The Historical Journal, 51, 1 (2008), pp. 145–168 © 2008 Cambridge University Press
doi:10.1017/S0018246X07006619 Printed in the United Kingdom

THE EMERGENCE OF STATUTORY HYGIENE PRECAUTIONS IN THE BRITISH MINING INDUSTRIES, 1890–1914*

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ABSTRACT. *It will be fifty years in 2008 since Oliver MacDonagh suggested that the adoption of new responsibilities by the state in the early nineteenth century was an inevitable response to the social consequences of the industrial revolution, and impervious to ideological and philosophical influences. This article revisits MacDonagh's model by examining the emergence of occupational health reform in the British mining industry in the early twentieth century. Until the introduction of statutory measures in 1905 to protect miners against developing silicosis and basic sanitation provisions to prevent cross-contamination of disease, state regulation of working conditions prioritized the prevention of accidental injuries. It is argued that this decisive shift in the scope and nature of government intervention can be understood as part of a process of institutional expansion of mining regulations that broadly parallels MacDonagh's model. Yet the precise details of when, and how, health reform emerged and the nature of these specific regulatory controls were influenced by a variety of factors, including visibility of risk, human agency, economic performance of the industry, and contemporary thinking in political economy.*

There is an extensive literature examining the changing executive role of the state, the chronology of social policy, and the reasons why successive governments favoured reform of particular institutions, hazards, occupations, and industries. This brief depiction is by no means definitive. Until the publication of 'The nineteenth-century revolution in government: a reappraisal' by Oliver MacDonagh in 1958,[1] the origins of early Victorian social reform had been depicted as a linear sequence of events,[2] or broadly interpreted as either 'Tory',

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* The author would like to acknowledge the support of Professor Alan Booth and Dr Pamela Dale while preparing this article, and the editor and anonymous referees for their helpful and constructive comments.

[1] O. MacDonagh, 'The nineteenth-century revolution in government: a reappraisal', *Historical Journal*, 1 (1958), pp. 52–67.

[2] B. Hutchins and A. Harrison, *A history of factory legislation* (London, 1911).

motivated by an 'ethic of social responsibility', or 'radical', as A. V. Dicey first argued in 1905, essentially a Benthamite inspired response.[3]

MacDonagh suggested that government intervened only when obliged to do so by events or circumstances that were intolerable to society, such as the condition of underground female and child labour. Once government had proposed a legislative remedy, endangered interests brought their political influence to bear and forced a compromise that culminated in an emasculated law, insufficient to remove the original abuse but with potential for widening state regulation.[4] This released a 'runaway train' of accumulative expansion, in which human agency and political and philosophical ideologies were 'extraneous' and often antagonistic to the process.[5] The key step was the appointment of executive officers, followed by additional statutory controls based upon their day-to-day practical experience of upholding an inefficient law and their burgeoning knowledge and authority. Finally, an awareness was reached that a 'grand piece of legislation' would not offer a satisfactory remedy, and regulation began to be perceived as a dynamic process of 'closing the loopholes', 'tightening the screw ring by ring' and steadily extending the jurisdiction of the law.[6] Other historians such as David Roberts and George Kitsen Clark followed a similar line of reasoning.[7] These assumptions sit comfortably with the current renaissance in the notion of the 'the third way', whereby the state is largely reflexive and pursues only the dominant economic and social interests of society.[8] During the 1960s and 1970s, however, pragmatism and the assumption of an historical process were vigorously questioned, most notably by Jennifer Hart and Henry Paris.[9]

The study of health reforms and protective labour legislation in the nineteenth and twentieth centuries has followed a similar historiographical pattern. In 1948, Edward Merewether, a medical officer attached to the Factory Inspectorate, described what he termed the 'British tradition in industrial health': an ad hoc and piecemeal growth in hygiene and compensation policy. He drew parallels

[3] Robert Gray, *The factory question and industrial England, 1830–1860* (Cambridge, 1996), p. 7; A. V. Dicey, *'The debt of collectivism to Benthamism': lectures on the relation between law and public opinion in England during the nineteenth century* (London, 1905); and J. B. Brebner, 'Laissez faire and state intervention in nineteenth-century Britain', *Journal of Economic History*, Supplement, 8 (1948), pp. 59–63. See also W. Aydelotte, 'Conservative and radical interpretations of early Victorian social legislation', *Victorian Studies*, 11 (1967), pp. 223–36 at p. 227.

[4] MacDonagh, 'Revolution', p. 58.

[5] Ibid., p. 67.

[6] Ibid., p. 60.

[7] D. Roberts, in 'Tory paternalism and social reform in early Victorian England', *American Historical Review*, 63 (1958), pp. 323–37; see also D. Roberts, 'Jeremy Bentham and the Victorian administrative state', *Victorian Studies*, 2 (1959), pp. 193–210; and George Kitson Clark, *The making of Victorian England* (London, 1962).

[8] A. Giddens, *The third way, the renewal of social democracy* (Oxford, 2002).

[9] J. Hart, 'Nineteenth-century social reform: a Tory interpretation of history', *Past and Present*, 31 (1965), pp. 39–61; and H. Paris, 'The nineteenth-century revolution in government: a reappraisal reappraised', *Historical Journal*, 3 (1960), pp. 17–37. For a summary of the debate, also see V. Cromwell, *Revolution or evolution: British government in the nineteenth century* (London, 1977), pp. 245–55; see also B. Harris, *The origins of the British welfare state: social welfare in England and Wales, 1800–1945* (Basingstoke and New York, 2004), pp. 32–7.

with falling incendiary bombs; 'the fires had to be put out with the means at hand, without wasting time planning a national fire service'.[10] However, with the exception of Peter Bartrip, who briefly revisited MacDonagh's model in his study of the Home Office and the dangerous trades, protective labour legislation has largely been interpreted within an ideological and/or economic framework.[11]

Barbara Harrison, Angela John, Sylvia Walby, and Jane Humphries, amongst others, have offered feminist perspectives particularly on the prohibition of underground female and child labour, and the regulation of the dangerous trades in 1878.[12] Caroline Malone in particular, has highlighted the maternalist argument.[13] Bentley Gilbert, Geoffrey Searle, and Bernard Semmel have all explained liberal welfare reforms in the early twentieth century within the context of national efficiency.[14] It has been similarly suggested that occupational health reform 'fits neatly' into this model.[15] Ian Mortimer and Joseph Melling have suggested that the recognition of anthrax as industrially generated and compensatable is in part explained by the public abhorrence and fear that the disease generated, but also within the context of the wool trade.[16] Gillian Burke and Peter Richardson also adopted a similar economic interpretation in their study of compensation initiatives for miners' phthisis, comparing Cornwall to the Transvaal. They argued that British government sacrificed the health of Cornish miners in return for the last vestiges of profit in a rapidly declining industry.[17] In 'Disease, labour migration and technological change: the case of the Cornish miners', Burke suggested that labour militancy in a vital industry generated government intervention.[18]

[10] E. R. A. Merewether, 'The British tradition in industrial health', *British Journal of Industrial Medicine*, 5 (1948), pp. 175–9 at p. 177.

[11] P. Bartrip, *The home office and the dangerous trades, regulating occupational disease in Victorian and Edwardian Britain* (Amsterdam, 2002), p. 286. Also see A. Heesom, 'The Coal Mines Act of 1842: social reform and social control', *Historical Journal*, 24, (1981), pp. 69–88.

