland Professor should be a senior and respected fishery scientist and after some deliberation they wisely chose Professor Walter Garstang,

Professor of Zoology at the University of Leeds. He was born in 1868 in Blackburn and was the son of a local physician. He was educated at Blackburn Grammar School and Jesus College, Oxford. He was Chief Naturalist to the Marine Biological Association of the UK from 1897 to 1907 and Head of the Association's Lowestoft Laboratory from its establishment in 1902. He resigned on his appointment to the Chair at Leeds in 1907. He retired in 1933 and died in 1949 aged 81.

Although it had been initially agreed that the first lectures should be given in 1928, Garstang was taken ill and could not fulfil his task until 1930. His lectures were concerned with the life and work of the Founder, the natural factors influencing the balance of life in the sea and how these were affected by fishing activity. They were published as a pamphlet [37] and are still worth reading today because they provide an authoritative summary of the state of knowledge at the time.

Garstang helped to establish the style followed by all subsequent lecturers; this demands clear and informative writing, without jargon, suitable for the layman or the expert. Publication of the lectures also signalled the determination of the Trustees to see that the work of the Buckland Professor should reach a wide audience.

The Minute Books show the care exercised by successive Trustees in selecting possible holders who might be invited to accept the Professorship. To receive such an invitation is widely regarded by those concerned with fisheries research and administration as a considerable honour; nevertheless the Minute Books reveal some recurring problems. The Trustees have always sought to invite people who were expert in their field, or who were otherwise well known for their contribution to some aspect of fishery administration, research and development or the application of technology to problems of fish catching, handling or processing, but inevitably some who have accepted have found it easier to fulfil their lecturing commitments than to provide written contributions in a form suitable for publication. Sometimes they have been provided many months or even years late. Although this can be seen as a price to be paid for appointing senior and busy people with many calls on their time it is unfortunate. It has in a few instances resulted in the complete loss of some contributions which would have been of great interest and value, whilst others have been published late and have consequently been less timely.

The organisation of the lectures themselves has also provided some difficulty. In Buckland's day, popular lecturers might have audiences of many hundreds and even in the 1950s it was generally sufficient to advertise the details of a lecture to obtain an enthusiastic audience of interested people. Times have changed. It is difficult for even the most accomplished and well-known lecturer to compete with television and audiences are nowadays likely to be much smaller and composed of colleagues and other experts in the same or a related field to that of the lecturer, rather than of interested laymen or those employed in the fish industry itself. This fact gives even greater point to the desirability of rapid publication.

Nevertheless, too much can be made of the difficulties and too little of the achievements. The Trustees have been remarkably successful over many years in choosing Buckland Professors who between them have produced a range of lectures covering almost every aspect of fishery research and development. An appendix to this paper gives a complete list of all the holders to date; it was decided to " ... defer the resumption and publication of lectures ... " during the years of the 1939-1945 war and for various reasons they were only resumed in 1947, when they were given by W. J. M. Menzies. Other occasional breaks have occurred for unexpected reasons, such as illness.

The first lectures were published as pamphlets which were produced on behalf of the Foundation by the journal *Fishing News* which in the 1930s was based in Aberdeen. Although Edward Arnold

had offered in 1930 to act as publisher, the existing arrangements seemed satisfactory and no action was taken at the time, but a year or two later Arnold was asked to assume responsibility. It was an appropriate choice because the Arnold and Buckland families were connected by marriage through Frank's uncle, John Buckland. Edward Arnold died in 1942 but his company continued to publish the lectures until the task was assumed by Arthur Heighway in 1965.

Arthur Heighway purchased the journal *Fishing News* in 1953 and extended activities with imagination and vigour into the publication of books about all aspects of commercial fishing. Although he died in 1978, the book publishing company has remained under the leadership of his daughter and her husband until very recently. Thus it has come about that Fishing News (Books) Ltd has published the Buckland Lectures since 1965: the company has been owned since 1990 by Blackwell Science. Since *Fishing News* was responsible for publishing the first lectures, there is an appropriate symmetry about the present arrangements.

Frank Buckland would have approved of the Buckland Foundation. It is of course impossible to know exactly what he had in mind when he made his will, but he certainly would have been proud of an organisation which he founded and which over many years has been providing information on such a wide range of topics to anyone with an interest in the fisheries.

Although the Foundation has been an unqualified success, time has on the whole been unkind to the Founder who has suffered the fate of an enterprising pioneer who died too soon so that his achievements have been largely forgotten. One can only speculate about what his role might have been in the affairs of the Plymouth Laboratory had he lived to retire at 65 in 1891. He was certainly not a man to stand idly by and somehow or another he would have become involved in the early development of Government funded fishery research.

Yet there is a lingering uncertainty about what his contribution might have been. His Museum performed a useful function during his lifetime as a means of increasing public awareness about fish and fishing and also as a centre for disseminating technical and scientific information. With his death, however, the Museum lost its leader and its vitality; it was probably not deliberately sabotaged, but it was certainly allowed to die by neglect, though this might have been its fate even if Buckland had remained alive and active. The Plymouth Laboratory became a much more effective centre than the Museum ever could have been. A new breed of marine scientists who had access to research facilities grew up at Plymouth, and later also at Lowestoft, who could speak with the authority of first-hand knowledge that Buckland, with his multifarious activities and largely administrative responsibilities, could never have matched.

Before long he would probably have found himself out of his depth in dealing with men like Walter Garstang, Ernest W.Holt and J. T. Cunningham to say nothing of the galaxy of able fisheries biologists in Scotland who began to make major contributions in the 1880s. They were all professionals with an analytical approach whereas Buckland was generally light-hearted, superficial and anecdotal. He might also have found himself increasingly isolated from activities which he had helped to initiate because although responsibility for the fisheries of England and Wales was transferred entirely to the Board of Trade in 1886, it had no powers to make scientific investigations. The contributions made by the Government of the day to the Plymouth Laboratory were probably by direct Treasury grant.

Buckland was a man for the time in which he lived. He was a supremely good publicist, a skilful author and a first-rate lecturer who dedicated much of his working life to the service of the fisheries of the British Isles. His infectious enthusiasm encouraged others and his contemporaries freely

acknowledged his great contribution. He deserves to be remembered as a pioneer: a loyal and hardworking public servant who laboured unsparingly. He probably died as a direct result of his frequent, and foolhardy, exposure to bad weather whilst netting spawning fish. The continuing activities of the Buckland Foundation will however serve to remind successive generations of fisheries biologists and also the public at large of his place in the early history of fisheries administration, research and development in the British Isles.

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Appendix – List of Buckland Lectures

1930 Frank Buckland's Life and Work etc
W Garstang

1931 Salmon Hatching and Salmon Migrations
W L Calderwood

1932 The Natural History of the Herring in Scottish Waters
H Wood

1933 The Natural History of the Herring in the Southern North Sea.
WC Hodgson

1934 The Hake and the Hake Fishery
C F Hickling

1935 Oyster Biology and Oyster Culture
J H Orton

1936 The Nation's Fish Supply.
E Ford

1937 Fish Passes
T E Pryce Tarrant

1938 Hydrography in Relation to Fisheries
J B Tait

1939 Rational Fishing of Cod in the North Sea
Michael Graham

1947 The Stock of Salmon. Its Migrations, Preservation and Improvement.
W J Menzies

1948 Sea Fisheries
G T Atkinson

1949 The Plaice
R S Wimpenny

1950 River Pollution
H D Turing

1951 Fishery Hydrography
J R Lumby

1952 River Purification
F T K Pentelow

1953 Irish Salmon and Salmon Fisheries
A J Went

1954 Inshore Fisheries
H A Cole

1956 The Haddock
B B Parrish

1957 Plankton
A P Orr

1958 Lemon Sole
Bennet A Rae

1959 Fish Capture
R Balls

1960 Historical Background of International Organisations for Regulating Fisheries etc.
R J D Beverton

1961 The Stocks of Whales
N A Mackintosh

1963 British Freshwater Fishes
M E Varley

1964 Developments in the Handling and Processing of Fish
G H O Burgess

1965 The Lobster - its Biology and Fishery
H J Thomas and A C Simpson

1966 Sonar in Fisheries - a Forward Look
D G Tucker

1967 The Artificial Cultivation of Shellfish
P R Walne

1969 Ocean Currents and their Influence on fisheries
A J Lee

1970 Fish Nets and Men - an Underwater Approach to Fisheries Research
A C Hemmings

1971 Behaviour and the Fisheries
F R Harden Jones

1974 Exploitation of the Salmon Stocks
K A Pyefinch

1977 The Edible Crab and its Fishery
E Edwards

1979 Maximum Use of British Aquatic Food Resources
J J Connell and R Hardy

1980 Scallop and Queen Fisheries in the British Isles
J Mason

1981 Marine Pollution and its Effect on Fisheries
A Preston and P C Wood

1982 Engineering, Economics and Fisheries Management
G C Eddie

1983 A Story of the Herring
G Buchan

1984 Mackerel
S J Lockwood

1985/86 Fish Cultivation
R J Roberts

1987 Nephrops
C Chapman

1988 North Sea Cod
C T Macer

1989 Atlantic Salmon
W M Shearer

1990 Pollution and Freshwater Fisheries
R Lloyd

1991 The Common Fisheries Policy: Past, Present and Future
M J Holden

1992 Industrial Fisheries, Fish Stocks and Seabirds
R Bailey

1993 Marine Protected Areas and Fisheries
S Gubbay

1994 Deep-Sea Fisheries: A New Resource?
J D M Gordon

1995 Bivalve Cultivation in the UK: Structuring Influences
B E Spencer

Not all lectures have been published.
The 1957 Lectures were published under the title ‘The Fertile Sea’.

BRITISH MARINE SCIENCE AND ITS DEVELOPMENT IN RELATION TO FISHERIES PROBLEMS 1860-1939: THE ORGANISATIONAL BACKGROUND IN ENGLAND AND WALES

Arthur J. Lee

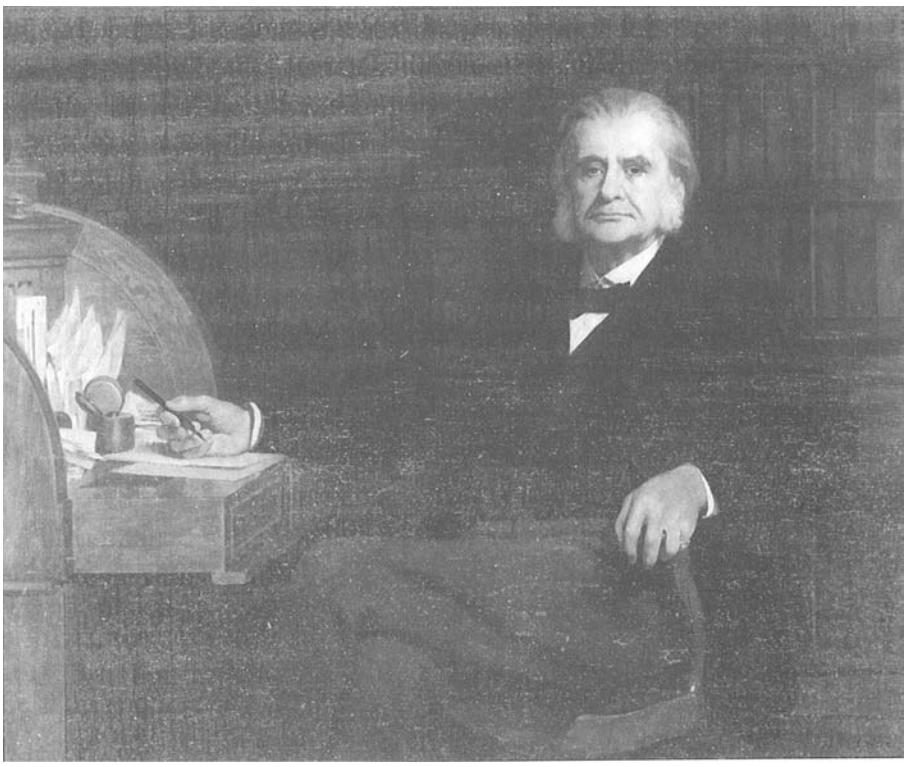

Plate 1. T. H. Huxley (see pages 36-37).

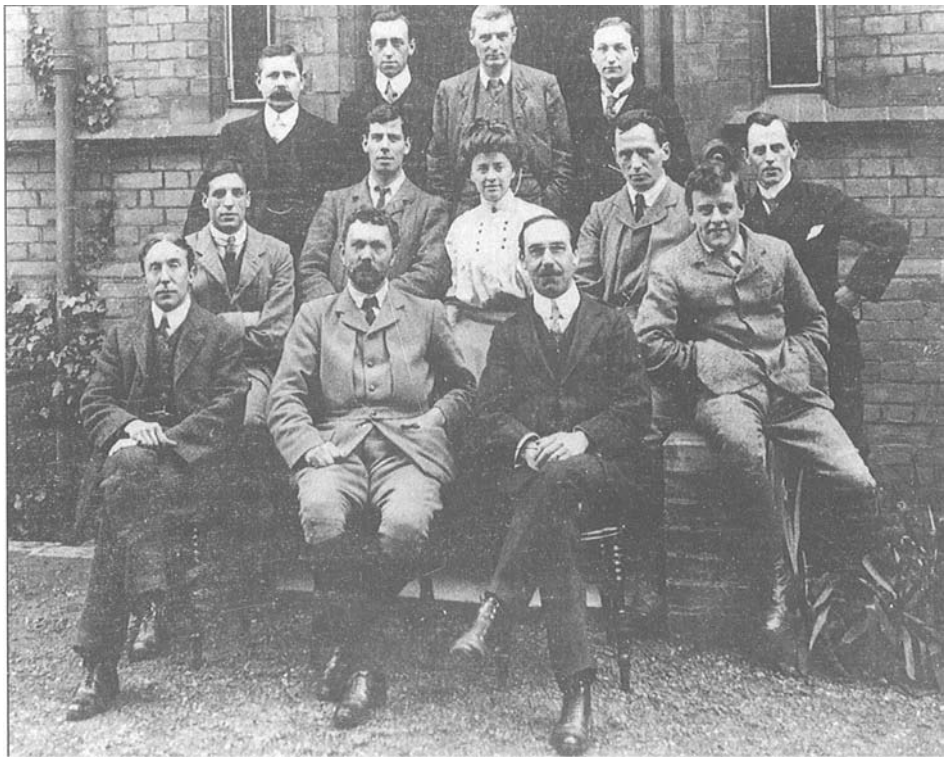

Plate 2. The staff of the MBA out-station at Lowestoft in 1907. Walter Garstang is in the centre of the front row (see pages 38 and 40).

BRITISH MARINE SCIENCE AND ITS DEVELOPMENT IN RELATION TO FISHERIES PROBLEMS 1860-1939: THE ORGANISATIONAL BACKGROUND IN ENGLAND AND WALES

Arthur J. Lee

My purpose in this paper is to show that most of the marine science institutions in England and Wales owe their origin, either wholly or in part, to the problems of the British fishing industry. At times I will have to go over the Border because many of the problems associated with the fishing industry of England and Wales have applied also to Scotland, but in so doing I hope not to trespass on the ground to be covered by later contributors.

My starting point is the mid-19th century. By that time the geographical expansion of the English trawling industry, which started after the end of the Napoleonic Wars, had taken it from its traditional bases at Barking, the Channel ports and Brixham to new ones as far north as Hull in the North Sea and Fleetwood in the Irish Sea. After 1850 the size of the industry increased even more rapidly as a result of the Industrial Revolution. The introduction of ice for preserving fish and the development of the railways, together with an increasing demand for fish in the fast-growing towns in the north of England and the Midlands, gave an impetus to the fishing fleets to range even further afield, so that by 1875 there was little of the shallower parts of the North Sea south of a line from Aberdeen to Esbjerg that was not exploited by British vessels [(1)]. Then, with the coming of the first British purpose-built steam trawlers to Grimsby in 1882, the foundations of the United Kingdom's steam trawling industry were laid and the way opened for a dramatic increase in fishing power in all the seas around the British Isles and in others further afield. Thus fish came to form an important part of the nation's food supply. So much so that even in the 1860s the weight of trawled fish supplied to the London market annually equalled the supply of beef (90,000 tons) and, in addition, large quantities of herring, sprat, salmon and shellfish were supplied by other modes of fishing [(2)]. It is no surprise that the terms of reference of a Royal Commission of Inquiry into the Sea Fisheries appointed in 1863 ended with the words "with a view to increasing the supply of a favourite and nutritious article of food for the benefit of the Public" [(2)].

This importance of fish brought about a public concern for the nation's fisheries. It was pursued by four groups of people (i) the nobility, from the Royal Family downwards, acting in their Victorian role of public benefactors, (ii) scientists, or rather Naturalists as they were then called, (iii) fishing vessel owners and (iv) bankers who were financing the fishing industry. These groups did not work separately: although they at times held different views with respect to national fisheries policy, they frequently combined to bring the importance of the well-being of the industry to the notice of politicians and the public at large.

Their early concern is reflected in the setting up of two Royal Commissions of Inquiry, one into Salmon Fisheries in 1860 and the other into Sea Fisheries in 1863. The former was concerned with a marked decrease in catch in the rivers of England and Wales. It attributed this primarily to river pollution and the erection of dams, both products of the Industrial Revolution, and its report led to the Salmon Fisheries Act of 1861, which placed certain regulations on salmon fishing and made the erection of fish passes over dams and weirs compulsory. The Act was to be enforced by two Inspectors of Salmon Fisheries appointed by the Home Office [(3)].

Among the first of these were two men who were to have a great influence on subsequent events - Frank Buckland and Thomas Huxley (Plate 1). They were two very different characters. Geoffrey

Burgess has already written about Buckland [8]. With his concerns about sea, river and shell fisheries, river and estuarine pollution, weir construction, and the protection of sea-birds and seals, and with his stimulation of public interest through books, articles in periodicals, public lectures, exhibitions and aquaria, he was pursuing one of the great public concerns of our present times, namely how best to manage the natural environment and its resources, and in doing so he was taking maximum advantage of the news media of his day. I regard him as being over 100 years ahead of his time – a 19th century Friend of the Earth.

Thomas Huxley, on the other hand, was a distinguished anatomist and a President of the Royal Society. He was in the van in the struggle for hegemony which was conducted against the influence of the church and the aristocracy by the scientific naturalists of Victorian England. To assist in this, he founded the X-Club in 1864: this consisted of nine distinguished men of science all but one of whom were Fellows of the Royal Society. They were a pressure group which sought to influence elections to the Royal Society and the British Association for the Advancement of Science, the award of grants-in-aid, and the Parliamentary representation of science [4]. Thus Huxley's modern day equivalents are those who prefer to advise Government in the formulation of policy less publicly and on a solid basis of sound scientific investigation.

The different approaches of these two men were to give rise to our first British marine science institutions. Taking Huxley's contribution first; he sat on the 1863 Royal Commission of Inquiry into Sea Fisheries which had come about as a result of complaints from linesman, seiners and operators of set nets that the expansion of trawling was destroying the sea fisheries. It was asked to find out if current methods of fishing involved a wasteful destruction of fish or spawn and, if so, to suggest legislative remedies. It reported that it did not find the use of the beam trawl injurious to the fisheries but it did conceive of a situation where the use of improved gear might lead to the destruction of fry to such a pitch "as to bear a large, instead of, as at present, insignificant ratio to the destruction effected by the natural enemies of fish, and by conditions unfavourable to their existence. In such a situation the best remedial action would be to introduce a minimum landing size regulation. However, the existence of such a state of things could only be determined by the examination of a long time-series of trustworthy fisheries statistics". So the Commission recommended that these should be collected systematically, perhaps by the Coastguard or Customs organisation [2].

Twenty years later, in 1883, Huxley became a member of another Royal Commission. It was chaired by the Earl of Dalhousie, and appointed to inquire into "complaints by line and drift net fishermen of injuries sustained by them in their calling owing to the use of the trawl net and beam trawl" [5]. If the complaints were substantiated, then legislative remedies were to be put forward. This new Commission immediately found that, despite the advice given by its predecessor, there was no statistical information available to it. In an attempt to get around the problem so caused, the Commissioners obtained the sum of £200 from HM Treasury to be expended on scientific investigations on (a) the results of the use of the beam trawl, and (b) the seasonal distributions of the food-fishes taken by trawling on various grounds. Huxley invited Professor William M'Intosh of St Andrews University to do this. The latter was allocated a Granton trawler with which to do the work at sea and then, with the help of the Fishery Board for Scotland, he set up a laboratory in a disused fever hospital at St Andrews. There he analysed his collections and so established the first long-lived British marine biological station; in due course this became the Gatty Marine Laboratory [6].

Turning now to Buckland's contribution; he was a keen supporter of Fisheries Exhibitions. The first such was held at Arcachon in France in 1866. Others followed elsewhere in France and in the Netherlands. In 1879 Sir Edward Birkbeck, the President of the Norfolk and Suffolk Fish

Acclimatization Society, a body concerned with the development of the fisheries of the Norfolk Broads, received an invitation to attend an International Fishery Exhibition to be held in Berlin in the following year [7,8]. Buckland was a member of the Society and he sent an exhibit, but that was the only British contribution amongst a series of splendid displays by other European countries and the USA. Nevertheless, this exhibition inspired the Norfolk and Suffolk Society to mount a National Fisheries Exhibition in Norwich in 1881. The enthusiasm of Birkbeck, the encouragement of Buckland, now a sick and dying man, and the hard work of the Society's Secretary, W. Oldham Chambers of Lowestoft, resulted in its being a great success. It was opened by the Prince of Wales and given support by the Home Office and its two Inspectors of Fisheries – Huxley and Spencer Walpole. By popular demand its duration was extended from two weeks to three [9]. Its success led to a similar venture in Edinburgh in 1882 and some of the profits from this helped towards the establishment of a Scottish Marine Station for Scientific Research by the Scottish Meteorological Society at Granton in 1884 [10]. From that point a line leads through the Marine Station at Millport to what is now the Dunstaffnage Marine Laboratory of the Natural Environment Research Council.

Birkbeck was a man of influence. His father was a member of a banking family and had married twice: first, to a member of the Gurney family which owned the Norwich Bank and other banks in East Anglia; second, to Elizabeth Barclay, a daughter of the Lombard Street banker. The Birkbecks, Gurneys and Barclays were all Quaker families and in 1896 the various Gurney banks became incorporated into Barclays Bank. Edward was one of the eight children arising from the Birkbeck/Barclay marriage. He became a Norfolk Member of Parliament and for many years showed a keen interest in the fishing industry and the welfare of fishermen. Also, from 1883 until his death in 1908, he was the Chairman of the Royal National Lifeboat Institution and was largely responsible for putting that body on a sound footing [11]. These concerns can be attributed to his Quaker upbringing: on the other hand, the concerns may have arisen from enlightened self-interest in that the Gurney Banks were helping to finance the change in the North Sea fishing fleet from sail to steam, and needed that enterprise to prosper. It is significant that at the very time Birkbeck was mounting the Norwich exhibition and helping to found the National Sea Fisheries Protection Association, a body concerned with the welfare of the fisheries and the protection of the trade of trawler owners, skippers and fish merchants, his half-brother Henry, the only child of the Birkbeck/Gurney marriage, was head of the Norwich Bank [12].

The success of the Norwich exhibition led Birkbeck, assisted by Chambers, to mount the highly successful International Fisheries Exhibition in London in 1883. Once again he obtained considerable support from the Royal Family and members of the nobility. A fisheries conference and a Practical Fishermen's Congress were held at the same time and these gave rise to a lively debate as to whether fishing effort could have an effect on fish stocks [13]. In this Ray Lankester led for the 'Ayes' and Huxley for the 'Noes' and to help resolve the matter Ray Lankester got 14 eminent scientists, but not Huxley, to sign a resolution appealing for the formation of a society, with a laboratory, boats etc., to foster the study of marine life, especially the life histories and food habits of fish, so that a thorough knowledge of fishery animals could be built up and come into use as the basis of legislation. This led to the Royal Society holding a meeting in London in 1884, with Huxley in the chair, at which the Marine Biological Association (MBA) was founded and the wheels set in motion for the building of its laboratory at Plymouth. This was opened in 1888 and partly paid for by private subscription and partly by a capital costs grant from the Government [14,15]. In its initial application for the latter the MBA was much helped by Joseph Chamberlain, then President of the Board of Trade and an influential Liberal, but by the time it came to make the grant, and another for running costs, the Tories were in office and the current costs grant was limited to five years and had the proviso that the research was to be aimed at obtaining results bearing on the management of stocks of food fish [16].

In 1886, as a consequence of the Report of the 1883 Dalhousie Commission, the Government moved to set up a Fisheries Department in the Board of Trade and the Inspectors of Salmon Fisheries in the Home Office were transferred to it and made responsible for all fisheries. From then on and up till the end of the century, although the MBA conducted fisheries research under Cunningham and others at Plymouth, and Ernest Holt at Grimsby, it found it increasingly difficult to get Government funding. Yet this was at a time when the National Sea Fisheries Protection Association, which had been formed in 1882, was pressing the Government to deal with the question of the catching of what were called undersized fish [17]. So much so that it persuaded the Foreign Office to arrange for an international conference to be held in London in 1890 in the hope of obtaining agreement with other North Sea countries on landing size limits for plaice and other flatfish. It was abortive because of a lack of scientific and statistical information.

It was also a time when the Sea Fisheries Regulation Act of 1888 was passed; so setting up a network of Sea Fisheries Committees (SFCs) with local regulatory powers in England and Wales and thus making nationwide regulation of fisheries nearly impossible. These committees could also carry out investigatory work with money from the County Council rates or Local Technical Instruction Committees. With such funding and the aid of private benefactors the Northumberland SFC established a laboratory at Cullercoats in 1897: this eventually became the Dove Marine Laboratory [18]. Likewise, in 1889, the Lancashire and Western SFC set up a laboratory in association with University College, Liverpool and, in 1897, another of its own at Piel near Barrow-in-Furness [19]. From that point a line leads to the founding of the Port Erin Marine Laboratory in the Isle of Man.

Events were now to be influenced from a very different initiative. At the 6th International Geographical Congress held in London in 1895, Professor Otto Pettersson of Sweden put forward a scheme for international co-operation in the study of the North Sea, Baltic Sea and Northeast Atlantic, especially regarding fishing interests, and he took back to King Oscar II a resolution endorsing it [20]. The upshot was that the Swedish Government convened an international conference in Stockholm in 1899 to take action. It so happened that, at the very time the invitation to participate arrived in the UK, the Prime Minister, Lord Salisbury, had been receiving delegations of English and Scottish fishermen expressing concern about the state of the North Sea fish stocks. It thus presented him with an opportunity to inform the fishermen that HM Government (HMG) was taking action; the UK would get the conference to devote itself to a consideration of the practical problems facing British fishermen [21]. Thus the UK delegates were briefed that they should inform the conference that the principal object of HMG in taking part was a careful inquiry into the effects of the present methods of fishing in the North Sea and that they should give every assistance in promoting a scheme for determining whether protection against overfishing was needed and, if so, what form it should take. This line was, in fact, conveyed to the Swedish Government before the conference. The UK would not take part in it unless such an inquiry into possible overfishing were to be its main object and take priority over the study of hydrographical and biological conditions, however valuable in itself that might be [22]. As a consequence, the conference moved a considerable way to agreeing a scheme of international investigation of the fish stocks of the North Sea and their physical and biological environment, but the UK-line led to a number of matters being unresolved and the need for a second conference in Oslo in 1901.

The membership of the delegation for this conference led to bitter feuding among the British marine science community for the next 10 years. The UK delegation to the Stockholm conference had consisted of Sir John Murray, Professor D'Arcy Thompson and Walter Archer, the Chief Inspector of Fisheries in the Board of Trade but, following submissions from the MBA and, in my view, the Royal Society and the Fishery Board for Scotland, Archer was dropped from that for the Oslo conference and replaced by Walter Garstang of the Plymouth Laboratory and H R Mill of the British

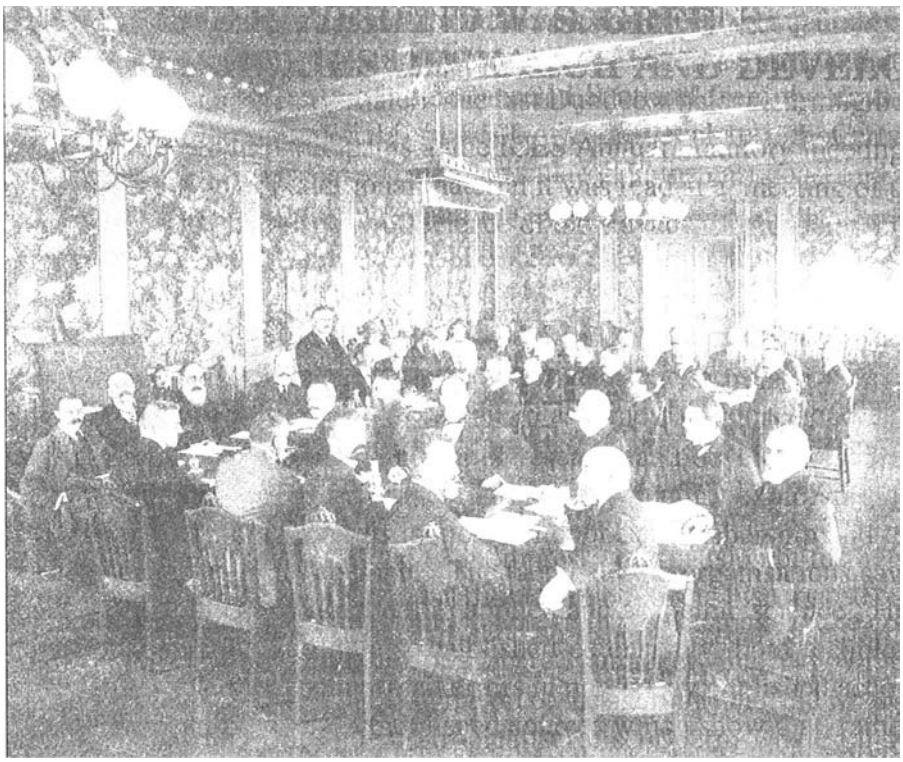

Plate 3. ICES in conference 1912: Walter Archer standing and Henry Maurice sitting at the far right of the top table

Plate 4. Henry Maurice in the uniform of the Fisheries Secretary of the Board of Agriculture and Fisheries: Fisheries Secretary, 1912-38 and President of ICES, 1920-38 (see pages 41-42).

Rainfall Organisation [23]. At the Stockholm conference it had been proposed that the state of the North Sea fish stocks should be assessed on the basis of a series of groundfish surveys carried out conjointly with each participating country contributing a research vessel. Archer had his doubts and proposed no action until the results of previous such surveys were available. He had in mind those conducted over 13 years by the *GARLAND* for the Fishery Board for Scotland. That vessel had recently been declared unseaworthy and Archer had advised his Permanent Secretary not to support the Board's submission to the Treasury for money for a replacement vessel until the results of that work were to hand [22].

The brief to the UK delegates to the Oslo conference now dropped the demand for a sight of the results of earlier groundfish surveys and down-graded the priority to be given to the overfishing inquiry. The conference resulted in agreement over the content of a programme of international North Sea investigations, and the formation of the International Council for the Exploration of the Sea (ICES) to carry it out. This body was to have its headquarters in Copenhagen and to hold its first meeting in 1902 [23]. But HMG was now faced with the problem of deciding who should execute the British part of the programme.

The Board of Trade set up a Committee on Ichthyological Research chaired by Sir Herbert Maxwell MP, FRS (the 'Gilbert White of Galloway'). This carried out an in-depth review of fisheries research in Great Britain and Ireland, the problems requiring solution, and the best ways of tackling them [24]. Reference to the ICES scheme was inevitable and witnesses such as Fulton (Fishery Board for Scotland), Holt (Irish Fisheries Department), M'Intosh, Herdman (University College, Liverpool), Archer and Tizard (Assistant Hydrographer to the Admiralty) all said that it was seriously flawed and would not give the Government the information which it desired. The committee was in the process of preparing an interim report drawing the Government's attention to this conclusion when the Cabinet, which contained two Vice Presidents of the MBA (Arthur Balfour and Joseph Chamberlain), decided that the English part of the ICES investigations should be done by the MBA and the Scottish part by the Fishery Board for Scotland and that each should be funded by the Treasury for three years [23,25]. The MBA decided to carry out its work from Lowestoft and set up a laboratory there under Garstang in 1902 and acquired a research vessel, to be named *HUXLEY* [14]. Maxwell promptly resigned his chairmanship of the Ichthyological Research Committee and was replaced by another committee member, Sir Colin Scott Moncrieff of the Scottish Office.

When it issued its final report, the Committee recommended that research in England and Wales should be done by three bodies. The MBA would work in the Channel, the Lancashire and Western SFC in the Irish Sea, and the Cullercoats laboratory and a new laboratory, to be financed jointly by the fishing industry and by the Exchequer and sited at some central point like Grimsby, would do research in the North Sea; the whole to be co-ordinated by a Council of Fishery Research under the Board of Trade [24].

From the outset of the work at Lowestoft Garstang (Plate 2) found himself under fire from four quarters. These were:-

(i) The universities, particularly (a) St. Andrews where M'Intosh, who held Huxley's views on the effects of fishing, scathingly referred to Garstang and those who held Ray Lankester's views as the 'Impoverishers' and as being in error [26], (b) Edinburgh where Noel Paton showed that there was a serious error in Garstang's methodology and argued for the development of a mathematical treatment of the dynamics of the exploited fish populations [24,27], and (c) Liverpool where William Herdman wrote to *The Times* objecting to a petition signed by 160 men of science which urged HM Treasury to allow the work at Lowestoft to continue [28].

(ii) The fishing industry: this claimed through the *Fish Trades Gazette*, the official organ of the National Sea Fisheries Protection Association, that the work was not related to their problems [29].

(iii) The Board of Agriculture and Fisheries (BAF): this had taken over responsibility for fisheries from the Board of Trade in 1903, largely because of the fishing industry's dissatisfaction with the latter [24]. Archer became the Fisheries Secretary there and at once recruited Arthur Masterman as an Inspector [22]. He was a colleague of M'Intosh and a distinguished marine scientist in his own right. (He was to become the first MAFF fisheries scientist to become a Fellow of the Royal Society while still employed by the Department.) Archer, from the time of the Stockholm conference, had argued that the overfishing problem had to be attacked on the basis of a sound international scheme of fisheries statistics and not on the basis of research vessel surveys. Masterman agreed with him and together they started their own North Sea fishery investigations by bringing in (a) a scheme of fisheries statistics which has stood until the present day and which was a development of that introduced in Scotland by Fulton, (b) a system of market sampling for length, sex, age etc. (This was carried out in a small laboratory in Delahay Street, Westminster, the site of which is now occupied by part of the Cabinet Office, by a team of Lady Naturalists, to give them their official rank, who examined fish obtained by a boy who went on his bicycle to Billingsgate) [22].

(iv) HM Treasury: This had agreed only to fund the work for three years and once they were up, in 1905, proceeded on a year-by-year basis [30,31].

In 1907 this unsatisfactory way of proceeding led the Chancellor of the Exchequer, Herbert Asquith, to appoint a committee to carry out yet another review of the conduct of fishery investigations in the UK and to advise on how it should be carried out in future [32]. It was chaired by H J Tennant MP, his brother-in-law. At this point Garstang resigned from his post with the MBA. He became Professor of Zoology at Leeds University and, in 1912, set up a marine biology station at Robin Hoods Bay. In due course this became the Wellcome Laboratory which is now closed.

The Tennant Committee recommended the setting up of a Central Council to co-ordinate all UK fishery investigations of a national and international character and to control all public funding of them, but it said nothing about how the UK share of the ICES investigations should be conducted and financed in future. There now followed an intensive campaign by Archer to get the Treasury to pass control of the English part of them to the Board. Sir Humphrey Appleby, the Permanent Secretary in the TV series *Yes Minister*, would have awarded it an alpha plus marking [33]. In the end it was successful and the Chancellor of the Exchequer, Lloyd George, ruled early in 1910 that the cost of the English share of the ICES investigations should be borne on the BAF Departmental vote. Thus in April 1910, the MBA staff at Lowestoft transferred to the Board, which promptly closed the laboratory, moved the staff to London to join the Delahay Street staff, and left the MBA to dispose of the *HUXLEY*. But Lloyd George had a card up his sleeve. The Development and Road Improvement Act had been passed in 1909. It appointed Commissioners to make grants in respect of certain industries in order to promote the country's economic development. One such was the fishing industry and so, in 1910, the Development Commission was made responsible for all expenditure on fisheries research other than that related to the ICES investigations. It promptly set up a Fisheries Advisory Committee and four of its six members were members of the Council of the MBA and there was no Departmental representation [34].

The BAF had to come to live with this arrangement. Internal changes allowed it to do so. In 1912, Archer (Plate 3) had to retire because of ill-health and was replaced as Fisheries Secretary

by Henry Maurice (Plate 4), a very wise and able administrator from the Board of Education. At the time he took over, an old school-friend from his days at Marlborough gave him a copy of *The Science of the Sea* by G. Herbert Fowler which had just been issued by the Challenger Society [35]. It fired his enthusiasm for marine science and one of his first moves was to invite a group of eminent workers in that field to advise him on the future content of the Board's fisheries research [36]. The 1914-18 war stopped him from putting their recommendations into practice but towards the end of it, when Government thoughts were turning towards the reconstruction of the nation's industries, Maurice, together with William Hardy, the Director of the Food Investigation Board of the Department of Scientific and Industrial Research and before that Secretary of the Royal Society, proposed the establishment of what was referred to as a 'Fisheries University' at Lowestoft [37]. It would have combined the functions of what are now MAFF's Fisheries Laboratory at Lowestoft and Torry Research Station at Aberdeen, as well as including a technical college for the fishing industry. Maurice also regarded it as coming, in due course, to help the countries of, what was then, the Empire to develop their fisheries. But when BAF applied to the Development Commission for money to proceed the scheme met with opposition and, in 1919, the Commissioners set up a committee, chaired by Hardy, to advise it on how best to proceed [38].

Maurice and Hardy's 'Fisheries University' scheme was rejected but the committee made an important recommendation concerning the organisation and funding of fisheries research. It divided it into two parts – 'Economic' and 'Free' research. On receiving the committee's report the Commission changed the name of the former to 'Directed' research. It would be carried out by the Fisheries Departments whilst 'Free' research would be conducted through Grants-in-Aid to the marine stations at Plymouth, Millport, St. Andrews, Cullercoats, Port Erin and Piel and to the Department of Oceanography at Liverpool University and the Department of Zoology at the University College of Wales, Aberystwyth. The Commission also made the committee permanent and named it the Advisory Committee on Fishery Research (ACFR). All programmes of research, 'Directed' and 'Free', had to be approved by it before receiving funding from the Commission [38]. Thus from 1920 virtually the whole of British fisheries science became subject to the scrutiny of the ACFR and was funded by the Commission, the major exception being the research being carried out by the Fisheries Departments prior to the Development and Road Fund Act of 1909.

But the Committee, under the chairmanship of three Fellows of the Royal Society – successively, Sir William Hardy, Professor G C Bourne and Professor E W MacBride – interpreted 'Free' research in a very liberal way and so greatly advanced the development of British marine science in general[39]. To give two examples from the late 1930s:-

i) It started to fund Alister Hardy's pioneer work with his Continuous Plankton Recorder at University College, Hull. From that small beginning there is a line that leads through the Scottish Marine Biological Association to the setting up the Institute of Marine Environmental Research at Plymouth, now part of the Plymouth Marine Laboratory.

ii) It gave funds to the Royal Society to allow it to collaborate with the Woods Hole Oceanographic Institution in its research on variations in the Gulf Stream.

This brings me to the end of the 1930s: the title of my paper says that I should stop here, but there is one final happening that I must mention. The ACFR continued to meet during the 1939-45 War and, in 1942, one of its members, James Gray, suggested that it should review the institutional structure which it had been financing for over 20 years. As a result, the Fisheries Departments got the Development Commission to set up a Committee on Post-war Fishery Research [40]. Dr John Tait, of the then Scottish Home Department's Marine Laboratory at Aberdeen, submitted to it a

memorandum proposing the formation of a National Institute of Oceanography (NIO) [41]. This initiative was slightly earlier than a similar one by the Hydrographer of the Navy, Admiral Sir John Edgell, which was made through the Royal Society [42]. The committee, having taken evidence from George Deacon, John Tait, J N Carruthers and others, supported the idea and the two initiatives were to lead to the founding of the NIO in 1949 and to its being jointly funded by the Development Commission and the Admiralty. The money from the former was intended to support the research in the Southern Ocean, which had formerly been carried out by the *DISCOVERY* Committee for the Colonial Office and which also had its origin in a need for fisheries management, namely of the whale fisheries there.

