The Dazzling Zoologist

John Graham Kerr and the Early Development of Ship Camouflage

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Le développement du camouflage des navires de guerre sous forme de dazzle painting à compter de 1917 a été crédité au peintre Norman Wilkinson. Cependant, John Graham Kerr, un scientifique et naturaliste basé à l'université de Glasgow a offert à l'Amirauté un système semblable tout au début de la première guerre mondiale. Le système de Kerr a été basé sur ses observations de la nature et de ses connaissances des expérimentations dans le camouflage par Abbott H. Thayer et George de Forest Brush aux Etats-Unis. En dépit de l'acceptation initiale des idées de Kerr, l'Amirauté ne les a pas menées à leur conclusion logique. Wilkinson, qui avait vu certaines des idées de Kerr mises en pratique pendant la campagne des Dardanelles, a réfuté plus tard toute suggestion d'influence de Kerr. Cet article analyse la contribution de Kerr et conclut que son influence était en fait plus importante que n'est crédité dans la littérature sur le camouflage des navires.

"Now watch," said the Zebra and the Giraffe. "This is the way it's done. One-two-three! And where's your breakfast?"

How the Leopard Got its Spots, Rudyard Kipling, 1902

Introduction

Towards the end of the First World War large numbers of merchant ships were brightly painted in bizarre geometrical patterns known as "Dazzle Painting" later known as dazzle camouflage. The aim was to thwart German U-boat captains who had until then been so successful in destroying large amounts of shipping in British home waters and elsewhere. The colour scheme was designed to confuse and deceive an enemy as to the size, outline, course and speed of a vessel by painting her sides and upperworks in contrasting colours and shapes arranged in irregular patterns. The idea, in essence, was to confuse U-boat captains by making it difficult to plot accurately an enemy ship's movements when manoeuvring for an attack, causing the torpedo to be misdirected or the

The Northern Mariner/le marin du nord, XIX No. 2, (April 2009), 171-192

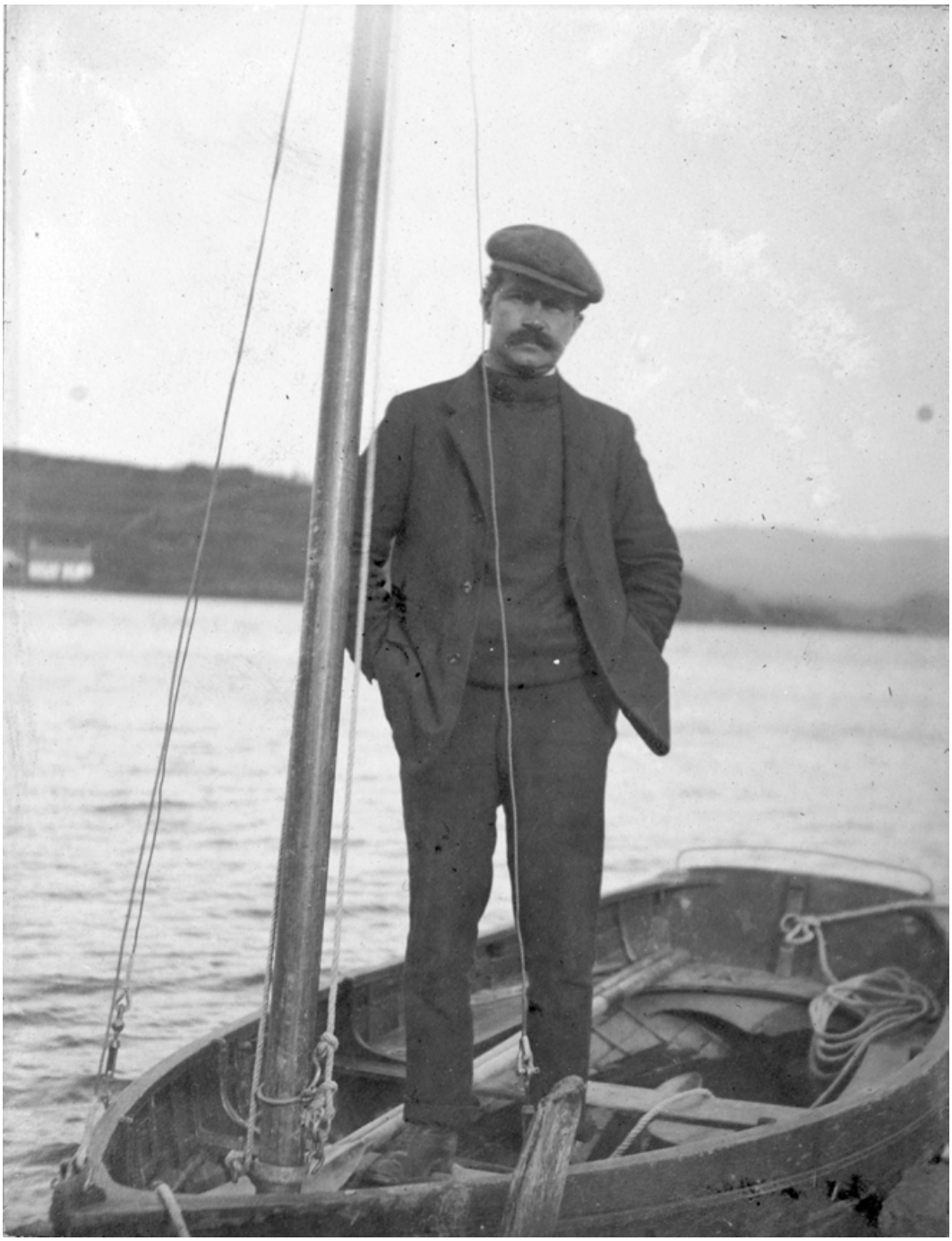

Illustration 1: John Graham Kerr undertaking field work at Loch Sween in 1913. Courtesy of Glasgow University Archives.

attack to be aborted.

It is generally assumed that the idea for this came from the marine artist Norman Wilkinson (1878-1971) in 1917.[1] However, as early as the first few weeks of the war, a scientist, John Graham Kerr (1869-1957) had submitted a similar scheme to the Admiralty, resulting in a number of warships being painted to his specifications. Historians of camouflage have tended to ignore, underestimate or misunderstand this work.[2] Kerr's ideas also pre-dated French *sections de camouflage* set up in 1915 who used cubist techniques to confuse aerial observers above and enemies in the field. This article therefore sets out to investigate the work of Kerr, assess his influence on the development of ship camouflage, and comment on the ensuing controversy over the invention of dazzle camouflage.

Early Influences

John Graham Kerr certainly had credentials to devise a scheme for ship camouflage. He had a deep love of ships and his fieldwork as a naturalist gave him first-hand experience of the importance of the role of colouration in animals. A formative experience that defined his later work was his participation in an expedition by the Argentine Navy up the Pilcomayo river (a tributary of the River Plate), from 1889 to 1891 to the area known as the Gran Chaco. He was only nineteen years old when recruited to the expedition. He had been studying medicine at Edinburgh University, but it was natural history that was his real passion. Despite his relative inexperience he managed to secure a position as the expedition's only naturalist and was given free reign to explore the area's almost unknown flora and fauna. The method of natural history study at that time required not just the observation of nature but the hunting and shooting of many specimens. Kerr was proficient with a rifle and enhanced his hunting skills by working with the native Indian hunters. His account of the expedition is replete with references to the "obliterative colouring" used by animals to conceal their identity.[3] Following this expedition Kerr studied natural sciences at Christ's College, Cambridge graduating with first class honours in 1896. He then led another expedition to the Gran Chaco from 1896 to 1897, primarily to study the embryology of the lungfish, but while there he also further developed his knowledge and ideas of protective colouration in nature. In 1902 he was appointed to the chair of natural history at the University of Glasgow, which a year later became the chair of zoology.

1 See for example, Peter Kemp ed., *The Oxford Companion to Ships and the Sea* (Oxford, 1976), 232-233, 940, and obituary for Norman Wilkinson, *The Times*, 11 June 1971.