[12] B. Harrison, *Not only the dangerous trades: women's work and health in Britain, 1880–1914* (London, 1996); A. V. John, *By the sweat of their brow: women workers at Victorian coal mines* (London, 1984); S. Walby, *Patriarchy at work* (Oxford, 1986); and J. Humphries, 'Protective legislation, the capitalist state and working-class men: the case of the 1842 Mines Regulation Act', in R. E. Pahl, ed., *On work: historical, comparative and theoretical approaches* (Oxford, 1988), pp. 95–124.

[13] C. Malone, *Women's bodies and the dangerous trades in England, 1880–1914* (Woodbridge, 2003).

[14] B. B. Gilbert, *Evolution of national insurance in Great Britain: the origins of the welfare state* (London, 1966); G. R. Searle, *The quest for national efficiency* (Oxford, 1971); and B. Semmel, *Imperialism and social reform: English social imperial thought, 1895–1914* (London, 1960). In addition, see J. R. Hay, *The origins of liberal welfare reforms, 1906–1914* (London, 1975), pp. 29–38; and Harris, *Welfare state*, pp. 23–5 and 156.

[15] Bartrip, *Dangerous trades*, pp. 286–7.

[16] I. Mortimer and J. Melling, 'The contest between commerce and trade, on the one side, and human life on the other', *Textile History*, 31 (2000), pp. 222–36.

[17] G. Burke and P. Richardson, 'The profits of death: a comparative study of miners' phthisis in Cornwall and the Transvaal, 1876–1918', *Journal of South African Studies*, 4 (1978), pp. 147–71 at p. 168.

[18] G. Burke, 'Disease, labour migration and technological change: the case of the Cornish miners', in P. Weindling, ed., *Social history of occupational health* (London, 1985), pp. 78–88 at p. 87.

Bartrip has also highlighted the role of the moral entrepreneur in both placing occupational health reform on the political agenda and mobilizing support, but also stressed the impact of the victim, medical expertise, the Factory Inspectorate, and the Labour Commission.[19] Historians such as Geoffrey Tweedale, Arthur McIvor, and Ronnie Johnston have highlighted countervailing forces of reform, emphasizing machismo working traditions, corporatism, effective trade unionism, race, and the extent of contemporary medical knowledge, particularly in relation to compensation policies in international non-ferrous mining, British coal mining, and the asbestos industry in the twentieth century.[20]

It is difficult to locate the emergence of mine hygiene firmly within this historiography. Up until 1905 state regulation of working conditions in the British mining industries had prioritized the prevention of accidental injuries in the coal sector. Government made a solitary attempt, based upon spurious medical evidence, to stem the rising rate of mortality from miners' phthisis (now recognized as silicosis) amongst the non-ferrous metal miners in 1872. Interest in the unhealthy nature of underground labour began decisively some thirty years later in 1902 with ankylostomiasis (hookworm), a parasitic infection of the small intestines specifically amongst Cornish metal miners.[21] Certainly, comparisons can be drawn with the scheduling of anthrax as an industrial disease; hookworm was contagious and transmission via the skin resulted in open lesions. The outbreak, however, was largely confined to one mine in the far south-west, the infection had peaked earlier in 1898 with twenty-nine hospital admissions, and only one miner had died.[22] Miners' phthisis was much more widespread and generally fatal.

Moreover, the Cornish sector faced fierce foreign competition and was in the throes of terminal industrial decline.[23] There was little economic interest left for the state to protect. Although the Cornish sector continued to be Britain's largest producer of non-ferrous metals, no women and only 5,396 men remained employed underground (female labour had been traditionally confined to surface

[19] Bartrip, *Dangerous trades*.

[20] Key studies include P. Bartrip, *The way from dusty death: Turner and Newall and the regulation of occupational health in the British asbestos industry, 1890s–1970* (London, 2001); S. Marks, The silent scourge? Silicosis, respiratory disease and gold mining in South Africa, *Journal of Ethnic Migration Studies*, 32 (2006), pp. 569–89; R. Johnston and A. McIvor, 'Dangerous work, hard men and broken bodies: masculinity in the Clydeside heavy industries', *Labour History Review*, 69 (2004), pp. 135–51; E. Katz, *The white death: silicosis on the Witwatersrand gold mines, 1866–1910* (Johannesburg, 1994); and G. Tweedale, *Magic mineral to killer dust: Turner and Newall and the asbestos hazard* (Oxford, 2000).

[21] Ankylostomiasis is known by a variety of names: brick maker's anaemia, chlorosis, Egyptian chlorosis, Gotthard tunnel disease/syndrome, Griesinger's disease, helminthiasis, miner's anaemia, necatoriasis, tunnel worker's anaemia, and uncinariasis.

[22] *Report to the secretary of state for the home department on an outbreak of ankylostomiasis in a Cornish mine*, British Parliamentary Papers, 1902, Cd 1843 (hereafter BPP *Ankylostomiasis*), p. 6.

[23] D. B. Barton, *A history of tin mining in Cornwall* (Truro, 1967); D. B. Barton, *A history of copper mining in Cornwall and Devon* (Truro, 1968); and *Report of the departmental committee on the non-ferrous mining industry*, British Parliamentary Papers, 1920, Cmd 652 (hereafter BPP *Non-ferrous mining*).

operations).[24] The workforce was fiercely independent, self sufficient, and unorganized.[25] It was generally accepted that the mine was a dangerous and unhealthy place. Safe and hygienic working practices were considered individual rather than company or state responsibilities.[26]

George Fox, ninth Baron Kinnaird, had championed the regulation of metalliferous mining in line with colliery reform during the 1860s and 1870s, but had been publicly threatened with violence should he return to the Duchy.[27] What little welfare interest the sector attracted was sporadic and localized. Since his appointment in 1872, the inspector for North Wales (previously south-western mining district) Clement Le Neve Foster, had persistently drawn the attention of successive home secretaries to both deteriorating respiratory health amongst the non-ferrous men, and to the burgeoning evidence suggesting a causal link to dust suspended in mine air.[28] Although MacDonagh's model predicted that ineffective intervention prompted expansion of the law, the government largely ignored Foster's recommendations for investigation and additional intervention.

At the end of the nineteenth century, Foster retired from active service, and the Home Office eventually responded to an isolated request from Inspector Joseph Martin (south-western mining district) for an investigation into mine ventilation in 1902. Why government responded to this request forms a key question that this article seeks to explain. The discovery that men were infected with hookworm resulted from the preliminary investigations. A series of departmental inquiries followed, culminating in an extensive report published in 1904 on the health of the Cornish miners that resolved much of the controversy surrounding the aetiology and natural history of miners' phthisis.[29] The extension of current metalliferous and coal mining regulation to improve basic sanitation and protect miners against developing silicosis followed in 1905, and marked the first significant occupational health initiatives specific to the underground environment.

[24] Data sourced from *Annual reports of the inspectors of mines*, British Parliamentary Papers, 1901, p. 12 (hereafter BPP *Inspectors of mines*).

[25] For most recent discussion on Cornish quietism see R. Burt, 'Industrial relations in the British non-ferrous mining industry in the nineteenth century', *Labour History Review*, 71 (2006), pp. 57–79.

[26] Catherine Mills, 'Safety and health provisions in the British mining industry, with particular reference to non-ferrous metals, 1800–1914' (Ph.D. thesis, Exeter, 2004), pp. 142–6.