Thus we had a situation where the Development Commission's ACFR, a committee which had been formed in 1920 in order to direct the course of fisheries research and to control its funding was, in fact, to exercise those functions with respect to nearly the whole of non-military marine research within the UK over the course of 45 years. Sir Frederick Russell described it as being a form of organisation which was peculiarly British; clumsy on paper but extremely simple and smooth to work. It came to an end in 1965, when initiatives to re-organise the whole of Government-funded research led to the formation of the Natural Environment Research Council. But that is another chapter for students of the history of British marine science to explore as the relevant Departmental files are put in the public domain over the next few years.

Postscript

Since writing this paper my book, *MAFF: The Directorate of Fisheries Research: Its Origins and Development* has been published [43]. It describes in detail the events dealt with above and, in addition, those leading to the formation of the Natural Environment Research Council and the end of the Development Commission's responsibility for marine science.

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FISHERIES RESEARCH AT PORT ERIN AND LIVERPOOL UNIVERSITY

Trevor A. Norton

Plate 1. Sir William Herdman, 1858-1924.

Plate 2. The interior of the original laboratory at Port Erin circa 1895, Herdman is at the extreme left, with Isaac Cook Thompson second from the left.

FISHERIES RESEARCH AT PORT ERIN AND LIVERPOOL UNIVERSITY

Trevor A. Norton
Port Erin Marine Laboratory, Isle of Man

Summary

Liverpool's involvement in fisheries research is traced from the days of Sir William Herdman (1858-1924) through the activities of the four marine laboratories that he founded: One of these was the first fisheries laboratory in England, another was the first sea fish hatchery. The surviving laboratory at Port Erin on the Isle of Man is still actively engaged in a variety of fisheries-related research and aquaculture projects. It also enjoys a unique relationship with the Isle of Man Government which facilitates experimental work in the sea which could not easily be carried out elsewhere. These themes are intertwined with the development of the Port Erin facility from the birth of a gentleman's club in 1885, to the major marine laboratory of today.

Early days

Not infrequently, great ventures spring from the vision of a single individual who galvanises those around him. One such man was William (later Sir William) Herdman (Plate 1). D'Arcy Thompson said of him: "He had the knack of stimulating others to do what, without his encouragement and example, they would not have done". Herdman's imagination and prodigious energy ensured that he would become the main force driving fisheries research in the Irish Sea.

In 1881 at the age of only 23, Herdman was appointed Professor of Natural History at University College Liverpool, a post he held for nearly 40 years. He subsequently founded, and for many years directed, the research at four separate marine laboratories. Two of these were wholly concerned with fisheries research, and although the Port Erin Marine Laboratory on the Isle of Man has a much broader spectrum of interests, it has also pursued a century of almost continuous endeavour in fisheries and aquaculture.

Herdman was a distinguished zoologist, but his real skill was in assembling important research groups. The first of these was the Liverpool Marine Biology Committee (LMBC). In 1885 representatives of colleges, museums and scientific societies from Liverpool and surrounding towns met in University College, Liverpool and formed a small task force of naturalists dedicated to the investigation of the marine biology of Liverpool Bay and adjacent areas of the Irish Sea, and determined to establish a marine station. The history of the Committee may be found in Herdman (1919).

In 1887 the Committee took over an abandoned semaphore station on Puffin Island in North Wales. It was the first marine laboratory on the west coast of Britain. Within only five years they had filled three thick volumes and five reports with their findings, before they abandoned this outpost for the reputedly superior collecting grounds of the Isle of Man. In 1892 they opened a modest laboratory (Plate 2) and aquarium beside Port Erin bay in the south of the Island (Herdman, 1893(a)). It was the precursor of much greater things to come.

Herdman's first taste of fisheries biology arose in 1891 from an invitation from the Lancashire and Western Sea-Fisheries Committee to give a course of lectures "to instruct fisherman on biological

matters bearing on the fishing industry". We should salute their perception that the fishing industry could not rationally exploit the sea without first studying the biology of the fish and their food. Elaborate manuals were produced and the instruction was extended to include oceanography, seamanship and navigation (Herdman, 1914; Johnstone, 1914).

Each course ran for two weeks with four courses held each year. It was an imaginative scheme and a successful one, for over the first 14 years the courses were held, almost 700 fishermen attended. No doubt they were encouraged by the receipt of £5 each, paid by City and County Education Committees in lieu of wages. The underlying purpose of the courses was however, not entirely to educate mariners, but to foster understanding between fishermen, scientists and legislators, to facilitate the introduction of restrictive legislation.

Prior to this period the consensus view was that the seas resources were inexhaustible. Indeed in 1868, the Westminster Parliament had repealed all fisheries regulations and declared that "unrestricted fishing be permitted hereafter".

However, the burgeoning fleet of fishing vessels and improvements in gear, soon resulted in declining stocks. This was apparent to the fishermen, and it was pressure from those in Lancashire that led to the formation in 1896 of the Lancashire Sea Fisheries Committee. The Committee was constituted to protect and improve local fisheries, specifically "To ensure continued fish supply to the public and to protect and assist the means of livelihood of fishermen". It is significant that from the very beginning the Committee perceived fisheries in terms of both a biological resource and a socio-economic force.

The Committee was composed of representatives from county councils, salmon boards and the Board of Trade. Their area of influence embraced the entire coastline from Galloway in the north to Anglesey in the South; over 1500 square miles of coastal waters supporting 1148 locally based trawlers, 2841 boatmen and 746 shore fishermen (Herdman, 1902).

The Committee recognised that a sure recipe for disaster was to allow unrestricted fishing, with whatever gear, and for any prey irrespective of its size or condition. In particular, they were aware that there was nothing to prevent the immense inadvertent destruction of juvenile fish. The Committee rapidly acquired extensive powers, specifically:

(i) To restrict or inhibit the use of some fishing methods and gear.
(ii) To determine suitable types of gear and mesh size of nets.
(iii) To control or ban any discharge or dumping detrimental to fisheries.
(iv) To fix the permitted minimum sizes and condition for harvested shellfish.

Such powers were enforced by bye-laws which were discussed with and approved by, the fishing community in advance of implementation. Even so, between 1890 and 1902 an average of 64 prosecutions took place each year. Perhaps the relatively small penalties imposed upon miscreants had little deterrent effect.

Nonetheless, the Committee employed a superintendent, 19 fisheries officers and assistants and a 263 ton steamer with a crew of 11. The main task of the officers was to enforce the bye-laws both at sea and along the shore, checking catches, and gear. They also collected samples for scientific examination.

Preparing the first course for fishermen had fired Herdman's interest in fisheries. Perhaps his appreciation of the paucity of the information available led him to recommend to the Lancs. and

Western Sea Fisheries Committee the potential benefits of establishing a laboratory to investigate biological problems associated with fisheries.

As a result, a laboratory funded by the Committee was erected on the roof of the Natural History Department at University College Liverpool. The entire cost of fabrication and fittings, including five 670 gallon fish tanks, was only £149 and 7 pence. In truth, it was no more than a wooden shack, stifling hot in summer and unbearably cold in winter. It was heated by the feeble flicker of a tiny gas fire which was turned off at night. The scientists were either frozen to their seats, or stupefied with fumes. During gales they lived in constant fear of the shed being uprooted and hurled down into the quadrangle below. This precarious eyrie was the first laboratory in England to be set up specifically to study fisheries biology.

The work rate was impressive, but the tedium of some of the tasks had to be relieved by games of indoor cricket and football – much to the detriment of the specimen bottles. All such frivolity ended in 1898 with the appointment of James Johnstone, a talented but serious minded Scot (see Cole, 1934). He ran the fisheries laboratory for the next seven years and all the fishermen's classes after the first year.

In exchange for the endowment of the laboratory Herdman supervised the scientific work of the Sea Fisheries Committee. The research at the Liverpool Laboratory concentrated on fisheries biology, hydrography and plankton. He and his colleagues initially conducted laboratory studies of the biology of sole, shrimps, mussels and cockles. Meanwhile, extensive data were collected at sea. They examined no less than 3000 fish in the first year and were soon able to produce a comprehensive list of the fishes of the Irish Sea (Herdman, 1902). In conjunction with the fisheries officers they also conducted sea trials of the effectiveness of various types of gear; comparing the catches achieved by different sizes of nets and mesh.

Johnstone himself conducted studies on subjects as diverse as hydrography, and the contamination, preservation and nutritive value of all types of seafood. He also became a specialist in fish pathology and parasites – his collection of diseased fish was unequalled and has recently been re-examined (Heron *et al.,* 1988). Even more importantly, he pioneered the application of mathematics to fisheries problems. His books on quantitative marine biology (Johnstone, 1908) and on the administration and problems of British fisheries (Johnstone, 1905) are classics still well worth reading.

Herdman instigated an extensive survey of the diets of various food fish and shellfish (Herdman, 1893(b)). He was highly sceptical of the reliability of anecdotal references to spawning beds, nursery areas and feeding grounds, so he set in train surveys to locate such sites, although the exact location of the herring spawning grounds was not determined for 70 years (Bowers, 1969).

The Piel Laboratory

As early as 1892 Herdman was convinced that the decline of fished stocks could not be arrested by fishing controls alone, and he investigated the possibility that mussels, oysters and shrimps might be cultivated rather than caught (Herdman, 1893(a)). He was also seduced by claims from abroad that cultivated fish eggs or fry released into the sea, resulted in a large increase in the adult stock. The notion was persuasive; for many species of fish produce eggs in enormous quantities but few survive to adulthood. If however, they were protected in culture during their most vulnerable early stages the majority should survive. He argued that aquaculture should be carried on as industriously and as scientifically as agriculture.

Herdman tried to persuade the Lancashire Sea Fisheries Committee to sponsor a sea hatchery. He claimed that no site on the Lancashire or Cheshire coasts had such clean unpolluted water as could be found beside the LMBC laboratory at Port Erin on the Isle of Man. His plan was to dam a big rock pool to make an even larger impoundment on the shore. Eggs of fish and crustacea would be hatched there and the fry then transported to the mainland to be released on the Lancashire coast.

For legal reasons the Sea Fisheries Committee were unable to fund a venture outside their area, but long afterwards a dam *was* built on the site to construct an outdoor swimming pool. Ironically, this was later taken over by a commercial aquaculture company as a stock pond, 70 years after Herdman's original proposal.

The Fisheries Committee did however establish a hatchery. In 1896 they took over a Lifeboat station and an adjacent house at Piel near Barrow – the first marine hatchery in Britain (Kofoid, 1910). Herdman was the original director, but Andrew Scott was transferred from the Liverpool laboratory to be the resident scientist.

Most of the fishermen's education classes were held at Piel, and successful hatching of plaice, flounder and lobsters took place there, but not without difficulty. The laboratory lacked spawning ponds, and the local water was so laden with silt that it had to be filtered through blankets and towels before it could be used. The work of both the Piel and the Liverpool laboratories is detailed in annual reports published both separately and in the Transactions of the Liverpool Biological Society from 1893 until 1920.

The Port Erin Laboratory

Meanwhile, Herdman had not abandoned the idea of further development at Port Erin. He turned for sponsorship to the Isle of Man Government. At that time there was a thriving herring fishery around the Island and a large local fleet (Smith, 1923). In 1894 the Government set up a Fisheries Board to promote and control the Manx fishing industry, and (presumably as a result of Herdman's advice) to encourage cultivation. The Board was charged with establishing closer links with the Port Erin Laboratory.

In 1901 the Tynwald parliament gave £2000 for the construction of a new, much larger laboratory on the southern limb of Port Erin Bay. It was to be controlled by the LMBC, but an integral fish hatchery would be managed by the Manx Government. The new building was opened in 1902.

A history of the LMBC is given in Herdman (1919) and the details of the plaice hatchery, and the techniques used, have been described elsewhere (Johnstone, 1905; Shelbourne, 1964). The results are detailed in the annual reports of the Port Erin Marine Station. In 1919 the financial responsibility for the laboratory was transferred to the University of Liverpool.

Herdman also envisaged that the role of the new laboratory was to instigate marine biological studies that would underpin fisheries. He perceived that the production of plankton might influence the behaviour and production of surface feeding fish. In collaboration with Andrew Scott he conducted the most intensive and systematic plankton surveys attempted to that time (Herdman, 1922) (Plate 3). They demonstrated irrefutably that the spring bloom of diatoms familiar in fresh water lakes was also characteristic of the sea, and they were the first to appreciate that planktonic organisms, were not uniformity distributed in the surface waters but occurred in discrete patches.

His results led Herdman to question much of what was then thought to be known about the abundance of plankton, and to challenge sampling methods in general. In his own words: 'Before taking

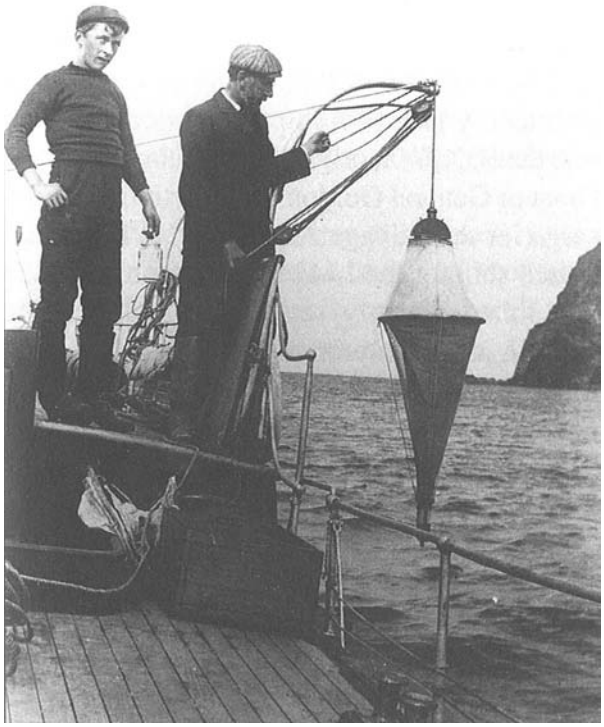

Plate 3. Herdman collecting plankton off Port Erin, 1907.

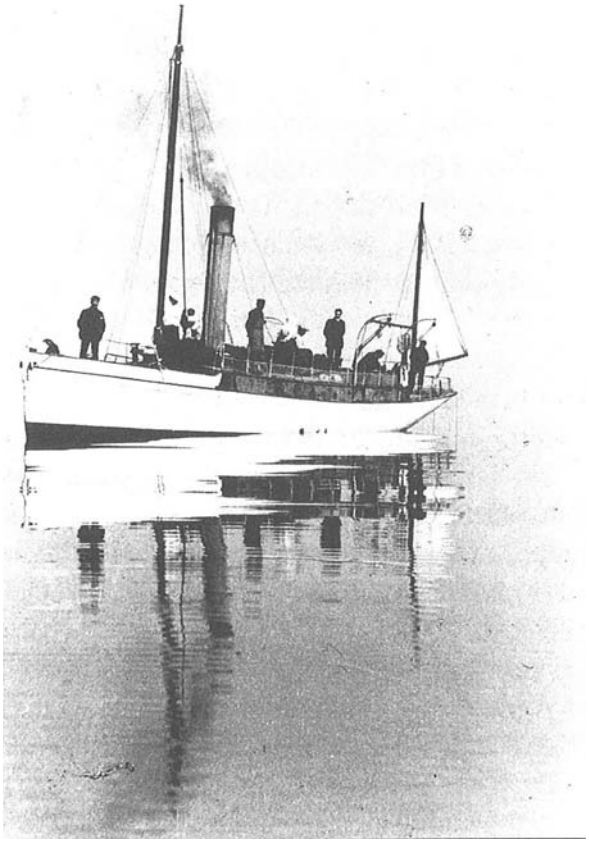

Plate 4. The *LADYBIRD*, one of Herdman's private steam yachts on a plankton cruise in 1908.

gatherings of marine organisms almost haphazard, and then proceeding to regard them as samples of large areas, we must find out what our gatherings really represent, and what relation they bear to fair samples, also how these samples vary with changes in time, place, wind, depth and other conditions'. He also went on to suggest how these data might be acquired.

In the early days the work of the committee was inhibited by lack of a ship. Occasionally, they gained passage on the ships of others. One of these was the *HYAENA*, originally a gunboat built for the Crimean War, which served later as the personal boat of General Gordon (of Khartoum) during the war in China. In her sedate old age she ferried cargo for the Salvage Association in Liverpool and her only excitement was to act as temporary research ship for the LMBC. Unfortunately, she was a shallow-draft gun platform rather than a ship, and rolled violently – even when in dock! She was christened *THE GREYHOUND* as she could, at best, attain only three knots, and (the tides being what they are) she sometimes went full ahead – backwards. She was, however, sturdily built. Once, when the captain was warned that they were heading for a reef, he calmly replied "So much the worse for the rock!"

Herdman escaped the limitations of the 'Laughing' *HYAENA* when he married a shipping heiress who supplied him with a succession of beautiful steam yachts that served as luxurious research vessels (Plate 4).

Herdman was a prolific scientist. He published over seven papers per year for 44 years, but his major contribution to fisheries was that he enunciated more clearly and persuasively than anyone before him the principle that the investigation of sea fisheries ought to be undertaken and subsidized by government under the direction of a national department of fisheries. He also advocated that the activities of regional fisheries and marine research groups should be co-ordinated nationally. Certainly such research was often too expensive to be conducted by private committees or university outstations.

In 1912 the Liverpool Marine Biology Committee and the Lancashire Sea Fisheries Committee announced that in future, projects would have to be at least partially funded by Government grants. The fisheries work was sustained chiefly by large grants from the Development Commmission in 1912 and 1922, the latter allowing some re-equipping and re-staffing at Port Erin. When such funding ceased, both the Liverpool and Piel laboratories closed down.

When Herdman died in 1924 three of the four laboratories he had founded had closed. Only the Port Erin laboratory survived, now under the direction of James Johnstone. He had been the first lecturer in Aquiculture (sic) in Britain and was now Professor of Oceanography at Liverpool.

Some of the early work by Johnstone and Andrew Scott on plaice is summarised by Holden *et al.* (1975). Later the laboratory studied the biology and feeding, not only of plaice (Bowers and Lee, 1971), but also gadoids (Armstrong, 1982; Gokhale, 1957; Nagabhushanam, 1964, 1965; Patterson, 1985), dab (Ortega-Sales, 1980) and dogfish (Lyle, 1983). Nagabhushanam's work in particular has been of critical importance. Most effort was however, directed at herring. In 1913 the Ministry of Agriculture, Fisheries and Food asked the Liverpool laboratory to participate in a study of the 'races' of herring (see Annual reports of the Lancashire Sea Fisheries District for 1921-1923). In 1925 W.C. Smith produced the first of a series of annual reports on the state of the Manx herring stocks which have continued until the present day (e.g. Brand, 1986), together with intermittent reviews (Bowers, 1973, 1980; Smith, 1923). These data enabled the laboratory to provide management advice to the Manx Government and, since 1973, to represent them at the ICES assessment meetings that are the source from which the EEC is advised.

In 1960 the large-scale plaice rearing experiments of the Ministry of Agriculture and Fisheries

were suffering from the limitations of the closed circulation system at Lowestoft, so the Ministry looked for a site with clean flowing seawater and an ample supply of plaice eggs. It turned to Port Erin and built a large new hatchery adjacent to Herdman's original plaice spawning ponds. The history of this project is well documented (Bowers, 1974; Shelbourne, 1964). Although the work was successful, plaice cultivation was not commercially viable. Nonetheless, the technical success of the project stimulated the development of mariculture of more valuable species.

The MAFF facilities were subsequently taken over by the Port Erin laboratory and used for experiments on the diet and cultivation of larval and juvenile turbot (Heap and Thorpe, 1987; Jones *et al.,* 1973), sole (Alderson and Howell, 1973; Dendrinos *et al.,* 1984; Dendrinos and Thorpe, 1987) and bass (Dendrinos & Thorpe, 1985), and genetical studies of *Tilapia* stocks (Cruz *et al.,* 1982). Part of the buildings have for 20 years also been occupied by a succession of commercial aquaculture companies which have conducted collaborative research with staff from the laboratory.

Herdman and his colleagues had from the early days, also studied molluscs of commercial importance. An initial concern was the problem of contamination of bivalves (Herdman, 1896; Herdman and Boyce, 1899; Johnstone, 1906, 1910). Significant work was also carried out on cockles (Johnstone, 1899) mussel transplantation, and pearl fisheries abroad (Herdman, 1906). The appointment in 1929 of J.H. Orton to the chair of zoology in Liverpool (and later as director of the Port Erin Laboratory) revived the research on cockles (Bunting *et al.,* 1936; McLoy *et al.,* 1936; Orton, 1933) and stimulated studies of commercial oyster beds (Orton, 1940) and oyster transplantation (Orton, 1931; 1932 and 1935). Herdman's early attempts to culture oysters were repeated on a bigger scale and with more success, using large outdoor ponds. Mamie Parke developed algal diets to feed the oysters. The details of these experiments are given in the annual reports of the Port Erin Biological Station (volumes 48-52, 1935 to 1939) and in Orton *et al.* (1933).

A fishery for scallops, *Pecten maximus,* began off the Isle of Man in 1937 and rapidly grew to become a major local industry. The Laboratory made several studies of the biology and mortality of scallops (Dakin, 1909; Tang, 1941; Gryffydd, 1972; Mason, 1957, 1958), and from 1925 to the present day has conducted annual stock assessments for the Manx MAFF. Recently, commercial capture rates have been assessed over several years by means of a bounty scheme for the return of tagged specimens. The genetics of the stocks has also been examined (Macleod *et al.,* 1985), and large scale experiments on stock enhancement have been conducted over several years (Brand *et al.,* 1980, 1989; Paul *et al.,* 1981) and currently an area in which fishing is forbidden is to be reseeded with cultivated scallops.

Crustacea of commercial importance were less well studied at first, although early research concerned shrimp fishing and its effects on juvenile fish (Herdman and Dawson, 1902), and lobster cultivation (Smith 1933). *Nephrops* the Norway lobster, was traditionally discarded if caught when fishing for whiting, until a valuable fishery developed in the 1960s. In response, research examined *Nephrops* ecology and fisheries biology (Chapman and Rice, 1971; Farmer, 1974; Hossain *et al.,* 1987; Oakley, 1979).

Extensive work in Mexico involved the biology and management of fisheries for soft-shelled crabs (Paul *et al.,* 1983) and penaeid shrimps (Edwards, 1978; Menz and Bowers, 1980, Paul and Bowers, 1982). Experiments were also conducted to underpin the aquaculture of lobsters and tropical shrimps (Brandford, 1978(a),(b), 1979; Menz and Blake, 1980). Currently, work abroad is concentrated on the fisheries of the Bitter Lakes in Egypt.

The Port Erin Laboratory celebrates its centenary in 1992 and it is as dedicated as ever to fisheries related research. We have just bought a new 25 m research ship possessing the latest fish finding sonar, and capable of deploying commercial sized fishing gear. Richard Nash, the latest addition to our staff, is a fish population biologist adept at acoustic survey. We also continue to enjoy a close collaboration with the Isle of Man Ministry of Agriculture, Fisheries and Forests resulting in a unique working relationship between scientists, administrators and fishermen. Many of our graduates occupy senior posts of government fisheries departments, academic institutions and commercial aquaculture companies. Currently we are training 40 research students and 36 Honours students.

We are looking forward to our next 100 years.

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THE MARINE BIOLOGICAL ASSOCIATION AND FISHERY RESEARCH, 1884-1924: SCIENTIFIC AND POLITICAL CONFLICTS THAT CHANGED THE COURSE OF MARINE RESEARCH IN THE UNITED KINGDOM

A. J. Southward

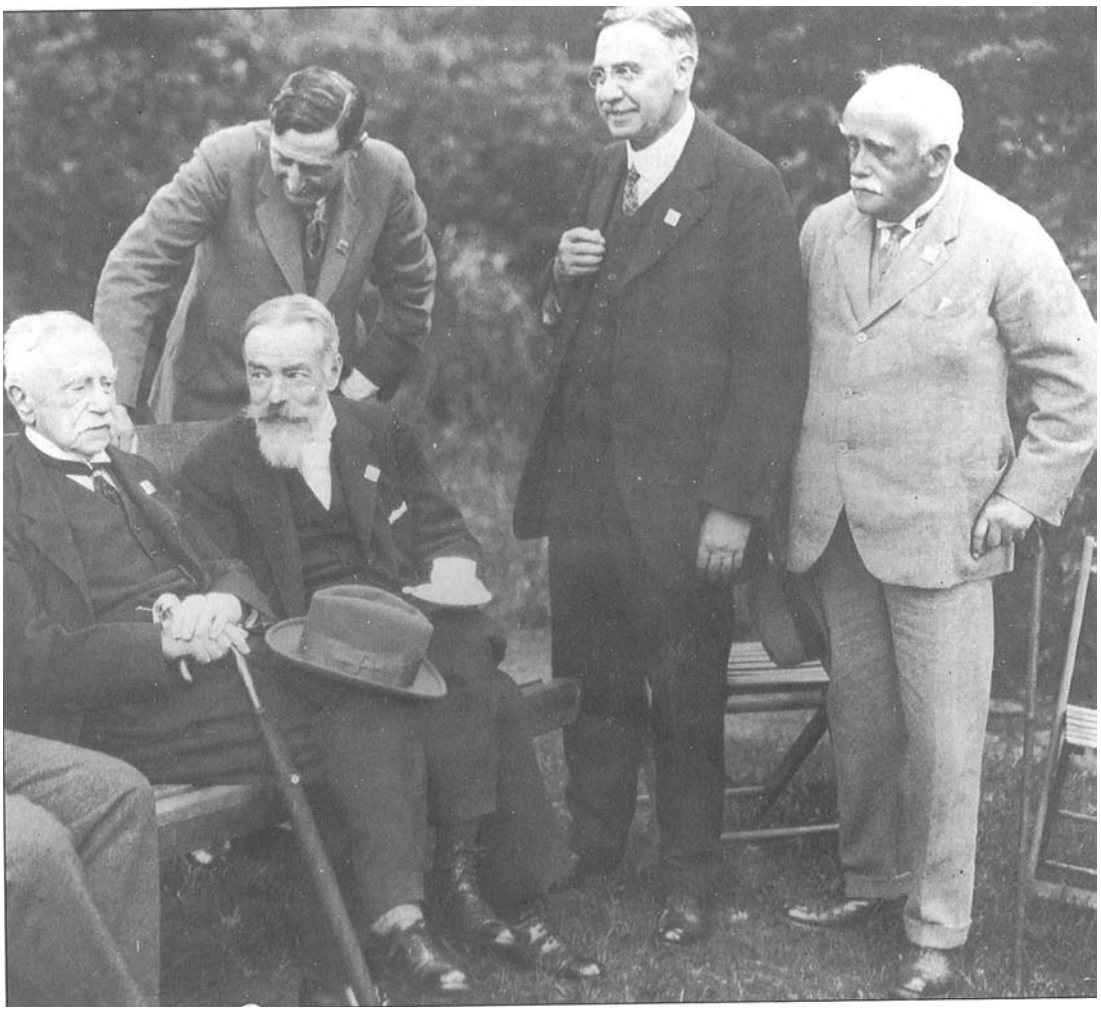

Plate 1. Dr E. J. Allen and Dr G. P. Bidder at an impromptu meeting of part of the Council of the Marine Biological Association during the British Association meeting at Leeds in 1929.
Standing (from left to right): R. S. Clark, former fishery expert of the MBA, Director of the Aberdeen Laboratory; E. J. Allen, Director of the Plymouth Laboratory; Professor E. W. MacBride of Oxford. Seated: G. P. Bidder is on the right.

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A. J. Southward
Leverhulme Unit
The Laboratory, Citadel Hill, Plymouth PL1 2PB

Introduction

Other authors in this volume also describe the building of marine laboratories and the beginning of fishery researches in Britain. I wish to highlight events in two periods that strongly influenced the development of the Marine Biological Association and its laboratory at Plymouth and fundamentally affected the course of marine research in Britain. These periods include the beginning and growth of fishery research in England and the origins of strategic research into marine ecosystems. The first covers the establishment of the laboratory itself and its early years of operation, from 1888 to 1901. The second lasts from 1902 to 1924 and covers eight years of stress (1902 to 1910) when the Association carried out the English share of the International Fishery Investigations for the government and came near to collapse, followed by re-establishment as the premier English marine laboratory for strategic investigations and pure researches. The archives of the Association, kept in the library at Plymouth, hold many private letters and memoranda in addition to public reports and official letters. It is especially fortunate that part of the correspondence of Dr G. P. Bidder is preserved. The material includes copies of letters from third parties sent to him for consideration, together with drafts or copies of most of his replies as well as letters sent to him directly. This source will be acknowledged as (BL) when quoted below; other unpublished material in the Minute Books of the Association will be acknowledged as (MB). Bidder was the grandson of George Parker Bidder, the famous 'calculating boy' (Clark, 1983) and was a successful and astute man of affairs as well as an enthusiastic marine biologist (Russell, 1955). He served for many years on the Council of the Association and was the confidant of E. J. Allen, who was Director of the Plymouth Laboratory from 1895 to 1934 (Plate 1). Bidder gave generous financial assistance as well as advice, and was of particular importance in helping to obtain the required funds for extending the laboratory and for purchasing and maintaining research vessels. From his correspondence covering the period from 1901 to 1913, including some very forthright documents, it has been possible to obtain a more detailed and accurate view of the happenings than is presented in the Minute Books or could be published on the occasion of the Centenary of the Association (Southward and Roberts, 1984). The Bidder letters are of especial value in helping to understand recent events which have repeated the same pattern of frictive interaction between research scientists and government administrators.

Foundation 1883-1901

Most of the marine laboratories founded between 1870 and 1900 had much the same aims – to foster knowledge of life in the sea and to understand fisheries problems. All were in some degree dependent on local benefactors for financial support and tended to stress practical aims such as improvement of fisheries. Plymouth, however, was much more deeply involved on the fisheries side. The International Fisheries Exhibition of 1883 provided the starting impulse, and some of the scientists present, who were most anxious to see marine researches started, became founding

members of the Marine Biological Association. Evidence at the Exhibition suggested that man's activities could affect stocks of fish and that to undertake corrective action it was imperative to have a thorough understanding of the life histories of the fishes and their relationship to the environment. However, there was a clear dichotomy in the views of the supporters of the idea of coastal laboratories. Some of those who wanted marine laboratories, but who failed to understand ecological principles, maintained that man's activities were infinitesimal when viewed against the workings of nature, and cited the enormous natural mortality of fish eggs, larvae and juveniles in support. To this party belonged Professor T. H. Huxley, who was President of the Royal Society when the Marine Biological Association was founded. We may term Huxley and his friends the pure scientists, interested in physiology and experimental zoology.

In opening the scientific proceedings of the 1883 Exhibition Professor Huxley repeated what he had said in the report of the Royal Commission of 1865:

> I believe, then, that the cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, and probably all the great sea fisheries, are inexhaustible; that is to say, that nothing we do seriously affects the number of the fish. And any attempt to regulate these fisheries seems, consequently, from the nature of the case, to be useless (Huxley, 1884).

Professor Huxley appears to have still held this opinion in 1890. Such a view of fishing activity stems from Huxley's scepticism of the views of many fishermen and fish merchants, 'the practical men' who yet failed to understand the workings of their craft. Time and time again in the detailed proceedings of the Royal Commission of 1865 (Caird, Huxley and Lefevre, 1866) we see the chairman asking those giving evidence to explain how trawling was destroying fish spawn on the sea bed, and always it was evident that the 'practical men' had no idea of how the spawn of the great sea fisheries was constituted. They would quote what the scientists knew to be benthic invertebrate life as eggs of demersal fish or regard the floating mass of jelly-imbedded eggs of the angler fish as pilchard spawn. As commission followed commission, the views of Professor Huxley became firmer, and his denigration of the practical men's view of the need for conservation of juvenile fish became an obsession.

The opposite view to Huxley's group, maintained with clarity and vigour by Professor Ray Lankester was that life in the sea was delicately balanced:

> It is a mistake to suppose that the place of fish removed on a particular fishing ground is immediately taken by some of the grand total of fish, which are so numerous ..... There is on the contrary evidence that shoal fish, like herrings, mackerel and pilchard, and ground-fish such as soles and other flat-fishes, are really localised. If man removes a large proportion of these fish the natural balance is upset (Lankester, 1884).

He held that taking one species of fish from a particular fishing ground did not necessarily mean that individuals of the same species would move in from surrounding unfished areas and restore the catch, rather that opportunist species of less value might take over, a view we now know to be substantially correct. This was the view of those interested in ecology, then called marine bionomics.

In effect, the Association was founded at the 1883 Exhibition, and the group of scientists who signed an agreement then to establish marine laboratories on the British coast became the nucleus of the Council of the Association at its inaugural meeting. Huxley did not sign this agreement, which gave great prominence to plans for fishery investigations, but the dispute was patched up at the April 1884 meeting chaired by him, when he agreed to become the President of the Association (Marine

Biological Association, 1887). Huxley had not changed his views, however, and the dispute about the value of fishery research surfaced again from time to time until he gave up the presidency in 1890. Professor McIntosh of St Andrews was by then also dubious about the fishery researches being carried on and created further problems for the Association up to 1910 and for the Lowestoft Laboratory when it was re-opened by the government Fisheries Department after World War I; his attacks on the International Investigations achieved great prominence (McIntosh, 1907, 1919; reply by Garstang, 1919).

The published aims of the Association at its foundation, were (MB):

> Establishing and maintaining laboratories on the coast of the United Kingdom, where accurate researches may be carried on leading to the improvement of zoological and botanical science and to an increase of our knowledge as regards the food, life-conditions and habits of British food-fishes and molluscs.

Thus the role of experimental physiology was played down, and an emphasis given to ecology and applied research. The public appeal for funds to build a laboratory would have taken much longer if the fishery aspect had not been stressed; a considerable part of local assistance from Plymouth businessmen was due to this promise to study practical fishery problems. This aspect also helped the founding members in lobbying the government and was crucial to the construction of the Laboratory and the survival of the Association during subsequent years when many other marine laboratories fell on hard times. It was the plan to investigate fisheries that persuaded the government to provide a capital grant towards building costs and promise an annual subsidy. At this time the Board of Trade handled U.K. fishery matters, a subject that they later passed on to the Board of Agriculture which was renamed the Board of Agriculture and Fisheries (it became a Ministry, and Food was added to the remit later). The President of the Board of Trade in 1884 was Joseph Chamberlain, a charismatic radical politician who appreciated scientific matters better than the older-type liberals with whom he was associated (Judd, 1977). It is probably not a coincidence that Chamberlain was at school (University College School, London, almost the only school of its type that would then take non-conformists as pupils) with Michael Foster, who was Professor of Physiology at Cambridge, and one of the signatories of the initial proposal for formation of the Association. The friendship continued throughout their lives. The capital grant and subsidy from the Government that Joseph Chamberlain helped to arrange became hedged in by conditions added by administrators during the progress of the affair (MB):

> that the Council pledges itself definitely to aim at procuring practical results with regard to the breeding and management of food fishes. (letter from the Lords Commissioners of her Majesty's Treasury, December 1885, signed by W. M. Ridley)

During the political upheavals of 1885 and 1886 Chamberlain lost ministerial office and split the Liberal party. Nevertheless, the Board of Trade and the Treasury kept their promise so that eventually the financial aid materialised. The arrival of the capital grant enabled building to start on the Hoe site in 1886. There had been additional problems due to a long-running dispute between the Plymouth municipality and the War Office (now Ministry of Defence) as to the ownership of the Hoe (MB). This dispute dates back to the Restoration of the Monarchy after the Great Rebellion, during which, Plymouth, as a Parliamentary stronghold, withstood three years siege by the Royalist forces. The town's puritans were punished by the erection on the Hoe of an enormous fortress to dominate them, and prevent another rebellion. Much of the Citadel is constructed on land purchased from two apparently compliant citizens, land that the rest of the town always claimed to be common land and used for grazing, part of it still bearing the name 'lambhay'. The formal documents are dated three years after the Royal Warrant for construction, and clearly the whole operation was a compulsory

purchase by the King's agents, as tacitly admitted by the War Office when they arranged for the Town to take over management of the rest of the Hoe (Worth, 1890; Woodward, 1987). When the Association was looking for a site for a laboratory in 1884, Plymouth Town Council, through the famous local amateur naturalist C. Spence Bate, offered land between the Citadel and the sea, but this was part of an area claimed by the War Office. Eventually an agreement was reached whereby the lease of the site was transferred from the Town to the Association by the War Office in exchange for a nominal annual rental. The parties in the dispute over the Hoe never had the time or the funds needed to fight out the conflicting claims in the lawcourts. Unfortunately this early 'appeasement' and nominal leasing had important repercussions in Mrs Thatcher's Britain where Departments of State were expected to charge the highest commercial rates for property. Since 1987, the Association, together with the Natural Environment Research Council's Plymouth Marine Laboratory, which shares the site, are having to pay large annual sums to the Ministry in return for an extended lease of the site, the ownership of which remains legally untested.

The Plymouth Laboratory building that was constructed on the Hoe seems to have been based on designs by Professor Lankester himself, as foreshadowed in his addresses to the 1883 Exhibition, owing something perhaps to features of the Zoological Station at Naples. At any rate, no mention is made of an architect in any of the archives, and the surviving plans were drawn-up by local surveyors. The Association's records do discuss alterations to the plans by War Office architects (MB). What is important to note is that the laboratory was very large compared with other British marine laboratories established in 1884-1900, as a direct consequence of the government subsidy; and the buildings constructed in 1886-88 formed the basis for later expansion right through into the 1930s. The public opening ceremony in 1888 was a grand affair (Anon, 1888) in which a rented red carpet and chairs hastily bought from the local department store were used to hide the paucity of funding for running such a large building (MB; Hardy, 1950). A fragment of the memoirs of the most recently appointed junior staff member, Walter Garstang, is most illuminating and refers to Professor Lankester, whom he had not yet met, as a 'Portly Gentleman', who looked like a 'Fishmonger' i.e. a member of the Fishmongers Company which strongly supported the Association (Hardy, 1950). There is a story still current in the Huxley family that Lankester's attempt to buy a suit at a 'one price' tailor was met by a demand for a higher price due to the large size of the customer. It would appear that the dispute between the ecological party and the physiologists left a lingering bitterness at a personal level, in spite of the fact that Ray Lankester had been a member of Professor Huxley's team at the Royal College of Science (now Imperial College), London, and with him had helped to educate a new generation of biologists (Bibby, 1959; Armytage, 1965).

Although the Association was fully launched by 1888, the annual grant from the Government was at first for a limited number of years, and had to be applied for each year. There was an understanding, based on Treasury letters, that ultimately the Government would form a comprehensive fishery section to collect statistics and carry out scientific work on fish for Great Britain, but pending formation of such a department the Treasury was graciously prepared to pay the Association a less than munificent sum to carry out fishery research duties on behalf of the Board of Trade (MB). The basic government grant remained the same for the first dozen years (£500). In conversation with Bidder and Allen, Chamberlain appears to have blamed the Chanceller of the Exchequer of 1886, Sir William Harcourt, for the low funding (BL); Harcourt was a 'Gladstonian' liberal, a brilliant classics graduate of Trinity College, Cambridge and barrister, but who was felt to have little depth or faith in spite of his grand manner. The annual sum provided by the government was insufficient to support the fishery researches at the laboratory and allow the purchase and operation of a reliable steam boat which was an essential tool for such work. For this reason, private sources and gifts paid for most of the first important work on fisheries, including studies at a temporary laboratory in East Anglia and voyages on commercial vessels. The degree to which the naturalists engaged

themselves in their work may be judged from the published papers, those by E. W. L. Holt being especially apposite. Holt's narrative of a cruise with a steam trawler from Grimsby is a classic of its kind and his comments on shipboard life suggest he did not always enjoy it:

> The decoction known on North Sea smacks as 'tea' made its appearance not long after we left the Humber. It consists of a quantity of tea, a tin of condensed milk and about two pounds of sugar boiled together for some hours in a huge kettle. Day and night this remarkable beverage is on tap ..... I can confidently recommend it to anyone who wishes to experience most of the sensations of sea-sickness without the trouble of going to sea (Holt, 1895).

Holt later became Director of Irish Fishery Research, which was run by the government, and the archives suggest he was then less than enthusiastic in helping the Association retain government grants to prosecute fishery work. However, the fishery work carried out by the Association between 1888 and 1900, including that by Holt, laid the foundation of much later research. Because of the lack of government funding it had been possible to operate only a half-decked steam launch. Two of these in succession were purchased second-hand for what were then substantial sums that exhausted the Association's funds and were later sold back to the original owners for a fraction of the purchase price when found unsatisfactory. The last one, with the unsuitable name of *PANSY*, was bought in 1892, according to G. P. Bidder (BL, MS note):

> on Calderwood's recommendation, as his parting act, 'since he knew about boats, at any rate', and was unanimously condemned by the Plymouth staff as unsafe and unseaworthy.