2 See for example: Guy Hartcup, *Camouflage: A history of concealment and deception in war* (Newton Abbot, 1979), 40. Hartcup states that it was doubtful if any ships were painted as a result of Kerr's efforts. Roy R. Behrens, *False Colors: Art, design and modern camouflage* (Iowa, 2002), 103-104 and Nicholas Rankin, *Churchill's Wizards: The British genius for deception 1914-1945* (London, 2008), 128-129, both mention Kerr but only in passing; Tim Newark, *Camouflage* (London, 2007) fails to mention Kerr at all. David Williams, *Naval Camouflage 1914-1945: A complete visual reference* (London, 2001), 63 -64, devotes a short section to Kerr but misunderstands the basic concept of his scheme.

3 John Graham Kerr, *A Naturalist in the Gran Chaco* (Cambridge, 1950).

Illustration 2: The Argentine naval expedition vessel Bolivia on the Pilcomayo, 1891. Courtesy of Glasgow University Archives.

Kerr's love and knowledge of ships was equally important in the development of his ideas on camouflage. He was a keen yachtsman and on his first Gran Chaco expedition he noted that "as soon as the Commander realised that I was accustomed to boat work he allocated me to pilotage duty," and at times he was also put in charge of navigating the river steamer *Bolivia*.[4] Kerr's love of boats also took him to the opening of the Kiel Canal in 1895 crewing aboard a friend's yacht. Here he saw German and French warships dressed overall in shades of battleship grey, contrasting greatly with the British vessels in the Victorian colours of black hull, white superstructure and yellow funnels. This set him thinking about how to best conceal or disguise warships using the principles of obliterative colouring that he had recently been studying in nature. He had friends in the navy and in speaking with them realised that the coming war would likely be fought at very long range. He determined that the key issue was to devise a method that would "stultify the enemy's range finders" and so he undertook a special study of the visibility of ships "with a view to helping the Admiralty when war actually broke out." [5]

Kerr was not the first to investigate protective colouration of warships based on

4 Kerr, *A Naturalist in the Gran Chaco*, 23, 41.

5 Kerr to Balfour, 28 June 1915, Glasgow University Library (hereafter GUL), MS Gen 1302, 9; draft of letter to Sir D. MacAlister, November 1917, John Graham Kerr Papers, Glasgow University Archives (hereafter GUA), DC6/359.

observations from nature. That honour goes to the American artist and amateur naturalist Abbott H. Thayer (1849-1921), known as the "father of camouflage." [6] Thayer, with a fellow artist, George de Forest Brush (1855-1941) and their respective sons spent many years studying "concealing coloration" in the animal kingdom. In 1896 Thayer published his theory on counter-shading, now known as "Thayer's Law," in the journal of the American Ornithologists Union. This principle is based on the observation that animals are frequently dark on top with white undersides. When viewed from a distance this tends to counteract the bright light from sunshine above and the shadow below to provide an effective means of concealment. In 1898, during the Spanish-American War, Thayer experimented with large scale models of counter-shaded warships and was invited to demonstrate them to the Department of the Navy. By the time of the demonstration the war was over and nothing came of the scheme, but in order to protect his ideas Thayer took out a U.S. patent.[7] He continued to publish his theories in scientific journals and eventually his work was summarised in the book *Concealing Coloration in the Animal Kingdom*, put together by his son in 1909.[8]

Kerr had first met Thayer when the latter had visited England in the 1890s. Their interests clearly coincided and although they did not always agree, one approaching the subject from an artistic and the other from a scientific point of view, a friendship developed. In the spring of 1914 Thayer renewed his acquaintance and forwarded a copy of his book to Kerr.[9] Thereafter, shortly after the outbreak of war, Kerr took the opportunity to lay before the Admiralty a summary of his plans for colouring ships.

The Outbreak of War and *Ad Hoc* Camouflage

The early history of ship camouflage is poorly understood and there are few records concerning its design and application. From the diary of Commander Dudley Pound, written aboard the dreadnought HMS *St Vincent* at the then largely unprotected anchorage of Scapa Flow in the Orkney Isles, it is clear that a number of *ad hoc* schemes were applied on the immediate outbreak of the war as a rather panicked measure against potential attack by German surface vessels and submarines.[10] Pound noted on Saturday

6 Roy R. Behrens, "The Theories of Abbott H. Thayer: Father of Camouflage" *Leonardo*, vol., 21, No.3, (1988), and *False Colors*, 37-57.

7 Abbott H. Thayer & Gerome Brush, "Process of Treating the Outsides of Ships, etc., for Making Them Less Visible," *U.S. Patent No. 715,013* (1902).

8 Gerald H. Thayer, *Concealing Coloration in the Animal Kingdom: An Exposition of the Laws of Disguise Through Color and Pattern; Being a Summary of Abbott H. Thayer's Disclosures* (New York, 1909), 151.

9 GUA DC6/367 and 368, Abbott Thayer to Kerr, 11 April 1914 and 25 June 1914.

10 Imperial War Museum, London, Box 92/53/1, Diary of Dudley Pound July 1914 - January 1915. Pound's diary has been published with a commentary by Paul Halpern, in "Dudley Pound in the Grand Fleet, 1914-1915", in Michel Duffy, ed., *The Naval Miscellany. Vol. IV,* (Navy Records Society, 146, Aldershot, 2003), 378-426. Halpern does not mention camouflage or comment on Pound's views on it. HMS *St Vincent* was the rear-admiral's ship in the First Battle Squadron of the Grand Fleet, and Pound spent the first five and-a-half months of the Great War aboard her. For a biography of Pound, who became first sea lord

15 August that:

> Ships have been painting their masts, and in some cases, their funnels, white in order to make ranging on them more difficult for the enemy. Some ships have painted their turrets black and white like the Spit fort but this does not seem to serve any useful purpose. We have wrapped strips of canvas loosely round the topgallant and topmasts so as to break the edge and have painted the masts white in between the strips of canvas. The funnels and lower masts have been painted with large irregular blobs of white.

The colour schemes were apparently the invention of those aboard individual ships and the following day Pound remarked that "the fancy painting of the ships has reached an extraordinary state this morning - some had zig zags, some had blotches others specks, and the old *Superb* is like a cheap imitation of the Spit fort." However, all this fanciful painting did not have official sanction and in fact proved "too much for the C in C who has made a signal that all masts and upper works are to be painted a whiteish grey." After some efforts to determine whether the painting had been effective in making ranging more difficult, just a week later "an order came to all ships from the Admiralty that they were to paint a combination of dark grey and light grey like the Grand Fleet, also that all paint had to be scraped off."

Winston Churchill also remembered seeing camouflaged ships off the coast of Wester Ross in September 1914:

> before us far below there gleamed a bay of blue water at which rode at anchor, outlined in miniature as in a plan, the twenty Dreadnoughts and Super-Dreadnoughts on which the command of the seas depended. Around them and darting about between them were many scores of small craft. The vessels themselves were painted for the first time in the queer mottled fashion which marked the early beginnings of the science of Camouflage.[11]

Pound's diary and Churchill's memoir clearly demonstrate that the idea of ship camouflage was well known, if not well understood, even if the Admiralty initially seemed to take a dim view of it.[12] Whether any other fleets attempted similar schemes to the Royal Navy is beyond the scope of this article, and the authors would welcome some comparative work.

Kerr's Method of Diminishing the Visibility of Ships

After a poor start German U-boats had some considerable success with the sinking by torpedo of the cruiser HMS *Pathfinder* by U-21 on 5 September and three old armoured cruisers, *Aboukir*, *Hogue* and *Cressy*, by one small and obsolescent U-boat, U-

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and chief of the naval staff at the outbreak of the Second World War, see Robin Brodhurst, *Churchill's Anchor* (Barnsley: Pen and Sword, 2000).

11 Winston S. Churchill, 'My Spy Story' in *Thoughts and Adventures* (London, 1932), 91. First published in *Cosmopolitan*, September 1924.

12 This evidence, together with Kerr's scheme, clearly lays to rest the accepted theory that camouflage was "invented" by cubist-inspired French artists on the Western Front in 1915.