[27] *Hansard*, Third Series, Lords, 179, 11 May 1865, col. 626.

[28] For example, see *Preliminary report of Her Majesty's commissioners on accident in mines, and means of preventing their occurrence, or limiting their disastrous consequences*, British Parliamentary Papers, 1881, C 3036 (hereafter BPP *Accidents*), pp. 128–36 paragraphs (4074 to 4300), evidence of C. Le Neve Foster.

[29] BPP *Ankylostomiasis*; also see *Report by the vice-consul on the outbreak of ankylostomiasis in the Westphalian colliery district in Germany*, British Parliamentary Papers, 1903, Cd 1671; *Report to the secretary of state for the home department on ankylostomiasis in Westphalian collieries*, British Parliamentary Papers, 1904, Cd 1843 (hereafter BPP *Westphalian collieries*); *Report on the diagnosis of ankylostoma infection, with special reference to the examination of the blood*, British Parliamentary Papers, 1904, Cd 2066 (hereafter BPP *Diagnosis*); and *Report to the secretary of state for the home department on the health of Cornish miners*, British Parliamentary Papers, 1904, Cd 2091 (hereafter BPP *Cornish miners*).

Industrial decline and lack of labour militancy offer possible explanations as to why there was little attention paid to Foster's health concerns in the last quarter of the nineteenth century, but still leaves the questions unanswered of precisely how, when, and why hygiene initiatives emerged in the way they did. Explanations for this decisive shift in the scope and nature of government intervention can be found only by locating health reforms within both the historical development of mining regulation, and the national socio-economic and political context.

I

By the mid-nineteenth century, the estimated life expectancy of a British coal miner was thirty-six years, and for a metalliferous miner roughly twenty-nine years. These figures compared unfavourably to the agricultural labourer who lived for approximately sixty-two years.[30] Differing working methods and local geological factors produced variations in the scale, frequency, and nature of hazards between the two sectors. Methane posed a grave danger to colliers and to miners working iron in conjunction with coal. The gas burns readily in air and is explosive in certain critical mixtures.[31] Many lives were lost often across several generations, mine and machinery were destroyed, and production brought to a standstill without warning from repeated explosions.

The non-ferrous men laboured in hard stable rock that was generally free from methane, but often rich in silica. Over time, the daily inhalation of dust particles less than ten microns in diameter resulted in a deadly fibrotic scarring of the lungs. This effectively sealed cellular tissue, prevented full aeration of the blood to produce chronic shortness of breath, commonly known as miners' asthma (now recognized as silicosis), and predisposed to secondary infection, particularly pulmonary tuberculosis. This mixed fibrotic and infective process gave rise to the term miners' phthisis.

For a problem to be remedied it has to be first noticed. Occupational medicine was in its infancy, there was no systematic collection of data, and no comprehensive understanding of risk.[32] Consequently, contemporaries looked to what was visible, and explosion, as one commentator described, 'forced itself on publicity'.[33] In contrast, although prognosis of miners' phthisis was poor, the onset of disease was slow and uncertain. Moreover, the death rate was only high amongst the older age groups. Between thirty-six to forty-five years of age, mortality was roughly 9·0 per 1,000 men employed per annum, and this rose to 34·0

[30] Data sourced from *Report of the commissioners appointed to inquire into the condition of all mines in Great Britain to which the provisions of the Act 23 & 24 Vict. c. 151 do not apply*, British Parliamentary Papers, 1864 (3389) (hereafter BPP *Kinnaird commission*), Pt II, Appendix B, III, 'Statistics and evidence', pp. 154–6.

[31] The explosive range falls roughly between 5 and 15 per cent of methane in air.

[32] P. E. H. Hair, 'Mortality from violence in British coal mines, 1800–1850', *Economic History Review*, 21 (1968), pp. 545–61.

[33] R. Nelson-Boyd, *Coal mines inspection: its history and results* (London, 1897), p. 28.

between the ages forty-six to fifty-five years and to 63·0 between the years fifty-six to sixty-five.[34]

Single deaths, aptly described by historian John Benson as a steady 'drip drip', not just from miners' phthisis, but human falls, entombment, drowning, suffocation, and entanglement with machinery in both sectors of the industry were largely obscured by immediate impact and visibility of a pit explosion.[35] Consequently, the deteriorating respiratory health of the non-ferrous men attracted nominal concern, whereas each colliery explosion provoked a furore of public protest, one of the key factors of intervention identified by Bartrip, from a wide variety of interests, including concerned individuals, safety societies, civil and mining engineers, politicians, organized labour, colliery owners, and their managers.[36]

The arousal of public concern clearly paralleled the first phase of MacDonagh's model. It was a direct response to the exposure of a 'social evil' and despite the unified objective of the reforming interests to prevent further explosions, there was no consistent ideology motivating their campaigns for remedial action. However, their initial responses were not to demand immediate intervention, as MacDonagh suggested, but to promote wider public awareness of explosion hazard, encourage the voluntary introduction of technological solutions, such as the safety lamp, and to improve technical training.[37] Appeals for state intervention emerged in strength following a simultaneous but separate campaign to regulate underground female and child labour in the early 1840s that owed it origins to factory reform.[38]

Although the 1842 *Mines and Collieries Act* brought some indirect safety provisions to the collieries (it removed the very young from tasks that might endanger life), the primary aim of the law was to protect women and children by simply removing them from the hazardous and unwholesome working environment. The campaign and subsequent intervention, however, facilitated wider public awareness of the brutal realities of pit labour, and established a precedent of government interference in the coal sector. Moreover, it provoked thoughts of national as opposed to local unionism, and created a strong political interest amongst the colliers by demonstrating that it was possible for them to better their lot in the workplace by parliamentary means.[39]

In the non-ferrous mines very few young boys and no females were employed underground. Consequently, the sector attracted a relatively positive image during the 1842 campaign, and although theoretically regulated under the Act, in practice the law was never enforced.[40] This served to increase the invisibility

[34] BPP *Kinnaird commission*, Pt II, Appendix B, III, 'Statistics and evidence', p. 154.
[35] J. Benson, *British coal miners in the nineteenth century: a social history* (Dublin, 1980), p. 39.
[36] Bartrip, *Dangerous trades*, p. 285.
[37] Mills, 'Safety and health', pp. 44–7.
[38] A. Bryan, *The evolution of health and safety in mines* (London, 1975), pp. 28–9.
[39] R. Challinor and B. Ripley, *The miner's association – a trade union in the age of Chartists* (Worcester, 1990), p. 45.
[40] See G. Henwood, 'Bal boy', in R. Burt, ed., *Cornish mines and miners* (Truro, 1972), p. 96.

of conditions in the non-ferrous metal mines compared to collieries, and the limited reforming interest in the men's health continued to emphasize the voluntary amelioration of unhealthy working conditions rather than petition the state. This line of action arguably appealed to the unorganized, fiercely individualistic, and self-sufficient workforce who claimed responsibility for their own welfare in the working environment. Whilst the non-ferrous men remained silent to their conditions, the colliers became increasingly militant in their demands for government intervention as the 1840s progressed.[41]