It was sold in 1895. Calderwood, who returned to fisheries work in Scotland, was one of the succession of early Directors at Plymouth who survived only a year or two under the continuing financial crises and the overbearing attitude of Ray Lankester as Honorary Secretary of the Association (Bourne, 1930). The first effective vessel was the 60 ft *BUSY BEE*, a name at least suggestive of hard work. This boat was used for beam trawling inshore and for testing of gear that helped the development of the work in deep water and later for the International Investigations, for example the closing nets and quantitative samplers developed by Garstang. Some of the investigations in this period laid the foundations for the later time series studies. Fishery research was ably carried out by Cunningham and Garstang, in addition to Holt, already mentioned. Garstang, the most junior naturalist for a while, became interested in the changes that took place in the plankton off Plymouth. There were changes of less regular appearance than the progressions of the seasons, some of them in the form of massive influxes of plankton organisms from offshore. Such changes could be embarrassing to an infant laboratory if visiting workers arrived and found the animal they wished to study had 'gone away' or been replaced by something else. Garstang was encouraged in these studies by E. J. Allen, the first really permanent Director of the Association, appointed in 1895. Allen was instrumental in obtaining funds to purchase and run *BUSY BEE*, and was keenly interested in this matter of fluctuations in marine life, as shown by weekly reports he sent to *Nature*. Allen and Garstang were convinced that more records were needed, taken farther off the coast, and with help of Council members of the Association they obtained a small grant from the British Association to rent a steam tug to make a series of cruises for a year across the mouth of the Channel and out into the Celtic Sea, measuring temperature and salinity and taking plankton samples from various depths with pumps and nets (Lankester *et al*., 1899). The tug was called *STORMCOCK* a rather inauspicious name. Encouraged by the success of this work the Association raised private funds in 1901 to buy and fit out a smallish ocean-going steam yacht, *OITHONA*, that served the laboratory well for 20 years and was intended to further the monitoring work. G. P. Bidder was of great help over this purchase and together Allen and Bidder superintended the conversion of the vessel and made her more seaworthy (Bidder, 1943). When *OITHONA* was disposed of in

1921 Bidder remarked that she was a 'kindly vessel'. He implied that the replacement vessel, the steam trawler/drifter *SALPA* that had been obtained as surplus to naval requirements, renowned for unseakindliness (Cooper, 1960), was forced upon the Association by the government. However, this is anticipating future events.

It was at this point in 1901, when the Association had purchased a vessel suitable for open sea researches and trawling that the International Investigations started and the effort of the MBA staff became increasingly directed to fishery investigation.

The International Investigations 1902-1910

The call for international cooperation on the North Sea fisheries was viewed by Ray Lankester and the Council as a chance for the Association to expand its activities on behalf of the government (MB). However, by this time the ponderous mechanisms in the civil service had produced a government fisheries department, to the alarm of the Association's Council Members, who wished to limit its powers (BL). The Council had, in 1895, produced a document based on work of their staff that was highly critical of the official Fisheries Statistics produced then by the Board of Trade, suggesting remedies that were eventually applied (MB). This will not have endeared them to the civil servants. As Stanley Gardiner remarked (1941):

> The Ministry (sic) of Fisheries was not a happy family, its chiefs viewing scientific technique with suspicion.

The official in charge of fisheries was W. E. Archer, who became under-secretary when the department was transferred to the Board of Agriculture a few years later. He is said to have been a gentleman of independent means, a keen fly fisherman, and the owner of riverine fishing rights. It was Archer, accompanied by Professor D'Arcy Thompson of University College, Dundee, the representative of the Scottish Fishery Board, and Sir John Murray, of the 'Challenger' Investigations, who formed the British delegation to the first international conference in Stockholm in 1899. However, the fisheries section was still largely administrative, and was palpably unfitted to carry out the English share of the International work under the North Sea Convention. The Scottish share could be handled by the Fishery Board for Scotland, which had been formed much earlier and had experience of research. It was only by commissioning the Marine Biological Association that the British Government could begin the English share, but from the start they were reluctant. Lobbying by the Association (MB) was needed to force the inclusion of a member of the MBA staff, Walter Garstang, in the delegation to the second international meeting which saw the formation of the International Council for the Exploration of the Sea (ICES).

The increased grant to the Association for purposes of carrying out the English part of the U.K. share of the investigations was initially for a period of three years only, not the five years specified by the International Council (MB). This might be thought to emphasize that the commissioning of the Association was a temporary measure pending takeover by the fisheries department, but the commissioning of the Scottish Fishery Board to undertake the northern sector of the North Sea investigations was also limited to three years, so that in fact the timing of the grants can be seen as no more than the usual caution of government officials in preventing an assumption of any continuity of research, a policy that is still with us today. Although Lankester and Garstang were enthusiastic about the International Investigations, words of caution are seen in the Bidder correspondence as early as 1902. Mr J. A. Travers, a graduate of Trinity College, Cambridge, Treasurer to the Association and Past Prime Warden of the Fishmongers Company, remarked (BL):

> Put not your trust in Government Grants or you will be left in the lurch is the proper form of the old motto for us.

Bidder wrote to Stephen Spring Rice at the Treasury in July 1902 (BL) pointing out that the Treasury Committee's estimate of the grant required for the International work was only 75% of that actually needed, and that the work would suffer, saying, however, that it would be impertinence on his part to criticise how they had arrived at the figure of £5 500 a year after what he though was deliberate and kindly consideration. Mr Spring Rice replied:

> I regret the very extensive scale on which people find it necessary to undertake (or recommend undertaking) work of this nature as it appears to me likely to result in nothing being done. The fishing industry is small in money importance as compared with many others; and 'doctors disagree' fundamentally as to the value of any scheme of exploration or investigation which any of them propounds.

Clearly there had been attempts by McIntosh and others to undermine the efforts of the Association, bringing about a division among experts that would benefit only the administrative civil servants and increase their power. Of course, this statement disregards the evidence on the industry submitted to the International Exhibition of 1883 by the Duke of Edinburgh (1884); the status of trawler and drifter crews in supplying naval reserve personnel in times of danger to Great Britain and the role of cheap fish in nourishing the workers in industries of greater monetary value had to be taken into account. But it was true then, and still true today, that if marine scientific investigations were to be supported only by a levy on the fishing industry, then precious little research would be possible.

Notwithstanding the uncertain future for the work, the new influx of funds enabled the Association to appoint more staff and to run a large steam trawler as well as the smaller *OITHONA*. The grid of stations begun with the tug in 1899 were included in the new series of quarterly cruises covering the whole Channel; similar stations were used on later series in 1919-35 and in the 1960s and 70s (Figure 1). Sampling in 1902-07 followed the style of that carried out from the tug *STORMCOCK*; reversing thermometer casts and water samples for temperature and salinity, with vertical quantitative nets for plankton and horizontal closing nets to determine stratification and vertical migration, though the earlier idea of pumped samples with a hosepipe seems to have been abandoned due to evasion by fast-moving zooplankton (Gough, 1905; Bygrave, 1911). A trawler of 115 ft was obtained and renamed *HUXLEY* (after the first President of the Association, now dead and unable to object to the emphasis on fishery work). This large vessel carried out the Channel work in the stormier months of February and November, leaving *OITHONA* to deal with May and August. In return *OITHONA* came round to the North Sea to do the inshore sampling, while *HUXLEY* worked further afield, trawling, marking and transplanting flatfish. Currents were measured by means of surface and bottom drifters deployed under Bidder's direction, and in later years sea bottom deposits were investigated (BL, MB). A laboratory was opened in a rented house at Lowestoft, and new staff recruited.

The impression gained from some publications is that the Association carried on the International Investigations from the Lowestoft and Plymouth laboratories without let or hindrance for 8 years until 1910, when the work was transferred to the Board of Agriculture and Fisheries and continued; this is ludicrously far from the truth. Michael Graham (1949, 1956), who directed English Fishery research after World War II, hinted at some of the tensions of the period, and further details are given by Mills (1989). The full extent of the problem can only be gauged from unpublished material in the archives (BL, MB). It is of first importance to note that Bidder himself bought the big trawler and leased it to the Association for the North Sea work. This enabled a cheaper rate than the Scottish Fisheries Board could obtain for the trawler *GOLDSEEKER* used for the Scottish part of the International Investigations. With other economies at Plymouth this saved the Treasury something like £800 a year, a large sum in those days and allowed the Association to extend the work outside the bare framework provided by the Treasury's assessment of the accounts (see next two pages). Nevertheless, all the other marine laboratories in England were envious of the fortunes of

the Association in getting so much money from the government, no matter how insecure the future prospects were, and the Scottish Fishery Board was also critical. Matters were not helped by the appointment of Walter Garstang as chief naturalist in charge of the International Investigations and head of the laboratory at Lowestoft. Garstang appears to have been a blunt northcountryman, in spite of his years at Oxford (Hardy, 1950), and friction developed between him and the other British expert delegates to the ICES meetings, Archer of the government fisheries section and D'Arcy Thompson, the Scottish Fishery Board representative. It has already been noted that Archer was a gentleman of means as well as a civil servant. In contrast Thompson was a polymath product of the Scottish educational system, equally at home in classics and statistics as well as zoology, but apparently contemptuous of lesser brains and a man of a few real friends (Dobell, 1949; Thompson, 1958). He was said to be embittered by failure to obtain a fellowship of Trinity College, Cambridge, where he took a first in the Tripos. After this his whole professional life was spent in Scotland, first at Dundee (which became a college of St. Andrews in 1897, a source of further friction) and then later at St. Andrews where be succeeded McIntosh and where one of his first acts of authority was to close down the Gatty Marine Laboratory. From the Bidder correspondence it was clear that 'fireworks' were expected, and happened, when these ICES delegates met together, as Professor W. F. R. Wheldon (Council Member) wrote to Bidder from Oxford on 13 March 1905 (BL):

> The meeting last Thursday was fun, if it had not had a serious meaning. D'Arcy W. coming prepared to talk down anything Garstang or anyone else might say, and Garstang with all his feathers up.

Garstang was the only one of the three with a grasp of ecological principles and experience of research work at sea. Unfortunately he was the one who was accused of over-assertive advocacy of his ideas in spite of his public posting of the old German saying 'Behaupten ist nicht beweisen' (to assert is not to prove). He got on well with the Scandinavian delegates, who classed him as a fellow Viking or Dane (Hardy, 1950), yet it appears to have been Thompson who acted as interpreter for the British delegation (Thompson, 1958). This was a time when most Foreign Office functionaries spoke little but English and French.

Less than a year after the International work began, the government Fisheries Department was enlarged and transferred to the Board of Agriculture. In 1903, Archer persuaded his new chief, Lord Onslow, to request the Treasury to have the Association's basic grant (by now increased to £1 000 with assistance from Chamberlain) placed under the control of the Board of Agriculture and Fisheries, suggesting that to do so would be administratively more convenient and would tend to economy (i.e. that some of the Association's grant could be applied to the work of the Board). Archer was well aware that part of the money was being spent in backing up the International work, that the two subventions were inseparable, and that his department would thus gain control of both types of investigation and the two laboratories. Ray Lankester predictably over-reacted, as he was wont to do when confronted by what he saw as poseurs and imposters (Bourne, 1930). Official letters with statements such as this were sent (MB, 9 December 1903):

> The Association ... cannot consent to their naturalists being subject to direction by officers of the Board of Agriculture and Fisheries as suggested in the letter of the Board to the Treasury.

This attempt collapsed, but further reaction from the MBA was triggered by a seemingly innocuous request to Allen from the Treasury Committee that dealt with the International Investigations, asking

for a formal answer to the question:

> Is the Statement of Results enclosed with that letter (from Allen Nov. 1904) an unanimous expression of opinion by those present at the meeting with a full knowledge of the details of the investigations? or is it of the nature of a preliminary statement which has still to be considered by the Council?

Letters to Bidder and Allen from Lankester (BL) are scathing about this question which was thought to emanate from Archer (I suspect that a member of the MBA Council, possibly D'Arcy Thompson, may have leaked information about Council 'toning down' Garstang's reports). There are references to 'intolerable insolence', 'accursed skunks who officially act for the government', 'official Machiavellis who know the way to destroy such a loosely constituted body as ours' and 'official murderers', ending with:

> any attempt to seduce the Treasury or Board of Agriculture official by sweetness ... is a preposterous error - as well try to melt the heart of a wolf if you are a lamb or a gazelle and he meets you after six weeks starvation in the depths of winter.

Poor Allen is referred to as an 'innocent fool' for trying to reply to this question and advised to temporize and never attempt a direct reply to such impertinent enquiries. By this time Archer had put in a further bid for control of the International Investigations, and the Association had evidence that the Fisheries Department intended to close down the sea-going work and the laboratories, and transfer the money saved to collection of statistics and market sampling of fish (BL). Bidder helped the Council prepare a memorandum for submission to the Treasury, signed by many eminent scientific men and business men interested in fisheries, stating their reasons against transfer of the grant to the Board. Many scientists were on the side of the Association, but quite a few were not, including those who may well have misunderstood the situation. For example, Professor Thistleton-Dyer, the Director of Kew Gardens, in noting that his organisation had recently been taken over by the same Board, but as a separate department, could see no reason for the Association rejecting a similar move, and said he had always found the Board 'helpful' (BL). This is one of those weasel words often cast about, like 'accountability' and 'economies of scale', when mergers and takeovers take place in government and quasi-government institutions, and is certainly not how the Association regarded the Fishery Department officials by the end of 1904. Hugh Robert Mill, the meteorologist, supported the Association, even though he was in favour of the Meterological Office coming under the Board of Agriculture and Fisheries, again as a separate department (BL). Professor Michael Foster wrote privately (BL):

> In my opinion no government department can hope to carry out scientific inquiry ... if it attempt to do so by the ordinary organisation of the department which is primarily fitted for administration.

but officially he felt unable to intervene and could see no objection to takeover of the Association's work by the Board given a promise of a proper scientific department for fisheries. Very quietly Bidder sent a copy of this letter to the secretary at the Treasury dealing with the MBA grant and the International Investigations. We have to remember that Professor Foster had retired by this time, and it is also probable that as a member of the physiological party on the Council he had opposed too much concentration on fishery matters. Both D'Arcy Thompson and Professor W. A. Herdman of Liverpool (also a member of Council) refused support, as did Professor Noel Paton at Edinburgh. A letter from the last, refers to a 'petition got up by the Cambridge men', and shows how opinions were becoming polarised by prejudice. It should not be thought that there was a simple case of Scots versus English or even provinces versus Cambridge. Indeed things were quite complicated.

D'Arcy Thompson at Dundee was already embroiled in quarrels with his opposite number across the Tay at St. Andrews, Professor McIntosh, who denied the value of the International Investigations; and not everyone at Cambridge was on the side of the Association or fully supportive of Garstang's views on North Sea plaice (BL). After appealing in person to the Chancellor of the Exchequer (Austen Chamberlain) and reminding him of his father's help in the past, Lankester noted to Bidder on March 6, 1905:

> there is still a chance that Chamberlain will not do what the Board of A & F (Asses and Fools) wants (BL).

We should note that the 'Superintendent Inspector of Fisheries' appointed to supervise the scientific work of the government fisheries department was A. T. Masterman, one of Prof. McIntosh's assistants from Scotland (Gardiner, 1941). The Association at first welcomed him, but evidence grew that he was not on their side in this dispute (BL). The Council probably failed to appreciate the indoctrination he had received from McIntosh against the sort of work planned by Garstang, who was determined to continue and expand the studies on immature fish begun by Holt. Masterman was under pressure from Archer to support work on statistics and market sampling of fish which the latter thought more representative of North Sea stocks than catches taken by *HUXLEY*, of whose fishing capacity he was scornful (BL).

The MBA petition eventually succeeded, and for a moment, 'the enemy' (as the correspondence regrettably refers to the Board of Agriculture and Fisheries) were repelled and the work continued. The next crisis soon arrived - would the government agree to the further two years of the International Investigations to which they appeared committed internationally? The Association staff wished to continue and complete the work in hand but both Allen and Bidder rather rashly stressed the need for a 'thread of continuity' in the work (BL), a phrase that still acts like the proverbial red rag to the bull when seen by administrators intent on short term contracts. The staff felt uncertain of the future and began looking at more secure jobs on offer elsewhere, including the Directorship of the Millport Marine Station, to which one of them moved in 1905, and Allen noted in February 1905:

> These short commissions must always be trying from that point of view, but it is very unpleasant to feel that everybody wants to clear as soon as a £150 job is visible.

Comments like this are equally valid today since most government work through the Research Councils is issued to the scientists as three year contracts, whereas the administrators who control the contract are secure themselves in fully established civil service or civil service-like posts or have much longer and renewable contracts. Garstang, in charge at Lowestoft, was several times close to a breakdown, having to attend to the sea-going work with his small staff, to write the reports and help fend off the predators who were gathering (BL). The grant for the English and Scottish International Investigations was renewed for two years, to the relief of D'Arcy Thompson on behalf of the Scottish Board (BL) but the Association was subjected to further indignity and uncertainty while the Treasury debated a final bid by Archer to take up all the English share of the International funds to support his statistical work from Whitehall. This assault also was repelled but it began to look obvious that at some time the Board would prevail. In granting £5 000 a year for 1906 and 1907 the Treasury took away £500 from the previous sum, and once more Bidder came to the rescue, offering to forego the nominal lease of *HUXLEY* which amounted to the very same sum. Matters came to a head again in 1907; the arguments were not helped by statements made by Ray Lankester during a public lecture:

> The Association ... had been hindered and threatened by the jealousy of highly-salaried government servants who were unable to do the work achieved by the Association or to understand its importance (Lankester, 1906)

Twice Lankester was close to resignation from the presidency of the Association. He had faced similar problems of dealing with government administrators when in charge of the Natural History Museum (Bourne, 1930). Even the mild-mannered Allen was getting bitter:

> We are being attacked right and left ... Herdman and his people are hard at it, Meek in Northumberland , Archer and Masterman, Heneage and probably Towse, Noel Paton too I believe ... the Fish Trades Gazette is making the worst public attack, in series of articles evidently written by a man with some scientific training, misquoting, misrepresenting and magnifying every little slip or misprint he can find. Headlam (secretary of the Treasury Committee) is saying it can only end in the withdrawal of all the International money. (BL, January 1907).

As already noted, the uncertainty of the future was damaging the work of the Association, especially of the staff based at Lowestoft, and in 1907 Garstang sized up the situation and successfully applied for the unadvertised post of Professor of Zoology at Leeds, writing personally to the retiring incumbent, Professor Miall (BL). Garstang could see no future for himself with the Board and thus his active involvement in fishery work ceased, although he gave the first set of Buckland Lectures in 1930 (Garstang, 1929). From 1907 to 1910 the Director at Plymouth, E. J. Allen, had to commute between Plymouth and Lowestoft, where he rented a house, to oversee the final years of the North Sea work, a line of investigation for which he felt no keen inclination and for which he thought he had 'little aptitude' (BL).

The Council bolstered further appeals to the government with glowing testimonials written by Professors Kofoid and Loeb of the University of California. Kofoid noted how much the Association was dependent on meagre private funds for work of importance to the state and showed how badly Britain was falling behind most other nations in applications of state funds to marine investigations. The letter from Loeb is more interesting scientifically today since it discusses the value of reseach into aspects of cellular physiology that we now regard as molecular biology. Both the Californians paid tribute to the originality and high standard of the work at Plymouth, and there is evidence that the work of Allen and Garstang helped to influence researches put into practice at the La Jolla laboratory (BL). These and other representations to the government provided a temporary respite. The grant to the Association was renewed for 1908 and 1909, but at rather short notice that unsettled everyone:

> it seems impossible to get them to decide anything ... it is difficult to see anything effective that can be done just now, short of taking Lloyd George by the shoulders and shaking him, like the suffragette. (E. J. Allen, December 1909, BL)

The battle ended on 31 March 1910. Thereafter the fishery work, including the International Investigations, was taken over by Archer and Masterman at the Board of Agriculture and Fisheries, and the Association was left only with the prospect of a smallish grant from the Development Fund to help maintain the laboratory at Plymouth. The takeover was followed by the closure of the laboratory at Lowestoft, as foreseen earlier by the Council, but the Plymouth Laboratory was saved by the representations of Council to Lloyd George. The Board did not want *HUXLEY* which was sold off by the owners, now the Association (to whom Bidder had sold it on mortgage in 1909 in attempt to force the negotiations). The nominal profits from the sale together with the nominal profits of its leasing for the International work, were used by G. P. Bidder to fund the Ray Lankester Investigatorship at Plymouth; Ray Lankester felt greatly honoured by this act (BL). This particular fund has prospered and a grant is still available under the same title for those wishing to carry out independent researches at Plymouth. The troubled history of the origin of this fund needs to be borne in mind in today's atmosphere of continued reductions in government support of research.

Details of the final round of negotiations between the Association and the government remain unrecorded and many of those who took part or were around at the time refused to discuss the affair later, including Masterman himself (Gardiner, 1941). We can draw parallels with the takeover of the larger part of the English and Scottish independent marine and fresh-water laboratories by the Natural Environment Research Council in 1988. The daughter of G. P. Bidder, Anna Bidder, (personal communication) confirms that, just as in recent events, some interested parties thought they had been let down by the negotiators, and there was talk of a 'sell-out'. There is no doubt that Lloyd George, the Prime Minister at the time, was both a charmer and a wily negotiator, and suspicion falls on Arthur Shipley, Chairman of Council, who conducted much of the negotiations, but those still in the know prefer to remain silent about the 'guilty men'. It should be noticed that Shipley was one of the 'Cambridge men' but was relieved when Garstang applied for the chair at Leeds, and expressed concern only when Ray Lankester appealed to Garstang to stay with the Investigations; he believed that relations with the Board would improve in the absence of Garstang, who was felt to be a constant source of friction (BL). But this was not so, and relations remained stressed through the final three years.

We can see clearly now that the idiosyncracies of the leading marine biologists governed a large proportion of the events in English marine researches from 1902 to 1910. All of them had high opinions of their own powers and tended not to listen to their antagonists. McIntosh, D'Arcy Thompson and Masterman were clever zoologists, but their leanings were towards taxonomy and morphology rather than biology and ecology, and a clash with Garstang was inevitable. After 1907, when Allen took over direction of the work of the Lowestoft laboratory he fared little better, since his views were at the time moving towards ecology, including experiments on phyoplankton production. As he says in his letters (BL), he had little inclination for the mechanics of fishery studies i.e. measurements and vertebral counts, but D'Arcy Thompson also confessed to a similar feeling in later years (Dobell, 1949).

Although the takeover may have been seen as an attempted death blow to the Association at the time, a more mature view, with benefit of hindsight, is that the crisis was ultimately of benefit to British marine science if not immediately to fisheries research. It is quite likely that fishery investigations would have become fossilised if the Association had surrendered in 1905, and most of the pure researches carried out at Plymouth would have ceased. This is more than a suspicion for it is not in doubt that Masterman, as one of McIntosh's team, was unconvinced of the value of much of the work carried out by the Association and other participants in the International Investigations, and would have supported Archer in closing down most of the researches of the Association. This is evident from the way in which McIntosh (1907) quotes Masterman favourably in the very acerbic criticisms published in *Nature* in July 1907 at the time of a meeting of the International Council in London, criticisms repeated and expanded in the second edition of McIntosh's book, *The Resources of the Sea* (McIntosh, 1921; see also Garstang, 1919). The survival of the Association from 1902 to 1910 allowed time for the change in nature of government support for marine research, which in turn assured the independence of the Plymouth Laboratory through the 1920s and 1930s. This independence, together with a measure of both competition and cooperation with the government controlled institutions at Aberdeen and Lowestoft, fostered growth of research on scientific rather than political principles. Would that such considerations still held today when most marine research is firmly centralized.

With the transfer of the International Investigations, the MBA naturalists were offered employment by the Board. This offer did not initially include Rosa Lee, the statistician at Lowestoft and the first female member of the scientific staff. The Association and Garstang reacted strongly to this, according to Dr Molly Spooner of Plymouth (personal communication), who is a niece of Miss Lee

and who has placed in the MBA archives a photograph of the Lowestoft staff in 1907, identified by Miss Lee. The Board huffily said 'The Fisheries Department does not employ women scientists' to which Garstang riposted that they were already doing just that i.e. in London they were employing some low-salaried ladies to measure fish-market samples. A bias against ladies, but of a different kind, is recorded by Riedl (1980) who says that there was a proviso in the building permission for the Naples Zoological Station that women would not spend the night there, the town councillors being convinced the laboratory would become a bawdy house. It is good to report that Miss Lee stayed on with the Board in London until 1919, working up the data already collected, but she had to leave when she got married, a civil service rule then strictly enforced. Some Lowestoft staff resigned, one for reasons of health, and Matthews, the expert hydrographer, begged to remain with the Association; his wish was achieved by 'sharing' him with the Irish Fishery Board, though he later resigned after personal difficulties with the administration at Plymouth and took up a new career in naval acoustics. The rest became 'Inspectors of Fisheries' in London, and most of the real research work ceased. A little field work was carried out with chartered yachts and commercial vessels and the lines of hydrographic stations sampled from cross-Channel steamers were continued. But all was not well with the Fisheries Department, as already attributed to Gardiner (1941). A proposal by the Development Commission for a committee to examine problems of fishery research was vigorously resisted by the Board of Agriculture and Fisheries. Allen, who felt a sense of relief at getting rid of the worries of the International work, but was fearful of the future for the Association, was able to take a detached view of what he could now regard as inter-departmental squabbles. He could even laugh at a proposal that Archer should be invited to join the MBA Council, where 'he could get together with his dear friend D'Arcy Thompson' (BL). The committee was eventually set up in 1913 after Archer retired, but not much was done during the war. It was left to a post-war committee under the Cambridge biochemist, Professor W. B. Hardy, later Sir William Hardy, to make radical improvements to the organization of fishery research and rescue British marine science.

Considered today, it is difficult to view the work of 1902-10 with anything but awe. A small number of dedicated and hard-working scientists, operating all year round from a pair of cranky steam boats, covered all the English Channel and approaches as well as a large part of the North Sea. In his assessment of the Association years Michael Graham (1949, 1956) is critical of much of the fishery work. Graham gives most praise to E. W. Holt, as a better practical fishery scientist than Garstang or Cunningham who favoured what he judged to be an academic approach to fishery research. But it should be noted that some of the research at the Scottish Fishery Board was also of academic character. Holt's service to the North Sea work was comparatively short, but highly significant. His work, and that of the other MBA fishery naturalists including Garstang, formed the basis of much of the MBA operations and publications from 1903 to 1919. In spite of the reservations expressed by Graham they did establish enough facts to allow a rational treatment of many problems of demersal fisheries, if only the politicians had agreed; and as a bonus they examined the ecological background which we know now is essential to fishery science. In the first forty years of the Association's existence over 900 papers were published and many reports written (Marine Biological Association, 1928). Of the publications, 35% were on fish, shellfish and related matters, including the reports of the International Investigations. Since most of the other papers published were written by visiting scientists from other institutions working at Plymouth, it is evident how much the staff of the Association followed the rulings laid down by the government as a condition for financial support. In the same period only 5% of their publications concerned physiology, and at one stage the physiology laboratory was turned over for handling and storage of biological specimens that were sold to schools and colleges (MB). After the fisheries work was transferred to the government department, physiology could be given greater prominence, and a course of 'experimental zoology', which included embryology, was held as early as 1911. More active studies had to wait for the building of extensions to the laboratory and internal modernisations

to the existing rooms, including a supply of electricity, work carried out with private funds after 1919. This was the start of the 'golden years' for the Association, when, largely unfettered by interference from government officials, and under the gentle direction of E. J. Allen, the Plymouth staff could give as much free rein to their imaginations as allowed by straitened financial circumstances (see Mills, 1989). To begin this process, Allen had first to blow life into the remnants of the staff at Plymouth, using the first small portion of the grant from the Development Commission promised by Lloyd George as a consolation when the other grants were lost to the Fisheries Department. Initially, the grant was half the previous basic grant, and as Allen said to Bidder, this took them back 16 years, with the staff reduced to little more than a Director (BL). Eventually, when further aid from the Development Commission materialized and some more staff could be appointed, fishery work was resumed at Plymouth on a smaller scale, than before, including studies on herrings (Orton, 1916; Ford, 1933). But another crisis developed in connection with the civil service machine, this time in shellfish work by Orton (1923, 1926); the government withdrew special funding after two years, leaving the Association to complete a study of oysters and pollution out of its basic grant (MB). Bidder had not enjoyed the 1902-10 negotiations with government officials and after this additional discourtesy he recommended that the Association should not in future take on any more commissioned fishery work (BL). Instead it should concentrate on basic science. This dictum was largely followed until 1936, but did not prevent Allen and the Secretary of the Development Commission from introducing into the Plymouth programme some strategic research of fishery interest, a safeguard that helped ensure continuance of the annual income of the Association provided by the government through the Development Commission.

This acceptance of strategic research, combined with the freedom from the short term *ad hoc* investigations typical of government directed research, led to the firm establishment of the Plymouth researches on production in the sea. The time series that had been started over a quarter of a century earlier were now put on a fully quantitative basis, and investigations begun on the various factors thought to influence growth of phytoplankton and changes in zooplankton and fish distribution and abundance. As already noted, the replacement for *OITHONA* was possibly the least sea-kindly vessel owned by the Association. However, the possession of this vessel allowed Atkins and Harvey to resume, from 1921, one line of the pre-war grid of Channel stations, worked at quarterly intervals, adding analyses of inorganic nutrients to the regular hydrography (Atkins, 1926; Harvey, 1925). More significantly they could now work the station closest to Plymouth, E1, at monthly intervals (Figure 1). F. S. Russell was asked by Allen to work on vertical distribution of fish eggs, to which he added all the other macroplankton taken in the same nets. Eventually his series of samples taken at weekly intervals at the Eddystone station could be evaluated alongside the work of Atkins and Harvey to provide the basis for the observations of what we now call the Russell Cycle (Russell, 1973; Southward & Boalch, 1989). Slightly later, A. C. Hardy, who like Garstang had escaped back to academic life from fisheries research, originated that other significant U.K. time series on plankton, the Continuous Plankton Recorder Survey, now also based at Plymouth, but that is another story and so is its financial abandonment by the Natural Environment Research Council. However, it is doubly ironic to report that the successor to the Development Commission refused to continue funding this work whereas the successor to the former Board of Agriculture and Fisheries has taken on a supportive role.

This account should end in 1924, with the strategic work and time series on the environment proceeding well. But events since then must be summarised with due regard to the future. Under the directorship of Allen and then Kemp, the important environmental studies continued up to the outbreak of World War II. They were resumed again and expanded when Russell became Director, and were continued under the next Director at Plymouth although the nature of the work itself had come under criticism in some sectors of the Natural Environment Research Council which took

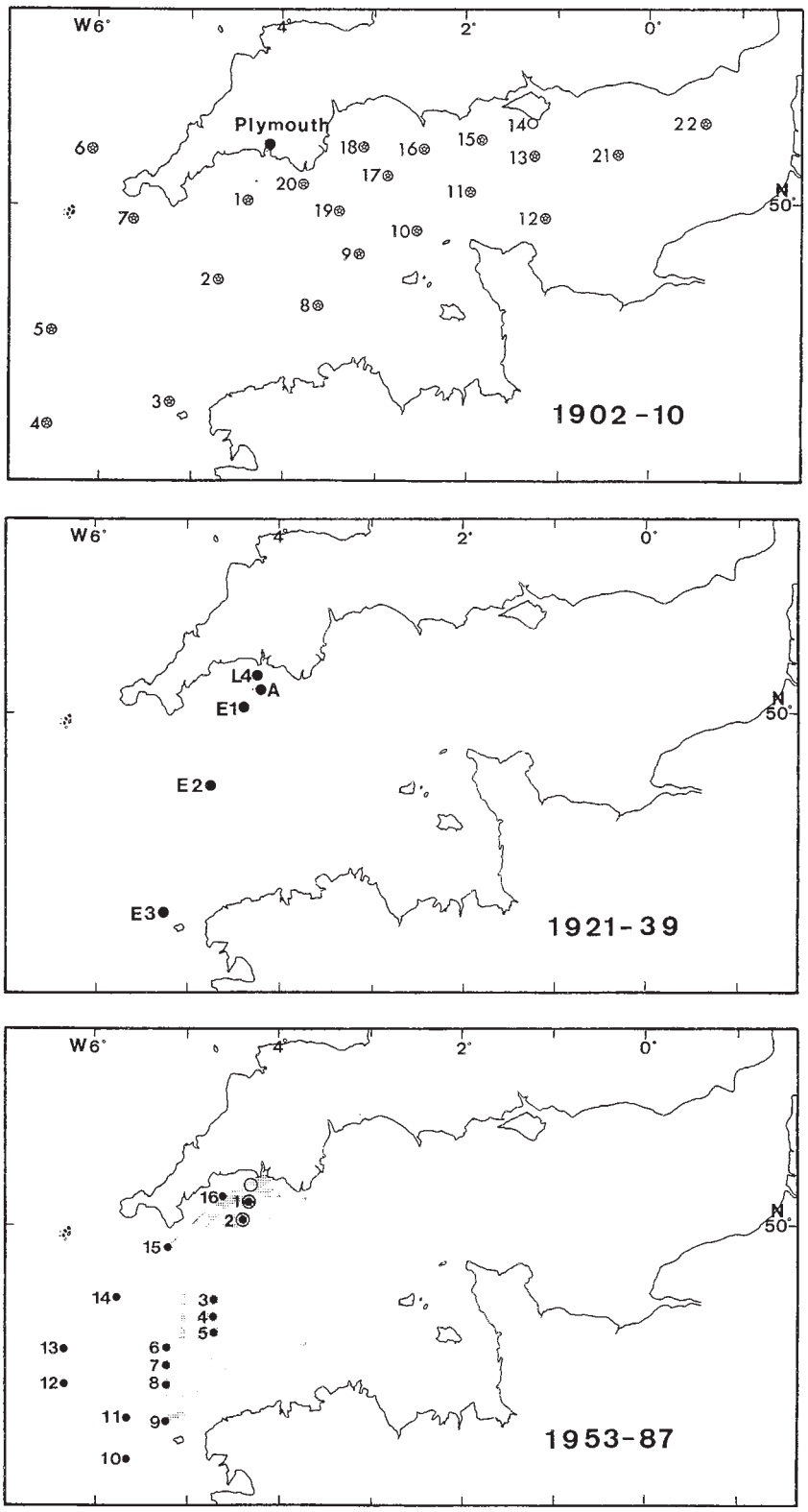

Figure 1. Examples of the scope of serial observations made by the Plymouth staff and research vessels. Top, 1902-10; the 'E' stations worked by *HUXLEY* and *OITHONA*, 1902-10; biological sampling was restricted after 1907. Middle, 1921-39; the line of stations worked by *SALPA*. Bottom, 1953-87; the hatched area covers four lines of detailed stations worked by *SARSIA* in the early 1960's; the set of numbered stations (filled circles) was sampled by *SARSIA* from 1964 to 1974; the larger open circles are the stations near Plymouth sampled with various vessels, including *SARSIA*, *SULA*, *SQUILLA* and *SEPIA* up to 1987. Additional sets of stations covering various parts of the western English Channel and the Celtic Sea were sampled by *SARSIA* from 1953 to 1980, sometimes several times a year.

over the financial responsibility for the government grant to the Association. After 1974 pressure increased for more 'accountability' i.e. NERC wished to assume direct control of the researches, and the criticism of the work increased. Plans for replacement of the research vessel acquired in 1953, and essential for the work, continued and a more modern vessel actually entered service in 1981, but demands for centralized control prevailed and it was soon withdrawn from Plymouth and then sold off by NERC, preventing the prosecution of all-year-round sampling in the Channel and approaches. When NERC merged the two laboratories at Plymouth in 1988 and took over direct control of most of the environmental work of the Association, as distinct from pure research such as neurophysiology, membrane physiology and symbiosis, all regular environmental and fisheries sampling in the Channel was stopped. The data series available for the Plymouth area up to this closure is immensely valuable in predicting what will happen to marine ecosystems when the sea really begins to warm up as a consequence of the greenhouse effect – we may already be seeing the start of this indeed but lack of ongoing data is a handicap. After the recent about-turn in government thinking on the environment, we have to hope that the administrators will see fit to re-allocate financial support for work on the Plymouth time series before it becomes a lost 'folk-memory'. Otherwise, if they persist in disregarding history, they will, in the words of the philosopher Santayana, have to 'relive it' i.e. carry out another long time series to provide a new baseline. We have in fact already relived the events of 1902-10, in that both then and now environmental research was first criticised then threatened and finally stopped after a takeover. Although there has been uninformed criticism of the Plymouth work as being 'expensive' and 'local', the true real cost was a fraction of the money now being spent on *ad hoc* 'big science' short term projects in the marine field; and the applicability of climate-linked changes is universal. Britain requires more smaller-scale but sustained science (Lovelock, 1989), of the type for which the Marine Biological Association became renowned.

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BRITISH WHALING AND WHALE RESEARCH

Ray Gambell

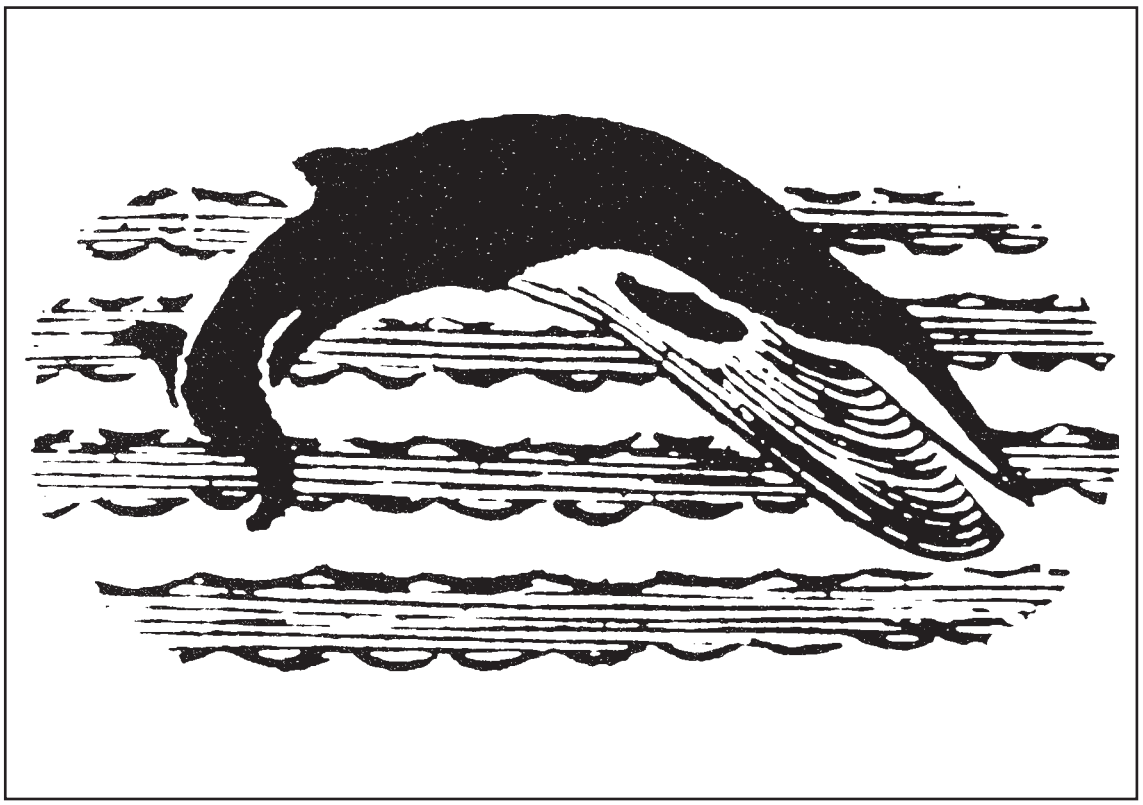

Plate 1. The *DISCOVERY* crest (see pages 89-90).
(Photograph: Greg Donovan).