9, with the loss of around 1,400 men on 22 September 1914.[13] The U-boat threat had also forced the Grand Fleet from its anchorage at Scapa Flow to Lough Swilly in Donegal whilst Scapa's defences were strengthened. Given these important setbacks, any measure that could ameliorate a perceived threat from the enemy was opportune. Unaware of the *ad hoc* measures already undertaken in the north of Scotland, Kerr wrote to Winston Churchill, the first lord of the Admiralty on 24 September 1914 enclosing a memorandum outlining his own methods for diminishing the visibility of ships at a distance, based on scientific principles.[14] He detailed three options. The first was colour, in which he observed that small animals can appear invisible due to their tint and colour pattern being identical with that of their natural habitat. However, he noted that it was of "little importance in the case of large animals and it may safely be ignored entirely in regard to large objects such as ships."

Kerr's second option was "Compensating Shading," as in Thayer's theories. He recommended that this principle "should be constantly borne in mind in painting the upper works of ships," and that:

All deep shadows should be picked out in the most brilliant white paint and where there is a gradually deepening shadow, this should be eliminated by gradually shading off the paint from the ordinary grey to pure white. Big guns should remain the ordinary grey along their upper side (only a narrow strip, say six inches wide in the case of a 12-inch or 13.5 inch gun), and this should shade off into pure white along their lower surface.

Kerr finally pointed out the need to break up the continuity of surface, using a scheme that he described as "parti-colouring":

> It is essential to break up the regularity of outline, and this can easily be effected by strongly contrasting shades. The same applies to the surface generally – a continuous uniform shade renders conspicuous. This can be counteracted by breaking up the surface by violently contrasting pigments. A giraffe or zebra or jaguar looks extraordinarily conspicuous in a museum, but in nature, when not moving, is wonderfully difficult to pick up, especially at twilight. The same principle should be made use of in painting ships.[15]

Moreover, he recommended that the continuity of outline should be broken up by patches of white, especially the bow, stern and upper line of the hull, which should be "broken up by very large patches of white extending quite irregularly on to the sides of the ship." Masts should also have irregularly edged bands of white.

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13 The latter were sunk within a few hours of each other. See Sir J.S. Corbett and Sir H. Newbolt, *History of the Great War. Naval Operations*, 5 vols. (London, 1920-31), I: 177. See also A.J. Marder, *From the Dreadnought to Scapa Flow*, 5 vols. (London, 1961-70), Admiral of the Fleet the Earl Jellicoe, *The Grand Fleet, 1914-1916: Its Creation, Development and Work* (London, 1919), and for the political view, W.S. Churchill, *The World Crisis, 1914-1919*, 5 vols. (London, 1923-9).

14 GUA DC6/246 and 658, Kerr to Churchill, 24 September 1914 with enclosures.

15 GUL, MS Gen 1302, 2, Kerr to Winston Churchill, 24 September 1914, John Graham Kerr - Protective Coloration of Ships, 2.

These ideas seem to have found favour as a few weeks later Kerr received a letter from the Admiralty thanking him for the "valuable information" and informing him that "the data and suggestions contained in your memo have been communicated to the fleet confidentially in a General Order." [16] The general order was issued on 10 November 1914 headed "Visibility of Ships – Method of Diminishing." [17] It was a straight copy of Kerr's original memorandum with the addition of a rider: "The following copy of a letter which has been received from Professor J. Graham Kerr, Regius Professor of Zoology at Glasgow, is promulgated for information. The trial or adoption of the proposals made therein is left to the discretion of Flag Officers, &c. concerned." Given his scientific training and experience it is doubtful if Kerr expected his original letter to be circulated in this manner without any further discussion, refinement, or clarification. However, his instructions were now in the hands of those commanding the navy and all he could do was sit back and see what kind of a job they made.

The Application of Kerr's Scheme

The early indications were very favourable. At the beginning of December Kerr received a confidential letter from a former pupil now serving aboard HMS *Implacable*. He stated that the order had: "aroused great interest on board among my brother officers, all of whom I may say heartily endorse your statements, especially with regard to the increased difficulty of accurate range-finding." He went on to state that this was "one of the few cases where My Lords of the Admiralty and the humbler personnel of H.M. ships are in entire agreement." In closing he observed that he could see a cruiser passing which had "irregular spatches of white dotted here and there on her hull and funnels," and that Kerr's memorandum was having "the desired effect." [18] Kerr was flattered that his scheme has been adopted, albeit in a more *ad hoc* way than he had intended, and as news of his expertise spread he received enquires about the possibilities of concealing the likes of oil storage tanks and airships.[19]

As this was a purely discretionary scheme and no records were kept of those vessels painted it is difficult to establish how many ships adopted the scheme or the way in which Kerr's instructions were applied in practice. In later years Kerr was able to assemble evidence from photographs and first hand accounts in an attempt to quantify how widely it had been adopted. Coupled with our own research we know that a range of warships were painted to varying degrees using Kerr's recommendations.[20] However,

16 GUL, MS Gen 1302, 6, Admiralty to John Graham Kerr, 19 December 1914.

17 GUL, MS Gen 1302, 2, Visibility of Ships – Method of Diminishing, 10 November 1914.

18 GUA, DC6/372, Archibald Jeffrey to Kerr, 1 December 1914.

19 GUL, MS Gen 1302, 3, Kerr to Admiral Egerton, C-in-C Plymouth,26 November 1914, in reply to his enquiry re oil tanks; GUL MS Gen 1302, 6, Major Waterlow, Squadron Commander, HM Naval Airship Station South Farnborough, to Kerr, 11December 1914, re application to air ships. See also copy letters in GUA DC6/247, 248, 250 & 251.

20 For example, these included three battleships, HMS *Irresistible,* HMS *Canopus* and HMS *Agamemnon*, a battle cruiser, HMS *New Zealand*, an armoured cruiser, HMS *Argonaut*, and a submarine, *E 11*.

given the evidence of Dudley Pound an element of caution should be noted as some vessels may have been painted independently of Kerr's instructions.

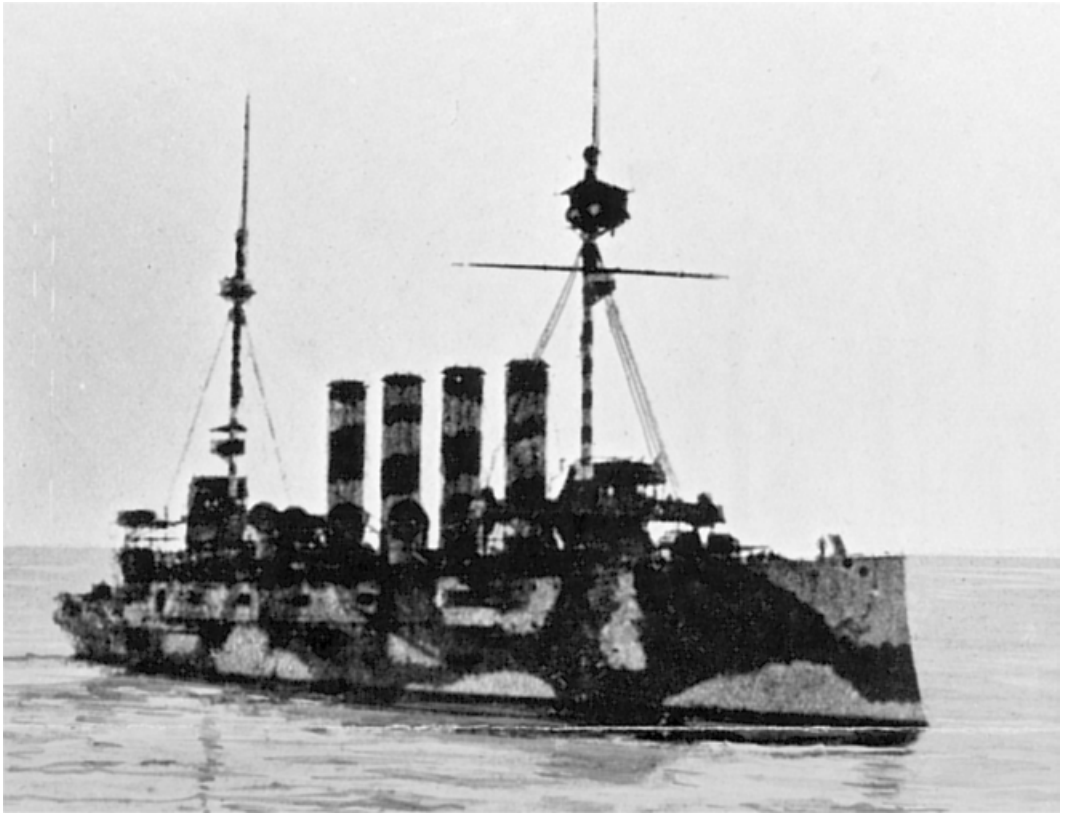

Illustration 3: HMS Argonaut *December 1915 painted in Kerr's parti-colouring scheme. Copy of photograph obtained by Kerr in relation to his claim to the Royal Commission on Awards to Inventors, 1922. Courtesy of Glasgow University Archives.*