Clearly, 'public intolerability', MacDonagh's 'master card' of reform, had not automatically followed on from an exposure of social evil; instead it was influenced by a legal precedent. Neither did government immediately respond with a legislative remedy as the model suggested. Gillian Burke had argued that militant labour in a vital industry generated government intervention.[42] Coal was central to the economic wealth and commercial power of the nation; it fuelled the factories and workshops, propelled the steamships and the railways, and provided domestic fuel. Although the non-ferrous sectors occupied a sound and stable market position in the first half of the nineteenth century, the coal trade overshadowed their economic status. In 1800, coal production stood at an estimated fifteen million tons per annum and the sector employed roughly 58,000 hands. By 1830, output had reached thirty million tons and the workforce had risen to an estimated 121,500.[43]

These two key characteristics of the coal sector coupled with the strength and extent of the reforming interest placed the safety of the collier high on the political agenda; conversely the health of the non-ferrous men was consigned to a position of secondary importance and largely ignored. Government also steered a fine line between protecting their strategic interests in coal, placating protest; and rigidly adhering to laissez faire principles. By appointing eminent and prestigious scientists, such as Michael Faraday and Henry De La Beche, to investigate the causes of explosions, government successfully defended themselves against criticism and resisted intervention.[44] Although MacDonagh dismissed the role of human agency, it took sustained and relentless pressure, particularly from organized colliery labour, to crack this defensive shield.[45]

II

The bill to regulate coal mining, introduced in 1850, attracted very little discussion in either House. This contrasts with MacDonagh's model, because the 'mobilization of endangered interests' and subsequent 'emasculation of the law'

[41] Bryan, *Evolution*, p. 50.

[42] Burke, 'Disease', p. 87.

[43] See M. W. Flinn with the assistance of David Stoker, *The history of the British coal industry*, II: *1780–1830: the industrial revolution* (Oxford, 1984), table 1·2 p. 26, and p. 365.

[44] O. MacDonagh, 'Coal mining regulation: the first decade, 1842–1852', in E. Robson, ed., *Ideas and institutions of Victorian Britain: essays in honour of George Kitson Clark* (London, 1967), pp. 58–86 at p. 70.

[45] Mills, 'Safety and health', pp. 40–4.

had taken place earlier, in 1849. Government had appointed a select committee to examine the feasibility of introducing safety inspection. The committee had brought together all interested parties and a mild non-coercive system of inspection was agreed upon. The coal owners, like government, had an interest in preventing explosions, and it was organized labour that was forced to compromise over their desire for more punitive measures. Nonetheless, as the model predicted, it was a weak and limited law that entered on to the statue book in August 1850. The Coal Mines Act simply made provision for the appointment of inspectors and defined their duties. These were limited to an authority to inspect, draw attention to dangerous practices, and suggest remedial measures only.[46]

The newly formed Inspectorate responded enthusiastically to their task. Their day-to-day experiences revealed the difficulties of their office, the limitations and weakness of the law, and the true extent and nature of underground hazards. Their systematic collection and critical analysis of mortality data revealed that colliery explosions, despite the continued occurrence and the heavy death toll, were not the major cause of death in the underground environment. Colliers also suffered frequent fatal injuries from a wide variety of causes, and questions were raised regarding the effects of underground labour on respiratory health. Much more than the provision of effective ventilation to prevent accumulations of methane would be required to improve occupational mortality.[47]

The failure of the law to meet more optimistic expectations provoked demands, particularly from organized colliery labour, for additional and strengthened legislative provisions. These appeals were legitimized and supported by the developing experience and authority of the Inspectorate. Bartrip, in particular, attributes to them a strong role in influencing legislative amendments.[48] In 1855, although emphasis remained on ventilation, the Home Office increased the numbers, salary, and authority of inspectors and introduced a limited code of working practice, largely based upon their recommendations, with penalties for non-compliance.

There was no cohesive plan or blueprint for reform; as weaknesses and deficiencies in the law were exposed, government responded by nominally 'plugging the gaps'. This usually consisted of information gathering, particularly from scientific and technological experts, and there was no guarantee that amendment of the law would follow, even if it was recommended. Until every occupational hazard, legal loophole, and administrative difficulty were recognized and remedied, tragedies continued to occur and were followed by demands for expansion and extension of the law, and so the process was repeated.[49]

[46] An Act for Inspection of Coal Mines in Great Britain, 14 Aug. 1850, 14 & 14 Vict. c. 100.

[47] *Third report of select committee on accidents in coal mines*, British Parliamentary Papers, 1852/3, 820, paragraphs (1553–7), pp. 113–14, evidence of Inspector F. H. Mackworth.

[48] P. W. J. Bartrip, 'British government inspection, 1832–1875: some observations', *Historical Journal*, 25 (1982), pp. 605–26 at p. 622.

[49] Mills, 'Safety and health', pp. 73–91.

There is no perfect fit with MacDonagh's assumptions. The appointment of inspectors was an intrinsic part of the original 1850 Act, and not a response to its failures as predicted. Yet the continued development of regulations in an accumulative ad hoc progression correlates strongly with the final stages of his model. Although there was a degree of inevitable expansion and extension of the law, certainty, and precisely how and when, was often determined by extraneous influences, suggesting that the model required much more flexibility than MacDonagh originally envisaged.

Reform of the metalliferous mining sectors was part of this process of ongoing institutional expansion. The jurisdiction of the colliery regulation was extended in 1860 to ironstone worked in conjunction with coal, and between 1862 and 1864, all mining industries excluded under the current law were the subject of a royal commission chaired by George Kinnaird. The inquiry established 'excessive mortality', particularly amongst non-ferrous metal miners, from 'consumption and respiratory disease', rather than from fatal injuries as in coal mining and ironstone mining.[50]

The commission struggled to identify the pathology, aetiology, and natural history of the men's condition, and attributed the high incidence of respiratory disease amongst underground labour to the inhalation of bad or 'impure air'. This was essentially 'an excess of carbonic acid gas' from human respiration, and a chemical cocktail of spent gunpowder. The effects of inhalation, contemporaries argued, were exacerbated by exposure to extremes of temperature, the wearing of wet clothes, and the exertion of lengthy ladder climbs. The inhalation of 'gritty particles' was relegated to a minor contributory factor only.[51]

The commission recommended the introduction of a general code of working practice as was operational in the collieries. This would protect the men against the risk of fatal injuries and ensure the provision of adequate ventilation, with additional stipulations of a specific ladder inclination and the erection of buildings to remove and dry damp working clothes to combat respiratory disease. These measures were introduced in 1872 under the Metalliferous Mines Regulation Act, and although they undoubtedly improved conditions, they were unlikely to reduce the incidence of miners' phthisis.[52] Moreover, ventilation in isolation without the use of water was likely to increase risk. An efficient flow of air dried out the underground environment, produced higher concentrations of dust, and facilitated its spread into uncontaminated areas of the mine.[53]

By the late 1870s, inspectors had already begun to comment in their annual reports upon the deteriorating respiratory health of the non-ferrous men.[54]

[50] BPP *Kinnaird commission*, Pt II, Appendix B, III, 'Statistics and evidence', p. 156.

[51] Ibid., Pt I, 'Resolutions', pp. xlii–xliii.

[52] An Act to Consolidate and Amend the Law relating to Metalliferous Mines, 10 Aug. 1872, 35 & 36 Vict. c. 77, Part II 23. (1), (15), and (16).

[53] R. A. Williams, 'The high mortality of British metal and slate miners and beliefs about causes, 1556–1904', *British Mining*, 4 (1987), pp. 18–33 at p. 26.

[54] For example see BPP *Inspectors of mines*, 1884, District of North Wales, C. Le Neve Foster, p. 213.