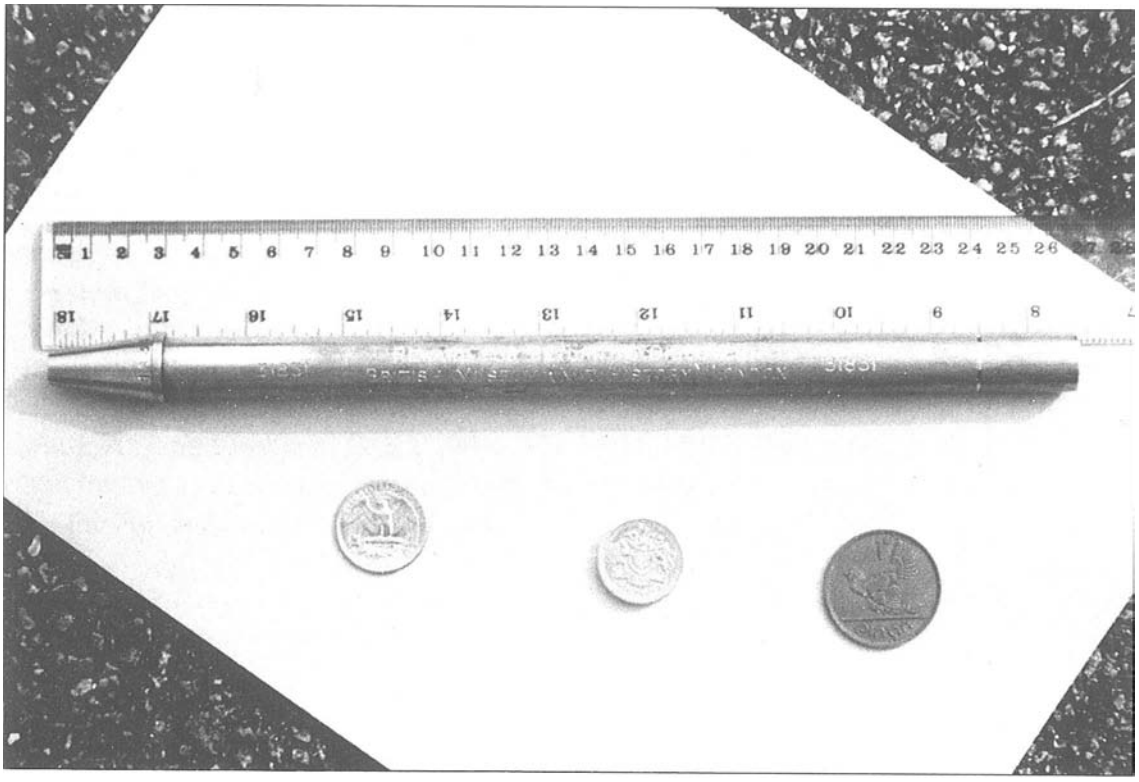

Plate 2. A *DISCOVERY* whale mark (see page 90).
(Photograph: Greg Donovan).

BRITISH WHALING AND WHALE RESEARCH

Ray Gambell

International Whaling Commission
Cambridge

Abstract

Britain has a long and important history in the context of both whaling and whale research. These activities have not been confined solely to the immediate area of the British Isles, but have had a world-wide dimension for many centuries.

Whales have been accorded the status of 'Royal Fish' in Britain since medieval times, and there were drive fisheries in Orkney and Shetland Islands for pilot whales in this period of history. But the main commercial industry was based on the development of ocean-going vessels which allowed the fishermen to venture further and further offshore in pursuit of those sorts of whales which were slow swimming and easily caught. Arctic whaling in the 16th and 17th centuries was for the Greenland Right Whale. In the 18th century the Southern Whale Fishery, mainly for sperm whales, spread from the Atlantic into the Pacific and Indian Oceans.

Modern whaling dates from the 1860s, with the Norwegian invention of the explosive grenade harpoon fired from a cannon mounted on the bows of an engine-powered catcher vessel. This brought even the fastest swimming whales within the reach of the hunters and opened up the fisheries for the large blue, fin and sei whales world-wide. Over-exploitation of the stocks closest to the Norwegian coast led to the establishment of whaling stations on the Hebrides and the Shetland Isles in the early 1900s until the late 1920s.

With the depletion of the northern stocks, the attention of the whalers turned to the vast resources of the Antarctic, where whaling started at the British controlled island of South Georgia in 1904. This great industry expanded rapidly with the introduction in 1925 of floating factory ships able to follow the whales and process them far from land. Since the 1950s the industry has been in decline because of its over-exploitation of the stocks, and the last British whaling ended in 1963.

Scientific knowledge of whales until the 1920s depended mainly on a few museum specimens, stranded carcasses and incidental observations. There were the notable exceptions of the writings of 19th century whalers like Scoresby on the Greenland right whale and the Northern whale fishery, and Beale on the sperm whale and the British Southern Whale fishery. But in 1920 the Discovery Investigations were founded to carry out research into the whales, their fishery and associated aspects around the Falkland Islands. This laid much of the foundation for present biological research into whales and their environment. British whale research continues to play an important role in the investigation of whale biology, movements and stock identity through the use of modern technology, as a continuing contribution to the global management of this resource.

Introduction

From the earliest historical times the knowledge that the whale is a useful source of meat, oil, baleen and other products has encouraged the hunting of these creatures. In European waters the first hunts for whales centred around those species which migrate sufficiently closely past the

coast that they might be herded into land and there slaughtered. In medieval times schools of pilot whales were driven ashore by fishermen in the Orkney and Shetland Islands in much the same way that the present-day drive fishery for pilot whales is conducted in the Faroe Islands. The fishermen encouraged the animals to cast themselves onto suitable sloping beaching by encircling the schools with their boats, and then herding them towards the shore by thrashing the water and making much noise. Once ashore, or at least in shallow water, the whales could be killed and cut up, and the meat prepared and stored for later consumption.

The future whaling industry, however, developed not from this northern whaling activity but from the kind of whaling started in the Bay of Biscay by the Basque fishermen. From its 12th century beginnings this fishery grew from a coastal enterprise to a major industry. The object of the fishery was the Black or Biscayan Right whale which came close inshore to breed. It was slow swimming and relatively easy to approach, but because it was hunted on its breeding grounds it all too soon was reduced in abundance. The whalers therefore had to search further afield for similar quarry to pursue their trade, and this led to the world-wide whaling industry which followed close on the heels of European discovery and colonization of the other oceans and continents.

The history of British whaling falls naturally into two parts (Jackson, 1978). The first covers the original and traditional whaling trade for the slow swimming species which float when they are dead, and so were the 'right' whales to hunt. These whales provided oil for illumination, lubricants and cloth-making, and whalebone for corsets. The second part is the modern industry which has a much greater catching power and can deal with any species of whale, including the largest and fastest swimming. The products from this industry were originally oil for soap and margarine, but latterly, all kinds of industrial and technical purposes, and meat for human and animal consumption.

The Northern Whale Fishery

The northern voyages of the 16th century Elizabethan explorers led to the discovery of various whaling grounds in the Arctic regions, particularly on the trading route to northern Russia, around Bear Island and Spitsbergen. In 1611 the first Greenland right whale was taken off Spitsbergen by a British whaler, using Basque harpooners.

The methods employed in this hunt changed little over the next 250 years. The right whale was approached by a whale boat under six oars or sail, and the harpooner threw his hand harpoon into the back of the animal to make fast. The line attached to the harpoon allowed the hunters to slow down the whale's attempted escape, and eventually to approach near enough again to kill it with repeated thrusts with long lances into some vital organ. The carcase was then towed to a convenient beach where the blubber was flensed off and boiled in try pots to extract the oil. The oil was stored in casks to be transported back to England on the whaling vessel.

There was considerable competition between rival whaling interests in the Spitsbergen fishery, and between the British and Dutch governments. The whales became scarce close to Spitsbergen and the whalers began to move into the icefields towards the north and west where larger stocks were discovered and which offered better prospects. By the mid-17th century the Greenland and Davis Straits fisheries had become the major centres, dominated by the Dutch but with a continuing British component.

The ice fishery was rather different from the shore-based enterprise on Spitsbergen. The whaleship was the base of operations and whales caught by the whaleboats were towed back and flensed

alongside. The blubber was cut into strips and stored in casks to be tried out at blubber works in the home ports in England or Scotland. After 1840 this ice fishery began to decline and its final phase belonged to the Scottish sail and steam whalers, the last Dundee whaler returning home 'clean' in 1913.

One major work stands out at the peak and almost sole scientific study from this period, and that is the landmark volume by William Scoresby Jnr (1820). Scoresby was a whaling captain with a keen interest and aptitude in many aspects of nature and science. His 'Account of the Arctic Regions' is a classic of whaling literature, including a history of the fishery and a first hand account of the hunting methods employed. Since the Greenland right whale became so scarce as a result of the fishery, Scoresby's account of this whale has remained as almost the only good description until very recent times.

The Southern Whale Fishery

A new phase in whaling began in the 18th century as the right whale stocks in the cold Arctic zone were depleted. After the chance discovery in 1712 by a Nantucket whaler blown out to sea by a storm of the relative ease of capture and value of the oil of the sperm whale, the whalers turned their attention to these whales in tropical and sub-tropical waters. Sperm whale oil was a superior illuminant to the oil from baleen whales and the spermaceti from the head made the finest wax candles.

This was principally an American enterprise conducted out of New England ports, but British (and other) ships joined in as the industry spread from the Atlantic to the Indian and Pacific Oceans. The first British involvement in this fishery dates from 1776, although the vessels and crews were American, dispersed by the Revolution. A British whaler was the first to hunt sperm whales in the Pacific Ocean in 1788. This was a truly pelagic operation, with the whaling vessels cruising for up to three or four years in the various oceans. The hunt was conducted from open boats lowered in pursuit of the sperm whales, and the whales were cut up in the water alongside the whaleship before the oil was extracted from the blubber by boiling in the try pots on deck. It was then stored in casks to be unloaded at convenient ports on the voyage.

An account of the Southern fishery and of the sperm whale was written by Thomas Beale (1839). This provides an equivalent record to Scoresby's work on the Northern fishery, although it is generally considered to fall short of the standard of the latter (Brown, 1973). Nonetheless, Beale, who served as a ship's surgeon on two British sperm whaling vessels in 1830-33, was one of the first observers to provide an accurate description of the appearance, habits and biology of the sperm whale. This was gained by the need for the whalers in their open boats to come into close contact with their quarry, and to know these details if they were to hand harpoon and lance it successfully. One interesting sidelight on Beale's *Natural History of the Sperm Whale* is that it was the main source of information on whales and whaling used by Herman Melville (1851) in writing his classic *Moby Dick*.

This Southern fishery reached its peak in the first half of the 19th century and also took humpback whales in the equatorial seas and right whales in the southern seas and the North Pacific. Soon all these stocks around the world were reduced to the point where the industry itself went into a slow decline, although the discovery of petroleum in 1859 may have had some bearing on the sperm whale fishery which, finally, ended as late as 1925.

Modern whaling

Modern whaling began in the 1860s with the combination of an explosive harpoon fired from a cannon mounted on the bows of a steam-powered catcher boat. The Norwegian Sven Foyn successfully developed and employed this technology, which allows even the fastest swimming rorqual whales to be pursued and killed. The carcasses can then be brought alongside the catcher vessel to be inflated with air to keep them afloat. At this stage in the development of modern whaling the actual dismembering of the whales and the processing of the raw materials was still carried out at a land station.

After Foyn's first experimental catches in 1868, the new-style whaling operations quickly spread along the coast of Finmark, in north Norway. Within 20 years, however, the blue, fin, sei and humpback whales close to the whaling stations had become scarce and the whalers started to look for other whaling grounds. There was also the problem of a conflict with the local fishermen, who blamed the whalers particularly for their poor cod fishing seasons at the end of the century, and objected to the smell from the whaling stations. Together with internal and external political considerations, these conflicts led the Norwegian government to ban all whaling in the territorial waters of the northern part of the country in 1904.

Thus, the Norwegian whalers were forced at this time to look elsewhere for land bases. New enterprises were established in Iceland, Newfoundland and the Faroe Islands, and a floating factory ship began whaling around Spitsbergen. In 1903 two stations operated by Norwegian companies started work in the Shetland Islands, and in 1904 a Norwegian company began operations in the Outer Hebrides. This was the beginning of modern whaling in the British Isles.

Modern whaling around the British Isles

The development and catching results of whaling around Britain in the early part of the 20th century have been summarised by Brown (1976). The first two (Norwegian) whaling stations on the Shetland Islands were situated in Ronas Voe on the northwest coast of the Mainland. The following year, 1904, two more stations were established; a third Norwegian company started whaling activities in Colla Firth, Yell Sound, and a Scottish firm, Chr. Salvesen and Company, set up a company working in Olna Firth on the west coast of Mainland.

Whaling in Shetland was the first conducted on the territory of Great Britain, and the raw materials were more fully utilised here than elsewhere. But despite the fact that the first non-Norwegian crews used in British whaling were recruited from the Shetlands, conflict developed here too between the local fishermen and whalers which was very bitter. Finally the complaints from the fishermen about the alleged detrimental effect of whaling on the herring fishery led to the licensing and regulation of the whaling industry from 1907 (Tønnessen and Johnsen, 1982).

Whaling operations were continued by all four stations each year from 1904 to 1914, when activities were suspended because of the war. The seasons generally lasted from April to September, and the 8 or 10 catcher boats ranged up to 150 miles in a northward arc from west to east of the Islands. Fin whales made up about two thirds of the catch and sei whales a little less than one third, with only a few blue, humpback, right, sperm and bottlenose whales taken (Table 1).

Whaling activities in the Outer Hebrides began in 1904 when a Norwegian company transferred its operations from Iceland to Bunaveneader on West Loch Tarbert, Harris. Three boats worked each season from May to September up to the first World War, hunting in a westward arc up to 180 miles from shore. Fin whales predominated in the catch, making up just over half of the whales landed, with 20% sei whales and 15% blue whales, and rather more right and sperm whales than in

Table 1. Whales caught from the Shetland Islands (after Brown, 1976)

Year	No. of catcher boats	Blue	Fin	Hump-back	Sei	Right	Sperm	Bottle-nosed	Total
1903	2	-	117	5	5	-	-	-	127
1904	7	-	400	8	5	-	1	-	414
1905	8	6	372	5	32	-	1	1	417
1906	9	1	298	3	262	-	-	1	565
1907	10	3	300	4	140	-	6	1	454
1908	8	-	328	1	198	-	-	-	527
1909	8	1	320	7	168	-	-	2	498
1910	8	2	268	10	171	4	-	1	456
1911	8	4	261	4	86	-	1	2	358
1912	8	3	201	-	73	-	-	8	285
1913	10	-	194	1	149	1	2	7	354
1914	10	5	228	1	203	1	-	-	438
1920	6	25	176	-	228	-	-	1	430
1922	4	11	226	-	44	-	-	-	281
1923	4	8	158	-	9	-	-	-	175
1924	4								266*
1925	4								176*
1926	4	7	246	-	16	-	-	-	269
1927	4	2	103	-	21	-	4	-	130
1928	4	3	87	-	25	-	2	1	118
1929	4	4	73	2	4	-	2	-	85
Total 1903/1929		85	4356	51	1839	6	19	25	6823

** Catch by species not published*

the Shetland Islands (Table 2). The take of the right whales, with their particularly valuable baleen plates, encouraged a number of Norwegian expeditions to search for the migration routes throughout the North Atlantic, but with no success (Tønnessen and Johnsen, 1982).

The resumption of whaling in British waters following the Great War was not at the same level as in the pre-war period. In the Shetland Islands, Chr. Salvesen and Company operated the station in Colla Firth for the one season of 1920 with two catchers and then closed down. Its Olna Firth station also reopened in 1920, and then worked from 1922 to 1929 with four catchers until whaling ceased altogether in the area.

Table 2. Whales caught from the Outer Hebrides (after Brown, 1976)

Year	No. of catcher boats	Blue	Fin	Hump-back	Sei	Right	Sperm	Bottle-nosed	Total
1904	3	42	37	5	4	-	5	-	93
1905	3	31	78	1	2	-	4	-	116
1906	3	53	19	2	64	6	1	-	145
1907	3	9	96	1	11	24	4	1	146
1908	3	17	51	1	34	20	1	-	124
1909	3	32	112	5	55	21	7	-	232
1910	3	19	113	2	19	5	1	-	159
1911	3	1	83	-	44	-	17	-	145
1912	3	9	91	-	35	11	9	-	155
1913	3	2	65	-	10	-	6	-	83
1914	3	14	97	1	45	4	-	-	161
1920	3	31	130	1	31	1	-	-	194
1923	3	15	154	-	1	2	-	-	172
1924	3								189 *
1925	3								203 *
1926	3	29	154	-	5	-	4	-	192
1927	3	1	160	-	12	-	11	-	184
1928	3	5	52	-	3	-	6	-	66
Total 1904/1928		310	1492	19	375	94	76	1	2759
1950	1	2	33	-	-	-	-	-	35
1951	1	4	13	-	3	-	1	-	21
Total		6	46	-	3	-	1	-	5

** Catch by species not published*

The Outer Hebrides saw a Norwegian operation in 1920, which was taken over by a subsidiary of Lever Brothers and worked from 1923 to 1928. A new company operated in West Loch Tarbert in 1950 and 1951 with one catcher before it too closed down.

In some ways it is surprising that little research was carried out on the material available from these whaling operations. There were a number of statistical reports (Haldane, 1904-1909), and Thompson (1928) analysed the records to determine the distribution and composition of the catches, but there were little if any biological studies of a substantive nature.

Thompson (1928) and Brown (1976) showed that very few fin whales were caught on the continental shelf within the 100 fathom line, and most blue and sei whales were also taken in the deeper waters. Blue and right whales occurred mostly west of the Outer Hebrides. From a simple analysis of the

catch per boat, Brown (1976) concluded that fin whales were being overfished on the Shetland grounds at an early date, and that blue and right whales, but not fin whales, declined in numbers on the Hebridean grounds during the British whaling episode.

Antarctic whaling

It became apparent at an early stage of modern whaling that the stocks in the North Atlantic were insufficient to sustain an industry of the size which quickly developed. The future, and the major focus of attention in the 20th century, lay in the Antarctic. The vast whale resources of this region were recognised by the early sealers, and Antarctic whaling by modern methods was pioneered by a Norwegian, C. A. Larsen. In 1904 he established a whaling station at Grytviken on the British controlled territory of South Georgia in the Falkland Islands Dependencies. This employed Norwegian personnel, but was operated by a company registered in Argentina. The next year a Norwegian whaling factory visited the South Shetland Islands, and the boom in Antarctic whaling was underway. Further development after 1912, when 21 catchers were employed at South Georgia, was restricted by British Government action for fear that the stocks of whales would be unduly depleted. But it was clear at an early stage that this whaling area was extremely productive, and the catches soon realised more than those from the rest of the world put together.

A major expansion in Antarctic whaling occurred with the development and deployment of the floating factory ships. The first such vessel, with a slipway up which the whale carcases can be hauled for flensing and processing, was introduced in 1925. The removal of the restriction of being able to operate only in sheltered coastal waters which this innovation created led to pelagic whaling fleets hunting throughout the Southern Ocean. Norway was again the pioneer in this enterprise, with the United Kingdom having the second largest stake in the industry.

The catching power of the whaling fleets far outstripped the reproductive capacity of the whale stocks to sustain the level of catches taken. In the 1930/31 season 40 201 whales were caught, including 29 410 blue whales and 10 017 fin whales, by 6 shore stations and 41 floating factory expeditions operating 232 catchers. The British contribution to this kill, by 2 shore stations on South Georgia and 11 floating factories with 68 catchers was 12 196 whales.

Because of the over-production of oil by this massive catch the British and Norwegian whaling companies attempted to introduce a degree of self-regulation designed to stabilise and maintain the world market. This was followed by a series of international agreements through the 1930s intended to halt the by now obvious over-exploitation and depletion of the stocks which was occurring. The Second World War provided a short respite for the whales, but catching resumed at too high a level again after the war, when catch limits were set by the newly created International Whaling Commission, and the stocks and the industry declined steadily from the 1950s. Finally, after the imposition of increasingly restrictive catch limits, the International Whaling Commission imposed a pause in all commercial whaling throughout the world from 1986, the effects of this decision to be reviewed in 1990.

Discovery Investigations

Britain, besides being the second largest whaling nation operating in the Antarctic, played an important role in the scientific research associated with the commercial whaling activities. Its initiative in the 1920s to send a scientific expedition to the Antarctic was intended as a systematic exploration of all the economic resources of the Falkland Islands Dependencies. This was prompted

by the rapid development of the whaling industry, and the fears which soon arose that this industry would follow the pattern of its predecessors in other parts of the world and prove to be short-lived. The emphasis was thus to undertake investigations on the whales and any related factors which influence them. So the Discovery Investigations were set up, funded by the considerable financial resources derived from the Falkland Islands Government's taxes on whale oil (Kemp, 1929).

The base for these studies was a laboratory built on South Georgia, the Marine Biological Station, close to the whaling station at Grytviken. This afforded good opportunities for the collection of measurements, observations and anatomical specimens from the whales taken in the summer season whale fishery. However, during the winter the whales migrate northwards, and in order to follow the annual cycle of changes in feeding and reproduction, *DISCOVERY* staff extended their programme of work to the South African whaling stations at Saldanha Bay in the Cape Colony and Durban in Natal. The first published results, with an account of the methods used, were by Mackintosh and Wheeler (1929) on blue and fin whales, with later contributions on humpback, sperm, right and sei whales by Matthews (1937-1938).

The importance of finding some means of marking whales for evidence of their movements and migrations had been recognised from the start of these investigations. In cooperation with Norway, and after considerable experiment, a successful mark was devised in the form of a stainless steel tube bearing a serial number, fired from a 12-bore shotgun (Plate 2). The mark was buried under the whale's blubber, and recovered when the whale was killed and the carcase processed at the factory. A reward was offered for any mark returned together with the date and place of capture of the whale. The results obtained have led to considerable information on the relationship between the breeding and feeding grounds of the whales in the Southern Hemisphere, as well as the degree of longitudinal separation of the various species (Rayner, 1940; Brown, 1962).

The pioneering studies of the Discovery Investigations were continued after the second World War by the newly formed National Institute of Oceanography (NIO), which included a specialist Whale Research Unit. A number of lines of investigation were particularly significant. Amongst these were the analysis of data from visual observations of whales obtained independently of the commercial whaling industry. Sightings from the *DISCOVERY II* during six years' voyages in the 1930s gave the first quantitative view of the seasonal abundance and fluctuations of the large rorquals in the Antarctic (Mackintosh and Brown, 1956).

The importance of age determination in population studies was recognised from the outset of the Discovery Investigations. Questions of growth rates, age at sexual maturity, mortality rates and related parameters hinge critically on having an accurate method of ageing individual whales. The search for such a method lasted for many years, and finally succeeded when the earplug of the fin whale was demonstrated to contain periodic growth layers (Purves, 1955). This work was carried out in the British Museum (Natural History), using NIO collections. The rate of deposition of these growth layers remained in doubt until detailed histological evidence demonstrated their annual formation (Roe, 1967(a),(b)). The use of marine mammal tooth sections for age determination had been demonstrated by Laws (1952), including sperm whales. Their teeth were shown by Japanese workers to be composed of dentine and cement also made up of regular growth layers. Again, the rate of formation was in doubt for some time but, based on material collected in the Antarctic, South Africa and Western Australia, it now appears to be annual, although the timing of the deposition varies between areas and sexes (Gambell, 1977).

Fundamental studies of the reproductive biology of the major species were also undertaken. These were the product, to a large extent, of collections of biological material and observations made by biologists acting as whaling inspectors on British shore stations on South Georgia and floating factory ships. Together with specific studies undertaken by biologists with the kind cooperation of the whaling companies and factory ship personnel, major reports on southern blue, fin, humpback, sei and sperm whales were completed (Mackintosh, 1942; Laws, 1961; Gambell, 1968, 1972). Much of this work involved collection and analysis of ovarian and testis material, foetal measurements and related observations to determine the reproductive cycles, pregnancy and foetal growth rates of these species.

Mention should also be made of the pioneer work carried out by British scientists on the whales and whaling industries conducted in other countries. This includes the account of the Azores whale fishery by Clarke (1954) and the sperm whales hunted (Clarke, 1956) by this relic of the 19th century Yankee whaling industry. Clarke was also involved with an investigation of the sperm whales taken off Chile and Peru, a study initially promoted by the Food and Agricultural Organisation of the United Nations (Clarke *et al*., 1968, 1972, 1988).

Strandings

One other British initiative which has provided considerable information on whales, and which has now spread to many other parts of the world, is concerned with the routine recording and study of stranded animals.

In England, Wales and Northern Ireland, Royal Fish i.e. whales, dolphins and porpoises (and sturgeons) belong to the Crown. This is the case regardless of whether the animal is dead or alive, except where the carcase is washed ashore or stranded within the limits of a Manor where the title to Royal fish has passed to the Lord of the Manor. In Scotland, whales less than 25 feet in length and bottlenose whales are not Royal Fish.

Just before the first World War, in 1913, the Keeper of Zoology in the British Museum (Natural History), Sir Sidney Harmer, instituted the systematic reporting of the whales, dolphins and porpoises which strand around the British coasts. This was organised institutionally through the cooperation of the Board of Trade, and later the Ministry of Transport. Receivers of Wreck and Officers of the Coastguard Service sent in reports and carcases, or required portions of the bodies, and in this way a valuable supply of cetacean material was accumulated. Most of the records came from the commonly occurring species, of course, but other less frequent visitors to the British shores were reported (Fraser, 1969).

From these records and specimens it has been possible to build up a considerable data base of information on the seasonal frequency, locations, and changes in the pattern of strandings of the various species around these islands. This is in addition to the museum's interest in obtaining skulls, skeletons and anatomical specimens for the national collections. Cooperation with the Royal Scottish Museum, the relevant Irish authorities and many private individuals added considerably to the success of this scheme over the 75 years and more it has been in operation.

To give some idea of the numbers of records available, there were 631 common porpoises *Phocoena phocoena* reported up to 1966, the most frequent stranding, with 185 bottlenose dolphins, *Tursiops truncatus* as the next most abundant. A number of species have appeared only once in the records, including the white whale, *Delphinapterus leucas*, and the pigmy sperm whale, *Kogia breviceps* (Fraser, 1974).

Current research

Unhappily, the Antarctic whaling industry has followed the same path as most other whaling enterprises throughout the world. After initial expansion and boom, the stocks were over-exploited to the point where their depletion led to the demise of the industry. The last British factory ship operated in 1962/63 and the land stations on South Georgia closed after the 1961/62 season, although two were leased for two seasons to Japanese companies.

With the reduction in commercial catching there has been an inevitable lessening of whale research relying on the observations and collection of measurements and samples from the carcases processed by the industry. This has encouraged a greater interest in and development of the so-called 'benign' research techniques which do not require dead whales. Increasingly too, such research is international in its scope, with wide cooperation between individual scientists and research groups around the world.

Recent developments in sightings theory now allow visual sightings of whales made on planned shipboard and aerial surveys to be converted into stock estimates (Hiby and Hammond, 1989). This is the most reliable method currently employed. Satellite monitored radio tags to track and record whale movements and activity (Martin and Smith, 1992) also offer the prospect of unravelling the details of migrations and behaviour patterns previously only inferred from 'Discovery' type marking and later recoveries from dead whales.

Work on these and other cetacean studies in the UK, including continuing analyses of material leading to a better understanding of age, reproduction and energy budgets (Lockyer, 1972, 1976, 1984) is centred in the Natural Environment Research Council's Sea Mammal Research Unit in Cambridge. This Unit, together with the Ministry of Agriculture, Fisheries and Food's Fisheries Laboratory in Lowestoft provides the government input into international whale research, the latter dealing particularly with management aspects (Horwood, 1987).

In addition, new developments in biochemical genetics being pursued in Cambridge University also show much promise in distinguishing between and identifying biological stocks of whales. Small skin samples collected from living whales provide ample genomic DNA for these purposes (Hoelzel and Dover, 1989).

Thus, while Britain is no longer a whaling nation, after centuries of involvement in the industry, it continues to occupy a leading role in research, conservation and management of this global resource.

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THE SCOTTISH CONTRIBUTION TO MARINE AND FISHERIES RESEARCH WITH PARTICULAR REFERENCE TO FISHERIES RESEARCH DURING THE PERIOD 1882-1939

J.A. Adams

Plate 1. *THE ARK* at Port Loy, a sheltered inlet at the entrance to Kames Bay, Millport. It was open to visitors and a notice stated "In order to make the Educational Value of the Institution as largely available as possible, only a Nominal Charge is made for Admission, viz., ONE PENNY". The vessel broke up during a severe storm in December 1900.

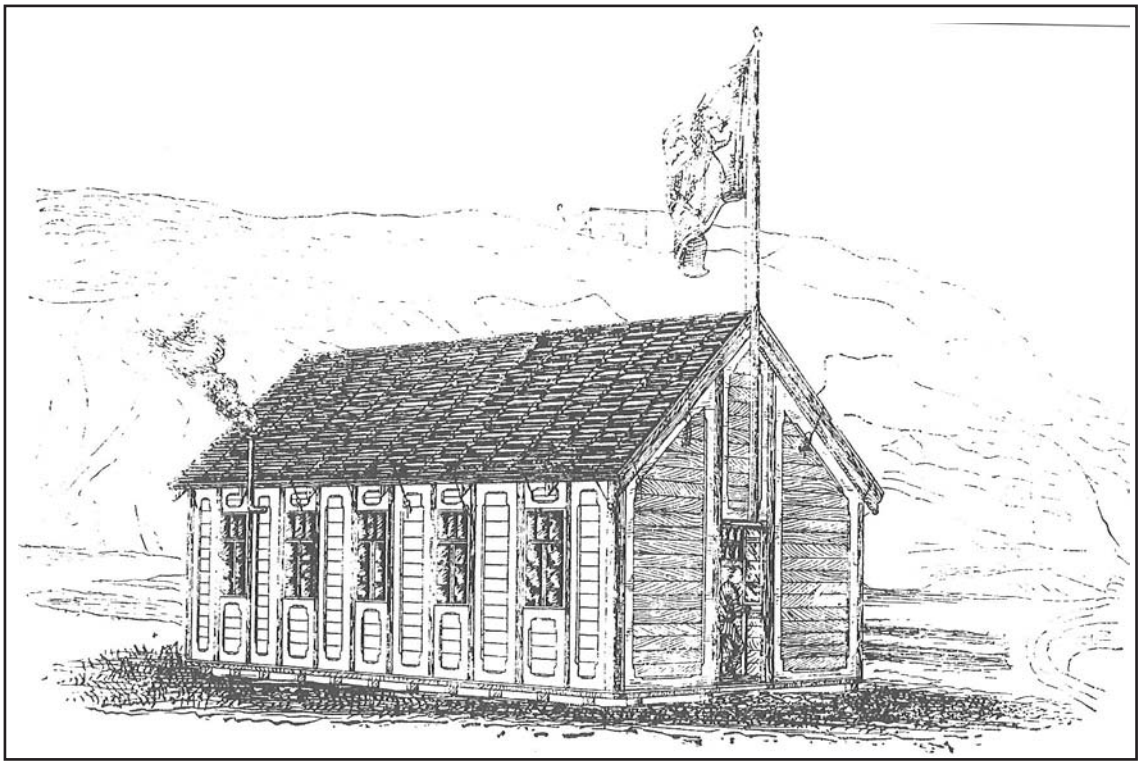

Plate 2. The Scottish Zoological Station at Cowie, near Stonehaven, in 1879 as illustrated by Parker (1879). Assisting Ewart in the running of the station was 24 years old biologist Patrick Geddes, perhaps better remembered to-day as a sociologist and pioneer town planner.

THE SCOTTISH CONTRIBUTION TO MARINE AND FISHERIES RESEARCH WITH PARTICULAR REFERENCE TO FISHERIES RESEARCH DURING THE PERIOD 1882-1939

J.A. Adams
SOAEFD, Pentland House, Robb's Loan, Edinburgh EH14 1TW
(formally Marine Laboratory, Aberdeen)

Introduction

"For about twenty years Edinburgh was the centre of oceanographic research and the Mecca towards which marine biologists from all over the world turned to inspect the wonderful collections and to discuss the results". Thus wrote Sir William Herdman (1923) in his book *The Founders of Oceanography and their Work*. He was referring to the aftermath of the 1872-76 *CHALLENGER* Expedition (Rice, 1986) the leader of which, Charles (later Sir Charles) Wyville Thomson, was the University of Edinburgh's Regius Professor of Natural History. Throughout the *CHALLENGER's* voyage the Expedition's collections were dispatched to Edinburgh from where it had been arranged that, after sorting, they would be sent to appropriate experts for determination and description. These arrangements were hotly contended by the British Museum but fortunately Wyville Thomson's arrangements prevailed (Deacon, 1971). Thus was assured Edinburgh's place in the world history of marine science. As a result much has been written about this Scotland-centred contribution to marine science, of its main personalities, and of the activities of earlier years of which the *CHALLENGER* Expedition was, in effect, the culmination. In addition to the detailed account given by Deacon (1971) there are, among others: Herdman (1921, 1923); Tait (1968); Linklater (1972); Currie (1983) and the volumes of the *Proceedings of The Royal Society of Edinburgh* (72B and 73B) containing the proceedings of the Second International Congress on the History of Oceanography held on the occasion of the centenary year of the *CHALLENGER*'s sailing. Of the personalities involved, the accounts are, time and time again, of men who embarked on medical studies, characteristically given up sooner or later for a life devoted to natural history and to marine studies in particular. This was related partly to natural history's origins in "the predilection of professors of medicine to underline their knowledge of life by studying the anatomy and physiology of other animals" (Laverack, 1983). It was also related to the practicalities of the situation: natural history was seen as a crucial component of the education of medical doctors and, until the practice was eventually prohibited, medical candidates could choose zoological subjects for their MD theses.

Sir Charles Wyville Thomson died on 10 March 1882, five days after his fifty-second birthday. The accumulated physical and mental strains of the Expedition, of the work which followed in its wake and of his professorship had proved too much (Merriman, 1972(a)). Thereafter responsibility for the *CHALLENGER* Office in Edinburgh and for organising the writing up of the Expedition's findings passed to John (later Sir John) Murray who had been a naturalist of the Expedition. He also became the most prominent figure in marine science of his day and was responsible for opening in 1884, with the help of funds from the Scottish Meteorological Society and private individuals, the Scottish Marine Station for Scientific Research at Granton on the outskirts of Edinburgh. The history of that Station and its barge-laboratory, *THE ARK* (Plate 1), has been described by Boog Watson (1969) and by Marshall (1987) in her account of the Marine Station at Millport to which the work and facilities of the Scottish Marine Station were eventually transferred, while Deacon (1993, and this volume) details the origins and development of the Scottish Marine Station against the background of the collective fortunes and inter-relationships of Britain's (and in particular Scotland's) early marine stations.

Thus, in effect, were taken the first steps which were to lead to the present-day Scottish Association for Marine Science (SAMS), the University Marine Station Millport and the Dunstaffnage Marine Laboratory of the Natural Environment Research Council (NERC). A few words of explanation are called for, however. While preparing the scientific results of the *CHALLENGER* Expedition for publication, Murray felt that, "for the purpose of comparison (with these results), a detailed examination of the fjord-like sea-lochs of the coasts of Scotland might yield very valuable information" (Murray and Pullar, 1910). The Granton Station was the base from which he planned to carry out that work and he commissioned the steam yacht *MEDUSA* (Rice, 1986) as the Station's principal research vessel. During the summer of 1884 the *MEDUSA* investigated the herring shoals off the east coast, an operation which proved her unsuitability for work in such open waters. There then followed an eight year's association with the more sheltered waters of the west coast and with the Firth of Clyde in particular. Murray was also persuaded by David Robertson, the Cumbrae Naturalist, of the suitability of Millport on the Isle of Cumbrae as a location for a summer branch of the Granton Station. Consequently, in the spring of 1885 *THE ARK* was towed through the Forth and Clyde Canal to be first moored in Kames Bay but later beached at Port Loy near Farland Point. There she was used by David Robertson and a succession of distinguished workers.

In 1894 Robertson and a group of professional and business men in Glasgow formed the Millport Marine Biological Station Committee to promote the building of a permanent station. Sadly, Robertson had died by the time the new station was formally opened by Murray in 1897 when Murray also finally presented *THE ARK* and her contents to the Committee. In 1901 the Marine Biological Association of the West of Scotland was formed, subsequently to became in 1914 the Scottish Marine Biological Association (SMBA) which, with funding recommended by the Development Commission, continued to run the increasingly successful Marine Station at Millport. In 1970 the SMBA, now funded by NERC, left Millport for expanded and better equipped laboratories at Dunstaffnage. On that occasion the Universities of Glasgow and London took over the Millport Station to foster university teaching and research in marine science and the arrangement continues to this day.

At Dunstaffnage, SMBA's scientific programme was increasingly directed according to the same priorities and criteria that applied within NERC. The logical outcome was for NERC to take over the management of Dunstaffnage; this it did on 1 April 1989. On that occasion an appropriate part of the previous Grant-in-Aid was made available to the SMBA to enable it to act as a learned society and to broaden its activities to promote marine science. To more effectively meet these objectives the name of the Association was changed to The Scottish Association for Marine Science (SAMS) in 1992.

At the same time as Murray was establishing the Scottish Marine Station, developments were taking place in association with the scientific investigation of Scottish fisheries. To these latter developments can be traced the origins of the Gatty Marine Laboratory of the University of St Andrews (Laverack and Blackler, 1974; Gunther, 1977; Deacon, 1993) and the Marine Laboratory, Aberdeen (Lucas 1956, 1987). Central to these scientific investigations of fisheries issues was the Fishery Board for Scotland, the first official body in the United Kingdom to possess a permanent scientific organisation devoted to the study of fisheries problems. Much of the rest of this paper deals with the situation leading to the establishment of the Board in 1882, and with its subsequent activities until the transfer of its responsibilities to the newly created Fisheries Division of the Scottish Home Department in 1939. Details of the Board's numerous scientific publications are given by Fulton (1905) and Ritchie (1940).

Scottish fisheries and Government initiatives for their development

There is evidence that fishing has been of importance in Scotland from the days of its earliest inhabitants and that there were commercial fisheries by the medieval period. Certain specialised fishing communities are known to have evolved, particularly on the east coast and in the Firth of Clyde, by the eighteenth century, and in some cases from even earlier (Coull, 1983). These developments were based on inshore operations in relatively small open craft and, as regards fishing for herring, contrasted markedly with the Dutch deep sea fishery. From at least the fifteenth century, and even more so from the sixteenth century, this Dutch fishery worked off the northern coast of the Scottish mainland and around Orkney and Shetland using vessels sufficiently large for the catch to be cured and barrelled on board (Kranenburg, 1983).

To rival the Dutch fishery became a national ambition: various enactments of the seventeenth and eighteenth centuries were directed to this end (Dunlop, 1978) but it was late in the latter century before they began to prove effective. This led to an impressive expansion of the herring fishery in the nineteenth century, by which time the Board of British White Herring Fishery had been established in 1808. It is with that Board that our account of Scottish fisheries research starts.

Board of British White Herring Fishery

The Board of British White Herring Fishery was established in 1808 when the Board of Trustees for Improving Fisheries and Manufactures in Scotland was enlarged from 21 to 28 members, seven of whom were to be Commissioners for the management of the white (i.e. cured by pickling) herring fishery. Until 1849 the new Board also had jurisdiction in England and, as regards the collection of statistics, in the Isle of Man from 1821-1868. It is with Scotland and Northumberland, however, that its activities, directed towards better regulating and further encouraging the herring fishery, were most closely associated.

For the purpose of encouraging the fishery it administered the various bounty schemes first introduced in the eighteenth century, although by 1830 all had been withdrawn (Mitchell, 1864). By the application of an official 'brand' to barrels of herring which had been cured in a particular and closely specified way, it helped develop the reputation of 'Scotch cured' herring in overseas markets; and by keeping statistics of herring cured (and of salt cod, ling and hake) the Board accumulated for Scotland one of the longest series of fishery statistics in the world. Together with the Admiralty it also kept order and enforced regulations on the fishing grounds and was provided with its own fishing cruiser – the ex-naval cutter *SWIFT* – in 1818. Additionally, the Board initiated some very early examples of fisheries research.

In 1836 an increased sprat fishery in the Firth of Forth led to complaints that the herring fishery was being destroyed, the complaints being compounded by the assertion that sprats were simply young herring. To resolve this latter question the Board asked Dr Robert Knox (the Edinburgh 'Anatomist' whose reputation had been put in jeopardy by the Burke and Hare scandal of 1828 (Rae, 1964)) to investigate. He established conclusively that sprat and herring were different species and the Marine Laboratory, Aberdeen, still possesses the mummified specimens which he presented as part of his evidence. His evidence did not of itself solve the conflicting interests of the two groups of fishermen, but it did establish the important principle that if regulations are to be introduced they must be based on established fact and not on opinions.

Further work was undertaken in 1843-44 by Henry (Harry) D. S. Goodsir who spent time on May Island in the outer Firth of Forth studying the growth, food and habits of herring. Unfortunately,

Goodsir's work came to an end when he joined *HMS EREBUS* of the ill-fated Franklin expedition as Acting Assistant-Surgeon (Beattie and Geiger, 1987). Sixteen to eighteen years later Professor Allman, one of the Fishery Commissioners and also Professor of Natural History in the University of Edinburgh, looked at the possibility that trawling for white fish off Pittenweem and Anstruther was damaging spawning grounds. He had difficulty in obtaining any material from the fishermen which was unquestionably fish spawn, and he found no evidence of an 'injurious influence'. However, further work carried out with the help of divers working from the fishery cruiser *PRINCESS ROYAL* early in 1862, proved that herring spawn "was deposited on the surface of stones, shingle, and gravel, and on old shells and coarse shell sand, and even on the shells of small living crabs, and other crustacea" and that it "adhered tenaciously to whatever matter it happened to be deposited on" (quoted in the Fishery Board for Scotland, 1884). Furthermore, from 1873 the Board cooperated with the Scottish Meteorological Society in that Society's study of the relation between climate and fisheries (see Deacon, this volume).