Among the first hand accounts is that of a midshipman on the battleship HMS *Agamemnon* who reported that "the upper works of the ship were painted so as to give us a strange appearance." This was carried out at sea in February 1915 while the ship was on active service in the Dardanelles. Photographs of *Agamemnon* at this time show a random pattern of lighter patches applied to the forward part of the hull and irregular striping on the guns, superstructure and masts.[21] A soldier in the New Zealand army on his way to the Dardanelles in April 1915 "saw a good example of maritime camouflage – a town class

21 H.M. Denham, *Dardanelles: A midshipman's diary 1915-16* (London, 1981), 33, 42, 62, 121. See also photograph of *Agamemnon* in 1915 at http://www.battleships-cruisers.co.uk/hms_agamemnon.htm; The National Archives of England and Wales, Kew (Hereafter, TNA) ADM 53/32927, the Log of the *Agamemnon* gives no clues as to the motivation or application of the scheme and simply states "employed repairing and painting ship."

cruiser painted grey and black and white to resemble a storm-tossed sea."[22] In September 1915 the commander of the destroyer HMS *Viking,* operating on the Dover Patrol, reported that his ship was referred to as a zebra after it was "painted in a coat of striped camouflage." [23]

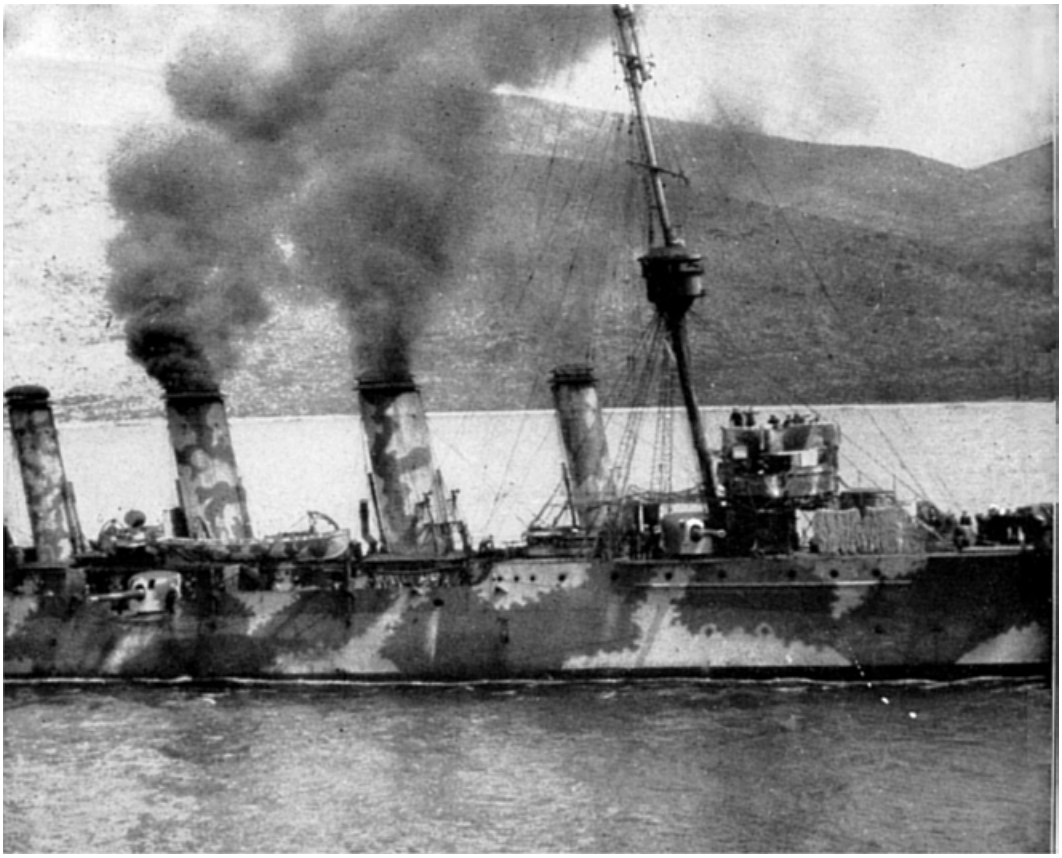

Illustration 4: A Town class cruiser, probably HMS Dartmouth*, in the "new war paint of the British fleet" in the Dardanelles, 1915. Adapted from* Collier's Photographic History of the European War *(New York, 1916).*

Kerr had advocated that countershading should be applied in conjunction with parti-colouring. However, this required a greater degree of technical expertise and skill to achieve good results and this aspect of Kerr's scheme was largely ignored. Kerr was able to identify only a few isolated cases where it had been attempted, such as the torpedo tubes aboard HMS *Swift*.[24]

Kerr, to his chagrin, had no practical input into transferring his ideas into reality

22 Fred Waite, *The New Zealanders at Gallipoli* (Christchurch, 1919), 67. The vessel was probably HMS *Dartmouth*.

23 E.R.G.R. Evans, *Keeping the Seas* (London & Edinburgh, 1919), 64.

24 GUL, MS Gen 1302, 30b.

and when he began to hear reports and see examples for himself on the river Clyde of how it had been applied he became increasingly concerned and frustrated. Towards the end of the academic year in 1915 he wrote to the Admiralty offering his services "for purposes of inspecting and advising in connection with the matter of visibility."[25] This offer received no response so he wrote once again to Winston Churchill, politely pointing out that: "I notice from time to time attempts to carry out the plan which could be made very much more effective with a little advice and guidance." [26] However Churchill, first lord since 1912, had been moved on from the Admiralty after the Dardanelles disaster and so a few days later Kerr tried again, this time with Churchill's successor Arthur Balfour, taking care to fill him in on the background to the scheme and his proposals and reiterating that he had noticed cases "where the method is in use but where it could be made immensely more efficient by a little personal talk and explanation." [27] Kerr's appeals were to be in vain. He received a reply from the Admiralty expressing their thanks, but stating that as a result of trials "their Lordships had arrived at a definite decision as to what is the most serviceable scheme of colouring for H.M. ships and this having been adopted it is not proposed to proceed with any further trials at present."[28] The Admiralty had decided that its warships should now be painted a uniform grey.

This greatly annoyed Kerr and in a lengthy reply he reiterated and expanded on the principles involved and politely pointed out where their application had not been carried out correctly.[29] He also wrote to fellow Glasgow University scientist Dr George Beilby who was serving under Lord Fisher in the Admiralty's newly established Board of Invention and Research.[30] This body was created to assess invention proposals made by members of the public and forward those of use to the Admiralty technical departments. Kerr explained how he had outlined his ideas to the Admiralty and summarised the progress of his scheme to date. He conceded that he understood why an outsider might not be welcome in the navy, but he expressed doubt, from what he had seen of one or two vessels recently, whether they are really making the most of the possibilities and sought assurances that someone competent was put in charge. As he put it: "What I should like to feel assured of is that they have put this matter in the hands of a man who will take a broad view of things, who will not let himself be distracted by less important details, who will not get scared by his work making a battle ship startlingly conspicuous when close at hand provided that its visibility is diminished at long."