Mechanized rock drilling and dynamite, introduced from the mid-1870s, had significantly increased the amount of fine dust suspended in mine air.[55] Inspector Clement Le Neve Foster in particular had been an ardent campaigner for both safer and healthier working conditions. When called as an expert witness before a royal commission in 1879 investigating mining accidents, he took opportunity to highlight the rising rate of mortality amongst the non-ferrous men compared to colliers. In his opinion, the greatest danger to their health was the inhalation of 'solid matter' suspended in mine air, and not carbonic acid gas.[56] The commissioners, however, remained preoccupied with the ongoing and highly visible consequences of accidental ignitions of methane in the vital coal sector. Consequently, the Home Office dismissed Foster's astute observations and ignored his continued demands for investigation and additional legislative controls.[57]

Failure to remove the original abuse, according to the model, should lead to expansion of the law. Although the metalliferous mining regulation was a separate Act of Parliament it was not perceived as such by the legislature. Government had originally proposed to simply extend the jurisdiction of colliery regulation to the non-ferrous sectors, as they had done previously with ironstone, rather than enact fresh legislation. However, the Cornish mineral lords, in particular, argued that colliers, due to the presence of methane, required much more stringent regulation than was necessary for the protection of non-ferrous metal miners. They vigorously opposed a single code of practice applicable to all underground operations.[58]

Government conceded this point in theory only. In practice the 1872 Act resembled current colliery regulation in all but stringency, ventilation, and the use of safety lamps. With the exception of two appointments to cope with the additional workload, 'Coal Inspectors' also enforced the code of practice at the non-ferrous metal mines, and the nominal amendments to the 1872 Act were non-specific to the sector, largely administrative, and originated from research into, and the adoption of, safer working practices in coal mining.[59] The protection of the collier continued to dominate mining reform and health initiatives were not perceived to be a priority.

Since the introduction of regulation in 1850, occupational mortality had steadily improved amongst colliers. By the early 1890s, they enjoyed a rate of 12·5 deaths per annum per 1,000 men employed, which was significantly below the average rate of 16·0 per 1,000 occupied males.[60] Improvements in ventilation, and the introduction in the late nineteenth century of water sprays to minimize the magnitude of explosion from the accidental firing of coal dust, afforded the men

[55] Burke and Richardson, 'Profits', pp. 156–7.

[56] BPP *Accidents*, pp. 128–36 paragraphs (4074–300), evidence of C. Le Neve Foster.

[57] Williams, 'High mortality', pp. 18–33 at p. 27.

[58] Mills, 'Safety and health', pp. 169–72.

[59] Ibid., pp. 199–203.

[60] R. Church, A. Hall, and J. Kanefsky, *The history of the British coal industry*, III: *1830–1913 Victorian pre-eminence* (Oxford, 1986), p. 584. The data does not include non-fatal injuries.

some indirect protection against inhaling the dust.[61] Whilst the colliers' health appeared robust and not under threat, the sector generated very little interest in mine hygiene, until the Cornish hookworm epidemic exposed the vulnerability of the collier to cross infection and the role of occupational disease in reducing the human body's capacity to labour efficiently.

III

In 1893, a patient with severe anaemia was admitted to the West Cornwall Miner's Hospital in Redruth.[62] The clinical picture was complex, with both alternating constipation and diarrhoea and a distinctive skin eruption on the forearms, recognizable from the early twentieth century as a classical presentation of hookworm. Symptoms often resembled those of iron deficiency anaemia. Sufferers presented with pallor, listlessness, dizziness, shortness of breath, severe fatigue, oedema, and circulatory changes, and were not dissimilar to miners' phthisis. Even with medical training, the two conditions were often confused.[63] Gastro-intestinal symptoms were commonly constipation with intermittent diarrhoea and abdominal discomfort. In cases of skin transmission, there was intense itching and papular vesicular eruptions. Infection was often extremely debilitating, but rarely fatal.[64]

Transmission of the parasite to its human host can take place by ingestion of the ova, and/or through skin contact with infected earth or water, typically via the feet. The larvae enter through hair follicles, travel in the blood stream to the small capillaries of the lungs, via the bronchial tubes into the oesophagus, and down into the gut. The adult worm, roughly one centimetre in length, attaches itself to the mucous membranes of the gut causing small haemorrhages. The adult female produces thousands of ova per day, which are passed out of the body in faeces and develop into filariform larvae in warm and moist soil conditions. The ova will not hatch below 60 °F, and the optimum temperature for development is 75 °F.[65]

The wet, warm, muddy, and unsanitary conditions of a mine provided an ideal environment for the development of ova, and the transmission of infection. In poor illumination, infected faeces were easily spread underfoot throughout the working environment.[66] Miners often laboured naked to the waist in close contact with infected material, and soiled ladder rungs specifically contaminated lower arms and hands. Despite the identification of the worm in 1838 and acceptance of its pathogenic importance in 1853, there was no recognition of

[61] Bryan, *Evolution*, pp. 107–8.

[62] A. E. Boycott and J. S. Haldane, 'An outbreak of ankylostomiasis in England I', *Journal of Hygiene*, 3 (1903), p. 96.

[63] Ibid., p. 93.

[64] K. F. Kipple, ed., *The Cambridge world history of human disease* (Cambridge, 2003), 'Hookworm infection', J. Ettling, pp. 165–8.

[65] D. Hunter, *The diseases of occupations* (London, 1964), p. 726.

[66] Boycott and Haldane, 'Ankylostomiasis', pp. 95–141.

hookworm as a hazard to underground labour until 1882, when Edoardo Perroncito studied men labouring on the construction of the Gotthard tunnel in Switzerland.[67]

The hospitalized patient was a miner who worked at Dolcoath, a local tin mine. Dolcoath was large, technologically advanced, employed roughly 1,250 men, and raised an estimated 725,189 tons of tin, copper, zinc, arsenic, arsenic pyrite, and bismuth per annum during the period 1878 to 1913.[68] Conditions at Dolcoath were ideal for development of ova. By the early 1890s, workings had reached 3,000 feet, and underground temperatures in excess of 90 °F were not unusual. There were no underground toilets to prevent pollution from infected excrement, and the men either made use of 'any dark corner', or the open cisterns that stored underground water before it was pumped to the surface.[69]

By 1897, the number of cases at Dolcoath had reached what contemporaries described as 'epidemic proportions', and most of the labour force and mine management presented with symptoms of varying severity. The number of cases admitted to hospital peaked at twenty-nine in 1898. Although most sufferers did not require hospitalization, some men were sent for convalescence, and some were transferred to surface labour.[70]

The emergence of a tropical parasite in Cornwall can be explained within the context of a culture of migration. Throughout the nineteenth century, the Cornish provided 'a highly mobile and highly skilled workforce whose expertise made a significant contribution to the world development of metalliferous mining'. Although three main areas of migration have been identified, namely North America from the 1830s, Australia in the 1850s, and South Africa in the 1880s, movement was often more diffused. In the 1820s, Cornish labour and equipment were exported to Central and Southern America, and labour to India and Central and West Africa in the 1890s.[71]

Although it is impossible to determine accurately when and how the parasite was first introduced into Cornwall, a Penzance general practitioner observed symptoms of anaemia amongst miners recently returned from Chile in 1858, and again in the St Just mining district in the early 1860s.[72] In his study of emergent occupational health medicine in the mid-nineteenth century, W. R. Lee draws

[67] See Hunter, *Diseases*, p. 725; G. Rosen, *The history of miners' diseases: a medical and social interpretation* (New York, 1943), p. 36; G. Agricola, *De re metallica*, translated from the first edition of 1556 by Herbert Clerk Hoover and Lou Henry Hoover (New York, 1950), pp. 214–15; and B. Ramazzini, *De Morbis Artificum* Bernardini Ramazzini Diatriba [1713] *Diseases of workers*, the Latin text of 1713, revised, with translation and notes by Wilmer Cave Wright (Chicago, 1940), p. 31.