Unfortunately, the Commissioners never persevered with the various scientific investigations which they initiated. Partly they believed that their powers did not permit of the continuing commitment that would be necessary. There was also the problem that from 1839 onwards the secretariat that served the Fishery Board was also the secretariat of the overarching Board of Trustees for Improving Fisheries and Manufactures in Scotland. The latter Board (variously referred to as the Board of Trustees or the Board of Manufactures) was set up in 1727 to encourage economic development in post Union Scotland. Since the manufacture of domestic textiles like linen and carpets was important in the Scottish economy, the Board realised that these might sell better if they looked attractive; consequently in 1760 the Board founded a Scottish School of Design. In 1822 the Board agreed that they would occupy, along with the Royal Society of Edinburgh, the Society of Antiquaries and the Institution for the Encouragement of Fine Arts (virtually an offspring of the Board), a new building planned for the north end of the Mound in Edinburgh. After various delays the building was completed in 1826 and, known as the Royal Institution, was the centre from which Scottish fisheries were administered until the early 1880s when the then recently created Fishery Board for Scotland moved to rooms in the Bank of Scotland at 101-103, George Street, Edinburgh. Enlarged for the Board in 1831-6, the Royal Institution is better known to-day as the Royal Scottish Academy.

In 1847 an Act was passed which permitted the Treasury to provide money for education in the fine arts generally. As a result the Board began negotiations which led to the opening of the Scottish National Gallery, also on the Mound, and a reallocation of space in the Royal Institution permitted the Board to centralise its School of Art (for details see Gordon (1976 and 1988) in particular, but also Youngson (1966 pp 162-5) and Gow (1987)). These were the developments which lay behind the explanation given by the Hon. Bouverie F. Primrose in 1881 to a House of Commons Select Committee on Herring Brand (Scotland). He said:

> "My office is consolidated with that of the Board of Manufactures, and the Board of Trustees of the National Gallery, carrying on an immense school of art in affiliation with the Science and Art Department, and conducting large exhibitions of great public importance. There are a considerable number of meetings connected with the selection of pictures, one's time being taken with all these different subjects; unless the Fishery Board is separated from the Board of Manufactures, and put into the position of being a great national establishment for fish, we cannot undertake these scientific investigations which have been referred to".

Happily, the situation was about the change. Those interested in promoting the scientific approach could point to the benefits of applying science to agriculture and to various industries. They could also, as did Mr Pender, MP for Wick, when examining the Hon. Bouverie Primrose for the Herring Brand Select Committee, point to the scientific activities of the United States Commission of Fish

and Fisheries which had been established in 1871. When the Select Committee reported in 1881 (HCP 293), having recognised that herring may not continue to be as abundant off the coasts of Scotland as they then were, and having noted the importance of doing "as much as practicable to preserve and develop other branches of the fisheries", it mentioned the part science could play in effecting such aims. Additionally, it recommended that the Board's branding officers, and its fishery cruisers "be made available for the purpose of scientific investigations similar to those so advantageously carried on in America". Consequently, the Fishery Board (Scotland) Act of 1882, in establishing the new Board on 16 October of that year, required that, *inter alia*, it should "take cognisance of everything relating to the coast and deep sea fisheries of Scotland, and take such measures for their improvement as the funds under their administration and not otherwise appropriated may admit of".

Thus arose the conditions which allowed the new Board to start, almost immediately, what was to become an organised and continuing programme for the scientific investigation of fisheries problems. Although it was 1895 before an Act of Parliament stipulated that one member of the Board should be "a person of skill in the branches of science concerned with the habits and food of fishes", the Board was served in that respect from the beginning. From 1882 to 1892 the eminent marine biologist on the Board was James Cossar Ewart, Professor of Natural History at the University of Edinburgh and from whose department, until 1889, much of the Board's initial scientific research was carried out.

The Dalhousie Commission

Before considering that period in detail, however, we must take account of an additional push towards a scientific approach to the study of the fisheries. This came from the difficulties faced by the Royal Commissions appointed from time to time to investigate various fisheries problems. Traditionally they relied to a large extent on evidence which, some believed, reflected the "inherited prejudices of the fishermen" or indeed "the opinions of people, who knew next to nothing of the matter" (to quote a newspaper article of 1884).

The Commissioners who, under The Earl of Dalhousie, were appointed in August 1883 to consider complaints made by line and drift net fishermen about the allegedly harmful effects of trawling within territorial waters, were certainly conscious of the limited nature of much of the evidence likely to be placed before them. Consequently, shortly after they had started their inquiry they arranged for Professor M'Intosh of St Andrews University "to obtain accurate information respecting the destruction of immature fish and spawn said to be caused by trawling" and, if the opportunity permitted, also to collect "information respecting the breeding of food-fish in general, the temperature of the sea, and the nature of the sedentary and floating fauna of the trawling grounds, so far as such bears upon fishery problems". For this work M'Intosh had placed at his disposal, at regular intervals for a period of eight months, steam trawlers belonging to the Granton Steam Trawling Company and W. Meff of Aberdeen. Other vessels were used on occasion. Additionally, in 1884, the Fishery Board for Scotland funded the conversion of a small wooden building at St Andrews to provide a laboratory for associated work ashore. Hastily erected a few years earlier on the East Bents as a fever hospital, its "wooden roof was never water-tight and its walls never wind proof, yet it is no exaggeration to say that the foundation of research on the biology of food fishes of British waters was laid during the twelve and half years occupancy of the St Andrews Fisheries Laboratory" (Laverack and Blacker, 1974). It is also noteworthy that some of M'Intosh's associates from this period were to go on to hold leading positions in fisheries research and administration: A. T. Masterman as Inspector of Fisheries and subsequently Director of Fisheries Research in England and Wales (Graham, 1941), H. M. Kyle with the International Council for the Exploration of the

Sea and E. E. Price as Dominion Commissioner of Fisheries for Canada (Anon), to name but a few. Further details are given by Prince (1911).

An annual visitor to St Andrews was Charles Henry Gatty an amateur naturalist of independent means. His interest in M'Intosh's work led to his offering funds to the University for a new marine laboratory – the Gatty Marine Laboratory – which was opened in 1896 and became involved in more fundamental research. When M'Intosh retired in 1917 the Laboratory was closed as a University Department, although M'Intosh continued to work on in the Laboratory, now with the minimum of equipment and unheated, until his death in 1931. It reopened in 1947 and continues to function as a Department of the University. In addition to the account of its history given by Laverack and Blackler (1974) and Deacon (1993) much is also provided by M'Intosh's biographer Gunther (1977). Also, Merriman (1972b) deals *inter alia* with M'Intosh's views that there was no scientific basis for closing large areas of the sea to trawling and Southward, in this volume, recalls his criticisms of the thrust of the International Fisheries Investigations.

James Cossar Ewart and his Work for the Fishery Board for Scotland

Irrespective of the claims made of the St Andrews Fisheries Laboratory, the appointment of Ewart to the Fishery Board for Scotland also had its merits, although Deacon (1990) suggests that "the discrepancy between his enthusiasm for research and his administrative talents and judgement" lay at the root of concerns that came to be expressed about "the way the scientific work was being run and over accountability" (see also page 108 regarding Ewart's proceeding with the building of the Dunbar laboratory without the authority and knowledge of the Board).

Ewart, who was born in Penicuik in 1851, graduated in medicine at Edinburgh in 1874. However, he had more than an adequate exposure to natural history in general and marine matters in particular. It is known that he attended lectures given by Wyville Thomson in the year that Wyville Thomson left in charge of the *CHALLENGER* Expedition; later he was Demonstrator of Anatomy under Professor William Turner, who, in keeping with the traditions of Edinburgh's medical men, was also active in natural history, his particular interest being whales and other cetacea. In May 1875 Ewart was appointed Conservator of the Zoological and Anatomical Museums in University College, London, where he assisted E. Ray Lankester organise the College's first course of practical zoology. Just over three years later he returned north, first to a briefly held lectureship in anatomy in the School of Medicine in Edinburgh and then to the Chair of Natural History at the University of Aberdeen. At Aberdeen, following the example of Lankester, he instituted classes in practical zoology. Besides, and of greater significance in the present context, he not only started so called 'dredging' expeditions (in fact a range of biological sampling gears were used), but he also started collecting funds for a marine zoological station. Thus, in early August 1879 the 'Scottish Zoological Station', a small, sectional, wooden building consisting of two apartments and erected temporarily on the sea shore at Cowie, near Stonehaven, was opened for its first two-month-long autumn season (Plate 2). T. Jeffery Parker (1879) in describing the station in *Nature* extolled its virtues and suggested that the English universities should follow the example of Aberdeen and provide themselves each with such an establishment!

The honour of formally opening the station – the first marine station of its kind in Britain (Deacon, 1993) – fell to George John Romanes (Romanes, 1896). Romanes, a close friend whom Ewart met at University College, London, and who had also been involved in collecting funds for the station, was a physiologist of note. Having ample private means, he had his own small private laboratory near the Romanes' summer residence at Dunskaith on the northern shore of the entrance to the Cromarty Firth. There during the 1870s he had studied the nervous system of medusae in

relation to their movement and coordination, providing what was to remain the classical account of the subject until the work of G. A. Horridge in the 1950s; and it was in the Cromarty Firth area that the Scottish Zoological Station was erected in the autumn of 1880. On that occasion Ewart also initiated trawling experiments along a two mile long tow west of Cromarty, apparently having bought a sailing trawler from Aberdeen for the purpose. The following year, Oban was the chosen site for the station and the locomotor system of echinoderms the subject of interest.

Ewart was, therefore, a marine biologist of wide experience and scientifically well qualified for his appointment to the new Fishery Board in 1882. That same year Ewart had returned to his Alma Mater as Professor of Natural History, his arrival bringing to the University an increased attention to practical teaching. By May 1884 *Nature* reported that the department had "undergone remarkable developments" with, in addition to other important improvements, the former "dingy museum of Jameson's time" having been converted to a splendid room for practical work and the corresponding room on the lower level being in the process of being fitted as "a laboratory ... with all the necessary apparatus for studying the life history and development of marine organisms". Ewart had already referred to his plans for these developments in opening the Natural History Class for 1883-1884. Referring to *The Scotsman's* (30 October 1883) account for Ewart's remarks we read:

> "It would be remembered that the university formerly had in her possession a large and valuable natural history collection. That collection some years ago was removed into the new Science and Art Museum, and the two extensive rooms it had occupied were left empty. But, unfortunately, the university not only allowed herself in an evil hour to be persuaded to give away one of the finest series of natural history specimens ever brought together, but what was almost worse, she as good as gave away the rooms in which they had been displayed by allowing the new museum to be planted so near her own walls as to practically convert one magnificent hall into a dungeon, and another into a dingy chamber But the great dungeon would, if restored to the Natural History Department, without much difficulty form a splendid aquarium; while the other hall had already had a flood of light thrown in upon it through the roof; and, when the walls had been restored to their former brightness, they should possess the most magnificent zoological laboratory that anywhere existed".

In addition, J. T. Cunningham (at that time one of Ewart's colleagues) has also referred to Ewart's plans for the future. In a diary entry for 2 June 1883 (now in the library of the Dunstaffnage Marine Laboratory) he refers to Ewart's "scheme for a Zoological Station supported partly by the University and partly by the Fishery Board". However, this proved harder to realise than Ewart had anticipated; furthermore, he was forestalled by the opening of the Scottish Marine Station (Deacon, 1993, and this volume). Nevertheless, for a number of years Edinburgh's Natural History Department was often referred to as the Board's Central Laboratory. To this laboratory were returned, not only the material collected in the field by Ewart and his associates, but also a wide range of specimens and samples which the Board's officers were instructed to provide. Much of this material was to be dealt with in the early reports of the Fishery Board for Scotland and, in terms of links with the past, it is interesting to realise that at least some of the Board's fisheries research would have been carried out in what had been Jameson's famous museum (Calder and Andrews, 1986).

And what of the work in the field? In the autumn of 1883, Ewart and his associates directed their attention to the spawning and early life history of the herring in the Moray Firth. Ashore, the Scottish Zoological Station was now at Hilton on the coast near Geanies House (which Romanes rented from 1882 to 1890) while the seagoing capability was provided initially by *HMS JACKAL* and subsequently by the Board's own cruiser *VIGILANT*. The trawls, dredges, tow nets and other gear were taken on board *JACKAL* at Invergordon on 6 August, and the following day the vessel

began investigating the inshore spawning grounds between Wick and Fraserburgh. During the month that *JACKAL* was at Ewart's disposal, 60 stations were visited while a similar number were occupied by the *VIGILANT* from the time she relieved *JACKAL* at the beginning of September until she returned to Granton on 6 October. With surface and bottom temperatures being taken, and with samples of water, sediments, plankton, benthos and fish being collected, the work of the cruises would not have been unfamiliar to a present day fishery scientist. Likewise, we can readily identify with Ewart's, and his colleague Cunningham's, work on the artificial fertilisation and development of herring ova. Initial experiment using spawn from herring which had been out of the water for several hours proved unsatisfactory. Thereafter, they arranged to board the herring boats as the nets were hauled and expressed milt and roe on to squares of glass which were then placed in specially designed carrying boxes. These were then brought by the *JACKAL* to the laboratory on the shore at Hilton where the glass plates with the developing eggs were transferred to hatching boxes; through these a constant flow of water was provided from a large tank. In 10 days eggs were successfully hatched, but just as arrangements had been made for experimenting on a larger scale the herring fishery ended suddenly making it impossible to obtain further supplies of ova.

Ewart and his colleagues then directed their attention to the question of the availability of suitable food for the herring fry over the spawning grounds, and when this was no longer possible because of the weather they proceeded to examine the mussel scaups in the Dornoch, Cromarty and Inverness Firths. The question of a ready supply of bait for line fishermen was still one of considerable practical importance (Ewart *et al*., 1883).

The following March, Ewart was again on the *JACKAL*, on this occasion investigating herring spawning on Ballantrae Bank in the Firth of Clyde. In addition to returning some egg coated stones to Edinburgh (where the herring hatched eight days after their removal from the spawning grounds), Ewart also started to use tanks which had been provided for the Board's use at Rothesay Aquarium. There he observed the spawning of male and female herring and conducted various experiments to examine the factors that may influence the way the eggs were deposited on substrates such as stones and seaweeds (Ewart, 1884).

The tanks in the Rothesay Aquarium provided a useful facility for the Board for a number of years and, in addition to the spawning of herring and the development of their eggs, observations were also made on the spawning of cod. However, in the spring of 1885 work started on the erection of the Board's own temporary laboratory at Tarbert on Loch Fyne. A wooden building of 40 x 20 feet, it was divided into two rooms, a small one fitted as a work room and a larger one provided with tanks for fish and other marine forms. Outside two concrete tanks, each approximately 15 x 5 ft and 3 ft deep were constructed (indeed they are still there), and there were plans for more. Charged with the task of selecting the site of the laboratory was George Brook who from 1884 to 1887 held the joint appointment of scientific assistant to the Board and lecturer in comparative embryology to the University of Edinburgh. Largely self taught, he had earlier studied the life history of the lesser weaver and of the rockling in tanks of sea water set up near his home in Huddersfield (M'Intosh and Masterman, 1897). He died suddenly in 1893, aged 36, having, in addition to his fisheries related work, made important contributions to the study of corals (Anon, 1893).

While supervising the erection of the laboratory, Brook started to investigate the Loch Fyne herring fishery, subsequently providing what is probably the first description of the seasonal changes in the abundance of *Calanus* in the upper layers in the Firth of Clyde (Adams, 1986). Together with fellow workers Thomas Scott and William L. Calderwood, other work covered such subjects as the food of Loch Fyne herring, the copepods of the loch and the movement of herring between

Ballantrae Bank and the inner lochs. Additionally, experiments were carried out in the deep waters of Loch Fyne to ascertain whether herring eggs would hatch at depths of 100 fathoms. This work had been prompted by the fact that the herring fishery in the North Sea was then being prosecuted further offshore than formerly, and there was concern lest the herring would be forced to spawn on unsuitably deep grounds. However, the emphasis of the Board's work was soon to be directed to the study of the abundance of fish in those inshore areas which, at various dates from 1886 onwards were closed to trawlers. Initially, these studies – the so called trawling experiments – were mainly on the east coast of Scotland and, because of limited funds and difficulties in replacing staff, the Tarbert Laboratory was closed in 1887 and shortly afterwards burnt down (Deacon, 1990).

The trawling experiments and the purchase of the *GARLAND*

The closure of areas to trawling was allowed under the Sea Fisheries (Scotland) Amendment Act of 1885 which had come in the wake of the recommendations made by the Dalhousie Commission. More specifically, this Act, *inter alia*, allowed the Fishery Board for Scotland to make byelaws restricting or prohibiting fishing within Scotland's exclusive fishery limits when they were satisfied that the fishing was:

> "injurious to any kind of sea fishing within that part, or where it appears to the Fishery Board desirable to make experiments or observations with a view of ascertaining whether any particular mode of fishing is injurious, or for the purpose of fish culture or experiments in fish culture".

The first byelaw came into force on 5 April 1886 and prohibited beam trawling in what may be loosely referred to as the Firth of Forth, St. Andrews Bay, the Firth of Tay and Aberdeen Bay. The Board made it clear, however, that the byelaw was passed not because they were satisfied that trawling was injuring any kind of sea fishing, but because it was desirable to make experiments and observations to ascertain whether beam trawling was an injurious mode of fishing.

In order to undertake the trawling experiment the Treasury agreed to provide funds part of which were used to purchase the six-year-old *GARLAND* from J. W. Woodall of Scarborough. Having been provided with a trawl, dredges and other appliances the vessel began her work on 16 June 1886 and continued in the service of the Board until 1902 when she was sold (Somner (1983) provides details of all the fishery research vessels operated by the Board and its successors). Although the inadequacies of the vessel were frequently dealt with at length in the Annual Reports of the Board, the vessel was involved in pioneer fisheries research not only with regard to the trawling experiments conducted in the areas closed under the 1885 Act and the subsequent Herring Fishery (Scotland) Act of 1889 (which, except for areas to be specified by the Board, prohibited beam and other trawling around the whole coast of Scotland), but also the Board's early fish tagging, studies of currents (Adams, Henderson and Turrell, 1992) and other ecological work.

Employed as naturalist aboard *GARLAND* during the last few years of her operation as a fisheries research vessel was Frederick Gordon Pearcey who had joined the *CHALLENGER* Expedition as taxidermist and laboratory assistant as a boy of about 16 (Anon, 1927). On the return of the senior Expedition staff to Edinburgh, Pearcey assisted in the *CHALLENGER* Office and subsequently participated in the cruises of the *KNIGHT ERRANT* (1880) and the *TRITON* (1882) which established conclusively the existence of the Wyville Thomson Ridge in the Faroe Shetland Channel (Deacon, 1977). Later, in 1884 he sailed on the fishing smack *ENERGY* providing some of the early detailed examples of the relationship between the distribution of plankton and herring (Pearcey, 1885), while in 1902 he sailed with B. Helland Hansen on *HMS JACKAL* (see page 111). In 1905 he

was appointed assistant curator of zoology at the Bristol Museum having had previous museum experience at the Owens College Museum in Manchester. (At Manchester Pearcey worked with William Evans Hoyle (Bather, 1926) a former colleague in the *CHALLENGER* Office; indeed numerous zoologists of the late nineteenth and early twentieth centuries had worked in that Office in the early years of their careers.)

The hatchery movement

Although the closure of territorial waters was aimed at the long term good of the fisheries, such legislation was not universally popular. A much more acceptable approach was the belief that stocks could be improved by the release of hatchery reared fry.

In the autumn of 1884 Ewart visited North America at the request of the Board to study Canadian and United States progress in fish culture. Reporting on his visit in the Third Annual Report of the Board, he stressed the need for sea fish culture facilities to be provided in Scotland, and suggested that it would be necessary to erect a hatchery with sea water ponds, laboratories etc. near the mouth of the Firth of Forth. The choice of location was apparently a compromise between the desire to have facilities as near Edinburgh as possible, but sufficiently near the open sea to ensure an abundant supply of pure sea water. The wish for a laboratory near the mouth of the Firth of Forth was further noted in the same Annual report in relation to the need to investigate the influence of trawling in territorial waters in the vicinity. However, it was 1889 before the Board commenced the development of a site at Dunbar the first building erected being a small laboratory (Plate 3) at the cost of £166-9-10. Unfortunately, this sum contributed to a large excess expenditure on the Board's scientific vote and in March 1890 Treasury wrote on this and similar matters, claiming that it was "indicative of lax financial administration". The situation was further complicated by the fact that Ewart had given orders for the erection of the laboratory without the authority and knowledge of the Board. Fortunately they stood by him, stated that "it is a suitable place for such a building, and since the large laboratory for which the Board applied is not to be gone on with, it will be found very useful". Perhaps in taking this stance the Board were influenced by the fact that Ewart had often used his own personal resources to support its scientific work (Scottish Record Office, AF 37/110).

The hatchery, designed and apparently actually built in Norway under the supervision of Captain G. M. Dannevig of Flodevig, has been described by Kirk (1987) as "without doubt, the best of the British hatcheries". It was fully operational by 1894. Thereafter, it operated for 6 years during which it produced over 152 million 'fry' (of which over 136 million were plaice). However, the work was impeded and restricted by the absence, contrary to the original plans for the site, of a large sea-water enclosure in which adult fish to be used for spawning could be kept and accumulated from season to season. At the end of the 1899 season, the hatchery and its equipment were therefore dismantled and transferred to a site at the Bay of Nigg, Aberdeen, where a new marine laboratory had been built in 1898.

The choice of Aberdeen reflected the growth of the fishing industry at that port in the latter part of the nineteenth century. In commenting on their decision to move to Aberdeen, and to concentrate their laboratory and hatchery work at one site, the Board wrote in their Annual Report for 1897:

> "In coming to this decision consideration was given to the fact that special facilities exist at Aberdeen for the prosecution of scientific fisheries research. As the chief fishing port in Scotland it possesses a large fleet of steam fishing vessels, both trawlers and liners, as well as herring boats, and opportunities will thus be afforded for the study of the life-history of fishes and marine biology generally".

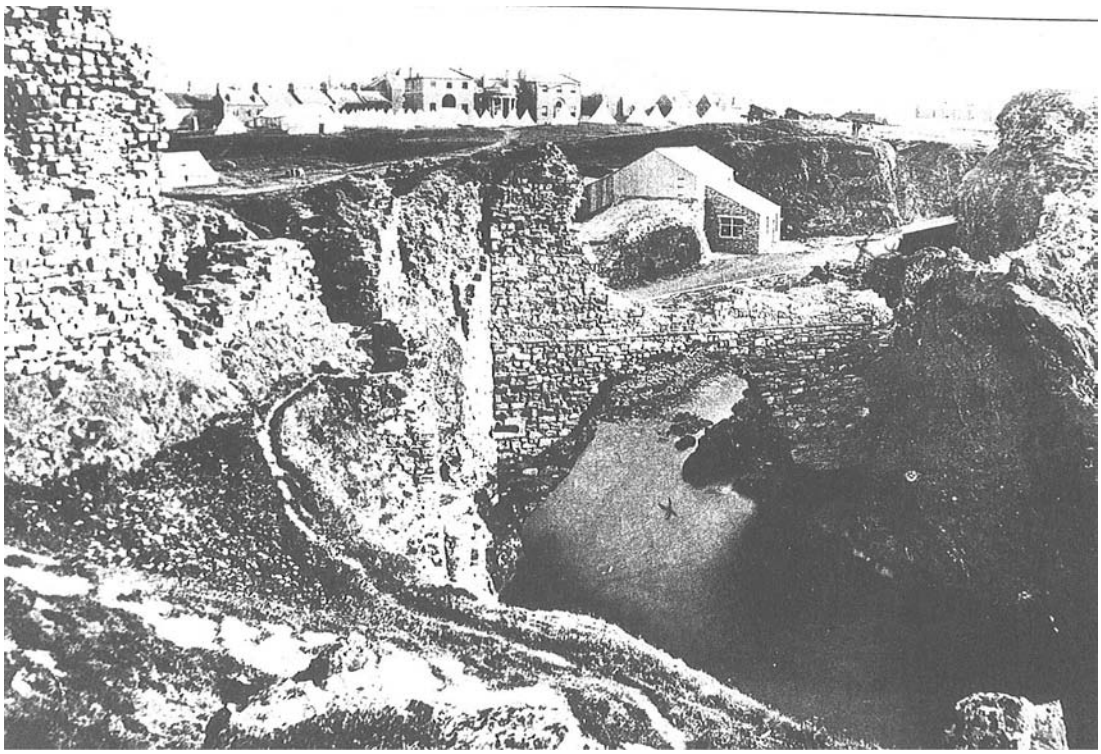

Plate 3. The laboratory (i.e. the building with a window in the end wall) and part of the sea fish hatchery near Dunbar's Victoria Harbour. The larger adjoining building enclosed the spawning pond, while the hatchery (see Plate 5) is hidden from view. Also shown is the inlet of the sea which the Board had hoped to enclose. Most of the ground belonged to the War Office whose barracks and tents are a prominent feature in the background. Photograph kindly provided by the District Library, East Lothian District Council.

The site, leased from Aberdeen Town Council, was towards the north-west corner of the Bay of Nigg and the facilities included a one-storey brick building containing an office and two laboratories, a tidal spawning pool, a hatchery (removed from Dunbar) (Plates 4 and 5) and associated pump houses etc. A further resiting of the hatchery became necessary in 1905 when Greyhope Road was extended round Girdleness and along the north side of the Bay.

Thomas Wemyss Fulton

No account of the days of the Fishery Board for Scotland would be complete without reference to Thomas Wemyss Fulton, the Board's first Scientific Superintendent. Like so many of his contemporaries, Fulton had a medical degree and choose a zoological subject for his MD degree, namely the maturation of the pelagic eggs of fishes. After having spent two years working in the *CHALLENGER* Office he joined the Fishery Board about the time the trawling experiments were starting and took charge of these, devoting considerable attention to tabulating the results of the experiments over many years. However, he was a pioneer in several branches of fisheries research; for example in 1889 he first tagged plaice successfully and later pioneered the systematic use of drift bottles to investigate the surface currents of the North Sea and their implications for the drift of pelagic fish fry. International legal difficulties which arose out of the closure of the Moray Firth helped, according to Thompson (1929), to turn Fulton's attention to the question of maritime law. The outcome was his classical volume on the *Sovereignty of the Sea* published in 1911. He retired in 1921, and was followed by Edward William Nelson (1921-23), Alexander Bowman (1923-33) and Robert Selbie Clark (1934-48).

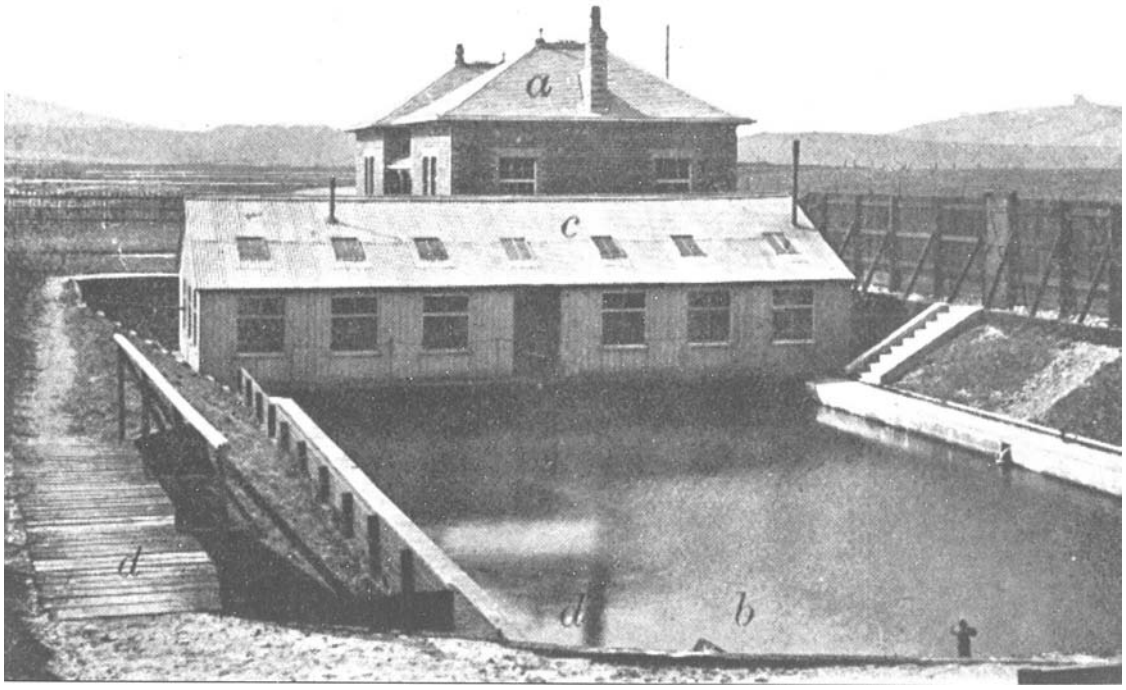

Plate 4. Part of the former Marine Laboratory and hatchery site at the Bay of Nigg, Aberdeen, showing the Laboratory (a), and the tank house (c) partly built over one end of the spawning pond. The pond had a capacity of 160,000 gallons (728,000 litres) and could be filled or emptied, via a pipe at (d), according to the state of the tide. The tank house was erected in 1901-02, funded by a £200 grant from Aberdeenshire County Council. In return the Board agreed to give technical instruction to fishermen at the Laboratory for a period of 5 years.

Plate 5. The wooden hatchery at the Bay of Nigg, Aberdeen, after it had been resited to allow for the extension of Greyhope Road. Following its removal from Dunbar, the hatchery was

The international dimension

With fish and fishermen going beyond national boundaries, the international dimension has, as other authors in this volume have noted, been an essential element of the European approach to the scientific study of the seas virtually from the beginning. Thus in 1893-94 Scotland participated in four international hydrographic surveys of the North Sea (Adams, 1995). These cruises had been proposed by the Swedish scientists Gustav Ekman and Otto Pettersson following the success of earlier multi-ship surveys in the Skagerrak and Kattegat. Pattersson was, in modern terminology, a chemical and physical oceanographer and he believed that hydrographic investigations should be carried out over a very wide geographical area (Thompson, 1958). But he also experimented on means to avoid or lessen the wasteful destruction of young fish by trawls. These interests and beliefs were no doubt of prime importance in his being instrumental in initiating, together with others of a like persuasion, the developments which led by the way of meetings in Stockholm in 1899 and Oslo in 1901 to the setting up, in 1902, of the International Council for the Exploration of the Sea.

Scotland was represented in these developments from the beginning by Professor (later Sir) D'Arcy Thompson who by that time was scientific advisor on the Fishery Board for Scotland having succeeded Ewart (Board member 1882-1892), M'Intosh (1892-1894) and Sir John Murray (1895-1897), who was also present in Stockholm as the Chief British Delegate. The Scottish connection was further strengthened at the 1901 meeting when the Chief British Delegate was Sir Colin Scott-Moncrieff, Under Secretary for Scotland, and H. R. Mill (one of the early workers at the Scottish Marine Station at Granton) was one of the 'experts'.

Scotland immediately started to contribute to the work of ICES under the auspices of the Fishery Board. Although the Board's Scientific Superintendent, T. Wemyss Fulton, and his small staff at the Bay of Nigg Laboratory were involved in the work, the Director of the Scottish International Investigations was, for a number of years, D'Arcy Thompson, who, together with the Investigation's hydrographer, was based at the University College, Dundee. Indeed £2000 of the Bay of Nigg Laboratory's vote of £2770 were redirected to the International Investigations! A small temporary Laboratory for the International Investigations was also located at Mearns Street, Aberdeen and later at the Old Post Office Building in the City's Market Street.

When Britain pledged herself to participate in the International Investigations, £4000 was allocated by Parliament for two British research vessels and Professor D'Arcy Thompson was entrusted with procuring the one for Scotland. Having inspected various vessels he eventually made a bargain for the *GOLDSEEKER*, the arrangement being that £1200 a year would be paid for three years, with an option to purchase for £2000 at the end. This bargain was concluded in November 1902 by which time the first two quarterly cruises (August and December 1902) had taken place. For these Scotland used *HMS JACKAL* and D'Arcy Thompson invited B. Helland Hansen of Norway to come and take charge (Adams, 1995). By the following year the *GOLDSEEKER* was ready, having been overhauled and fitted out for her new role. An important series of reports subsequently appeared over the period 1905-1913 (Cd. 2612, Cd. 3358, Cd. 4350, and Cd. 4893) containing papers dealing almost in equal number with hydrographic and fisheries subjects ranging, for example, from the mathematical investigation of ocean currents to the statistics of the catches of Aberdeen steam trawlers and great line fishing vessels. Two papers dealt with plankton investigations.

Responsibility for the International Investigations eventually passed to Fulton in 1910. However, the partial separation of the staff in Aberdeen obviously continued since in 1913 Fulton was writing to the effect that it would be advantageous if all the staff at Aberdeen were under his supervision and brought together at the Bay of Nigg. Professor D'Arcy Thompson was not impressed. He wrote

of the latter Laboratory that it was "far from town, situated on a bleak shore, and approached by an exposed country road beyond the tramway terminus". And he added "it would be a real hardship, especially in winter, to compel our assistants, and especially women assistants, to work there and to make the journey there twice a day". In similar mood he argued against the need for all the staff to be under Fulton's supervision, emphasising the point by writing that "such constant supervision has not been considered necessary in the past, as is sufficiently proved by the fact that the Scientific Superintendent has for many years done his work at home, and has only visited the Bay of Nigg at very infrequent intervals" (Early papers at the Marine Laboratory, Aberdeen).

The inter War period

The planting out of plaice fry from the Bay of Nigg hatchery ceased in the early 1920s with the Board admitting that the extent to which the liberation of fry affected the stocks was uncertain. About the same time British marine and fisheries research was being reinvigorated. This was partly in the wake of the recognition of British fisheries as a source of food supplies, and of the vital role played by the fishing fleet in the 1914-18 War. It was also as a consequence of the activities of the Development Commissioners. Thus in 1923 the staff from Aberdeen's Old Post Office Building and from the Bay of Nigg moved to Wood Street, Torry. There a vacant single story building (Plate 6) had been purchased and adapted with funding recommended by the Commissioners. It had originally been erected by the Admiralty, probably in 1917, as a hostel for trainee boy riveters. The same increased level of support for research also saw the arrival of *GOLDSEEKER's* replacement, an ex-Admiralty Mersey class trawler which was commissioned as the *EXPLORER* (139 ft. reg. length, 351 g.t.) in 1922 providing facilities for sustained deep sea work.

Since an exhaustive study of all the commercial species of importance to Scotland was beyond the capacity of the small staff available, most of their effort concentrated on the two species of greatest importance, namely herring and haddock. Using data obtained by *EXPLORER*, combined with those from commercial fishing vessels and market statistics, a considerable body of information was built up regarding haddock; for example on the age composition of the stocks in the North Sea and on the marked natural fluctuations in the numbers of each year's brood of young which survive. Progress with the herring investigations presented greater difficulties but nevertheless important advances were made, while, in addition, the environment of both species received considerable attention. Other investigations dealt with the lobster and crab fisheries and with the Scottish seine net fishery, mainly for plaice and lemon sole, which began in 1921 during a period of great hardship for Scottish fisherman caused by the loss of central and eastern European herring markets. Much of the associated research was necessarily in inshore waters and this was undertaken by the *ENID* bought in 1920 and, later, by the *KATHLEEN* (55ft) which was commissioned in 1937.

The Fishery Board for Scotland scientists were also involved in studies of the destruction of immature fish by various fishing gears. Their evidence, together with that of others, pointed to the need for conservation methods based on mesh size regulations and on minimum size limits for fish offered for sale. For fishing outside territorial waters, such regulations were first introduced by the UK in 1933.

The initiation of change

Although the staff moved to Wood Street in 1923, the large sea water pond and a series of large and small sea water tanks continued to be used at the Bay of Nigg. Unfortunately, the premises at the Bay of Nigg were subject to serious and increasing encroachment by the sea and the sea water supply was polluted from a nearby sewer. In 1937 a sub-committee of the Development Commissioners'

Plate 6. The former Marine Laboratory at Wood Street as it appeared in the late 1940s and early 1950s. This red brick building, the nucleus around which the present Marine Laboratory site developed, was demolished in 1995.

Committee on Fisheries Research visited the Marine Laboratory to report on those aspects of the programme which they were supporting. During their visit they devoted much of their time to an examination of proposals for improving the laboratory accommodation and the facilities for experimental work. In view of the high cost of protective work that would be required at the Bay of Nigg, and the fact that a suitable sea side location could not be found for a joint venture involving a public aquarium for the City, facilities for staff and students at the University and facilities for the Board, it was decided to advise the Board to concentrate future developments at the Wood Street site and to develop an aquarium facility using a closed water circulation system. It was to be the 1950s, however, before these developments were effected. By that time, not only had the Second World War of 1939-1945 required the Wood Street premises to be vacated temporarily and a skeleton staff housed at 15 Dee Street, Aberdeen, but important changes had taken place in the arrangements for the administration of fisheries.

On 4 September 1939, the day after the outbreak of the 1939-45 war, the powers and functions of the Fishery Board for Scotland were transferred to the Fisheries Division of the Scottish Home Department. This was a result of the findings of the Gilmour Committee on Scottish Administration (Cmd. 5563) which, interestingly, had reported that certain of their witnesses had "strongly urged that the method of administration adopted in England, where a single Ministry is responsible for both Agriculture and Fisheries, should not be followed in Scotland". (Such an arrangement was, nevertheless, to follow in 1960.) After the War and under the new administration a period of expansion of staff and facilities followed at the Wood Street and adjacent Victoria Road site; but that takes us beyond the period with which this paper is particularly concerned. The interested reader should consult Lucas (1956) and Bailey and Parrish (1987) for the more recent history of Scottish fisheries research.

Acknowledgements

Material relevant to the history of the Fishery Board for Scotland, and to individuals associated with it, has been consulted in, or provided by, a number of institutions by whom help was always readily given. Although it has not been possible in the present article to use all the information available, I am indebted to: Aberdeen University Library; the Archivist, Argyll and Bute District Council; Bute Museum; City of Bristol Museum and Art Gallery; East Lothian District Council, Library Headquarters; Dunstaffnage Marine Laboratory; Glasgow University Library; Marine Laboratory, Aberdeen; Mitchell Library, Glasgow; National Maritime Museum; the former Property Services Agency, Aberdeen; Public Record Office (Kew); Rothesay Library; Royal Geographical Society; Royal Museum of Scotland; Scottish Record Office; University of Edinburgh, Special Collections. In addition, I must thank the following: Dr William C Allan; Anna Bowman; Miss E Christie; Dr Robert Kearney; I Y Macintyre; K Munro (Sen); and my wife, Betta, who accompanied me on many visits and helped in the transcribing of records.

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SOME 19TH CENTURY RESEARCH ON WEATHER AND FISHERIES: THE WORK OF THE SCOTTISH METEOROLOGICAL SOCIETY

Margaret Deacon

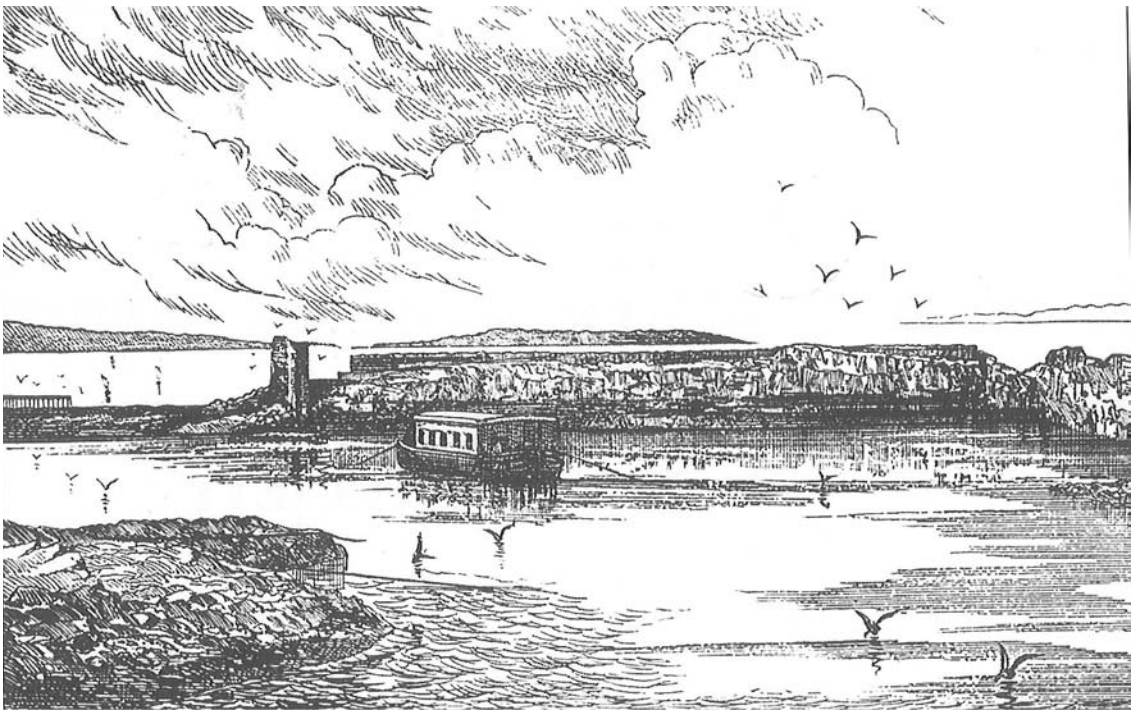

Plate 1. View of the Quarry with the *ARK* afloat, looking west (see page 126).