Again, Kerr was to be disappointed. Beilby did consider that the matter was "clearly of capital importance" and promised to take it up with the Admiralty.[31] What he found though was that the scheme had been abandoned, due, in the Admiralty's view, to the great variations in environmental conditions neutralising any beneficial effects of the

25 GUL, MS Gen 1302, 7, Kerr to Admiralty , 14 June 1915.
26 GUL, MS Gen 1302, 8, Kerr to Winston Churchill, 25 June 1915.
27 GUL, MS Gen 1302, 9, Kerr to Balfour, 28 June 1915.
28 GUL MS Gen 1302, 11, V.W. Baddely, Admiralty to Kerr, 9 July 1915.
29 GUL MS Gen 1302, 12, Kerr to Admiralty, 18 July 1915.
30 GUL, MS Gen 1302, 10, Kerr to Sir George Bielby [no date, but July 1915].
31 GUA, DC6/381, Beilby to Kerr, 30 July 1915.

special painting.[32] Beilby later put Kerr's proposals to Admiral Fisher who promised in turn to present them to Admiral Jellicoe but nothing ever came of this.[33]

Kerr never gave up. In December 1915 Abbott Thayer paid a visit to England and Kerr took this opportunity again to press the Admiralty. He entreated their lordships to meet Thayer and at the same time summarised his own ideas. This again had no effect and by the end of 1915 those ships that had been applied with Kerr's colour scheme were gradually repainted in standard grey in the course of general maintenance.[34] The following year Kerr tried again to interest Churchill "to put pressure on the government to force them even at this 11th hour to take up this question of obliterative colouring really seriously." [35] Churchill responded in true official style stating that he had written to the Admiralty and that they "have the matter well in hand." [36]

Having failed to get anywhere with the Admiralty, Kerr now turned his attention to aircraft. In September 1916 he wrote to the minister of war, David Lloyd George, about concealing aircraft flying at night through the use of matt black paint. These suggestions apparently found some favour and were the subject of some experimental work although again Kerr was not party to the experiments.[37]

Dazzle and Acrimony

On 1 February 1917 Germany resumed a campaign of unrestricted submarine warfare, which was initially highly successful in sinking large numbers of merchant vessels. In April, Norman Wilkinson, then serving as a lieutenant in the Royal Naval Reserve at Devonport, had an idea for a paint scheme that would protect merchant vessels from submarine attack. He wrote to the flag officer at Devonport proposing to "paint a ship with large patches of strong colour in a carefully thought out pattern and colour scheme …, which will so distort the form of the vessel that the chances of successful aim by attacking submarines will be greatly decreased." He contrasted his own idea with earlier theories which he considered were based on making a ship invisible, whereas he aimed to "largely distort the external shape by means of violent colour contrasts." [38]

The flag officer was taken with the idea and passed it to the Admiralty who on 23 May 1917 ordered a storeship to be painted according to Wilkinson's design. Even before the success of this was established a further fifty ships were ordered to be painted in what became known as "Dazzle" colouring. Wilkinson was quickly put in charge of a newly

32 GUA, DC6/383, Beilby to Kerr, 26 August 1915.

33 GUA, DC6/384, Beilby to Kerr, 20 September 1915.

34 Thayer later wrote in the American press condemning the British method of ship colouring as "perfectly absurd" and gave credit to Kerr's efforts. Abbot Thayer, "Teaching Britannia her Job," *New York Tribune*, 13 August 1916.

35 GUL, MS Gen 1302, 15, Kerr to Churchill, 6.June 1916.

36 GUA, DC6/376, Churchill's secretary to Kerr, 27 June 1916.

37 GUL, MS Gen 1302, 21-24 and GUA, DC6/261-265, Kerr to David Lloyd George, 28 September 1916 and subsequent correspondence.

38 GUA, DC6/395, copy of letter 27 April 1917.

formed dazzle department within the Admiralty. All merchant ships over 150 feet in length were ordered to be painted in the scheme and during the remainder of the war some 4000 merchant ships and 400 naval vessels had dazzle applied.

Kerr was later to state that he "had the satisfaction of seeing the principle of parti-colouring come into its own," and was happy that its application had been "entrusted to skilled hands." [39] However it is clear that he was somewhat perturbed that someone else was now implementing a scheme that he felt was identical in concept to what he had been advocating for so long. In a letter to the shipping controller, Sir Joseph Maclay at the Ministry of Shipping, he again offered his services, claiming that improvements could be made to the way the colouration was being applied and stating that he was "probably the only man of science in this country who had made a special study of this subject." [40] However dazzle was now firmly in the hands of the artists and Kerr's services were not called upon.

Kerr also enlisted the aid of the principal of Glasgow University, Sir Donald MacAlister, to enquire of the Admiralty why Wilkinson's scheme was now being implemented while Kerr's had been abandoned. Their response emphasised that dazzle was designed for the deception of submarines which, whether by periscope when submerged, or from the low structure of the conning tower when surfaced, viewed ships against the skyline. For that reason "half measures such as light and dark greys as tried early in the war" were useless. They then proceeded to give a number of reasons why the principle of compensative shading was not employed, which included the limited supply of white paint.[41] Kerr realised that he would get no further with the Admiralty and dropped his correspondence.

In December 1918, after censorship restrictions had been dropped, Wilkinson wrote a number of letters to the press claiming sole credit for the invention of dazzle and dismissing earlier attempts to attain invisibility through painting schemes. [42] On seeing one such article in the *Glasgow Herald* on 6 December Kerr immediately wrote to his old friend Sir George Beilby expressing his annoyance at the way the Admiralty had handled his original suggestions and the fact that they were now allowing someone else to take sole credit for the scheme. He urged him to intervene at the Admiralty in order to put straight this "element of unfairness" and so avoid any element of public controversy.[43]

The Admiralty did no such thing and Wilkinson's claims gained more credence through further press coverage. Finally in May 1919 Kerr sent letters to both *The Times*

39 Kerr to *The Times*, 6 May 1919.

40 GUA, DC6/389, Kerr to Sir Joseph Maclay, 29 September 1917.

41 GUL, MS Gen 1302, 16-17, Admiralty to Sir D. MacAlister, 17 October 1917 and memorandum.

42 Norman Wilkinson to *The Westminster Gazette*, 5 December 1917 and *The Times*, 6 December 1918.

43 GUA, DC6/385-386, Kerr to Beilby, 6 December 1918. He also solicited a copy of his original 1914 letter from the Admiralty as he had not kept a copy himself. GUA, DC6/267, G.A. Steel to Sir Donald MacAlister, 18 December 1918, enclosing copy of Kerr's letter from 1914.

and the scientific journal *Nature*:[44]

> that the leading principle underlying ship camouflage - the breaking up of the form of the vessel by strongly contrasting colours - is one familiar to biologists, that it was made known to the admiralty in the early years of the war, although unfortunately its carrying into practice was bungled, and that consequently newspaper paragraphs which date the discovery of the principle, instead of the more efficient application of it, from the year 1917 are distinctly misleading.[45]