[68] Figures calculated from R. Burt, P. Waite, and R. Burnley, *Cornish mines: metalliferous and associated minerals, 1845–1913* (Exeter, 1987), pp. 162–6.

[69] BPP *Ankylostomiasis*, p. 6; and Boycott and Haldane, 'Ankylostomiasis', p. 103.

[70] Boycott and Haldane, 'Ankylostomiasis', pp. 104–5.

[71] G. Burke, 'The Cornish diaspora of the nineteenth century', in S. Marks and P. Richardson, eds., *International labour migration: historical perspectives* (Hounslow, 1984), pp. 57–73 at p. 58.

[72] Burke, 'Disease', p. 84.

attention to clinical descriptions resembling hookworm reported by the *Kinnaird Commission*. However, Lee questions the possibility of an earlier Cornish outbreak largely due to the absence of skin lesions, which were a marked feature of the outbreak at Dolcoath.[73] Certainly the recorded mine temperatures at the time of the commission were sufficient for the development of ova, and it is possible that earlier infections were solely via the oro-faecal route. The most likely source of the later infection at Dolcoath was from infected men recently returned from labour in the gold mines of Mysore in India.[74]

With the exception of Dolcoath's manager, R. Arthur Thomas, neither the skin lesions, known locally as 'bunches', nor anaemic symptoms aroused any suspicion of hookworm.[75] Thomas was, however, sufficiently concerned both to inform Inspector Martin of his suspicions, and to initiate voluntary measures to control the infection. Suspected polluted areas of the mine were disinfected with chloride of lime and permanganate of potash, and four centrifugal fans were installed to reduce the ambient temperature of the mine.[76]

Martin appeared sceptical of an additional disease process and the efficacy of Thomas's preventative measures. In his defence, pallor and respiratory distress were commonplace amongst Cornish underground labour. Moreover, Martin had received anonymous complaints from the men regarding ventilation during the outbreak.[77] He was an ardent supporter of the theory that exposure to 'bad air' was responsible for the men's deteriorating health. Despite burgeoning evidence suggesting a causal association between miners' phthisis and dust revealed by Foster, this erroneous theory persisted amongst the Cornish mining communities and their local physicians.[78] Cornish mines relied upon the natural movement of warm to cold air. It was an inefficient method of ventilation and subject to the vagaries of the British weather. Without a defined standard of air purity under the 1872 Act, the common benchmark for 'adequate ventilation' was either a burning candle or the men's continued ability to perform hard physical labour.[79]

Improvement of ventilation was Martin's universal health panacea. In his opinion, however, the cost of enhancing natural airflow (often only achieved by sinking an additional shaft) was not economically viable and would force most mines to abandon operations.[80] Burke and Richardson have interpreted Martin's actions as evidence that government intentionally neglected health in

[73] W. R. Lee, 'Occupational medicine', in F. N. L. Poynter, ed., *Medicine and science in the 1860s, proceedings of the 6th British congress on the history of medicine* (London, 1968), pp. 151–81 at pp. 161–2.

[74] Burke, 'Disease', p. 85. [75] BPP *Ankylostomiasis*, p. 33. [76] Ibid., p. 7.

[77] BPP *Inspector of Mines*, 1898, C 2964, p. 49, evidence of J. Martin.

[78] See Catherine Mills, 'The Kinnaird commission: siliceous dust, the pitfalls of cause and effect correlations and the case of the Cornish miners in the mid-nineteenth century', *Scottish Labour History Review*, 40 (2005), pp. 13–30.

[79] BPP *Accidents*, p. 134 paragraph (4250), evidence of C. Le Neve Foster. Also see BPP *Inspector of mines*, 1884, p. 213, report of C. Le Neve Foster; and D. B. Barton, 'The Cornish miner in fact and fancy', in D. B. Barton, *Essays in Cornish mining history*, 1 (Truro, 1968), pp. 13–66 at pp. 25–6.

[80] BPP *Inspectors of mines*, 1898, p. 49, J. Martin.

order to extract what little profit remained in the declining Cornish sector.[81] Although, the overall trend in tin prices from the 1870s was one of decline, there were two periods of revival, one in the early 1880s and again from 1898. During this latter period of prosperity, which lasted until 1913, Martin believed that the industry was now in a position to afford costly improvements.[82]

Health anxieties at Dolcoath provided Martin with the opportunity to seek evidence in support of improving ventilation. In August 1902, he applied to the Home Office for a formal investigation conducted by J. S. Haldane FRS, an expert in mine gases and their effects on the human body.[83] Although the home secretary had ignored Foster's earlier concerns about the men's poor health, he immediately agreed to Martin's request, and in mid-October, Haldane accompanied Martin to Dolcoath.[84]

IV

The home secretary was certainly aware of the possibility of an outbreak of hookworm at Dolcoath. In 1898, Inspector Foster had alerted the Home Office and the British mining communities to outbreaks of hookworm in the coalfields of Germany, France, Belgium, and Hungary.[85] This is the likely origin of Thomas's knowledge and his recognition of the infection. In 1899, and again in 1900, Foster warned that the spread of this debilitating infection amongst British colliers might be disruptive to national production.[86] Despite Martin's scepticism, he had reported Thomas's suspicions to the home secretary in 1901, who immediately sought information on the German epidemic from the British consul-general, and vice consul, based in Düsseldorf.

The European epidemic had begun in the mid-1890s in Westphalia and resulted in acrimonious labour disputes. The basis of this friction was the compulsory examination of all miners who had visible signs of infection, their removal from the collieries, and their compulsory treatment in barrack hospitals funded by the Knappschafts-Verein. The Knappschafts-Verein originated in the eighteenth century, and provided compulsory insurance for medical attendance and allowances in the case of sickness or injury, pensions in cases of incapacity, and, following death, funeral expenses and family welfare. The organization was funded by wage deductions and company profits and was supervised by the state. Under the scheme, however, infected men removed from their labours and incarcerated in hospital received only half pay, and those who had no dependants received no benefits.[87]

Notwithstanding the militant action benefit grievances had provoked, underground labour in Westphalia had also become scarce as 'many thousand hands'

[81] Burke and Richardson, 'Profits', p. 168.
[82] BPP *Inspectors of Mines*, 1898, p. 49, J. Martin.
[83] Ibid., 1897, p, 49, J. Martin.
[84] Ibid., 1902, p. 33, J. Martin.
[85] Ibid., 1898, p. 274, C. Le Neve Foster.
[86] Ibid., 1899, p. 352, and 1900, p. 21, C. Le Neve Foster.
[87] BPP *Westphalian collieries*, pp. 6–9.

were 'laid up in hospitals and barracks, or are working overground under medical supervision'. In addition, it was claimed that treatment 'takes weeks and months', legislation prohibited underground employment of infected men, and those free of the parasite refused to labour in known polluted areas for fear of contracting the infection.[88] Loss of production was significant.[89]