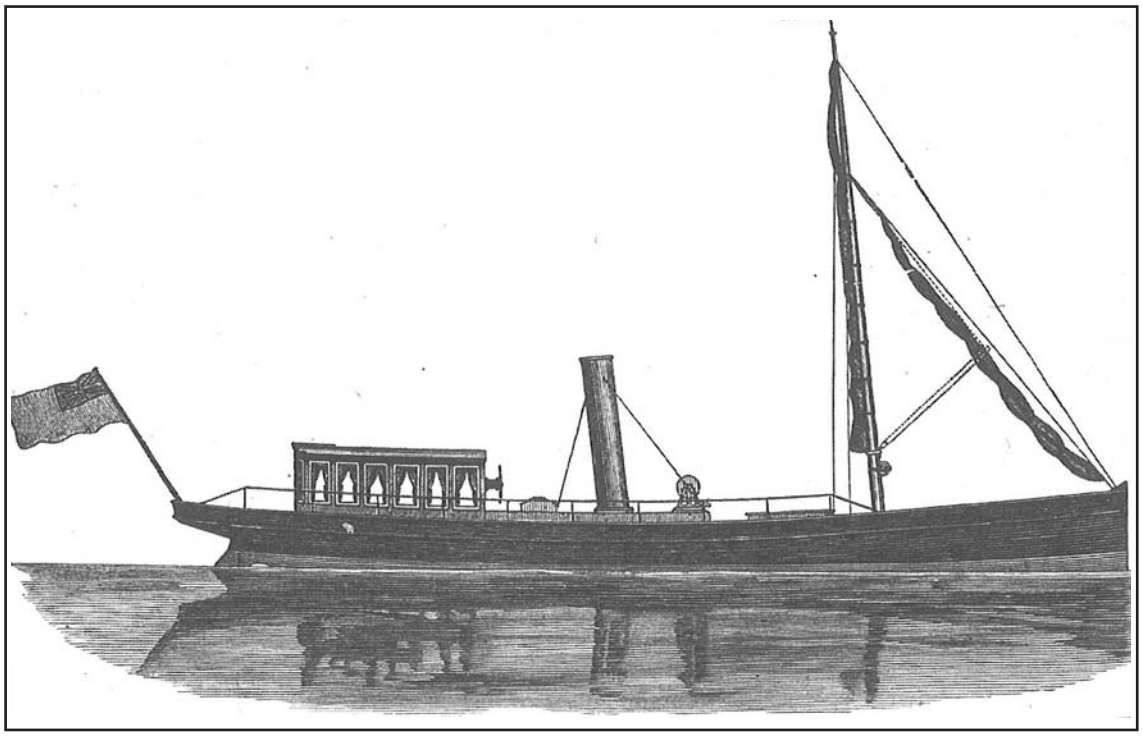

Plate 2. The MEDUSA (see page 126) (from a photograph by Mr H. J. Gifford).

SOME 19TH CENTURY RESEARCH ON WEATHER AND FISHERIES: THE WORK OF THE SCOTTISH METEOROLOGICAL SOCIETY

Margaret Deacon

Department of Oceanography
University of Southampton

Some ten years before the first officially-backed research into sea fisheries in the United Kingdom, the Scottish Meteorological Society began collecting information on fish catches and comparing yields with sea temperatures to see if any correlation could be established between them. The Society was active in the wider movement to promote fisheries research which culminated in the Edinburgh International Fisheries Exhibition held in 1882, a year before the better-known London one. The surplus funds accumulated by the exhibition were awarded to the society for its fisheries research and part of the money was used to set up the Scottish Marine Station for Scientific Research, which was intended to carry out work on fisheries as well as other aspects of marine science.

The origins of the Scottish Meteorological Society and its interest in maritime meteorology

The foundation of the Scottish Meteorological Society in 1855 was made possible by a combination of varied scientific interests (Milne-Home, 1877; Watt, 1910). Initially the dominant theme was the influence of the weather on disease and mortality. The newly-created Registrar-General for Scotland, W. Pitt Dundas had appointed Dr James Stark as Superintendent of Statistics because he was interested in meteorology and the possible effect of weather on health and the death rate. However there was difficulty in obtaining the necessary meteorological data and Dundas was anxious to have access to information from a network of observers similar to that already being supplied to the Registrar-General in England. They therefore approached Sir John Forbes of Pitsligo and David Milne-Home, two men who combined scientific ability with the wealth and social standing necessary to pursue their interests independently, and suggested to them that they should form a meteorological association. The setting up of a meteorological society had already been proposed by the Highland and Agricultural Society the previous year, as a result of Forbes' suggestion that more should be done to study the effect of weather on farming. Stark was appointed as the new society's first meteorological secretary and began setting up a network of observers throughout Scotland and issuing quarterly weather reports. In 1858 the Society was put on a more permanent footing and other interests henceforward predominated, although the study of the effect of weather and climate on health was taken up again a few years later and remained an important though subsidiary aspect of the Society's activities during the next forty years.

In the 1860s the active membership of the Society fell more or less into two categories. To follow a distinction made at the time these, broadly speaking, were the physical meteorologists whose aim was to improve understanding of the physics of the earth's atmosphere, and those who were more interested in the possible practical application of meteorological knowledge, or climatic meteorology, in various aspects of national life, such as health, agriculture and fisheries. The aims of these two groups were not necessarily mutually exclusive and both saw the importance of obtaining more information not only on the actual weather as recorded throughout Scotland by the Society's observers (who numbered 55 by 1857) but also further afield, including observations at sea.

Alexander Buchan, who became the Society's Meteorological Secretary in 1860 and remained in that post until his death in 1907, regretted that so little was known about the temperature of the sea off

British coasts, "exercising, as it does, so powerful an influence on their climate" (Keith and Buchan, 1866). This was not intended as a criticism of the Society which had been actively collecting sea temperature data since 1857, following a suggestion by John Fleming, one of the council members (Stevenson, 1874), but as an incitement to greater efforts elsewhere. Maritime meteorology was a relatively new field but one in which important steps had already been taken. Pioneered in the United States by M.F. Maury in the 1840s, and encouraged in Europe by the Brussels conference of 1853, it promoted the introduction of standard observations by naval and merchants ships and the growth of national organisations. One such, in Britain, was the Meteorological Department the Board of Trade, the forerunner of the Meteorological Office (Burton, 1986).

In addition to the Scottish Meteorological Society's own observers who, where situated by the sea, often added temperature measurements to their usual observing routine, several other opportunities for acquiring information were also available. Naval surveyors working in Scottish waters proved the most fruitful source of data and their observations were regularly published, first in the society's quarterly reports but from the end of 1863 onwards in the *Journal of the Scottish Meteorological Society (*JSMS) (Buchan, 1865). The Society also had close links with the Stevenson family, at that time engaged in building lighthouses at dangerous points on the Scottish coast. Thomas Stevenson, father of Robert Louis, was among the most active members of the Society during this period and keenly interested in this, as in other aspects of its work. Observations of sea conditions were made during planning and construction of lighthouses and, once built, some observations could be continued by lighthouse staff. Through the good offices of the Commissioners of Northern Lights, meteorological returns were obtained from 61 lighthouses during the five years up to 1873 (JSMS, 4:135). At this time the commissioners had no lightships and sea temperatures were not included (JSMS 4: 272) so the Society approached the Mersey Docks and Harbour Board to have observations made at their North-West Lightship (Stevenson, 1874). However, by the 1890s sea temperature observations were being reported from both lightships and lighthouses around Scotland. Yachting was a popular pastime among the Victorian professional and leisured classes. Society members who kept meteorological Journals of their voyages included George Keith (Keith and Buchan, 1866) and Robert Tennent, whose 'Meteorological notes of a trip to Faroe in Mr James Stevenson's yacht the *BLUE BELL*, during August 1870,' appeared in JSMS 3:154-60. ln 1866 Buchan designed a schedule for recording meteorological data at sea, including sea temperatures.

Observations of this kind were discussed in several notes on the temperature and density of the Atlantic Ocean by Buchan and other authors. They showed that the temperature of the sea off Scottish coasts, except for part of the east coast, was 2° to 3°(F) higher than the average that would be expected from air temperatures. Buchan (1865, p255) wrote. "...it is only fair and reasonable to suppose that that current which flows northwards past the shores of Great Britain is fed by the warm waters of the Gulf Stream". In 1866 an important development occurred when the Society was able to extend the scope of its meteorological and sea temperature observations, acquiring observers in Iceland and the Faroes. From 1867 Buchan also had access to the North Atlantic data compiled by Henrik Mohn (Johnston and Buchan, 1871) in Norway which permitted the Scottish work to be seen in a broader context. The Society's interest in this area was not confined to the sea's effect on climate; they were also looking at ways of improving understanding of short-term weather patterns. In 1868 the Society welcomed the resumption of storm warnings issued by the Meteorological Department (Burton, 1986) because they were of particular benefit to Scotland. Thomas Stevenson believed that westerly storms could be accurately predicted if an observatory was established on the west coast of Ireland, using his method of observing barometric gradients (the spacing between isobars). "Sea meteorology is what we want; we want the physics of the globe," said James Glaisher (1875) in his evidence to the Devonshire Commission.

The Marquis of Tweeddale's Committee: Sea temperature observations and fisheries in the decade 1873 to 1882

The interest in sea temperature outlined above was inspired principally by its importance as one of the factors influencing weather, and therefore as a tool in promoting theoretical understanding of meteorological processes, rather than for immediate application. However, it was not long before a suggestion was made that perhaps such an application might exist in the field of fisheries. This came in 1872 from the Society's venerable president, the Marquis of Tweeddale, who, as Lord George Hay, had served as one of Wellington's aides in the Peninsular War. His association with the society arose out of his interest in investigating the influence of climate and weather on agriculture, and how this could be manipulated to the farmer's advantage. He had increased the amount of land on which cereals could be grown on his own estates in East Lothian through applying observations on soil temperature. When reading the Report of the Sea Fisheries Commission (published in 1866) he was surprised to find how little the migration of herring was understood and wondered if the timing of their arrival off the Scottish coast at different times of year was influenced by sea temperature change. If he had been younger (he was 85 at the time) he would, he said, have founded a new society, along the lines of the Highland and Agricultural Society, for research into fisheries because of their importance in Scotland as a source of food and employment. Instead he suggested that the Scottish Meteorological Society should investigate the matter further and a committee was established for this purpose with Thomas Stevenson as convener.

The Hon. Bouverie F. Primrose, Secretary of the Scottish Board of Fisheries (Deacon, 1990) since 1848, was himself a former council member of the Scottish Meteorological Society and did all he could over the next ten years to further these researches. The Board employed officials to collect statistics on the production of cured herring (the most economically important part of the fishing industry). From the weekly returns made by the Board's officers in some east coast districts for the previous six years (1867-72) the committee compared catches with sea temperature records and found that they appeared to be greater when sea temperatures were high (First report from the committee on the Marquis of Tweeddale's proposal to investigate the relations of the herring fishery to meteorology, JSMS 4:60-65). Their findings showed that:

> "the period when the temperature rises to the absolute maximum is further coincident with the date of the commencement of largest catches during the fishery season".

However, they concluded that "It is...still premature to lay much stress on the striking coincidence of these two facts". Such a simple correlation did not explain why the herrings appeared later further south, or the winter fisheries off the west of Scotland and south-west England. Only further research could throw more light upon the situation. For this, better information was needed and Primrose agreed to provide fuller details of daily catches and the number of boats engaged during the following season (1873), as well as sea temperatures and other weather records. In this way it was hoped to obtain:

> "accurate information regarding those currents of cold and warm water round our coasts, which are often found to interpenetrate each other, and which are supposed with apparent good reason, powerfully to influence the migrations of the herring".

Dutch fishermen were said to benefit already from knowledge of this kind.

The detailed statistical information which the committee had asked for on boats and catches was supplied by returns from the district officers of the Fishery Board. Sea temperatures and other

meteorological data were recorded on board the Fishery Cutter *VIGILANT,* from the end of July to mid September l873. Observations from nine of the Society's east coast stations, with the lighthouse data, were also used in building up an overall picture of weather conditions. The pressing need was still for more sea temperature observations, made both at sea and on the adjacent coasts. Thomas Stevenson (1874) proposed a method of measuring maximum and minimum sea temperatures "by means of thermometers continually immersed in the sea". An apparatus was installed at the end of the pier at Peterhead under the supervision of William Boyd FRSE. Observations began in May 1873 but were interrupted in the autumn when the protecting pipe was hit by a ship and the instrument destroyed. It was suspected that the widely fluctuating temperatures recorded were due to the influence of tidal currents. A new instrument was resited to avoid this and daily observations of maximum and minimum sea temperature began again in May 1874, with the assistance of the Harbour Trust of Peterhead. They were continued until February 1879 when the thermometer was broken during a storm (Buchan, 1879). However the reason later given for discontinuing the observations was "the local authorities declining to continue their pecuniary assistance".

A defect of the first report was that the sea temperatures used had not been taken in the area where the fisheries were being investigated and it was the object of the committee to get more direct evidence of conditions on the fishing grounds. In the 1873 season the *VIGILANT* had made observations six times daily of the weather and sea surface and bottom temperatures and these observations were repeated in subsequent years. To get the actual fishermen observing was more difficult; Primrose was happy to assist as intermediary but could not himself supply the instruments, and the Society, as will be seen later, was not well off itself. Lord Tweeddale, who had been a generous benefactor of the Society in former enquiries, came to its rescue in this instance as well. In June 1874 he presented twenty thermometers to the Society for use on the fishing grounds (Report of the half-yearly meeting, 2 July 1874, JSMS 4: 269, 271). Primrose sent the thermometers to fishery officers on the east coast and each "selected an intelligent fisherman to take the temperature of the sea where the herring shoals were found to be".

The new observations suggested rather different conclusions. The 1873 figures did not bear out the correlation between temperature and catch suggested by earlier observations. Indeed, it began to look as though prolonged high sea temperatures had an adverse effect upon the fishery, and this seemed to be confirmed in 1874 and 1875 when it appeared that the higher the deviation from the mean the lower the catch (JSMS 5:30-31). Catches indeed seemed to be better when sea temperatures were somewhat lower, though the end of the season in the autumn also seemed to be signalled by the sea temperature falling below 54.5°F. It was suggested that the depth at which the shoals swam might also be influenced by temperature and fishermen were asked to record observations on the depths at which the shoals struck the nets and the temperature at that depth. Not surprisingly, fewer fish were caught during stormy weather. Observations made in 1878 (Buchan, 1879) confirmed the pattern established over the previous five years with a sea temperature about average and an above average catch in the second week of July. Following this the temperature rose and the catch declined. During the latter part of July and during August sea temperatures fluctuated and catches were variable, increasing when temperature declined and falling when it rose. From the 13th to the 23rd August, temperature was about average and catches above average but for the rest of the season the temperature rose considerably above the mean and remained high and catches fell well below average. Buchan concluded:

> "It will be seen... that the relations pointed out in the results of the previous five years as subsisting between the temperature and the catch of the herrings were entirely confirmed by the fishings of 1878".

However, in order to make more precise the relationship between temperature and catches, and other important problems of the herring fisheries, he wished to draw up a large number of temperature and weather maps, showing catches, for different areas on different dates, but this more detailed investigation of the data so far collected had been prevented by the fact that the Society lacked money which could be applied to such tasks.

The Society had also begun to take an interest in the possible effect of weather on salmon and trout fisheries. Details were forwarded to Buchan by G.L. Paulin, secretary of the Berwick Salmon Fisheries Company, of the daily catch on the lower Tweed and the temperature of the river above the tide-mark, made over several years during the early 1870s (JSMS 5:30). The subject was brought up again in a letter put before the Society in 1876 (JSMS 4:329) in which Archibald Young, Secretary to the Commissioners of Scottish Salmon Fisheries (from 1882 Inspector of the Salmon Fisheries of Scotland and a member of the Fishery Board) also proposed investigations of the temperature of the sea and rivers, believing that the difference between them might be the determining factor in the timing of salmon entering the rivers. Measurements were already being made by independent observers, including several on the Duke of Sutherland's estates, under the supervision of William Boyd. The Society was anxious to reinstate his observations at Peterhead and to expand observations on the temperature of the sea and of rivers elsewhere. Young's interest in the subject was reinforced by the failure of the salmon fishery in early rivers in the spring of 1879, following a very severe winter (Young, 1879), and the spread of salmon disease.

The Edinburgh International Fisheries Exhibition of 1882

In undertaking work of this kind lack of resources was a perennial problem. The Society's observations so far had demonstrated that there was much to be learned about fish behaviour from studies of the physical conditions of their environment. The findings referred to above were based on the overall picture they had obtained. In fact there had been considerable variations between both temperatures and catches at different places on the east coast. Buchan was keen to study these in greater detail but he was hampered by the routine work of the Society, which had over a hundred observing stations by the mid 1870s, not to mention other projects it was engaged in, and there were no funds for extra work. To try and remedy this situation the Society had made repeated applications to the government for assistance, hoping that they might be given a share of the annual grant for meteorological observations made to the Meteorological Committee of the Royal Society, the forerunner of the Meteorological Office, but these hopes were always disappointed. At the heart of the problem lay the deeply ingrained attitude, common to most politicians and civil servants at that time, and shared by some scientists, that use of public money to finance scientific research was only justified in exceptional circumstances, whether large-scale projects of national significance, such as the *CHALLENGER* expedition, or where practical results of immediate value to the community as a whole were expected (Deacon, 1993). The government, backed by the Treasury (MacLeod, 1976), was extremely reluctant to get involved in supporting long-term scientific projects, particularly if it meant handing out money to private organisations, who would not be subject to the same kind of checks as a government department. The fact that the Society's fisheries researches were attracting interest from organisations engaged in similar work abroad (JSMS 5:199) was gratifying but not of practical assistance.

In the early 1880s however the Society obtained research funds from an unexpected source. As a result of the growing interest in different aspects of fisheries an International Fisheries Exhibition was held in Edinburgh in 1882, a year before the better known London International Fisheries Exhibition. It was organised by private bodies such as the Scottish Sea Fisheries Improvement Association together with the Scottish Meteorological Society. An application to the Fishery Board

for public funding for the event was turned down by the Treasury - though it was opened by the Earl of Rosebery (Bouverie Primrose's nephew and the future Prime Minister) who as Under-secretary at the Home Office had special responsibility for Scottish affairs in Gladstone's government (the post of Secretary for Scotland was not instituted until 1885). However the exhibition, which had been designed as a public relations exercise to raise the profile of fisheries matters among the general public, rather than as a fundraising exercise, made a profit of £1600. The executive committee therefore invited applications for the money, to be spent 'on purposes in harmony with the objects of the ...Exhibition'. The Scottish Meteorological Society submitted a proposal based on its existing work on marine and freshwater fisheries. It stated that:

> "The Council has hitherto been unable, from want of funds, to complete the discussion of the observations already made; to inspect the fishing districts and confer with the fishermen, and thereby secure observations of the fulness and exactness which is required; and to carry on certain investigations in physics and in natural history which are essential to this inquiry. Of the physical investigations may be mentioned the heating power of the sun's rays at different depths of the sea, which appears to have important bearings, directly and indirectly, on the depth at which the herrings are caught. The inquiries in natural history are mainly those which concern the food of the herring and also the food of the animals on which the herrings prey, together with the influence of weather and season on the distribution of these animals in the sea". (JSMS 7:52)

In order to promote the investigation of sea and river fisheries they intended (JSMS 7:53) to obtain more and better observations of the temperature of the sea at the surface and at different depths; the resumption of the observations at Peterhead and the institution of similar observations elsewhere; more observations in salmon rivers; daily measurements of sea temperature in selected places and investigation of the heating effect of the sun's rays at depth; the discussion of past observations and research on the food of herrings. They pointed out that work of this kind was already being done in other countries. In 1882 the Society received a report on enquiries, including meteorological observations, made by the German Fishery Commission with state support over a five-year period.

In February 1883 the Executive Committee of the Fisheries Exhibition met and unanimously decided to hand over to the Scottish Meteorological Society the entire amount at their disposal "with power to the society to establish... a zoological station and also to endeavour to get Government to assist them in the work". Following this the Society set up a Fisheries Committee to make recommendations to the Society's council on the course of action to be adopted (JSMS 7:57-59). They recommended that the Society should continue and extend the river observations and the observations by the District Fishery Officers and discuss all outstanding observations up to the end of the 1883 season. Further, they should employ naturalists to make observations at different fishing centres for a month as a basis for future investigations and establish a zoological station which would provide "facilities for biological researches and meteorological observations bearing upon these".

Some of the money from the Fisheries Exhibition surplus was allocated to the preliminary investigations by naturalists, nine hundred pounds went towards the expenses of running a zoological station, spread over three years, and the remainder was earmarked for discussion of the Society's existing data. In connection with the first stage of the project, W.A. Herdman went to Loch Fyne for a month in late August-early September 1883 (Preliminary reports on some observations made in connection with Scottish fisheries during the summer of 1883, JSMS 7:30-37). He was unable to hire a sailing boat or crew as all the vessels and men were engaged in the herring fishery but obtained tow-netting samples of the surface fauna, together with some from intermediate depths, from a rowing boat, comparing his catches with the contents of herrings' stomachs. He also made

meteorological observation, and, on a less regular basis, measured surface and bottom temperatures and carried out sounding and dredging in the deeper water. Trying to get information from the fishermen proved difficult; when their initial reluctance had been overcome he found that they only knew about their own speciality. Similar investigations were carried out at Peterhead in late July and August by W.E. Hoyle, looking at ways of finding out about the life history of the herring. F.E. Beddard was stationed at Eyemouth for 3 weeks in September but found that the herring season was almost over there. He too made tow-netting hauls to compare with the herrings' diet. Annexed to these reports was a summary of observations made by the veteran amateur biologist A.M. Norman (Mills l980) on the microfauna of some of the Scottish freshwater lochs. Hoyle and Beddard worked at the Challenger Office but Herdman, formerly Wyville Thomson's assistant, had been professor of natural history at University College, Liverpool since 1881.

The Scottish Marine Station for Scientific Research

The second phase of expenditure of the Fishery Exhibition surplus involved the setting up of a zoological station to study fishery problems. Why a meteorological society should find itself setting up a zoological station requires some explanation. The guiding force in this enterprise was John Murray, through his role first as convener of the executive committee of the Fisheries Exhibition and then of the Society's fisheries committee. There were both general and specific reasons for his enthusiasm to found what we would today call a marine station, which are more fully gone into elsewhere (Deacon, 1993). On his return from the pioneering oceanographic voyage of *HMS CHALLENGER*, 1872-76, Murray became the right-hand man of C. Wyville Thomson, professor of natural history at Edinburgh University, and the expedition's leader, who was now editing the scientific report. Thomson's health deteriorated and he died in l882. Murray was appointed to succeed him as editor and head of the Challenger Office in Edinburgh. Thomson had hoped that outstanding problems from the work of the *CHALLENGER*, together with further oceanographic exploration of British seas, could be carried out by continuing the fruitful collaboration, begun in pre-*CHALLENGER* days, between scientists and naval surveyors working off the coasts of Scotland. However, though the government accepted the responsibility for completing the *Challenger Report,* they were unable or unwilling to see that future exploration in marine science was also in the national interest, and beyond the reach of private individuals. When it became clear that two short cruises in the naval survey vessels *KNIGHT ERRANT* and *TRITON*, made in 1880 and 1882 (Deacon, 1977) would not be repeated, Murray was seeking alternatives. While there is no doubt that, given the choice, he would have been a deep-sea oceanographer all his life, the idea of a marine station had a great deal to recommend it.

British zoologists appreciated the important contribution such foundations would make both to knowledge of living organisms, and to some of the theoretical problems, many of them linked to Darwin's theory of evolution, that were engaging them at the time. They were conscious that Britain was lagging behind other European nations where zoological stations were already in existence, notably the Stazione Zoologica founded by the German biologist Anton Dohrn at Naples in the early 1870s. In spite of much discussion, and a certain amount of action (Deacon, 1993) no effective institution had so far appeared in the United Kingdom and it was generally agreed by scientists that Britain needed not just one but several. Murray's interest in founding a marine station differed to some extent from the aims of the biologists. He saw it as an opportunity to carry out oceanographic research, if only on a small scale. This was essential if British scientists were to continue contributing to a subject in which hitherto they had been regarded as leaders. An important subsidiary consideration was that work on the *Challenger Report* depended on keeping abreast of a subject that was rapidly developing elsewhere. Failure to do so would have adversely affected both the careers of the young scientists who staffed the Challenger Office, and their ability to contribute

effectively to the Report. The existing interest, in fisheries within the Scottish Meteorological Society made it a natural parent body for the scheme, and Murray was already an active member of the Society. Indeed while planning the marine station he was also directing the building of the Society's meteorological observatory on Ben Nevis. Murray knew that though governments had shown themselves unwilling to spend money on oceanography there were signs that they might more easily be persuaded to support research into fisheries, because of their economic and social importance. He hoped that the success of the station might be ensured by a government grant through the Fishery Board, in the same way that funds were channelled through the Meteorological Office to support the Ben Nevis Observatory.

The plan for the new station was made public with an appeal for funds during the summer of 1883. The response was initially good, if mainly local, enabling the Scottish Marine Station for Scientific Research to be formally opened in April 1884 (Boog Watson 1967, 1969). It was equipped with a floating laboratory, the ARK, moored in a flooded quarry opening off the Firth of Forth near Granton (Plate 1), and a steam yacht, the *MEDUSA* (Plate 2). The full-time staff included a zoologist, J.T. Cunningham, who acted as superintendent, and the crew of the yacht, but other scientists were attached to the station through fellowships from Edinburgh University. Unlike other marine stations which usually concentrated exclusively on biological research the Scottish Marine Station was intended to cover all aspects of the marine environment. Its name reflects the difference in emphasis from other similar foundations of the time. The station's physicist was H. R. Mill, a young Edinburgh University graduate in chemistry. For three years, while the Scottish Meteorological Society's grant enabled the station to run at full throttle, much useful work was done in the firths and sea lochs of both the east and west coasts of Scotland, involving studies of the local biota, sea and river conditions, and fisheries research.

Cunningham (1885, 1887) had already worked on herring in his previous post as assistant to J.C. Ewart, professor of natural history at Edinburgh University. He decided to concentrate his own work at the station on further researches into the embryological development of marine food fishes and their enemies, looking particularly at the development of the hagfish, *Myxine glutinosa*. Other members of staff were taken on to make studies of the marine fauna and flora of the Forth, and their distribution and habitats, and similar collecting work was carried out in the Clyde. In 1885 the *ARK* was taken to Millport and from that time on an increasing amount of the station's work was concentrated on the west coast (Marshall, 1987). It was an area which repaid long-term investigation in a way which the Firth of Forth on its own did not, combining great diversity of marine life with an interesting and unusual physical environment. lt had the added advantage that the *MEDUSA* could move around relatively freely in the large network of interconnected sea lochs and carry out trawling and dredging even further afield using canals, whereas she was unsuitable for general work in the North Sea.

As befitted its origins, the Granton station operated as an observing station for the Scottish Meteorological Society and meteorological observations were recorded daily at 9 a.m. and 9 p.m. Mill began by studying the effect of tidal movements in the Firth, which caused water temperatures in the quarry to vary in an unexpected way. From this work he progressed to a full-scale study of the temperature and salinity of the Firth of Forth, and to a lesser extent of other east coast estuaries (Mill,1889), and to a "much more detailed and systematic survey ... of the Clyde sea area"; this formed the basis of his monograph which may be considered the most important result of the Scottish Marine Station's work in this field. In spite of an impressive record of achievement, given the small scale of the operations, including improvements in apparatus as well as field research, Mill nevertheless was dissatisfied because "the staff and appliances of the station have always been so limited that, when a new field was entered on, a former one had to be neglected". Scientists today

may still sympathize with a young scientist's mingled feelings of excitement in developing new enquiries, coupled with frustration at the lack of time and money to investigate them. Yet as well as his work for the Scottish Marine Station he also found time during these years to work directly for the Fishery Board for Scotland (Mill, 1951, pp. 46-48) which was now undertaking scientific investigations on its own account. This development had unfortunate consequences for the Scottish Marine Station.

It had been clear from the beginning that the station would need to find other sources of money to survive after the grant from the Meteorological Society ran out. Murray hoped that government funds would be made available to the station in return for work on fisheries, since this was an area of active public concern. However, his application was referred by the Treasury to the Fishery Board for Scotland which turned it down. The reason given for this was that the Board had not enough money for its own scientific investigations and that furthermore the work proposed by the Marine Station would duplicate them. This sort of response to outside bodies hoping for a share in government funding was not unique; the Scottish Meteorological Society had had requests for an annual grant turned down on several occasions on the grounds that the sum required for running the Meteorological Office left none to spare, though they eventually succeeded in obtaining a small annual subsidy towards the running costs of the Ben Nevis Observatory (Paton, 1983). How essential this was may be seen by the fact that when this grant was withdrawn in the early 1900s, the Society was obliged to close the observatory. However, though the Fishery Board was short of funds for its scientific work at that moment, its reluctance to assist the Granton station was influenced by other considerations.

The demise of the Scottish Marine Station

In the 1870s the Scottish Meteorological Society had enjoyed good relations with the Fishery Board. Though the Board could not finance investigations it provided data and made available the statistics collected by its officers. However, its own revenue, from a tax on barrels of cured herring, was growing as the herring fishery expanded. As other branches of sea fisheries became more important, particularly with the extension of trawling, disputes broke out between the trawlermen and fishermen employing more traditional techniques who accused them of destroying their livelihood. It began to be felt that the Board's terms of reference should be changed to take cognisance of all coast and sea fisheries, and not just herring and a few other species, as hitherto. A select committee in 1881 also pressed for the herring brand surplus to be used to benefit the industry and those who worked in it, by building and improving piers and harbour facilities and extending telegraphs (for the transmission of storm warnings). It pointed to the scientific work on fisheries being done in other countries, but not in the United Kingdom. Many problems with sea fisheries had been highlighted in a series of royal commissions, but these relied on collecting information from fishermen and were hampered by lack of scientific knowledge about the various species of fish concerned, their life history and their environment. During the late 1870s information on sea fisheries was also collected during an enquiry made by the government inspectors (Frank Buckland, Spencer Walpole and Archibald Young) appointed to look after freshwater fisheries under the terms of the Salmon Acts (Burgess, 1967 and this volume). The 1882 Act creating the new Fishery Board for Scotland did not specifically mention scientific research but it empowered the new Board to take measures for the improvement of fisheries. Under the old system the work had been done by the secretary, Primrose, and the commissioners met infrequently and do not appear to have taken the initiative. Primrose himself retired with the advent of the new regime and its affairs were managed more directly by the Board members. One of their first actions was to create a committee for scientific investigations. The Board had one professional scientist among its members, the newly appointed professor of natural history at Edinburgh University, James Cossar Ewart. He had previously held

the chair at Aberdeen where he had been instrumental in founding the Scottish Zoological Station in 1879 (Deacon, 1993). This was more closely modelled on continental counterparts than the Scottish Marine Station and subsequent British foundations and was intended to be used for zoological research and teaching. The station depended entirely on funds raised by public subscription, except for small grants from the British Association for the Advancement of Science. Like some continental stations, it operated only during the summer and the station building was prefabricated so that it could be moved to different sites. Lack of money meant that its work remained on a very small scale, principally research being carried out by Ewart himself, but in collaboration with G.J. Romanes and Edward Schafer (later Sharpey-Schafer) from the physiology department at University College, London. When Ewart moved to Edinburgh his successor at Aberdeen, a geologist, was not interested in continuing the laboratory and it was allowed to lapse, but Ewart and Romanes kept the building and used it in conjunction with the fisheries research on which Ewart now embarked on his appointment to the Fishery Board. However, contemporary reports, letters and diaries show that he was confident that the government would provide substantial funds to construct a laboratory in the Forth for fisheries work (Deacon, 1990). He was disappointed when it proved harder than he had anticipated to persuade the government to make additional funds for fisheries research available and he was forestalled by the appearance of an independent institution (see Adams, this volume).

The Board's refusal of help to the Granton station was made at a time when its own scientific work was just beginning, and its existing revenue was already inadequate, especially as this had to be shared with other projects. The initial reaction of the Treasury was to forbid further overspending but lobbying behind the scenes led to extra funds being made available. However, even before this change of fortune, the Board needed a laboratory and began channelling money, not to Granton, but to the Marine Laboratory at St Andrews. W.C. McIntosh already had a distinguished record in marine zoology when he was appointed professor of natural history at St Andrews in 1882. He had long wished to found a marine station there (Gunther, 1877, p.75) but the opportunity only arrived when he was asked to undertake field work on behalf of a Royal Commission set up in 1883 to investigate the effects of trawling. According to McIntosh (1888, 1896) it was due to the action of Lord Dalhousie, chairman of the commission and a prominent politician, that grants were made through the Fishery Board to equip the laboratory and to carry on fisheries research there for a number of years. There was no suggestion that any duplication of effort might arise from this arrangement but this was the argument that the Fishery Board also employed when it tried, two years later, to prevent government funds being allocated to fisheries research at the projected Plymouth Laboratory of the Marine Biological Association of the United Kingdom (MacLeod, 1976, p. 148; Southward and Roberts, 1987). This reasoning was calculated to alarm civil servants with little understanding or appreciation of science, but the Marine Biological Association was better organized and more powerfully supported than the Scottish Marine Station and won its plea for financial aid.

This victory did not help the Granton station. By the end of three years the station was in debt, in spite of grants from the Meteorological Society and the British Association. It was clear that operations could not continue on the same scale once these had come to an end. Murray kept the *MEDUSA* working in the Clyde for several years, while some chemistry of sediments was done at Granton in the 1890s. Cunningham moved to Plymouth where he was the Laboratory's first member of staff and continued his work on fisheries there for some years. During the three years of Granton's full-scale existence the link with the Meteorological Society had been tenuous and ceased once the grant from the Society expired. The Society's interest in fisheries seems to have dwindled at this time. How the remaining sum of money from the Fisheries Exhibition was employed is not clear. Perhaps the possibility of making direct links between sea temperatures and abundance of fish began to look less clear cut than it had at first appeared. Another factor was the Ben Nevis Observatory which absorbed much of the Society's funds and energy from the 1880s onwards. However, it is certain

that, by drawing attention to the importance of the marine environment in fishery questions, the Society influenced both the course of the work done at Granton and the future direction of Fishery Board work. One has only to look at the concern for investigating and understanding the impact of the physical environment on fish populations in the work of the Board's first director of scientific investigations, Thomas Wemyss Fulton (1889), himself a former associate of Murray's, to see the how the work of Mill and others, who assisted the Board in its early days, bore fruit.

The demise of Granton was not only a loss for fisheries research. The Scottish Marine Station was intended to tackle all branches of marine science and could have formed the nucleus of an oceanographic institute. No institution of comparable breadth of scope existed in the United Kingdom until after World War II, and few elsewhere in the world. At the time of its foundation it was considered highly innovative (Beneden and Renard, 1884); though the work of the Kiel Commission in Germany had been in progress since the early 1870s (Mills, 1989) its programme of observations in all aspects was more narrowly directed towards fisheries objectives than was Granton's. Scientists appreciated that work towards the understanding of fundamental problems had an important part to play as well as the investigation of issues of immediate practical concern. However, it was hard to convey this distinction to British politicians who, in the latter part of the l9th century, were still mostly in favour of a laissez-fair liberalism which was not so much hostile to science as opposed in principal to state intervention in any walk of life, the 'let alone policy' (Spinner, 1973), and saw calls by 'new' radicals for parliamentary action as the first steps on the slippery slope to socialism. In practice, if only for humanitarian reasons, this policy or preference was liable to be disregarded, in scientific as well as other fields, and the result was a gradual increase in public funding for scientific research in the years up to 1914 (Alter, 1987), without any corresponding change of attitude. Through their reluctance to make grants to private individuals and organisations, who were supposed to raise the money themselves, irrespective of the real practicality of such an undertaking, governments actually became more directly involved in the running of scientific enterprises than they need have been. Haunted by the spectre of waste and inefficiency, their efforts to provide against this could nevertheless be self-defeating. Part of the trouble was that the support given to the Fishery Board for Scotland was not planned but evolved as a series of complex interactions between different levels of government over a number of years. Gradually the difficulty of controlling the increasing amounts of expenditure through individuals who were not government servants and therefore not fully accountable, hastened centralisation. Arthur Lee (1992) in his history of the Department of Agriculture's involvement in fisheries research in England and Wales throws light on the difficulties experienced by some independent institutions as a result of the concentration of research in government laboratories. In England these changes took place between 1890 and 1910; in Scotland the process took place earlier, was concluded by 1900 and the Scottish Marine Station was the main casualty.

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FISH UTILISATION

John Early

Plate 1. Sir William Hardy.

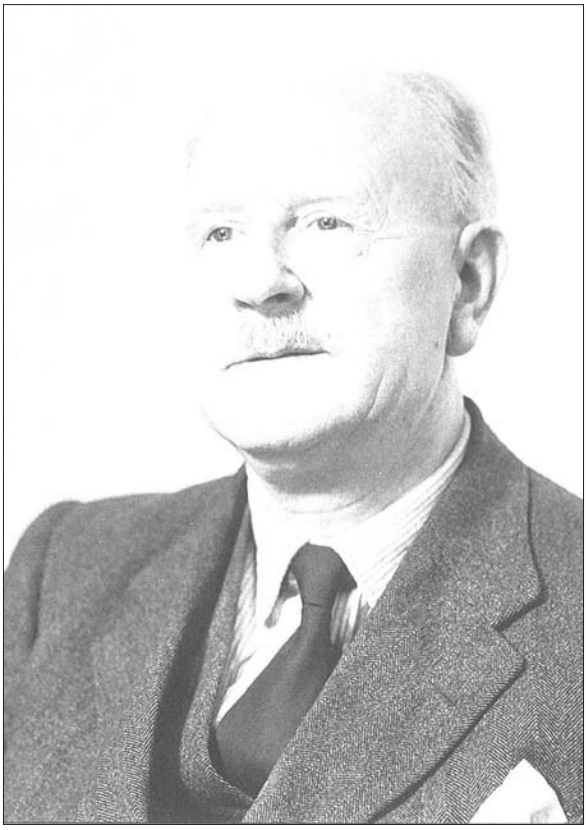

Plate 2. Dr G. A. Reay, Director of the Torry Research Station, 1937-

FISH UTILISATION

John Early

Introduction

This paper has two objectives. The first is to discuss the history of work on fish utilisation in the UK. The second is to tell something of the work and achievements of the Torry Research Station, since its establishment 60 years ago. My task, thankfully, has been made somewhat easier because since 1929 the history of the subject is very largely the history of Torry Research Station. I shall adopt a chronological approach.

Up to 1929

Prior to 1929, when Torry was established, there was no institution devoted to the study of fish as food. Some work was, as I shall mention, done by other establishments such as the Low Temperature Research Station (LTRS) at Cambridge and various Universities, especially those associated with the Scottish Fishery Board. Most advances, however, were due to the efforts of private individuals, as was often the case in those far off days.

Going yet further back, who knows how the use of salt, smoke and drying was first discovered, all of which, used separately or together, extend the shelf life of fish. What is certain is that various efforts to improve such traditional processes have been recorded and attributed to individuals, obviously not all of them British and thus outside my remit. Improvements to smoked fish and the smoking process, particularly cold smoking, appears to have been the most active field for British operatives, in the 19th Century. During this time the bloater was first made in Great Yarmouth in 1835 by a Mr Bishop. The kipper is said to have been invented by John Woodgers of Seahouses in Northumberland in 1843.

Turning now to the process, traditional smoking kilns are essentially chimneys in which the fish is hung after brining and dyeing. Smoking and drying take place concurrently over a period of several hours. Such primitive equipment leads to difficulties, particularly for cold smoked products, in that overheating can occur, especially in summer. When this happens the fish will cook and drop off the hooks into the fires below. Also, inevitably, the lower fish dry more quickly and, therefore, to give an even cure throughout the kiln the operatives had to move the fish around in the kiln during the process, a labour-intensive and laborious task. All these problems led to the suggestion by a Mr Leitch of Hull in 1883 that a mechanical kiln would overcome these problems. His kiln was never built, possibly due to the problem of driving a chain-belt of 700 ft in length. The introduction of mechanical smoking had to await the establishment of Torry Research Station.