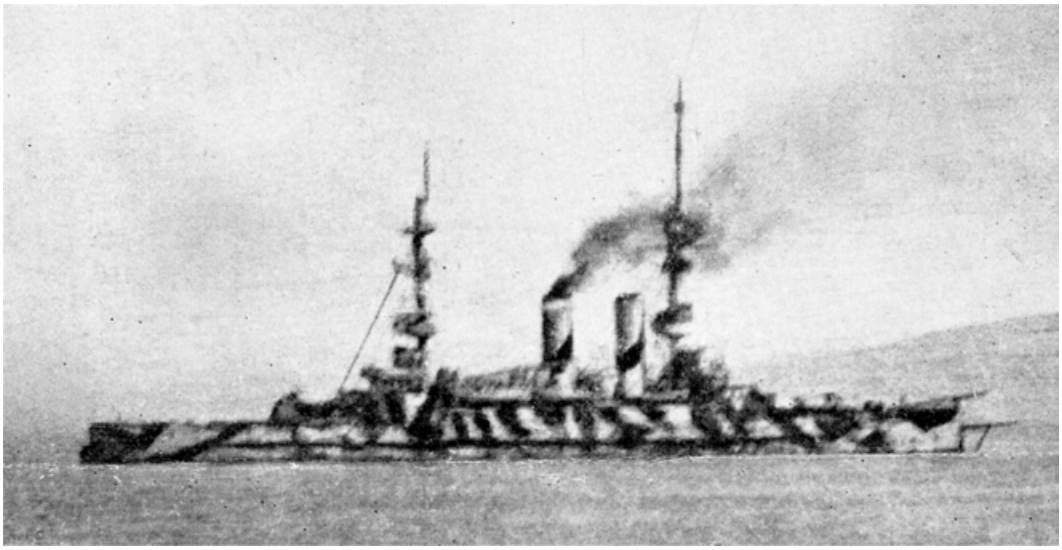

Illustration 5: The Formidable *class battleship HMS* Irresistible *in the winter of 1914/15, showing Kerr's parti-colouring scheme. Copy of photograph obtained by Kerr in relation to his claim to the Royal Commission on Awards to Inventors, 1922. Courtesy of Glasgow University Archives.*

This provoked both a private and public correspondence. The naval architect Gerard Holmes came out in favour of Kerr, acknowledging that in 1915 several of his own ships had been painted in "a manner corresponding very closely to modern camouflage methods."[46] This correspondence caught the eye of the secretary of the Newcastle Upon Tyne based North East Coast Institution of Engineers and Shipbuilders. Wilkinson was due to speak at their Victory meeting in July and Kerr was invited to attend and put his point of view. He was initially tempted to respond by saying that he hoped that Wilkinson would "take advantage of the opportunity to correct the impression industriously spread in the popular press that the main principle was first communicated to the admiralty in 1917." However, he crossed this out and instead submitted a contribution to be read at the meeting that he hoped would be regarded as a "temperate

44 Kerr to *Nature*, 6 May 1919, vol. 103, (May 1919), 204-205.

45 Kerr to *The Times*, 6 May 1919.

46 Gerald Holmes to *The Times*, 9 May 1919.

and not undignified treatment of a somewhat awkward matter."[47]

Meanwhile, Wilkinson had been preparing his own defence and in June wrote to both *The Times* and *Nature* denying that his scheme had anything to do with biological principles and stating that Kerr had "not thoroughly grasped the idea of the special form of camouflage on which I was engaged, and of which I still claim to be the originator."[48] Wilkinson's paper in Newcastle was his most extensive dealing of the subject to date. He took great pains to point out that all previous attempts to use paint as a defensive measure on ships were useless as they "were made with a view of rendering them invisible." He deliberately, and in our view wrongly, placed parti-colouring within this category and also took the opportunity to underscore the inadequacy of paint schemes as a protection against rangefinding in gunnery action.[49]

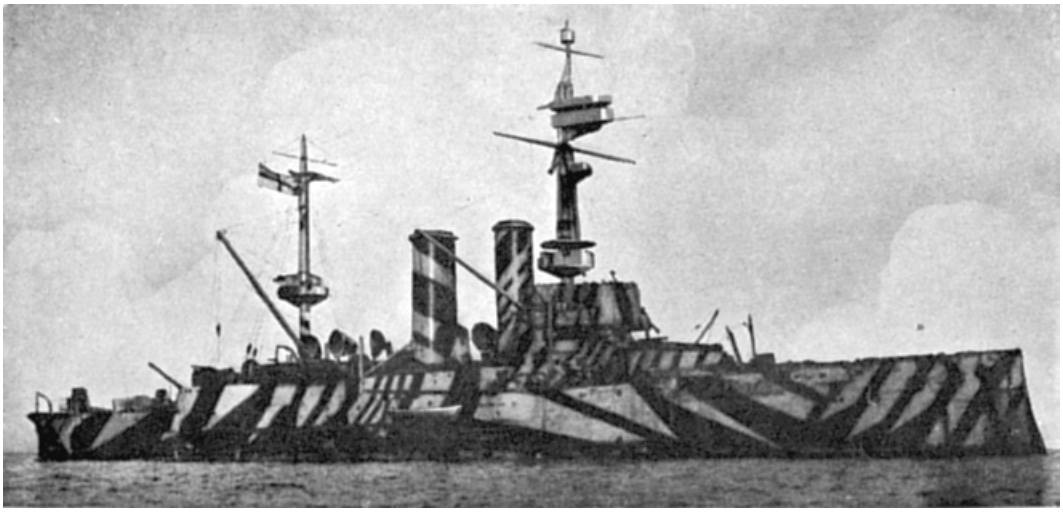

Illustration 6: The Formidable *class battleship HMS* London *painted in Norman Wilkinson's Dazzle camouflage in 1918. Comparing this with HMS* Irresistible *it is clear why Kerr claimed that there was a "remarkable parallelism" between the two schemes. Adapted from J.A. Hammerton,* A Popular History of the Great War*, (London, nd), V, plate 55.*

Kerr's contribution, written after declining to see a draft of Wilkinson's paper, elaborated on the biological principles underlying military camouflage and outlined his reasoning for breaking up the continuity of form of a vessel, which coincided almost exactly with the principles that Wilkinson described. He further defended his own position in the development of ship camouflage and highlighted the need to correct what

47 GUA, DC6/411-421, Kerr correspondence with E.A. Fraser Smith, Secretary of N.E.C.I.E.S., May to September 1919.

48 Wilkinson to *The Times*, 9 June 1919 and *Nature*, 6, 103 (June 1919), 304-305.

49 GUA, DC6/674, Norman Wilkinson, "The Dazzle Painting of Ships," read before the North-East Coast Institution of Engineers and Shipbuilders, 10 July 1919, reprinted by order of the council. A shortened version also appeared in *Engineering*, without Kerr's contribution; see "The Dazzle Painting of Ships," *Engineering* (8 August 1919), 192-195.

had appeared in the press.[50]

With tensions rising between the two men Kerr found himself embroiled in a battle for honour. He held a deep belief in the principles of fair play and decency and claimed that he had not the slightest desire to make it known that he had anything to do with originating the dazzle system until Wilkinson's claims of invention became public. He made it clear that he himself made no claims to have invented the system as it was a well-known biological principle. What he objected to was the fact that he considered the truth to have been misrepresented and that reports on the origin of dazzle had contained "gibes at scientific workers."[51] As a scientist Kerr reckoned that his "reputation for straightness and honesty" was his chief asset, and through Wilkinson's claims, and the Admiralty's failure to refute them, his scientific credit had suffered "grave injury."[52]

In August 1919 Kerr again wrote to Winston Churchill observing that he was being "placed in a rather awkward position and laid open to the suspicion on the part of those unacquainted with the facts." He felt that his scientific position obliged him to clear his name and was considering publishing a statement or getting one of his friends to raise the matter in Parliament. However he had "strong personal objections to doing so," and sought Churchill's advice on how his "difficulty may be got over by some less distasteful method."[53]

Whether Churchill had anything to do with it or not is not known, but later that year the Admiralty established a Committee of Enquiry on Dazzle Painting to investigate all the competing claims for developing the scheme and Kerr was invited to submit his case. The basis of his claim was that dazzle was essentially the same as the scheme proposed by him in 1914 and he gave substantial evidence detailing the "remarkable parallelism" between the two schemes. The committee however got caught up in semantics and the case seemed to rest on the term "invisibility." They figured that Kerr's scheme was aiming at invisibility, something which Kerr had repeatedly indicated was impossible, while dazzle was aimed at distorting visibility. This coupled with the fact that Kerr had originally proposed it as a protection from long-range gunnery rather that submarines led the committee to declare that they did not regard Kerr's suggestions as being responsible for the adoption of dazzle. Their view was that "incidental resemblance is no ground on which a claim can be properly based" and he was informed that if he wished to pursue the matter further he should make an application to the Royal Commission on Awards to Inventors, a body established to remunerate people whose inventions had materially benefited the war effort.[54]

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50 John Graham Kerr, "Camouflage of Ships and the Underlying Scientific Principles," in Wilkinson, "The Dazzle Painting of Ships," 22-29.