The home secretary, Aretas Akers-Douglas, was newly appointed in 1902 following Balfour's succession as prime minister. It is difficult to understand the motives of Akers-Douglas, or piece together the main influences determining his positive response to Martin's request. There is no record in the parliamentary debates and neither is the incident mentioned in his biography.[90] It is possible that he may have simply wished to make his mark by reversing previous indifference to the health of the non-ferrous metal miners. There were also inquiries into the respiratory health of miners, many of whom were migrant Cornish, underway in South Africa (see below). However, it is more likely that Home Office support of Martin's request was not about alleviating or preventing disease amongst the Cornish miners but to confirm the presence of the parasite and prevent the potential spread of infection to the coal mines, thereby pre-empting any potential disruption similar to the Westphalian experience. British colliers numbered in excess of one million and constituted the largest group of male industrial workers.[91] An estimated 728,900 held trade union membership.[92] Roughly, two-thirds of coal entering the world market originated in Britain, making it 'difficult to exaggerate' the importance of the sector to the economy.[93] Arguably, Akers-Douglas made a pragmatic response to the threat hookworm posed to the vital collier, and continued the established pattern of piecemeal intervention that had begun in 1850 and prioritized their welfare.

It is unclear as to whether or not Haldane was alerted by the Home Office to the possibility and the potential consequences of an infection amongst the Cornish miners. Haldane's report indicates that it was high underground temperatures together with clinical, employment, and migration histories of the Cornish men that immediately suggested the possibility of hookworm infection.[94] To confirm his suspicions, Haldane sought assistance from Dr A. E. Boycott, an Oxford scholar with an interest in parasitology. Boycott's examination of blood and faecal samples firmly established the diagnosis, and early in November Haldane published a preliminary report to this effect.[95]

Mindful of the need to proceed with caution and to avoid the potential consequences of scaremongering, particularly if the colliers were infected and required diagnosis and treatment, the home secretary disregarded both Boycott's recommendations for mass screening, and Haldane's draconian suggestions of

[88] BPP *Inspector of mines*, 1902, 'Conference of miners at Dortmund on ankylostomiasis', Enclosure 2, p. 20, attached to report of J. Martin.
[89] Burke, 'Disease', p. 87.
[90] See E. Alexander, *Chief whip, the political life and times of Aretas Akers-Douglas* (London, 1961).
[91] Church et al., *British coal*, p. 758. Figures for 1911.
[92] Ibid., table 8·1, pp. 690–1. The data is for 1911.
[93] Ibid., p. 758.
[94] BPP *Ankylostomiasis*, p. 3.
[95] Ibid., pp. 3–4.

compulsory exclusion from work and enforced medication.[96] Instead, infected Cornish men were treated successfully at home on a voluntarily basis, usually on a Sunday morning if they were in work, with either thymol or extract of male fern.[97] In consultation with Haldane and Martin, Thomas introduced underground sanitary pails, 'privy accommodation' on the surface, and supplied accompanying disinfectants. He instructed the men accordingly. Haldane was of the opinion that the reduction in underground temperature following the introduction of fans by Thomas in 1900 had already begun to check the development of ova, and the active treatment of the men and rigorous use of sanitary measures, he claimed, would 'soon stamp out the disease'.[98]

Despite his optimism, Haldane was concerned that infected Cornish miners may have harboured the parasite for at least ten years, often without visible symptoms.[99] During this period, a number of these potentially infected men had found employment in ironstone mines and collieries in various parts of the country. British coal mines were in reality too cool and dry for development of ova, and, unlike the non-ferrous men, colliers were also more circumspect in their toilet habits and used areas of the pit that would be subsequently collapsed.[100] At the time, however, Haldane believed that the Welsh collieries in particular were of sufficient depth and temperature to provide an ideal breeding ground. There was, Haldane claimed, a real 'danger of the disease spreading to the British coal mines, which has to be looked in the face'.[101] Government could ill afford further disruption, the coal sector had already witnessed high strike activity in the 1890s, and output per man-year was in decline.[102] The introduction of an export tax in 1900 had brought further threats of industrial action,[103] and the longevity of coal supplies was under question.[104] Moreover, Welsh steam coal was the power source of the Royal Navy, and any risk to production was a military as well as an economic threat.

The Home Office swung into action and ordered the Mining Inspectorate to make discreet observations amongst the colliers for signs of infection, and to collaborate with the relevant county councils with 'a view to their taking advantage of such opportunities as might present themselves locally', such as the use of council laboratory facilities.[105] The Cornish inquiry was interrupted, and Haldane was dispatched to Westphalia in September 1903 to report upon

[96] BPP *Diagnosis*, pp. 8–9; and BPP *Westphalian collieries*, p. 13.

[97] BPP *Ankylostomiasis*, p. 5. Also, see BPP *Westphalian collieries*, p. 11.

[98] BPP *Ankylostomiasis*, p. 7.

[99] BPP *Westphalian collieries*, p. 11.

[100] *Second report of the royal commission on metalliferous mines and quarries*, British Parliamentary Papers, 1914, Cd 7478 (hereafter BPP *Metalliferous mines*), evidence with appendices and index, volume III, Cd 7478, paragraphs (21, 140–1), pp. 75–6, testimony of Dr A. E. Boycott.

[101] BPP *Inspectors of mines*, 1902, 'Conference of miners at Dortmund on ankylostomiasis', Enclosure 2, p. 16, attached to report of J. Martin.

[102] Church et al., *British coal*, p. 487.

[103] *Hansard*, Third Series, Commons, 93, 6 May 1901, col. 795.

[104] See *First report of the royal commission on coal supplies*, British Parliamentary Papers, 1903, Cd 1724; and *Final report of the royal commission on coal supplies*, British Parliamentary Papers, 1905, Cd 2353.

[105] BPP *Inspectors of mines*, 1902, p. 33, and 1903, p. 115, J. Martin.

preventative measures in Europe.[106] Boycott was directed to consider methods of diagnosis 'applicable to a considerable body of men rather than individual cases'.[107] This is particularly revealing when it is considered that over one million hands were employed above and below ground in the collieries in 1902, compared to 1,270 at Dolcoath.[108] A special Home Office memorandum was prepared, chiefly for distribution amongst general practitioners and medical officers of health.[109]

The Inspectorate asked to meet with representatives of the colliers' trade unions. Together they reached an agreement that meetings to discuss the introduction of suitable measures to combat the spread of infection would be held in each mining inspection district, with colliery owners and their workforce in attendance. In October 1903, a paper entitled 'Miners' Worm' was presented at the annual conference of the Miners' Federation in which symptoms were detailed and the need for scrupulous personal hygiene stressed.[110] The *Colliery Guardian* published an 'Illustrated Supplement' in November 1903, and extracts from Haldane's Westphalian report were published in the *Times*.[111]

Although representatives of colliery owners and employees expressed widespread anxiety, their responses were sporadic.[112] In Staffordshire, a conference was held involving representatives of the North Staffordshire colliery owners and the miners' unions.[113] Boycott was permitted to take 'pin prick' blood samples from men at two local collieries, Talk o' th' Hill and Birchenwood. He also examined in excess of ninety faecal samples from underground deposits across the Midland pits.[114] It is unclear from the record if these samples were obtained covertly. The medical officer of health for Shropshire and Worcestershire published and distributed information leaflets amongst colliers in the two counties.[115]

V

Once Haldane had finished his inquiry in Westphalia, the Home Office returned him to Cornwall to resume the investigation with the assistance of Martin and Thomas. A comparative analysis of air composition at the Cornish mines revealed that there was on average less oxygen and a much higher level of carbonic acid gas in ironstone and colliery workings than at Dolcoath. Yet in

[106] BPP *Westphalian collieries*, p. 3.