Traditional methods of preservation, salting, smoking, drying, lead to a profound change in the flavour and texture of fish and, whilst this is considered desirable on some occasions, the flavour and texture of fresh fish has always demanded a premium. Fresh fish was regarded a luxury only available to people at the coast and from resources reasonably close by in inshore waters. Whilst live fish were landed by well-boats, this fish was very expensive and only available to the wealthy and even then in limited geographical areas. The expansion of the railway system in the mid-19th Century did result in fresh fish becoming available far more widely. As fishing effort increased,

however, there was a need to sail further afield due to the pressure on stocks and, therefore, for longer trips, causing fish quality to deteriorate even before landing. The use of ice ashore to preserve the freshness of salmon and to some extent herring during the journey south from Scotland had taken place from the late 18th Century. The credit for this must go to the Chinese, who used ice first. The ice used in Scotland was imported natural ice from Norway but, as the North Sea trawling fleet began to demand ice for the preservation of their catches around 1850, ice was gathered on the east-coast of England. Indeed, a new industry developed in which farmers flooded their fields in the region to satisfy the demand. The use of ice allowed an expansion of trawling to grounds yet further afield from the ports in the North Sea and resulted in big improvements in quality. It should be noted, however, that there were still very large amounts of fish wasted, since ice was not always available and, as it was expensive, it was not always used in sufficient quantities, if at all. Artificial ice, produced mechanically, became available on a reasonable scale around 1875, but it was not used at sea until the 1890s. It seems ludicrous today, but it was not accepted initially as being as effective as natural ice and natural ice continued to be imported from Norway until well into the 20th Century. All these developments allowed a very significant expansion of fishing into northern waters, but still much wastage occurred and, indeed, much of the fish sold was of poor quality.

The concept of institutional research and development to help solve the problems of the UK fish industry was not adopted until after the establishment of the Department of Scientific and Industrial Research (DSIR) during the First World War. It took a further decade for these plans to come to fruition.

DSIR, soon after its establishment, formed the Food Investigation Board (FIB) 'to organise and control research into the preparation and preservation of foods'. The first Director of FIB was Dr, later Sir, William Hardy (Plate 1). He was advised by several committees, one of which was the Fish Preservation Committee, formed to advise on, "the handling of fish once they have been caught". The Committee at an early stage advised that a specialised research station should be set up. Incidentally, there were similar moves in Scotland by the Fishery Board. There was considerable discussion by Hardy's Committee and at one stage it looked as if Lowestoft would be the site for the new station. Eventually, however, the so-called Empire Marketing Board gave financial support to Hardy, the Treasury having repeatedly refused adequate funding, and Torry, a suburb of Aberdeen, was chosen for the establishment of the station.

During the decade before the establishment of Torry Research Station, Hardy, with the backing of the Fish Preservation Committee, ran several studies at various locations on fish spoilage and preservation. For example, bacteriological work on the spoilage of herring was done at the University of Cambridge and work on brine freezing was commenced at Billingsgate. This work was transferred to the Low Temperature Research Station at Cambridge once that Station was built in 1921, and Piqué, who later transferred, at least nominally to Torry Research Station, started work on a brine freezer for use on trawlers.

Chemical work on fish also started in the early 1920s, for instance a study of amines in canned fish was undertaken and this led to a new method of estimating trimethylamine as a measure of fish quality, which is still used today. Bacteriological investigation of a form of spoilage in salt fish, which gives a pink discoloration, was also commenced.

Pre-war Torry

Hardy, however, was not satisfied since he felt insufficient work on fish was being done. LTRS had started to concentrate on meat in the mid 1920s and a new laboratory at Covent Garden was

now working on fruit and vegetables. He felt, I have no doubt correctly, that a Fisheries Research Station should be at a port and should have the services of a research fishing vessel. His contacts with Aberdeen came about as a result of fairly extensive trials based on that port of the use of refrigeration in conjunction with ice on a steam trawler. This was in 1927. The site in Aberdeen was sold to DSIR by the Town Council and a very modest conversion of former shipyard buildings was undertaken by the Office of Works. The first scientific staff were Adrian Lumley, who was Superintendent, and G A Reay (Plate 2). Piqué was also transferred on a temporary basis from LTRS.

As a result of the studies on trawlers, both from Aberdeen and Milford Haven, of icing practice and in the case of the former, of brine freezing too, by Lumley, Piqué and Reay, very practical advice, particularly for the improvement of icing, was given at the very beginning of Torry's existence.

The work on freezing was less successful. The reason for this was that brine freezing was used and cold storage was only at -10°C. They found that the eating quality was good but only for up to one month of storage. They also said that the product was of poor appearance and did not yield acceptable smoked products.

Work on brine freezing and cold storage continued in the 1930s as staff and new equipment became available. An early aim was to freeze the first part of the catch of a trawler (i.e. older than 12 days), when ice, however well used, is ineffective in preventing excessive spoilage. New cold stores, built at Torry, provided a wider range of temperatures since Reay's work had shown that fish demanded a lower temperature for longer term storage than most other foods. The new stores provided down to -30°C. The seagoing work was assisted, at this time, by the realisation of another of Hardy's wishes, the acquisition of a trawler, *CITY OF EDINBURGH*, for Torry. By the late '30s the freezing of herring was being studies by Adam Banks, a Chemist, who found that the brine freezing of fatty fish was not acceptable for long term storage due to its pro-oxidant properties. He advocated at this time the use of blast freezing for such species. Also, during this period, various people took up the study of smoking. C. L. Cutting was mainly responsible for putting the smoking of fish on a sound scientific and technical basis. By 1939 a mechanical kiln had been constructed and produced kippers suitable for demonstration to the trade at the British Industries Fair of that year.

James Shewan, another early recruit to the Station, and who remained for the rest of his working life, started systematic work on the spoilage of chilled fish. Apart from bacteriological and chemical studies, he initiated his work on the organoleptic assessment of fish, developing a modest scoring system in 1938. John Lovern, who eventually took over from Dr Reay as Director, also initiated his work on the chemistry of fish lipids.

The War years

The War years inevitably caused a change in direction when work on the drying of fish commenced. A system was developed which would have allowed the drying of herring and white fish after cooking and mincing. After drying the product was packed under nitrogen, in hermetically sealed containers. It was envisaged that had the War lasted much longer, this product would have been prepared in Canada and the USA for easier shipment to Britain. Some of this pilot plant work was done at the newly established Ministry of Food, Experimental Factory, adjacent to the Torry site in Aberdeen.

Post War

After the War the work of Torry Research Station, in common with other similar establishments, was expanded very significantly. One of the first areas to receive attention was freezing and cold storage, both at sea and ashore. Pre-war the main criteria for successful freezing had been established. These were the rapid freezing of fish down to -5°C (within 2 hours) and the application of glaze to retard oxidation and dehydration, if unwrapped, and storage below -20°C, preferably -30°C. The storage life of white fish in good condition had been established too – 12 months and fatty fish – 9 months. What had not been properly evaluated was the best means of freezing, either ashore or at sea.

So far as shore freezing was concerned, the freezing of herring was a priority as a large increase in the catch, which could not be handled fresh, was anticipated after the low level of exploitation caused by the war. Plate freezing versus blast freezing was examined for herring in conjunction with the Herring Industry Board (HIB) for their new shore-based plants at Fraserburgh and Lerwick. For freezing at sea suitable equipment was a particular cause for concern since coupled with the requirement for a compact unit was the need for extremely robust and reliable equipment.

Engineering of this type was a new activity for Torry but DSIR allowed the recruitment of suitable staff for this purpose. This work was mainly done for the Humberside based distant water fleet and necessitated considerable seagoing from Hull and Grimsby. This, incidentally, allowed a long term objective set by Dr Reay to be realised, the establishment of a laboratory, there, the Humber Laboratory, in Hull, completed in 1951. The equipment conceived, very largely due to the efforts of Gordon Eddie, was the Vertical Plate Freezer. The Vertical Plate Freezer consists of a series of parallel hollow plates which can be moved hydraulically, and through which refrigerant can circulate. By the time of this work, brine was being superseded by CFCs and these give the lower temperatures which lead to more rapid freezing and thus better quality frozen fish. Vertical Plate Freezers are equipped with hot gas defrost to release the frozen block which, in the case of distant water vessels, were 100 mm thick, weighing around 50 kg.

The preliminary work for freezing at sea started in 1949 and culminated in the application of freezing at sea on commercial vessels in 1961. The concept adopted was to freeze whole fish rather than fillets in order to give a more versatile raw material. It would have also allowed the conversion of existing vessels, although in the event most British freezer trawlers were new. A few did handle fillets, for instance, the 'Fairtry' Fleet, owned by Salvesens and on which Torry collaborated, but most followed Torry's concept of whole fish freezing. The pilot-scale work on Torry's own vessel, by this time the *KEELBY*, was followed by a collaborative trial on a commercial vessel, the *NORTHERN WAVE*. This work was funded by the White Fish Authority, with whom Torry have frequently collaborated since their formation in 1951.

To conclude on freezing at sea, the UK industry adopted Torry's concept readily after appropriate consideration of the economics. The *LORD NELSON*, a part freezer trawler, was quickly followed by *JUNELLA* which froze its entire catch. In approximately a decade there were around 50 very similar vessels based on Humberside, although their introduction was not without some hiccups. One of my first jobs when I was based at the Humber Laboratory was to investigate flesh colour and other problems brought about by improper handling, prior to freezing. This work resulted in some amendment to the design of the processing deck of later vessels. It is a matter for conjecture but this concept of freezing fish at sea might have become yet more important but for political decisions which led to the loss of our traditional distant water fishing grounds. Without doubt, however, many of the principles involved were adopted too by overseas operators.

Having frozen fish it must, of course, be thawed, a difficult job on a commercial scale. Two different approaches were looked at by Torry. The first was air blast thawing using warm moist air. The second group of methods used electrical energy. For sea frozen blocks, dielectric thawing was developed and patented in 1960 and, for smaller scale use, for instance catering establishments, an electrical resistance thawer was designed soon afterwards. In the event for large scale thawing the former technique, air blast thawing, was found to be more satisfactory on the grounds of economics and such thawers employed many of the principles that had been developed for the Torry mechanical smoking kiln.

Soon after the War work resumed on mechanical smoking. This was in collaboration with commercial firms and one in particular succeeded in perfecting a design which has only very recently been modified. Even now many design features, developed earlier by Torry, are incorporated. For some years now, virtually all smoked fish in the UK and indeed other foods too, such as bacon, has been smoked in Torry kilns. Also many kilns have been exported abroad.

The large increase in staff after the War, which continued until the early 1960s, allowed a substantial increase in the effort on background work. This included biochemical and bacteriological studies of fish spoilage, resulting in a deeper understanding of the spoilage process. For instance, such work on the biochemical side resulted in improved methods for quality assessment such as hypoxanthine determination. James Shewan elaborated his organoleptic scoring system, which has still not been equalled as a quality assessment tool both in research and, in a modified form, in factory quality control and in EC grading. There was considerable effort too on the microbiological safety of fishery products, including studies of *Clostridium botulinum*, which have made Torry a centre of excellence in this area. Certain physical properties of fish were also studied and in particular its dielectric properties. As already mentioned, this work led to developments in the thawing of fish but also more recently the Torrymeter has been developed which allows the assessment of fish freshness. Such work also formed the basis for a much more recent development, the 'Malthus' automated bacterial analyser.

With the loss of our traditional distant water fishing grounds in the 1970s, icing became relatively more important once again. Also chilled fish at the retail level was again in vogue, not so much as presented by the traditional fishmonger but by supermarkets. This led to a demand for work on the pre-packaging of fish, a subject that was studied jointly with the White Fish Authority Industrial Development Unit (IDU). Later, Modified Atmosphere Packaging, a technique used in the Meat Industry, in which the CO_2 concentration in the pack is increased to extend the chilled shelf life of the product, was studied. This was, once again, in collaboration with the Sea Fish Industry Authority IDU, the restyled White Fish Authority. Incidentally, it is interesting to note that Reay used CO_2 before the War to extend storage life on board fishing vessels. At this point I should explain that a chill temperature (0°C) cod will give a shelf life of around 8-9 days and still retain a residual sweet characteristic flavour – score 7 on the Shewan scheme mentioned earlier. By using a Modified Atmosphere of 40% Carbon dioxide, 30% oxygen and 30% nitrogen in retail parks, an extra day or so of storage is possible; supermarkets find this is worthwhile and that it also provides an attractive presentation for marketing.

Space will not permit a full description of the more recent work at Torry or, indeed, the Sea Fish Industry Authority, but many of the earlier basic and applied studies have been extended. For instance, background studies on many of the finfish and shellfish species, available in UK waters, have been undertaken. Following on the work on freezing at sea, new freezing equipment for land-based operations has been developed – the Torry air blast freezer – which is now available commercially. Approximately 80 units have been sold by an Aberdeen based firm on a royalty arrangement with

Torry Research. Earlier work on fish meal and other by-products has been extended. In the area of product development, work has been done on minced fish and on fish gels (surimi) and on cook/freeze and cook/chill products.

Up to 5 or so years ago Torry was totally Government funded, but from 1985 an attempt has been made to sell research and development, analytical services and information to offset Government's contribution to the extent of 15%. In the latter two areas there has been particular success, although it has to be confessed that selling research to the fish industry, in common with the rest of the food industry, is not particularly easy. This, coupled with the more recent decision to transfer funding for 'near-market' research to industry, has already had its impact on the balance and make-up of the programme. There is no shortage, however, of problems in the fish and fishery products field in those areas for which government has now set the priorities for funding. These are to support its policy and legislation, to ensure the safety of food, to provide for the public good, to protect the consumer and to enable the underpinning or strategic research to support these objectives to be done. For some years now there has also been a need to back up various EC regulations and directives on, for example, the grading of fish related to marketing measures. With the forthcoming introduction of EC regulations for hygiene, covering the fish and fish processing industry, Torry are going to find themselves very much involved in this area. I will conclude, however, with a work of caution. Throughout its existence Torry has been very close to the fish industry and as such has done very considerable amounts of 'near-market' research. It is my contention that without this type of involvement with industry, the work of a research station can become misdirected. It will, therefore, take much skill for both management and those directly involved in the work at Torry to maintain the relevance of future programmes.

Reference material giving more information on this topic

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ON THE FOUNDATION OF ICES: A LOOK BEHIND THE SCENES AT THE EVENTS IN BRITAIN

Jens Smed

Plate 1. Jens Smed at Aalborg, September 1995. The ICES Hydrographer 1946-1984 and the recipient of the ICES History Award 1995.

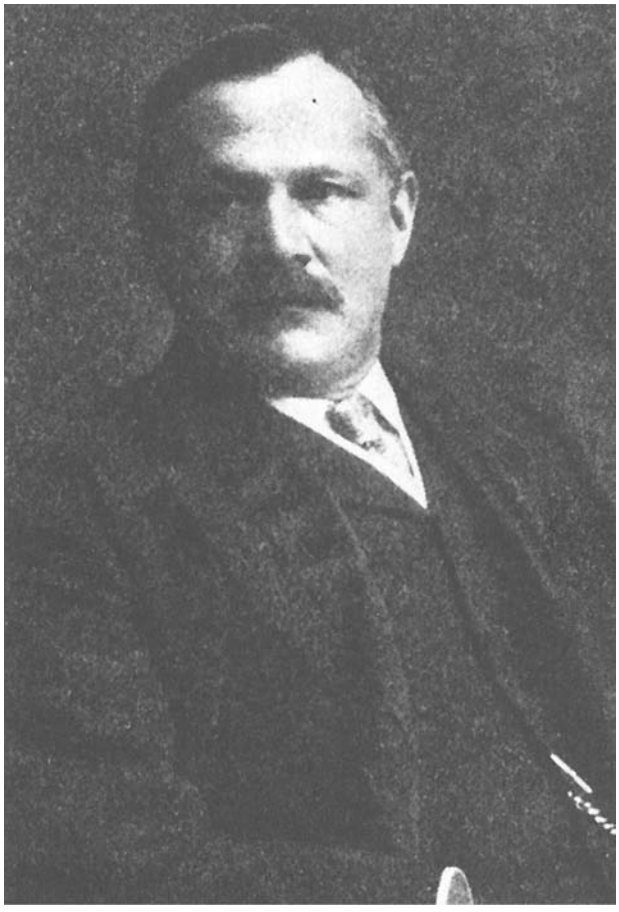

Plate 2. Walter Archer (see page 144).

ON THE FOUNDATION OF ICES: A LOOK BEHIND THE SCENES AT THE EVENTS IN BRITAIN

Jens Smed

In the last quarter of the nineteenth century the idea arose that there might be a connection between the occurrence of fish and the hydrographical (oceanographical) conditions. So when after 70 years absence, herring reappeared in the winter of 1877/78 on the west coast of Sweden, the Swedish Government asked the Swedish chemist Gustaf Ekman to carry out hydrographic observations on the fishing grounds (Ekman, 1878). It became obvious however, that such local investigations were not sufficient. So in February 1890 Ekman and his colleague Otto Pettersson organized an investigation of the Skagerrak and the northern part of the Kattegat by five Swedish ships (Pettersson and Ekman, 1891, pp.1-162). In this way the investigations could be undertaken in only a few days and thus a quasi-synoptic view of the hydrographic situation in the region obtained.

Pettersson realized, however, that the observations should be extended to the North Sea proper, and should be repeated regularly in order to study the seasonal variations and the variations from year to year. Consequently at the meeting of Scandinavian Naturalists at Copenhagen in 1892 he opened a discussion on the advantages that might be obtained by the hydrographic investigation of the North Sea, the Skagerrak and the Kattegat by co-operation between Scandinavian scientists (Anon., 1892, pp.171-183). The meeting approved Pettersson's proposal. To take care of the Swedish investigations the Swedish Academy of Sciences established a commission consisting of Pettersson, Ekman and Professor A. Wijkander. The joint investigation was carried out in May, August and November 1893 and February 1894. In fact, the co-operation was extended to include Germany and Scotland also, which made it possible to also cover the Baltic and a small part of the North Atlantic. The two last-mentioned countries did not participate in May 1893 but made observations in May 1894 instead (Smed, 1990, pp.357-366).

The results obtained were promising. It appeared, however, that further hydrographic studies would be of importance to the fishery research. There were also some ideas, especially expressed by Pettersson, that hydrographic observations might contribute to better weather prognoses. So Pettersson proposed a scheme for an international hydrographic survey of the Baltic, the North Sea and an adjacent part of the North Atlantic. He presented this scheme at meetings of relevant international bodies, such as the Sixth International Geographic Congress held in London in 1895 (Pettersson, 1895) which gave the scheme its blessing. This made the commission approach the Swedish government in 1897, and suggest the summoning of an international meeting for discussion of a plan for co-operation. The outcome was the Preparatory Conferences at Stockholm 1899 and at Kristiania (Oslo) 1901, which resulted in the foundation of the International Council for the Exploration of the Sea (ICES) in 1902.

The decisions and the short accounts of the discussions leading up to them are given in the minutes of the Conferences (Anon., 1899(a); Anon., 1901). What is not officially reported however, are the discussions that took place behind the scenes in the various countries in advance of, and in relation to, the Conferences. These often very outspoken discussions throw considerable light on the events leading up to the establishment of ICES and, as pointed out by Arthur Lee (1993, p.8), there is a need for such additional information.

In response to the application by the commission to the Swedish government the Swedish-Norwegian Ministry for Foreign Affairs sounded out the governments in what was described as the countries bordering the seas that surround the Scandinavian peninsula in regard to establishing international co-operation for the scientific exploration of the sea fisheries. According to the Swedish government the inquiry was favourably received by all parties [1].

Geographical institutions also expressed an interest: Hugh Robert Mill, Librarian of the Royal Geographical Society, London informed [2] Pettersson that he thought the Society should be able to do something to help with the international work. A meeting of the Society would be held in April (1898) when the Prince of Monaco would read a paper on oceanography. Sir John Murray and J. Y. Buchanan, both of them participants of the *CHALLENGER* expedition 1872-1876, would be there and possibly the question of international co-operation might be taken up. This did not happen however. According to Mill [3] the Prince spoke for two hours, so it was impossible to find time for any discussion, and Mill did not get an opportunity to talk to the Prince later on. He supposed that the Prince had been taken possession of by people not interested in oceanography or ignorant of the British students of that science! But Mill could report that Sir Clement Markham, the President of the Royal Geographical Society was greatly interested.

Apparently, however, the inquiry had not been too well received by the British government. Murray [4] at least was very annoyed and disappointed at the British reply. He knew that some of the officials were rather favourably inclined towards the proposal. "But we have at the Treasury some people who block every scientific proposal that involves an expenditure of money. They are especially afraid of me, or of any proposal that I may favour. They seem to think that if I once get another opportunity that I will run the country in for another *CHALLENGER* Expedition costing many, many thousands. I am quite disgusted with the way in which the Treasury people have treated me and I think the best thing I can do is to separate myself from all Government work and retire in my shell". Murray expressed the hope that Pettersson's proposals might be carried through and yield much new knowledge, and he would always assist if he could.

In April 1899, the Swedish government, though some of the governments had not yet been able to give their final views on the preliminary programme (Anon., 1899(a), pp.I-III) which had been submitted to them, felt that it should no longer defer the convocation of the planned conference, given the practical interest attached to a solution of the important questions involved and considering the desire expressed already. Consequently the Swedish government instructed[1] its ministers to address to the governments of Germany, Great Britain (with Ireland), Denmark, The Netherlands, and Russia a formal invitation to take part, by way of official delegates, in a conference which would open at Stockholm on 15 June 1899. That Norway is not mentioned in this context is due to the fact that in a way it was signatory to the invitation as this was sent out by the King and the Minister of Foreign Affairs, both of them at that time common to Sweden and Norway.

The conference would be charged with the elaboration of a plan for the joint exploration, in the interest of the sea fisheries, of the hydrographical and biological conditions of the Arctic Sea (including the Norwegian Sea), the North Sea, and the Baltic. The above mentioned preliminary programme would serve as a basis for the programme of work of the conference. It was understood, however, that during the conference the delegates would be free to discuss any questions of interest to sea fisheries and having relevance to the goal which the conference proposed to attain.

In June 1899 the Preparatory Conference was held at Stockholm. The British delegates were W. Archer, Inspector of Fisheries; D'Arcy W. Thompson, Professor at the University of Dundee; and Sir John Murray (Plates 2-4). As reported by Lee (1992, pp.36-38) the British government stressed

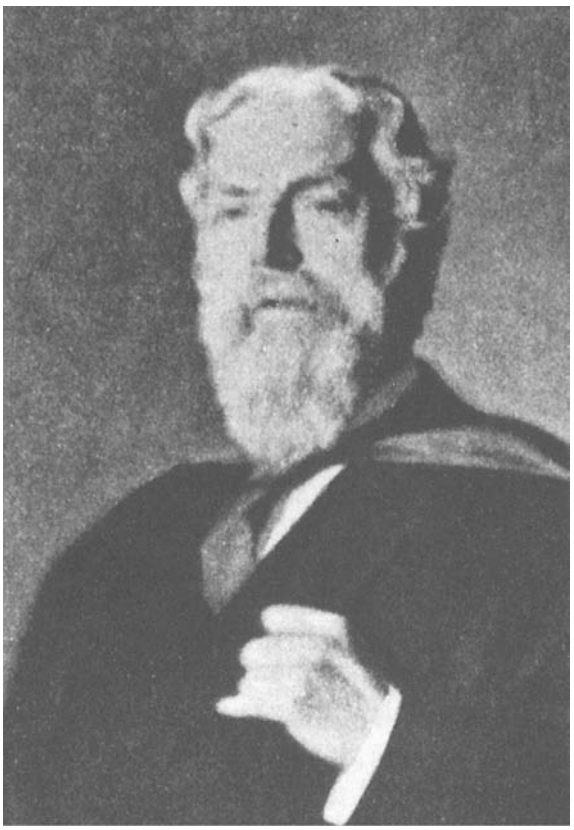

Plate 3. D'Arcy Wentworth Thompson.

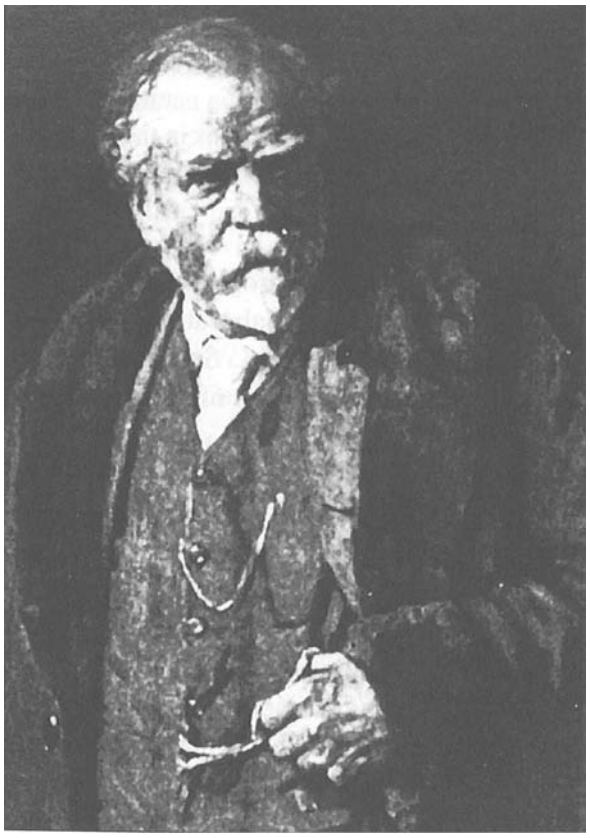

Plate 4. Sir John Murray.

that the outcome of the conference should be of practical value to the fisheries. So part of the instructions to the British delegation to the conference read as follows:

1. "You should propose that the scientific investigations shall be accompanied by a practical exposé of the steps to be taken in order to bring the exercise of seafishing more in accord with the natural conditions regulating the growth and increase of fish, and thus permanently increase the supply of fish in the markets of the countries adjoining the North Sea.

2. In making this proposal, which you should do at the outset, you should make it clear that the principal object which Her Majesty's Government have in view, in directing you to take part in the conference, is to secure a careful enquiry into the effect of the present methods of fishery in the North Sea and you should give every assistance in promoting a scheme for determining whether protection against overfishing is needed, and if so where, when and how should protection be given.

3. You should propose that a thorough scheme of obtaining statistical information with regard to the quantity and quality of fish caught by the various methods of fishery shall be organized, with a view of determining whether protection against overfishing is needed either by the prohibition of trawling in certain selected areas or the limitation of fishery during certain selected seasons."

The importance that the British delegation attached to the fisheries aspect of the conference was underlined when D'Arcy Thompson proposed, after it had been decided to establish a central organization, that the following paragraph be inserted in the report of the Conference (Anon., 1899(a), p.XLI):

> "That in all researches, whether hydrographical or biological, undertaken by the National Institutions or by the Central Organisation, it be recognized as a primary object to estimate the quantity of Fish available for the use of man, to record the variations in its amount from place to place and from time to time, to ascribe natural variations to their natural causes, and to determine whether or how far variations in the available stock are caused by the operations of man, and, if so, whether, when, or how, measures of restriction and protection should be applied".

It is obvious that whereas a detailed hydrographic programme was set up by the Conference the biological and fisheries matters were by no means elaborated to the same degree. It was felt that both time and the necessary preparation were lacking. So the programme was agreed upon in a more general form, in order that unanimous acceptance of it might be arrived at.

An internal German report (Smed, 1989, p.6) intimates that there was some difference of opinion within the British delegation, especially that Murray disagreed with his colleagues with regard to the practical application of the results as far as the management of fisheries was concerned. In his report [(5)] to the German Reichskanzler on the Conference the Head of the German delegation, Walther Herwig, relates one example of this disagreement. Herwig had suggested an introductory remark to the preamble, suggesting that the knowledge of the hydrographical and biological conditions in the Northern seas was not yet sufficient to form a safe basis for general legal and political agreements concerning sea-fishery. John Murray agreed completely in this. It was therefore very surprising when he later had to state that, although he had not changed his mind, the other British delegates could not accept the formulation suggested by Herwig under any circumstances.

After long discussions a preamble was agreed upon in which was said, i.a., "that a rational exploitation of the sea should rest as far as possible on scientific enquiry" and that "in the execution of the

investigations it (should) be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements". This obviously caused Herwig to indulge in a fit of sulks towards part of the British delegation. He reported in a caustic way that at least a part of the delegation appeared to feel mainly called upon to supervise the other part.

As the British delegates did not give any explanation of their objection Herwig tried to find one himself. He found it in certain fisheries problems in Great Britain, viz., the clash of interests between trawl-fishermen and line-fishermen. Because of the great economic importance of the British sea-fishery this clash became a political factor. Each sector urgently requested that severe measures be taken, which, however, might ruin the other part. The government had not yet taken sides and had explained this attitude by the need to wait for the results of the expected Stockholm Conference. A Conference resolution to the effect that honest science could not play this role of an oracle would therefore not fit into British policy.

As the British government had stressed that they wished the Conference to come up with a programme of direct importance to fisheries it is no wonder that they considered the outcome as unsatisfactory. The reaction of the government on the recommendations of the Conference appears in a letter [(6)] from D'Arcy Thompson to Otto Pettersson: "The government will so far accept the proposals of the Conference as to become a party to the establishment of an International Council that they will sent two representatives to this International Council, and pay their proportion (not exceeding £925 per annum) of the expenses of the Central Bureau for two years – all this on condition that the International Council shall make arrangements for a résumé of past works and statistics, and shall before the end of two years submit a new programme of investigation likely to be of practical benefit to the fisheries". D'Arcy Thompson explains:

> "You will see from this that our Government are not willing in the meantime to spend money on actual research. This is due to many causes. The cost of the war is perhaps one. The criticism our proposals have received, especially from the Plymouth people, is probably another. The imperfect organization of the Fishery Department in England (as opposed to Scotland) is a third. But I am still hopeful that the matter is only postponed and that in time all will go well. I have repeatedly urged on the Government that if our Scottish Fishery Board were supplied with a new and larger ship, we could do <u>our</u> share in the programme of investigation without further cost. But as yet we cannot get the new ship. I shall not cease to work until we do get it".

As a matter of fact their vessel *GARLAND* had been pronounced unseaworthy (Lee, 1992, p.39). D'Arcy Thompson summed up his opinion:

> "The whole matter is somewhat discouraging, but I am very glad it is not worse".

John Murray is more critical, as is seen from his letter [(7)] to Robert Irvine of Granton. The letter was copied (confidentially) to Otto Pettersson. It says in it:

> "The reply of Lord Salisbury (The British Prime Minister) is extremely unsatisfactory, and, in my opinion, discreditable to the government of Great Britain".

Murray had been told that much correspondence had passed between the Fishery Board for Scotland and the Fisheries Department of the Board of Trade concerning the reply that should be sent to the Swedish government and that there was considerable difference of opinion between these two bodies. Murray had understood that the Foreign Office refused to reply in terms of the first draft laid before them, because these were too indefinite. Murray thought the reply that had been sent

was apparently some compromise concocted by D'Arcy Thompson, Archer and Sir Courtenay Boyle, the Permanent Secretary of the Board of Trade. His letter continues:

> "The Conference pointed out distinctly the nature, scope, and duration of the researches which the British Government would be expected to undertake, and there is no more difficulty in our Government estimating the outlay involved in carrying out this work than there has been in the case of Germany, Denmark, Sweden, and Norway, who have already accepted the programme. Our Government evidently do not wish to spend the money for the ships, officers, naturalists, etc., necessary to carry out the scientific researches allotted to them in the co-operation, but they would like, all the same, to reap the benefit following from any such researches.
>
> The distinction in Lord Salisbury's letter, between 'a scheme of investigations which would result in the acquisition of information of practical advantage to the fishing interests of this country' and 'information of a purely scientific value' indicates a very muddled state of mind with regard to all the problems under discussion, and 'no fellow' can understand what is meant by their offer to send two representatives to the International Council and to pay towards the expenses of the Bureau a sum of £1850 for a period of two years. This is an absurd proposal, and should be rejected by the other countries.
>
> This reply of Lord Salisbury must be taken as a refusal on the part of Great Britain to join with the other Powers in carrying out the programme of the Stockholm Conference. The Swedish Government in their reply should say that they very much regret that the British Government cannot see their way to join with the other North Sea States in a scientific exploration of the North Sea for a period of five years, with the view of obtaining information on which International Fishery Regulations in the North Sea might be based, in accordance with the recommendations of the Stockholm Conference. The Swedish Government should also intimate that they propose to call together the delegates mentioned in par. H (an interim organ which might be useful in constituting the Council and the Central Bureau) whose Governments have accepted the programme, to determine what steps should be taken in the altered conditions brought about by the declination of Her Majesty's Government to co-operate. When the Swedish Government have sent their reply, we will get a Member of Parliament to move for copies of the correspondence with reference to this Conference".

Also Otto Pettersson, who had got a copy of Lord Salisbury's letter, was surprised that although the British would participate in the expenses as proposed by the Conference – though for two years only – they did not mention anything about the investigations. "Do they think they can content themselves with contributing to the administration without carrying out investigations and supplying material," he writes [8] to Nansen. He suggested that in order to arrive at an understanding the interim commission set up at the Stockholm Conference should be summoned. He was aware that the practical fishery questions were neglected at the Conference and an agreement on this matter should therefore be obtained at the meeting of the commission.

As a matter of fact Pettersson had proposed several times to Nansen that Norway should invite the next international conference to Kristiania (Nansen, 1900). In a private letter Pettersson had invited the Swedish-Norwegian minister in London, Carl Lewenhaupt to ask the British government whether they would accept that the next conference be held at Kristiania, an application which had got a favourable reply [9]. When informed [10] about this Nansen found [11] it would seem to indicate that Great Britain would participate in the investigations as he took it that they could not contribute to the Central Bureau without also doing their part of the work. He too, however, found Lord Salisbury's reply, of which he received a copy from Pettersson, a strange one [12]. He commented that to some degree the British had their own delegates to the Conference, i.e. Archer and D'Arcy Thompson,

to thank for the fact that the biological programme did not become very detailed.

There was considerable discussion among the biologists in England when the resolutions passed at the Stockholm Conference were published in the periodical *Nature* (Anon., 1899(c), pp.34-37). E. J. Allen of the Plymouth Laboratory of the Marine Biological Association, (Allen, 1899(a), p.54), while generally favourably disposed towards the plans of the Conference, suggested that the hydrographical investigations should be extended to include the English Channel, the Irish Sea and the western coasts of the British Isles. He noted that this was of importance also when considering the North Sea fisheries as it had been clearly demonstrated that Channel water enters the southern North Sea, and the fauna of this region had been shown to be an extension of the Channel fauna. Allen was somewhat sceptical with regard to an elaborate and expensive organisation with a central bureau and a central laboratory as proposed by the Stockholm Conference. He considered that an international Council, composed chiefly of the experts actually responsible for carrying out the investigations and meeting once a year would be an adequate arrangement for co-ordinating the investigations of the different countries.

W. A. Herdman, Liverpool was considerably more critical (Herdman, 1899(a), p.78) and characterised the report of the Conference as a disappointing document in some respects. He found that the primary, biological investigations were passed over lightly in the report whereas the secondary, physico-chemical work in the central bureau was strongly recommended. It had been anticipated, he said, that the report "would contain strong recommendations to the Governments concerned involving the use of sufficient boats and men to carry out a definite scheme of biological investigations during a definite period". The report however, said nothing about this. "In place of asking for boats and men, it urges the establishment of a 'central bureau', in which the work will apparently in large part be that of a physico-chemical laboratory". Herdman concluded by stating that in his opinion "what we want at the present time is not conferences, or committees, or a central bureau, so much as boats and men, and work at sea".

These 'letters to the editor' of *Nature* caused H. M. Kyle to enter into the discussion (Kyle, 1899, pp. 151-152) defending the decisions of the Stockholm Conference. He pointed out that if more stress was laid on the hydrographical work than on the biological the reason was that the biological investigations of the fisheries in the North Sea were in certain respects in a more advanced state than the hydrographical research. Some biological investigations could not be followed up because of lack of knowledge about temperature, salinity, currents and so on. Hence, biologists should welcome hydrographic work, and not object to its seemingly greater prominence. Furthermore, this work was not intended to hinder the prosecution of strictly biological research.

The polemics were continued by Herdman (1899(b), p.177) and Allen (1899(b), p.227), the latter still sceptical with regard to the justification for establishing a central bureau with a central laboratory: "All past experience has shown that the British Government is very reluctant to spend money upon scientific investigations of any kind....". It is therefore of the utmost importance, he argued, that what money is spent should be put to the best possible use, and he could not see any justification for using a considerable sum of money on a new organisation with a new laboratory. This does not mean that Allen was not co-operative. When in a letter [13] to the Swedish Hydrographic Commission he acknowledged receipt of an account of the exploration of the Atlantic Ocean during the years 1898-1899 he added: "I shall always regard it as a duty to assist such investigations by every means in my power".

Allen was sympathetic towards the International Council, participated in some of the Statutory Meetings and supplied data to its publications. Herdman on the contrary, for many years opposed the Council. As late as in 1907 E. W. L. Holt, Dublin in a private letter [14] to Martin Knudsen, editor of the Council's *Bulletin Trimestriel des Résultats* wrote:

> "Among the physical observations which are being sent to you you will find some which were communicated to me by Mr. Johnstone, with whom I have made arrangement for joint hydrographic cruises at the future quarterly periods. Professor Herdman has some sort of authority over Mr. Johnstone and as he (Herdman) has lately been conducting a campaign against the International Researches I am not sure that he would approve of Johnstone's communicating his results to the International Bureau. Therefore unless he or Herdman sends you the results direct it might be as well not to mention Mr. Johnstone's name".

In 1912 an attempt at reconciliation with Herdman and the people of the Marine Biological Association was planned. Pettersson had suggested to the Council's President, W. E. Archer that H. H. Gran of Norway be invited as an expert to the Council meeting in April. Archer was not against this idea; however, he then wanted to invite also Herdman and another British scientist [15]. His intention with this was to pacify the Marine Biological Association. Otto Pettersson doubted that the people of the Association would easily become friends of the Council; but Archer stated that he had now got a greater appropriation, and he had let Herdman have a certain amount of this. "Everything in England appears to be a question of money, and Archer buys the followers he thinks that he needs", Pettersson comments, and he did not have much sympathy for Archer's methods.

With regard to Herdman, Pettersson thought that he had materialized spirits which he could not control. According to Pettersson, Herdman was a distinguished naturalist who was not cast for playing any other role in the Council. However, Pettersson did not object to Herdman's admission and he agreed that there was a need for new blood in the Council. It was then decided [16] that Gran would be invited by the General Secretary, C. F. Drechsel, whereas Archer would invite the English guests. In case Herdman should attend the meeting everybody would have to do his best to bring about a reconciliation, Drechsel said: a grand 'reconciliation feast' would perhaps not be amiss! Nothing came of it, however, for neither Gran nor Herdman attended the meeting. Later on Herdman obviously changed his mind. In 1920 Otto Pedersson could report [17] that Herdman from being an antagonist to the Council had become its most ardent supporter.

Reverting now to the year 1900: with regard to oceanography there were more positive news, even conversions to report, according to Mill [18].

> "One good thing is that Markham is now one of the keenest advocates of oceanography I have ever known. The change is like the conversion of St. Paul, for beforehand he was actually a persecutor! Now he has taken to writing epistles to the Admiralty and other communities of unbelievers".

It was the intention to have the next conference in October 1900. With a view to this Murray [19] informed Pettersson that he would not be able to participate as he was departing for Christmas Island. If he had been at home however, he would have come if Pettersson so wished, whether the government had appointed him or not. Murray stated that he had given the Foreign Office officials a piece of his mind about the reply they sent the Swedish government. The answer he got from them had been to this effect:

> "The secret of the situation is that what with the war and other expenses the Treasury would flatly refuse to grant a large sum of money at the present moment for investigations. So

> you must blame Hicks-Beach (Chancellor of the Exchequer) and his myrmidons. There is absolutely no arrière-pensée about the position we are taking up. No Machiavellian desire to see other countries pull the chestnuts out of the fire for us! It is merely L.S.D".

To this Murray had replied that it would have been better to have said this in the communication to the Swedish minister. Murray concluded that this was the result of war, which was always bad for science. (The war referred to is the Boer War in South Africa.)

In connection with Murray's criticism of his government's lack of interest in science it may be appropriate to quote from a contemporary note in *Nature* (Anon., 1899(b), p.37) though it was related to quite another context:

> "science, and especially the latest developments of science, are the last things to interest our Government and the Government Departments; they do not believe in science, they care to know very little about it, and the scientific spirit is absent from too many of their plans and doings".

Murray may finally have become appeased to the official policy. At least he does not seem to have come over for the Kristiania Conference which had been postponed until May 1901 when he was back from his travels.

The British representatives at the Conference were Sir Colin Scott Moncrieff, Under-Secretary of State for Scotland; W. Garstang, of the Marine Biological Association's Laboratory at Plymouth; D'Arcy Thompson; and H. R. Mill (Anon., 1901). In advance of the Conference the latter wrote[20] to Otto Pettersson that he might be tempted to resign his nomination in favour of H. N. Dickson, whom he considered to be much more in touch with the special work. But Mill had reason to believe that Dickson would not be appointed in his case if he did so.