51 Kerr, "Camouflage of Ships and the Underlying Scientific Principles," 28.

52 GUL, MS Gen 1302, 30b. Kerr's moral code can be seen in his paper "Citizenship," *Proceedings of the Royal Philosophical Society of Glasgow* 54 (1926).

53 GUA, DC6/271, Kerr to Winston Churchill, 20 August 1919.

54 GUL, MS Gen 1302, 25-29, correspondence and transcript of evidence, 11 November 1919 to 20 October 1920; TNA, ADM 245/4, draft letter to Kerr in papers of the Committee of Enquiry on Dazzle Painting of Ships.

Kerr took up this offer and, in contrast to the rather hastily assembled evidence that he had presented to the first committee, this time he appointed legal counsel and took time to prepare a case based on copies of correspondence that the legal process now enabled him to extract from the Admiralty and other government departments. His original claim stated that he sought no payment, but simply wished public acknowledgement of the facts. This was ruled invalid as the commission settled only monetary awards and so he instead substituted a claim for the sum of £10,000.[55] The hearing duly took place in October 1922.[56] Despite Kerr's well argued case and the fact that two high profile witnesses conceded that they were unable to distinguish between the two schemes, the hearing veered towards a more general discussion on the efficacy of dazzle in preventing attack. An enquiry into dazzle had been carried out in 1918 which concluded that it had little impact on the rates of attack although it had been important in raising morale among merchant seamen.[57] The conclusion of the 1918 enquiry had a bearing as the commission had to consider the case in terms of its material benefit. The commission conceded that there clearly was a benefit, but that this was limited and so any award should be nominal.

Wilkinson's evidence was then rushed through before the end of the day. His case rested largely on the fact that he claimed to have no prior knowledge of Kerr's scheme. This was patently untrue. He had served in the Dardanelles in 1915 where several warships were painted according to Kerr's principles and he had even published an illustration of the submarine E.11 sporting camouflage paint.[58] When Wilkinson's Dazzle Section was being established the director of naval equipment reported previous schemes, including Kerr's, and Wilkinson's 1919 paper demonstrated that he was indeed aware of previous attempts to camouflage ships when developing dazzle.[59] However, in the short time the commission devoted to Wilkinson's submission there was no opportunity for Kerr's lawyers to draw out these points. Shortly afterwards the commission informed Kerr's lawyers that his case had not been upheld:"The whole question turned on Comdr. Wilkinson stating positively before the commission that he knew nothing of Professor Graham Kerr or of his scheme of Dazzle-painting when he prepared his scheme and sent it up to the Admiralty. Comdr. Wilkinson denied that his scheme had anything to do with the colouration of animals."[60]

In fact Kerr had never stood a chance. The brief to the counsel appearing on behalf of the Admiralty clearly advised against his claim and re-iterated the false notion

55 GUA, DC6/638, Particulars of claim by John Graham Kerr, 15 November 1920.

56 TNA, TS32/19B, Royal Commission on Awards to Inventors: Claim by Prof. Graham Kerr; GUL, MS Gen 1302, 30, Kerr papers and minutes of proceedings.

57 TNA, MT 25/16, Dazzle Painting - Report of Committee appointed to investigate results, 1918; TNA, ADM 1/8533/215, letter to Sir J. Maclay, 7 September 1918.

58 Norman Wilkinson, *The Dardanelles: Colour sketches from Gallipoli* (London, 1915).

59 Paper on "Dazzle Scheme of Painting Ships" reproduced in Norman Wilkinson, *A Brush with Life* (London, 1969), 84-86.

60 GUA, DC6/426, Clayton Sons and Fargus to Messrs Bruce & Kerr, 1 November 1922. Wilkinson was awarded £2000 by the commission, Wilkinson, *A Brush with Life*, 95.

that "the aim of Prof. Graham Kerr was to render the ship invisible."[61] With the commission's firmly negative conclusion Kerr had run out of options and he never did receive any official public acknowledgement of his role in the early development of ship camouflage.

There was a further irony in the commission's ruling. In fact, the merchant fleet had already been camouflaging itself as a result of poor quality paint and crew shortages long before Wilkinson developed his ideas for dazzle painting.

> As needs must, we painted sections at a time – a patch here, a plate or two there – laid on in the way that real sailors would call "inside out"! We sported suits of many colours, an infinite variety of shades. Quite suddenly we realized that grey, in such an ample range – red-greys, blue-greys, brown-greys, green-greys – intermixed on our hulls, gave an excellent low-visibility colour that blended into the misty northern landscape.[62]

So in fact both the navy and the merchant fleet had actually implemented rudimentary forms of camouflage prior to Kerr or Wilkinson describing their respective ideas, one precipitated by panic, the other forced by bad maintenance.

Conclusions

Kerr was in no doubt that the reason he had less success than Wilkinson in getting his ideas into practice had largely to do with influence. He was always an outsider and although he had great weight in scientific circles he simply could not penetrate the Admiralty, which had traditionally been resistant to ideas coming from outside its own ranks, particularly from professional scientists. Although Kerr was pleased that his original memorandum was issued to the fleet he was also a little surprised. He freely admitted that he had presented his ideas in a "rather crude and hastily written out form," and had "placed too much reliance upon the use of common sense in carrying out the instructions."[63] Those who did decide to adopt his proposals therefore did so without any training or direction. Kerr's repeated attempts to be involved in the application of his scheme ended in frustration. He was later to say that he had "very vivid memories of my feelings of almost complete despair during the war at the entire failure of the official people to grasp the real meaning of dazzle colouration."[64] Despite the initial support from Churchill, Kerr never had a true champion within the Admiralty and no one was ever given special responsibility for applying or administering his camouflage scheme. George Beilby's advocacy was the closest he got to internal support, but that was after the scheme had been abandoned and, Beilby, as a member of the widely mistrusted Board of Invention and Research was scarcely in a position of power. Beilby's enquiries revealed that Captain Thomas Crease, later secretary to the Board of Invention and Research "had

61 TNA, TS/32/19B, Royal Commission on Awards to Inventors: Claim by Prof. Graham Kerr.

62 David W. Bone, *Merchantmen-at-Arms: The British merchant service in the war* (London, 1919), 164.

63 GUA, DC6/659, "War Paint," typescript chapter of an unpublished autobiography by Kerr.

64 Kerr to M. Prendergast, 21 November 1931, GUA DC6/435.

been in close touch with the matter," but that hardly implies that he had been in any way an advocate.[65]

Kerr was not alone in his frustration at the British military establishment's failure to grasp the importance of camouflage. The artist Solomon J. Solomon who was eventually charged with implementing camouflage in the army late in 1915 apparently had to sit on the steps of the War Office for six weeks before obtaining an interview.[66] Had Kerr lived closer to the seats of power in London he too could have taken a similar stance and may well have had more success in his lobbying, but he was far too committed to his university post in Glasgow to contemplate such a move.

He frequently referred to the adoption of his scheme as being "muddled," "bungled" or "foozled," with the parti-colouring being applied at too small a scale and without sufficient contrast. Kerr commented that "the result was a complete absence of system, and an effect in individual cases calculated to excite, according to one's temperament, derision or tears." [67] The lack of scientific method, both in applying the scheme to individual ships and in evaluating the results meant that it was open to interpretation and prejudice at all levels. As we have seen, Kerr's ideas did have some early support among the fleet, but there was also a "natural repugnance of officers to see their ship painted in grotesque parti-colouring."[68] A graphic example can be seen in the aircraft carriers designed by Gerard Holmes which were initially painted in the scheme:

> On the arrival at Harwich the vessels suffered the fate of the wild and savage animals upon whose habits and colouring Professor Kerr is a recognized authority. Those who saw them were at first excited by their unusual appearance in the midst of more civilized-looking vessels, and were next actuated by a great desire to have their skins removed.[69]

It has been suggested that the use of camouflage in the Mediterranean in 1915 constituted a formal trial and that the colour scheme was abandoned due to the large patches of white reflecting the bright Mediterranean sun and increasing the visibility of ships.[70] However, Kerr was able to establish that the Admiralty received only a single report from a camouflaged ship at this time, suggesting that if indeed such a formal trial were implemented it was certainly not rigorously pursued.[71] Another theory for why Kerr's scheme was dropped came from Vice Admiral Ashley Waller who served with the Grand Fleet. He suggested that it had been developed under the false premise that the Germans were using coincidence range finders and when it was found that they were

65 GUA, DC6/435, Beilby to Kerr, 26 August 1915. Roy M. MacLeod and E. Kay Andrews, "Scientific Advice in the War at Sea, 1915-1917: The Board of Invention and Research," *Journal of Contemporary History* vol., 6, No. 2 (1971), 3-40.