As the hydrographical programme had been worked out in detail already at the Stockholm Conference the changes made in it at Kristiania were mainly editorial only. The biological and fishery programmes, however, which had been somewhat neglected at Stockholm were now elaborated to a much higher degree: they took up four times as much space as in the Stockholm version.

There was much uncertainty as to whether the British government would accept the new programmes and commit itself to co-operate. In July 1901 Mill [21] informed Otto Pettersson that he had heard nothing yet as to the action which his government would take but he thought the signs were hopeful. A month later however, he was much less optimistic[22]. He had heard no more about the position of the government in the North Sea business. But from the long delay he feared the worst, and also Scott Moncrieff was very pessimistic. It would be deplorable in a high degree if nothing was done, Mill felt.

In the end, however, the British Cabinet decided (Lee, 1992, p.40) that the country should play a full part in the investigations proposed. In January 1902 the Foreign Office informed the Swedish and Norwegian governments that Great Britain agreed to the decisions reached by the two Conferences. To cover the British part of the expenses involved in running the Central Bureau an amount of £38,000 for a 3-year period would be applied for in Parliament. Application would also be made for grants allowing the hire of two steamers for participation in the investigations (Anon., 1903(a)). Shortly after the Danish government was notified and at the same time asked for the date of the forthcoming founding meeting [23].

Information about the British decision caused considerable relief among the other countries. In view of Great Britain's geographical position its participation in the he investigations was of the greatest importance, as stressed by Nansen (1902) in a letter to H. R. Mill:

> "How glad I am that England has come forward so splendidly as to the International Oceanographical Research. I congratulate you most heartily, but I congratulate also ourselves for I have always considered that British investigations (on the Wyville Thomson Ridge and in the Atlantic) would be of most importance to us. And now I understand that they will be started at a proper scale. I feel also certain that the men for it, understanding what is wanted, may be found, or they may easily get the training necessary, for it is actually very simple. I do not doubt that the work will be a great success".

At the Kristiania Conference it had been decided to propose to the governments that Copenhagen should be the seat of the organization to be established. The Danish government, with the agreement of the governments of Germany, Great Britain, Denmark, Norway, The Netherlands, Russia and Sweden, and the Senate of Finland, then summoned a meeting of delegates from these countries to Copenhagen where the International Council for the Exploration of the Sea would, at long last, be founded on 22 July 1902 (Anon., 1903(b)).

Acknowledgement

I am greatly indebted to the late Arthur Lee for valuable comments on my manuscript which was written in response to his article in the ICES/CIEM Information.

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22. Letter of 15 August 1901 from H. R. Mill to Otto Pettersson.

23. Letter of 5 February 1902 from the British Legation at Copenhagen to the Danish Prime Minister. Copy archived as 1 above.

THE REVEREND W. S. GREEN: A PIONEER IN FISHERIES RESEARCH AND DEVELOPMENT

Christopher Moriarty

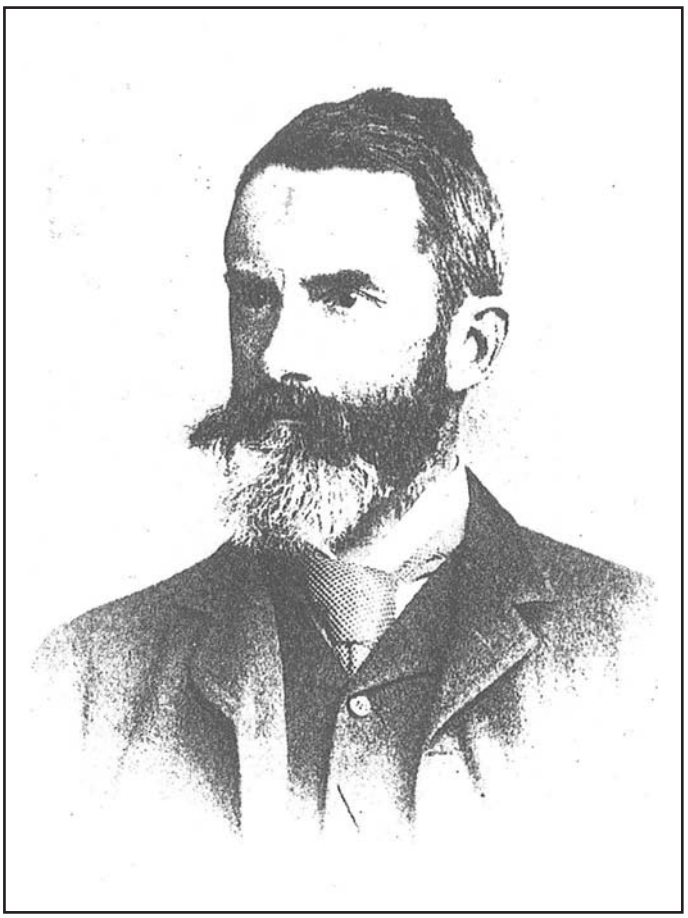

Plate 1. William Spotswood Green CB MA.

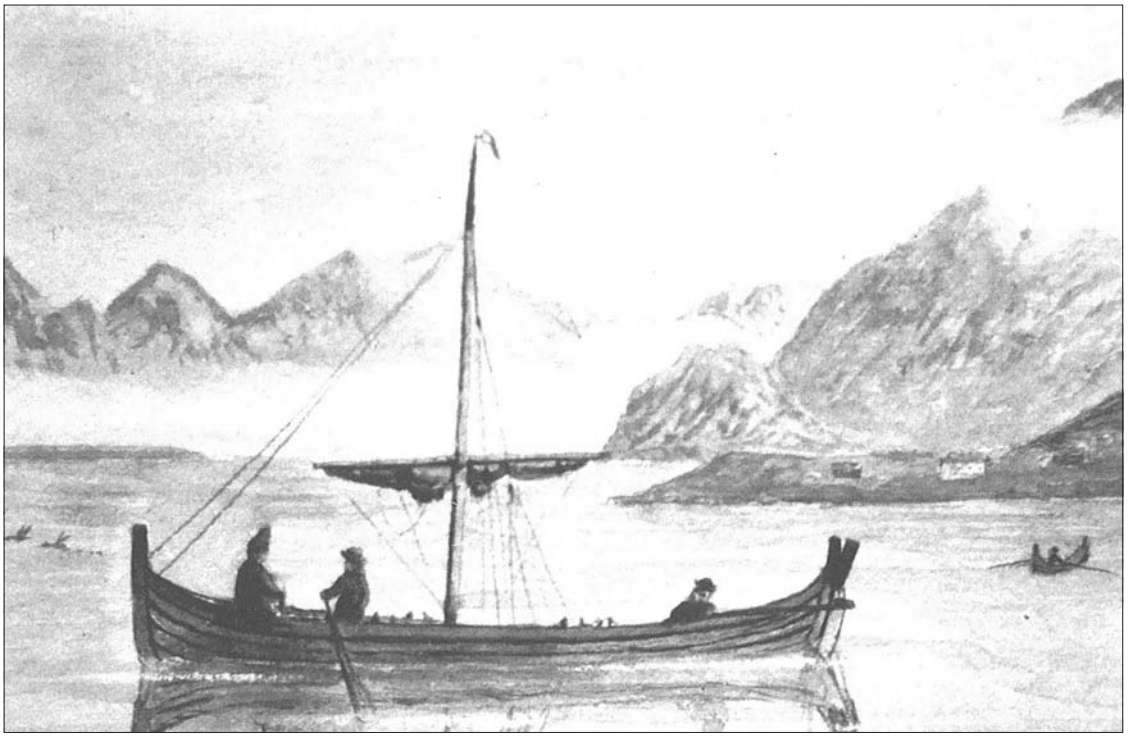

Plate 2. Watercolour of a yawl at Lofoten painted by Green on a visit in 1871.

THE REVEREND W. S. GREEN: A PIONEER IN FISHERIES RESEARCH AND DEVELOPMENT

This paper was first presented to participants at the ICES Annual Statutory meeting in Dublin in 1993. Following the inclusion of additional material it was read at a meeting of the National Committee for the History and Philosophy of Science of the Royal Irish Academy in March 1994.

Christopher Moriarty
Fisheries Research Centre, Abbotstown, Dublin 15, Ireland

William Spotswood Green was one of the giants of research and development in Ireland and a figure of considerable international significance in nineteenth century exploration (Plate 1). The Royal Dublin Society conferred its rare distinction of honorary membership and the Royal Irish Academy in due course elected him a member. The fact that both organisations saw fit to honour Green illustrates very neatly his prowess both in applied and academic science. He has been the subject of a number of memoirs and he also published extensively, both technical reports and popular books. My aim is to correct some small errors in previously published accounts of his life and work and, more importantly, to use unpublished sources which show that, rather than being a country clergyman who happened to be drawn into science and scientific administration, he was a scientist whose first professional appointment was as a minister of religion.

R F Scharff, keeper of natural history in the National Museum of Ireland, published an obituary notice of Green in *The Irish Naturalist* (1919). It is the first appraisal of his life and work and gives the views of a near contemporary. Robert Lloyd Praeger (1937) devotes some pages of *The Way That I Went* to an account of the man and his achievements, again based largely on personal knowledge but in this case by an author nearly twenty years younger, writing eighteen years after Green's death in 1919. Praeger's observations are probably the most widely used source of information. The most recent biographical paper is that by Arthur Went (1967). This is based on published material and includes a valuable reference list. Went had worked for some years under Charles Green, the only son of William Spotswood.

In 1990 I contributed a brief essay on Green to the Royal Irish Academy's *More people and places in Irish science and technology* (Moriarty, 1990) and in 1993 enlarged on this in an informal talk to members of the International Council for the Exploration of the Sea at its meeting in Dublin. Research for that talk brought me up against two facts. The first was that there were significant gaps in the published material on Green's life prior to 1885. This posed the question of how in that year he had suddenly appeared to be a sufficiently well-known figure for the Royal Irish Academy to entrust him with the organisation of the first serious exploration of the fauna of Ireland's offshore waters. The second fact was that, although the Royal Irish Academy and the Royal Dublin Society possess little or no unpublished material, many of Green's manuscripts, watercolours and photographs exist in private collections.

In the winter 1993-94, I had the great pleasure of meeting Molly Friel, who was married to a grandson of Green's, and Belinda Baldock, who is a grand-daughter. Belinda Baldock lives less than a mile from West Cove, the house by the sea which Green used as a base for some of his work for the Congested Districts Board and where he lived after his retirement. She and Molly Friel both have extensive material including watercolour paintings, diaries and details of the family history. They helped me to fill some of the gaps and also left me with the knowledge that this paper cannot do full justice to its subject. Green undoubtedly deserves a full biography.

The major source of information lies in his own publications. There is voluminous material on the marine fauna and fishery expeditions in the nineteenth century, published by the sponsoring bodies. On his two major mountain explorations, he wrote first a scientific paper and secondly a general book. Following his appointment as chief inspector of fisheries in 1900, he himself wrote substantial portions of the annual fisheries reports of the Department of Agriculture and Technical Instruction for Ireland. He also wrote two very valuable essays on the history and the present state of Irish fisheries early in the twentieth century. As it happened, that was the vital period when fisheries were changing from sail to steam and when the likelihood of universal overfishing arose for the first time in human history.

My paper is based primarily on Green's own writings, then on Praeger's and Went's accounts. I have been able to make some additions based on manuscript material which, I hope, will give a broader impression of the man and his work.

A family history of the Greens in Ireland by H. B. Swanzy and T. G. H. Green was privately printed (1902). It traces the ancestry to a merchant, Simon Green, born in Youghal about 1660 and believed to be the descendant of settlers who arrived at the end of the sixteenth century. Our William Spotswood belonged to the fifth generation and his father, Charles, was also a merchant of Youghal. It is said that the silting up of Youghal Harbour and its consequent decline in commerce ended the family business. Charles Green the merchant, however, was evidently a wealthy man. His house was so close to the sea that its dining room was flooded occasionally by high water – which no doubt contributed to WSG's affinity for the sea. He was born on 10 September 1847.

He seems to have had a very happy childhood and his obsession with boats, the sea and fishing began early in life. At twelve years old, he was sent to boarding school in Dublin and the choice of school was excellent. It was a private establishment, owned by Charles Benson, an enthusiastic naturalist who gave his pupils every encouragement to study wildlife. Green's first written observations on natural history date from this period.

Pasted into a later diary, there is a page, dated 1860, giving a list of shells which he had collected in Youghal. Significant in being very much more than a catalogue of a collection, it describes the substrates and relative numbers of each species. It becomes clear at this stage that we are dealing with a biologist and not just a collector. Benson may have been influential in this, but there are also diary references to help from his mother in shore collecting. Influenced by the publications of Philip Henry Gosse, collection of marine fauna and the keeping of aquaria were extremely popular pursuits at the time and Green became an addict.

He spent one or two years at Benson's school and then went to Midleton College. An article in the school magazine describes how he built a small raft to explore a partially submerged cave in the school grounds (Hutchinson, 1964). Diaries from this time, beginning in 1865, are in the possession of Belinda Baldock. The first one is entitled 'Diary of my aquarium' and is a record of observations on the animals in three tanks, located in various parts of his home. There are water colour illustrations of some of the species. He mentions that he owned a microscope and in November 1866 there is a record of his dredging in Youghal Bay. He also tried and failed to rear young nightjars but had some success with stock doves.

Green entered Trinity College on 1 July 1867, aged nineteen years and is registered as a Fellow Commoner. Fellow Commoners paid high fees and enjoyed special privileges, including exemption from lectures and from many examinations. His career, according to Went, was undistinguished – which is true in the sense that he received no special awards. His course work may have been

less than assiduous. The College records include many blank spaces opposite his name where one would have expected to find exam. results or details of attendance at lectures.

During this time the diaries record visits to the seashore in Dublin Bay – the Bull and Booterstown in 1866 and 1868 – to collect specimens and water for the aquarium. His companions on these trips included members of the Ball family, who were close friends and eminent members of the scientific community in Dublin. On 9 February 1869, Green went for a week's cruise 'in one of Mr Good's trawlers' in Dublin Bay, starting from Ringsend and there are other references to sea trips.

The Trinity College records reveal that in the Hilary Term of 1870, Green's courses included experimental physics, logic and maths-physics. Apparently his degree was in science rather than in arts. Dublin University awards a BA for both – which may have led to the supposition that Green was not a trained scientist. In the same year he travelled to the Swiss Alps and climbed Monte Rosa. On his journey to Switzerland he spent some days in Paris and made two visits to the Louvre – a reminder that he was a painter as well as a scientist. This was an adventurous holiday rather than a scientific expedition, but diary and watercolours give an interesting picture of travel at the time. It must be said, however, that Green's diaries are largely concise observations of where he went and how he travelled.

The following year, 1871, his degree was conferred on 28 June and three days later he set off for a visit to Norway. Diaries and sketchbook describe a visit to the Lofoten Islands (Plate 2). They give an outline of the trip and occasional glimpses of the life of the islanders, but are more concerned with describing the birds and the fishing craft which he saw. As in the case of the Alpine trip, this seems to have been undertaken in search of adventure rather than in the pursuit of science.

In 1872 he was ordained a deacon of the Church of Ireland. In 1873 he was ordained to the priesthood and travelled extensively in France, Italy, Austria and Germany. And then, in 1874, an element of settled life was introduced, on his appointment as curate of Kenmare. A sketchbook records an 'oceanographical cruise' in the yacht *PRIMA DONNA* in the same year.

Two references record his marriage to a cousin, Belinda Beatty Butler in 1875. Belinda's father, James Butler, was Green's uncle by marriage, so she was not a blood relation. There was a much more important connection: James Butler owned the valuable salmon and sea trout fishery on the Cummeragh River, near Waterville in County Kerry. The Greens had a son and five daughters. The son, Charles, born in 1876 accompanied his father on some notable cruises, had a distinguished academic career and ultimately became inspector of fisheries.

In 1877 Green temporarily abandoned his parish, his wife and his infant children for another journey, this time to the West Indies and to explore the Orinoco delta. The same year the family moved to Carrigaline on his appointment first as curate and subsequently as rector. One more holiday appears in the diaries, a second visit to the Swiss Alps and after that his life as an explorer seems to have taken a more serious turn – to scientific observer rather than simple adventurer.

Praeger's observation on a country clergyman's period of sick-leave deserves quotation in full:

> Never robust, he was advised not to spend the winter of 1881-82 in Ireland, and when he discovered that Mount Cook, the highest of the New Zealand Alps, had never been climbed and that its ascent was considered impracticable, he naturally went out and climbed it.

One certainly has to question Praeger's description of his friend as 'never robust' – all the evidence is that Green was positively rugged. He did suffer from time to time from bronchial trouble, but between these bouts constantly displayed exceptional energy and stamina.

The trip to New Zealand was the subject of Green's first official contact with the Royal Irish Academy – he wrote to request a grant of £50 towards exploring its glaciers. The Academy advanced £30 which, no doubt, was better than nothing. Green provided an excellent paper on his exploration which was published in their *Transactions*. He also contributed a paper to the *Alpine Journal.* Green, with two Swiss companions, failed by a narrow margin to reach the summit of Mount Cook, having been overtaken by bad weather in the final stages of the ascent. They also faced a time constraint. In spite of Green's decision to abandon the final attempt on the summit, the team came close to death when forced to shelter overnight standing on a narrow ridge. Failure to climb to the peak, however, was of little consequence in an expedition which had set out to describe and map the mountain and its glaciers, and the publications were evidence of its overall success.

An important aspect of Green's academic outlook comes to light after his scientific publications on Mount Cook. In 1883 he completed a travel book on the expedition. Throughout his life he continued to write popular accounts of his work, believing strongly in the need to spread scientific information as widely as possible.

The year 1885 saw the Royal Irish Academy's initiative in beginning the study of the offshore marine fauna of Ireland. The Council Minutes record agreement to make a grant of £50 to a Committee consisting of Professor E. P. Wright, A. Haddon, W. J. Sollas, H. W. Mackintosh, Percy Sladen, Joseph Wright and Dr Malcolmson for a report on the deep sea dredging off the entrance to Bantry Bay. A. C. Haddon had been appointed Professor of Zoology in the Royal University in 1880. In February 1886 he read a report of the deep sea dredging to the Academy. His report (Haddon, 1886) begins with the words:

> To Dr E. Perceval Wright is due the credit of forming a Committee to investigate the Fauna of the hundred fathom line off the southwest coast of Ireland.

Haddon continues:

> Most fortunately the Committee was able to secure the services of the Rev W. S. Green, whose enthusiasm in dredging operations is unbounded. His practical and topical knowledge justified the Committee in leaving him to make all the local arrangements.

Wright had been professor of botany in Dublin University since 1869 and would presumably have known Green in his student days and been fully aware of his interests in marine biology. Green's Alpine expedition and the publication of its observations in its *Transactions* would have ensured that the Academy was fully aware of his abilities.

The 'local arrangements' mentioned by Haddon included finding and hiring a steam-powered paddle-driven tug, the *LORD BRANDON* (Plate 3). The team spent a week at the beginning of August 1885 dredging in water down to 120 fathoms. Praeger (1949) includes a photograph of them in *Some Irish Naturalists.*

In 1886, a more ambitious trip was made, with government finance and a direction that the first set of all specimens must be deposited in the Science and Art Museum, Dublin. This trip succeeded in operating the dredge at 325 fathoms. Two years later, in 1888 a third expedition succeeded in

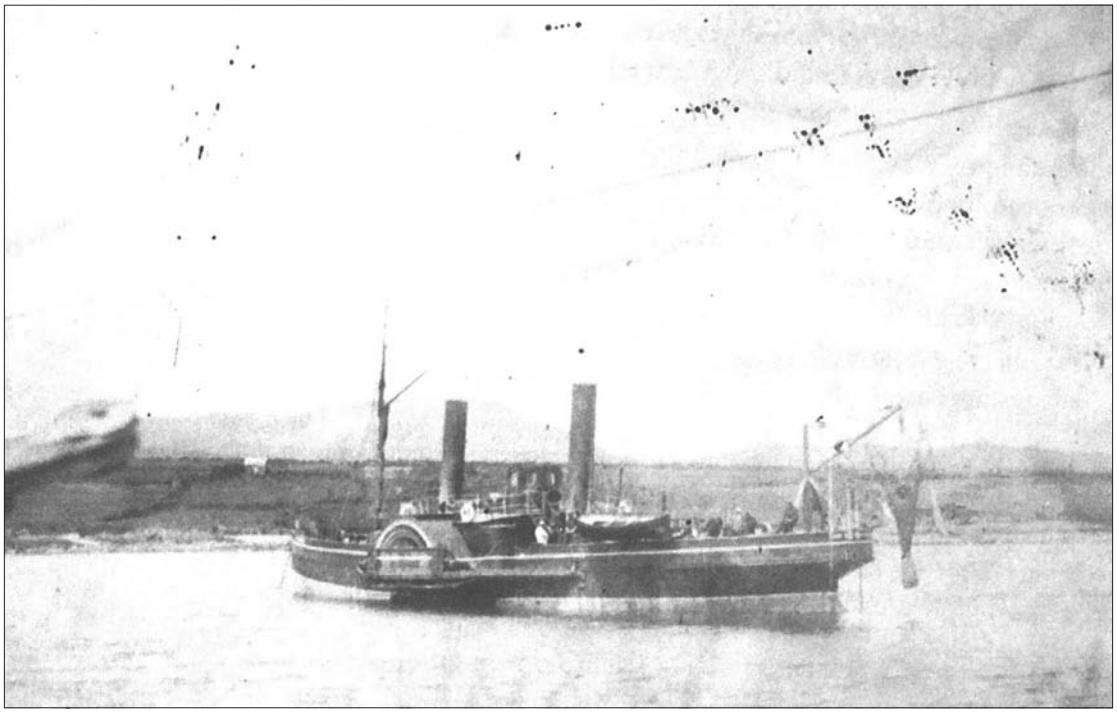

Plate 3. *LORD BRANDON* later named *FLYING FALCON.*

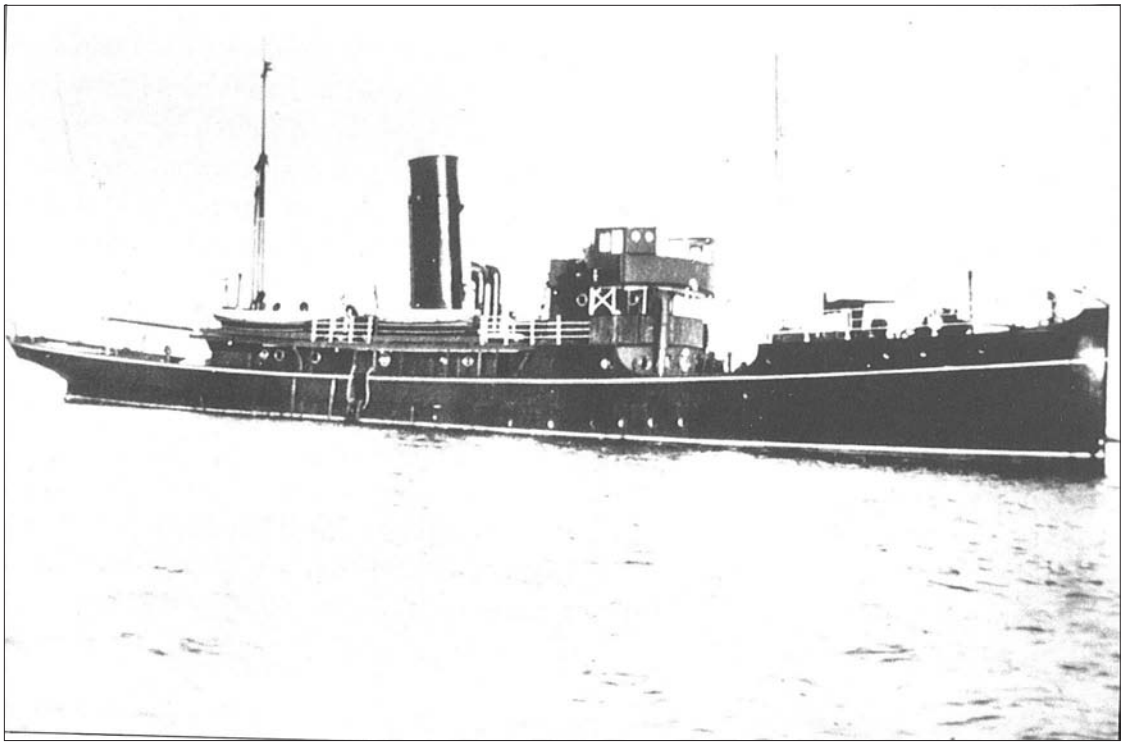

Plate 4. *HELGA II.*

dredging down to more than 1000 fathoms. It was another occasion of near disaster for Green who – as ever – came up smiling. The ship had been seriously damaged and Green injured. In spite of this he had stayed up through the night helping the skipper at the wheel.

While the Academy's zoological expeditions were in progress, the Royal Dublin Society had set up a fisheries committee early in 1887. George Francis FitzGerald, a college contemporary of Green's, was an influential member and A. C. Haddon appears again. The committee was charged with the duty

> of collecting information about Sea Fisheries in the south and south-west of Ireland, and suggesting how the Fishing Industry in Ireland could best be promoted.
>
> In order to gain the requisite information, preparatory to arriving at a decision in such matters, two courses are open — the one publicly to solicit evidence in the manner of Government commissions; the other for one individual to collect information on the spot. While the former method has undoubted advantages, your Committee resolved to adopt the latter, owing to the fact of several Royal Commissions having already reported on the subject.

There is something all too familiar in the Society's view of government commissions of enquiry. The report of the Committee continues:

> With this in view, the Committee entrusted the duty of collecting and sifting evidence to the Rev. W. S. Green, of Carrigaline, Co. Cork, a gentleman who has had great experience in marine fishing, and who is intimately acquainted with the coasts of Waterford, Cork and Kerry.

Green duly collected the information by a study tour of three south coast fishing ports, Baltimore, Kinsale and Youghal in 1887. His report foreshadowed much of the development which would take place in the course of the next twenty years or so. He divided it into three sections: supply, demand and means of development, and there were three appendices, including some observations on the food of the spring mackerel. In this he mentions reports by the fishermen of the presence of brown slime on the nets, together with phosphorescence and makes the suggestion that there is a bloom of algae in spring. It sounds from this that the idea of an algal bloom was an original one on his part, rather than the accepted theory which it has become.

Green's first conclusion was that the supply of fish was unlimited. He was far from being the only fishery expert at the time to believe this and, in the days when exploitation was mainly by sailing and rowing boats, may not have been far wrong. His view was that the most urgent need was to improve marketing and transport of the catch. No additional boats were needed because the existing fleet was able to satisfy the demand. He was very deeply impressed by the success of the Baltimore fishery school and stressed the need for proper training courses for young men who planned to enter the fishing industry. He considered that there was no realistic possibility of the local fishermen being able to raise the finance to improve their efficiency. Government support was essential.

Another cherished belief of Green's was that children in coastal schools should be taught about the sea and fishing, and he suggested that a schoolbook should be written for them. While he did not succeed in doing this, he did contribute two articles on sea fisheries to a *Fifth reading book* published by Browne and Nolan's.

Green's personality was a major asset in preparing the 1887 report. He loved people and wanted to talk to everybody. This meant that his views were very much coloured by the opinions of the local fishermen. The information he received must have been greatly superior to what could have been gained by a government enquiry. Green the friendly clergyman, with long experience of boating and fishing, was the ideal gatherer of relevant facts.

The other side of his character was the meticulous student of the available literature. He had made a close study of the reports of other fishery authorities both in the British Isles and in North America and was particularly impressed by the work of the Scottish fishery board. Its inspectorate was very much larger than its Irish counterpart *and* it was engaged in scientific research.

In 1888, the year after writing his first fisheries report, Green went off on his last foreign exploration. This time it was to climb in the Rocky Mountains of Canada and study the Selkirk glaciers there. In due course he wrote a paper on his observations for the Royal Geographical Society in London. In recognition of this work he was appointed a Fellow of the Society. As in the case of the Mount Cook expedition Green also wrote a book. It gives a graphic description of the problems faced by explorers and surveyors of the time and is also of great interest in giving an account of life in Canada just five years after the building of the Canadian Pacific Railway and not long after the decimation of the bison herds.

The fisheries committee of the Royal Dublin Society was very quick to take advantage of this trip and asked Green to make a study of fisheries on the Atlantic coast. So he visited a number of fishing ports, spent some time at Woods Hole Oceanographical Institution and all in all was deeply impressed by the achievements of the United States Fisheries Commission. At the end of his report (Green, 1889) he has this to say on his favourite theme of the need for basic information:

> The general impression left by studying the American fisheries is that we are sadly behind-hand in practical knowledge of the life-history and movements of our food-fishes. A great deal of knowledge of the subject exists amongst fishermen and others. The Americans have taken pains to collect and classify this, so as to form an accessible store of information to all concerned. The general history of fish may be studied to advantage in the Reports of the US Fish Commission; but as there is no similar institution in this country to collate and focus the knowledge floating in the minds of a multitude of individuals, it is impossible to know as much of our fish and their movements as the Americans do of theirs.

Green, the man of action, was aware that it needed a great deal more than talk and written reports to develop a fishing industry and that the scientific approach was essential.

His next cruise was in 1889, funded by the British Museum. A vessel named the *FLYING FOX* was chartered and the trip was one of very few which enjoyed good weather. It lasted for one week in July and they trawled successfully down to 1,000 fathoms between Cork Harbour and the Fastnet rock.

In 1889, the Royal Dublin Society followed up the first report on fisheries with a proposal for a much more ambitious survey. This was partly a continuation of the previous work of the RDS Fisheries Committee but it received, coincidentally, a helpful boost from the English Quaker philanthropist, J. H. Tuke who had rather naively written to the RDS to suggest that they should undertake work which in fact was already in progress. Green's comments on the proposal show that he was a very practical man – as well as a visionary:

> It is a very big order and would need a lot of patient investigation in detail not only with the mapping out of the grounds but the seasons at which fish visited them. And any amount of diplomacy in getting the truth out of local fishermen as a rough guess I said it would cost £1000 at least and take two years. It now strikes me that it could not be done for that. The direct expenses would probably be covered by this but I should have to pay my helpers, one of necessity being a civil engineer skilled in charting....
>
> I could not give up all my spare time and pay for a curate to take charge here while I was absent without being paid myself....
>
> My wife reminds me that with six children I must not give up my work for nothing. I consider my work would be worth £200 a year.

The year 1890 was an *annus mirabilis* for Green in his personal life and for Irish fisheries. Two major events happened.

The rather meagre administration of fisheries in Ireland was carried out by three inspectors. One of their number, Joseph Hayes, had died in 1889 and, in the following year, Green was appointed to the triumvirate. This was a full-time salaried post. Green retired from his duties as a parish priest and moved to Dublin, where he bought a house in Cowper Road, Rathmines. From that time, until his retirement twenty-four years later, he was free to devote all his very considerable energies to the development of fisheries in Ireland.

The second great event was the success by the Royal Dublin Society in securing the funds to carry out a survey of fish and fisheries. J. H. Tuke, who was exceedingly well connected, helped in encouraging the government to contribute to this project. Naturally, the tasks of finding boat and scientific staff went to Green. He chartered a steam yacht of 158 gross tons, the *FINGAL,* and they set sail from Cobh. They worked their way up the west coast to Killybegs and the cruise was completed late in August. A member of the company was the keeper of natural history in the Museum in Dublin, Robert W. Scharff. Scharff was not primarily a field worker and clearly remembered this cruise at least until the death of Green nearly 30 years later. He wrote in a very affectionate obituary:

> The pleasure of the trip was somewhat impaired by the instability of the trawler *FINGAL*, which had been hired for the occasion, but Mr Green's even temper and his merry spirits under the most trying circumstances enabled one to bear all hardships with comparative equanimity. At the break of dawn one heard his voice singing lustily "up in the marnin' early" while engaged in overhauling the gear. Always genial and gay and ready to console his fellow travellers at a time when the heavy ground swell which prevails on the south-west coast caused them to be mournful and despondent, Mr Green was the life and soul of the ship, and after a few days one felt prepared to admire the marvellous contents of the trawl with a kind of grim pleasure.

An interesting little feature of Green's report on the cruise is that he included the names of the entire crew, down to the two cabin boys who had just graduated from the Baltimore fishing school. Green's personal passion for the sea and ships was equalled by his concern for the welfare of the seamen.

In 1891, the Royal Dublin Society organised the most ambitious cruise of all, beginning in mid-March to take in the spring mackerel fishery in the south-west, and lasting till 4th June. In this case, Green not only took entire responsibility for gear, personnel and choice of the vessel but he skippered it as well throughout. The boat selected this time was the steamship *HARLEQUIN* – built in 1885 and fitted as a tug, a steam trawler and a yacht. She had comfortable quarters and electric light.

In contrast to the purely zoological expeditions Green had led for the Royal Irish Academy, the purpose of the work of the *FINGAL* and the *HARLEQUIN* was to make a study of fisheries, rather than marine fauna in general, and this clearly marks the beginning of fisheries research in Ireland.

Reports on the cruise were completed with impressive speed - each time within the year. Green provided a highly readable narrative and the scientists appended very detailed reports. There was a pleasant little social occasion when the *HARLEQUIN* called to Kilkieran, on the west coast and the scientists had a meeting with the local priest, Father Flannery, who was famous for his progressive work for his community. They arrived during a formal visit by the wife of the lord lieutenant and a daughter of the chief secretary. The ladies were invited on board, perhaps slightly to the consternation of Green who wrote:

> Not expecting a visit of this character our vessel was not in the best trim, but her Excellency and Miss Balfour seemed particularly interested in the fish eggs which were in process of hatching in glass vessels in the cabin.

The information gained from these cruises led directly to an increased interest in the possibilities of fishing, particularly on the west coast — at the time fishing was much better developed in the Celtic Sea, the Irish Sea and to the north of Ireland.

By coincidence, in 1891, the government established a Board to give long-needed development assistance to what they charmingly called the *congested districts* of the western coast. Green was appointed to membership of the Board and was able to apply many of his ideas. A brief quotation from Stephen Gwynn (1924) gives an idea of the work:

> Green, for the Board, equipped the islanders with large boats and suitable tackle, and taught them not only to catch mackerel in greater quantities when they came inshore at harvest-time, but also to fish for them in May from outside the islands — a new venture which proved highly successful. The mackerel in the nineties commanded a high price and could bear the railroad freight.

Details of the fisheries work are given in Micks's *History of the Congested Districts Board*. Green was responsible for the building of many of the small fishing piers that are still in use today. He gave particular attention to the south-west and in 1905 bought the house, West Cove, as a base for his work there.

He led one more expedition on behalf of the Academy, the first scientific exploration of Rockall. It took place in 1896 and is described in colourful terms by Praeger (1937), who was one of the distinguished team of naturalists on board. The vessel used was the Congested Districts Board's steamer *GRANUAILE* and an excellent scientific account was published in the *Transactions of the Royal Irish Academy* (Vol. 31, 1897). The expedition was something of a disaster, the only good point being that the ship and its company actually survived. They did in fact see Rockall and Green painted several beautiful water-colours of it while his son, Charles, took tolerable photographs. They managed a little dredging. All of them looked back on the Rockall expedition as a high point in their lives. The main reason for its failure, as in the case of Green's attempt on Mount Cook, was the constraint of an expedition planned without being able to allow any time to spare for contingencies.

By this time the Royal Dublin Society had achieved its original purpose of initiating the development of the west coast fisheries. It now turned its attention to the study of the fish themselves, a matter which Green had referred to in his report on the US Fishery Commission a few years earlier. A Royal Dublin Society Committee (Anon., 1898) approached the problem of:

> the lack of information that existed about the conditions which determine the movements and habits of food fishes, and which have such an important bearing upon the fisheries, especially those of the comparatively unstudied waters.

This led to a five-year plan beginning in 1898. The contribution of the Royal Dublin Society included the employment of a naturalist: the post was filled by Ernest Holt who had already published voluminous, meticulous and beautifully illustrated papers on a great variety of fishes and their food organisms. Green was too busy with his duties as an inspector to take a fulltime part in the five-year plan but he made a major input as an adviser to the committee.

This Royal Dublin Society committee built Ireland's first marine laboratory. Green (1902) wrote:

> As the field of observation was not intended to be confined to one particular district, it was essential that the laboratory should be capable of being moved from one place to another. Frame houses fulfil this condition, but are understood to be generally more easy to take to pieces than to put together again. Moreover, in the case of any building on land, fresh difficulty and expense in regard to site and supply of sea water would have arisen whenever the *locus* was changed.
>
> A floating structure is free of these disadvantages, and, if moored in sheltered water, is almost always sufficiently stable for the use of delicate scientific instruments.

So they obtained a brigantine called the *SATURN,* removed her superstructure, put in skylights and windows and made a very spacious laboratory. She spent a series of summers in the mackerel grounds off Cleggan, supported by a number of small fishing boats, and the scientific team studied mackerel and salmon among other species. In winter the *SATURN* was towed to the sheltered waters of Ballinakill Bay. History does not record when they abandoned her – but you may see her timbers lodged in the mud to this day.

In the middle of the five-year plan, in the year 1900, a permanent government fisheries authority was established and took over all the work which had been initiated by the Royal Dublin Society. Green was appointed chief inspector of fisheries and in the course of the next few years enlisted a distinguished team of biologists and engineers. He published little scientific work after this date, but his vivid prose style shows clearly in the annual reports of the new Department. The reports are more than just informative: they are written with deep feeling and understanding of the people in the fishery. They chronicle successes and give details of every tragedy. While Green himself may have been unable to find the time to carry out research, the team under his directorship produced an impressive series of papers.

Green did find time to write two particularly important documents. The first (Green, 1902) was the chapter on the sea fisheries of Ireland in the handbook produced for the Glasgow International Exhibition in 1901 and expanded for publication the following year.

Although the chapter is quite short, it shows that amongst all his other talents, Green was an historian of the first order. In a few pages he provides the best account of the history of Irish fisheries ever written. The research was thorough and all his own. By the time Green wrote this essay, some twelve years after his first report to the Royal Dublin Society, he had clearly changed his view that the fish stocks were unlimited and was very concerned with the need for conservation based on scientific knowledge.

The second paper (Green, 1906) was an account of the wrecks of a number of the ships of the Spanish Armada, delivered to the Royal Geographical Society in London in 1906. A subsequent paper, presented at the Royal Irish Academy in 1909, traces Armada wrecks on the Kerry coast. Tradition in fishing villages told of where many of them had foundered. Green had applied his sailor's knowledge of winds and currents to calculate exactly where they lay. In one case he secured a piece of timber. Modern SCUBA divers have used his work to locate more of the wrecks.

Green the practical fisherman made two more great contributions to Irish fisheries. He had been one of the first to see the value of internal combustion engines for fishing boats and used his position as chief inspector to organise the building and equipping of Ireland's first motor fishing vessels. He played a major part in the design of the *OVOCA* which was built in Arklow. In particular, he insisted on a number of features specially for the comfort of the crew. The second was the conception of a new research vessel. His ideas led to the creation of the second *HELGA:* 47 metres long with engines generating 1,000 horsepower. She was a truly beautiful ship and regarded as one of the finest research vessels of her time (Plate 4).

Reading Green's official reports with their accounts of new regulations, fishery protection, fishery development, concern for quality and so on confirms the impression of a man who, above all else, had the welfare and interests of the fisherman at heart. The fact that, when he reached the retirement age of 65 in 1912, he was twice asked to spend one more year at his post, makes it clear that his masters were as convinced of the contribution he was making as were the fishermen, the scientists and all who had dealings with him.

In 1914 Green retired, left Dublin and returned to West Cove. His last public appearance in Dublin was at a meeting of the Royal Zoological Society of Ireland held in his honour. At this he paid tribute to the Ball family in whose company, he said, his 'love of natural history was awakened'.

He remained interested in wild creatures to the end and published a note on bird behaviour just some months before his death in 1919. He was buried in the churchyard of Sneem, close to the sea that he had loved so deeply. From his grave you can see and hear the Sneem River. The church tower, appropriately, is crowned not by a weather cock but by a salmon.

Green, as I have said, was something of an intellectual giant. His serious dedication to the causes of science and fisheries began at the latest at the age of thirteen years and was followed by his choice of scientific subjects at university. In the 1870s, there were very few posts in Ireland for scientists and the Church was an acceptable profession for a person of his talents. It is clear that, in the course of his ministry, he spent much, perhaps all, of his spare time in pursuing his researches. Evidently his profound knowledge of marine biology and fisheries, his proven ability to organise ships and men and his track record of producing detailed and incisive reports on all his work commended him to the authorities. His appointment as inspector of fisheries enabled him to devote all his time and effort to this profession.

It is difficult to make an assessment of his influence in fisheries. The initiatives were taken first by the learned societies and next by the government. But the *success* of these initiatives, which led first to a major expansion of the Irish fishing industry, then to its modernisation and to the acceptance of the need for its scientific management, may truly be attributed to the mind and character of William Spotswood Green.

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