66 Rankin, *Churchill's Wizards*, 77.

67 Kerr to *The Times*, 6 May 1919.

68 GUL, MS Gen 1302, 30b.

69 Gerald Holmes to *The Times*, 9 May 1919.

70 Williams, *Naval Camouflage 1914-1945*, 64.

71 GUL, MS Gen 1302, 30b. Unfortunately the identity of the ship in question is not known.

using stereoscopic range finders the idea was dropped.[72] However, in the absence of official records, the true reason for it being abandoned remains open to speculation.

Despite his scheme being abandoned in favour of uniformly grey painted ships in 1915 Kerr was very clear that he considered the wholesale adoption of dazzle in 1917 as being a direct result of his own scheme. He cared passionately about camouflage and the benefits that it could afford ships in wartime and, having campaigned so vociferously to get the Admiralty to adopt it in the early part of the war; it hurt him to see credit for its "invention" going to Norman Wilkinson after the war. We ought now to consider why he failed to achieve any official recognition for his contribution.

One convincing reason is the high profile of Wilkinson. He was a well known marine artist prior to the war with a growing reputation and an important circle of friends. It undoubtedly suited Wilkinson for the scheme to be seen as a purely artistic endeavour, with him as the heart. The massive publicity surrounding dazzle and the way in which it influenced artistic and cultural life gave him increased artistic credibility and a distinct commercial advantage. He clearly milked this opportunity and it was wryly observed that he was "trading in camouflage."[73] He further cemented his position when he was asked to contribute the entry on naval camouflage in the 12th edition of the *Encylcopedia Britannica*, published in 1922, where he referred rather ungraciously to the "disease" of earlier schemes and claimed that Dazzle "embodied entirely new ideas on sea camouflage."[74] Having been so successful in putting his "invention" of dazzle into the public domain, and with friends in high places, Wilkinson did not have to try too hard to defend his position. Kerr clearly saw Wilkinson's reputation and the relative public perceptions of artists and scientists as being a threat to his own position: "The public does not trouble about enquiring into dates: if it hears of two rival claims one from a distinguished artist whose pictures are known to and admitted by all and the other from an obscure worker in science – there is no question on which side its prejudices lie."[75]

It is easy to see why Wilkinson himself was keen to be seen as the sole creator of dazzle, but the attitude of the Admiralty is harder to fathom. There is probably an element of the Admiralty supporting one of its own over an outsider. This should be seen in the context of the great number of suggestions, scientific or otherwise, that came its way. In the first six months of its existence the Board of Invention and Research considered some 20,000 proposals. The majority were utterly useless and promoted by cranks. A number of ship camouflage schemes were proposed, many of which were aimed at invisibility, and a number were given limited trials.[76] The 1922 commission on the invention of dazzle also included the case of Archibald Phillips, an art dealer, who proposed a system of zigzag painting based on an entirely erroneous theory of colour. It was quickly

72 Answer to query 15 (1970), *The Mariner's Mirror* 57 (1971), 219.

73 GUA, DC6/423, Gerard Holmes to Kerr, 19 February 1919.

74 Norman Wilkinson, "Naval Camouflage," in *Encyclopedia Britannica* (12th ed.; 1922), I: 546-547.

75 GUL, MS Gen 1302, 28, Kerr to Admiralty, 28 November 1919.

76 Williams, *Naval Camouflage 1914-1945,* 62-71.

dismissed by the chairman saying that "it is quite obvious that this suggestion had no value at all." The fact that Kerr was, to some extent, tainted by these associations is clear from the deliberations of the two enquiries and their lengthy diversions on the issue of invisibility.

Another possible reason why Kerr never received due credit was the fact that he never published his theories on camouflage beyond a few short articles. His scientific publishing concentrated on evolution and embryology and, although he gained an international reputation in these fields, the fact that his camouflage theories were not backed by a solid scientific publication may have had a detrimental effect on the way his contribution was viewed at the time and also in subsequent years.

Despite his disappointment at the outcome of the two enquiries Kerr never gave up on camouflage or the fight to achieve recognition. He continued to put his case in letters and articles to journals such as the *Nautical Magazine*, *Nature* and *The Times*, and carried on a personal correspondence with those sympathetic to his case, including the noted naval historians Maurice Prendergast and L.G. Carr Laughton.[77] In 1935 Kerr was elected as a Unionist MP to Parliament for the Combined Scottish Universities constituency succeeding the MP and novelist John Buchan who had resigned to take up the post of governor-general of Canada.[78] Kerr used his new position to press his ideas. He was influential in getting Hugh B. Cott, his former student and expert in animal camouflage, a position in the Advisory Committee on Camouflage in 1939, but despite this he became increasingly frustrated that, once again, artists came to dominate the development of camouflage during the Second World War.[79]

Kerr referred to his efforts to improve ship camouflage as "perhaps the most disheartening experience of my scientific life." However, he may well have been his own worst enemy. His method of lobbying was neither very efficient nor politic and he seems to have generally annoyed those in power. He waged, in his own words, a "practically single handed conflict" with those in charge of war camouflage. He vigorously pursued the adoption of biological principles through letters to ministers, speeches in the House of Commons and the circulation of reprints of his articles and raised 40 questions in the House and was fobbed off with replies that he regarded as "evasive, misleading or grossly inaccurate."[80] Through all of this he never lost an opportunity to state his own credentials in having been the first to suggest the camouflage of ships back in 1914, but this proved ultimately to be counter-productive and he was referred to in the prime

77 GUA, DC6/246-780, correspondence and copy articles; see also National Maritime Museum, Greenwich, London, Society for Nautical Research, Secretary's [Geoffrey Callender] papers, SNR/6/17 correspondence with Kerr, 11-17 April 1944.

78 Buchan coincidentally played a major role in the development of camouflage as applied to information in the war as director of intelligence. His adventures are described as the "premier novels of twentieth-century camouflage and deception" (Rankin, *Churchill's Wizards*, 47). Whether the two men ever exchanged ideas on camouflage is not known.

79 Kerr was highly influential in the training of Hugh B. Cott and in the writing of his seminal work *Adaptive Coloration in Animals* (London, 1940).

80 GUA, DC6/659.

minister's office as an armchair critic who was "on the way to becoming a nuisance."[81] The prime minister's advisor also commented disparagingly that "all this stuff is common knowledge and is used. In any event we are not caterpillars concealing ourselves from toads."[82] Even a prominent scientist remarked that "my dear fellow it is the job of an artist not of a zoologist to know about the use of paint."[83]

Although he never achieved official recognition, Kerr clearly did play an important role in the early development of ship camouflage. Although the practical applications of his ideas were "foozled," his was the first scheme based on scientific principles to have been given a practical trial. Despite Wilkinson's claims to the contrary, it is clear that the basic principles of naval camouflage did originate from nature and that Thayer, Brush and Kerr, not Wilkinson, had laid the foundations for the science of ship camouflage.[84]

81 TNA, PREM 4/97/3, Colonel Jacob to J.M. Martin, Prime Minister's Office, 15 August 1940; A. Bevir, prime minister's private secretary, to Brendan Bracken, 19 October 1940.

82 TNA, PREM 4/97/3, Lord Clerwell to Prime Minister, 4 September 1914.

83 GUA, DC6/659.

84 Williams, *Naval Camouflage 1914-1945,* 9.