[107] BPP *Diagnosis*, p. 3.

[108] Coal data calculated from BPP *Inspection of mines*, 1902, and for Dolcoath, see Burt, ed., *Cornish mines*, p. 165.

[109] BPP *Inspectors of mines*, 1903, Cd 2119, p. 115, J. Martin; also see BPP *Inspectors of mines*, 1903, Staffordshire district, W. N. Atkinson, p. 29.

[110] 'Miners' worm', *Times*, 13 Oct. 1903, p. 7 col. E.

[111] 'Report on the Westphalian collieries', *Times*, 10 Nov. 1903, p. 13, col. F.

[112] BPP *Westphalian collieries*, p. 13.

[113] BPP *Inspectors of mines*, 1904, Cd 2506, Staffordshire district, p. 27, W. N. Atkinson.

[114] BPP *Diagnosis*, p. 7.

[115] BPP *Inspectors of mines*, 1904, Staffordshire district, p. 27, W. N. Atkinson.

contrast to colliers and iron miners, respiratory health was poor amongst the Cornish.[116]

Haldane and his team, having dismissed both hookworm and 'bad air' as causal theories, turned their attention to particulate matter suspended in mine air. This strand of their investigation eventually resulted in the identification both of the relationship between dust and fibroid changes in lung tissue and the predisposition to secondary tubercular infection and the recommendation that 'dry mining should as far as possible, be converted into wet mining'. Although Haldane acknowledged that the use of water to combat dust hazard rendered the underground environment more favourable to the development of hookworm ova, inhaling dust, he argued, 'was by far the greater evil'.[117]

The final report, published in 1904, proposed the introduction of 'special rules' under current legislation that would both prohibit boring in hard rock without the use of water, and ensure safe disposal of faeces in the underground environment. 'Special rules' were formulated at the request of the inspector in consultation with mining management, and required only the authorization of the home secretary. They provided the law in both coal and metalliferous mining with a degree of flexibility and immediacy to address changes in working practices or the adoption of new technologies without resorting to an amending Act of Parliament. Authorization in January 1905 marked the introduction of the first significant health reforms specific to the underground environment.

If the initial response to hookworm was part of the ongoing process of government intervention that prioritized the protection of the collier, why did government continue the Cornish inquiry? The infection at Dolcoath appeared to be largely under control, and numbers of infected men had remained constant.[118] The discreet inquires by the Inspectorate revealed no visible evidence of a spread of infection either amongst metalliferous miners working the remaining British ore fields or amongst the colliers.[119] Moreover, Haldane had actually established that poor health amongst the Cornish miners was 'due entirely to lung disease' before his departure to Westphalia. Yet, incidence of miners' phthisis was localized amongst colliers and not yet recognized as posing a significant risk to their health.[120] There was also very little strategic interest left in non-ferrous metals for the government to protect, and the Cornish miners had remained unorganized and continued to shun state interference.[121]

The ad hoc process of expansion and extension of mining reform had become much more sophisticated as the nineteenth century had progressed. It was no longer passive but dynamic and proactive. Rather than pressing for legislative amendment following exposure of weakness and deficiencies in the law, the

[116] BPP *Cornish miners*, p. 11.
[117] Ibid., pp. 19–21 and 32.
[118] Ibid., p. 31.
[119] BPP *Diagnosis*, p. 7.
[120] A. Meiklejohn, 'A history of lung diseases of coal miners in Great Britain: part II, 1875–1920', *British Journal of Industrial Medicine*, 9 (1952), pp. 93–8 at p. 94.
[121] Mills, 'Safety and health', pp. 279–86.

Inspectorate began to identify potential hazards, by undertaking experimental research and fieldwork, and actively looking to the 'resources of science' to 'furnish practical expedients'.[122] This era of evidence-based intervention resonates strongly with the final phase of the model, in which MacDonagh suggested that executive officers undertook experimental investigations, kept in touch with new techniques, and foreign practice, and often 'called directly upon medicine and engineering'.[123]

The Cornish hookworm infection had taught both the Home Office and the Inspectorate a valuable lesson. The underground environment was a potentially unhealthy workplace, and in the words of Inspector Foster, 'it was really more serious for a worker to contract a disease as loathsome and wasting as ankylostomiasis or as practically incurable as phthisis than to be temporarily incapacitated by a broken limb'.[124] Contributing to this increasing visibility was a burgeoning interest in occupational health, particularly in relation to manufacturing, but also a dramatic rise in mortality from phthisis amongst the Cornish miners in the younger age groups.

The 1878 Factory and Workshop Act had introduced some general measures to protect against dust hazard. Anthrax, and phosphorus, arsenic, and lead poisoning, had also attracted regulation and control.[125] Between 1896 and 1899, government had carried out further investigations into a variety of specific dusty industries and regulated metal grinding from 1901.[126] The turn of the century also witnessed the publication of two important studies by Dr J. T. Arlidge and Thomas Oliver, an international authority on industrial diseases.[127] During this period the medical officer of health for Stocksbridge reported high mortality from respiratory disease amongst men mining ganister to the Factory Inspectorate. Ganister is a fine grained hard siliceous stone found in the coal measures and chiefly used in furnace lining.

There had been very little previous exchange of knowledge and ideas between the Factory and Mining Inspectorates, despite medical advisers often having a 'foot in both camps'. Edward Greenhow, for example, accurately identified dust particles in lung tissue in the 1860s, yet he initially failed to make the connection between the factory floor and the dusty mining environment during his appointment as part-time medical adviser to the Kinnaird Commission.[128] The pattern of independent inquiry changed decisively when Thomas Legge, the first medical inspector of factories, undertook a pathological and chemical

[122] BPP *Accidents*, p. i. [123] MacDonagh, 'Revolution', p. 61.

[124] BPP *Inspectors of mines*, 1904, 'General remarks – hygiene of the mines', p. 116, report of C. Le Neve Foster.

[125] For a brief but comprehensive overview see A. Wohl, *Endangered lives: public health in Victorian Britain* (London, 1984), 'The canker of industrial disease', pp. 257–403.

[126] BPP *Metalliferous mines*, p. 139.

[127] J. T. Arlidge, *The hygiene, diseases and mortality of occupations* (London, 1892); and O. Thomas, ed., *Dangerous trades: the historical, social and legal aspects of industrial occupations as affecting health, by a number of experts* (London, 1902). [128] Mills, 'Kinnaird commission', p. 24.

analysis of deceased ganister miners' lung tissue, and began to expose the complex relationship between fibroid changes and predisposition to tubercular infection.[129] Haldane and his team were able both to draw and to expand upon this developing body of knowledge.

Haldane's analysis of the Cornish mortality data suggested that the death rate from miners' phthisis had risen by roughly 110 per cent between the ages twenty-five to thirty-five and 175 per cent between thirty-five to forty-five years.[130] He estimated that roughly one third of the total number of deaths were due to the effects of underground labour in South African gold mines.[131] Large numbers of British miners in the 1860s, particularly the Cornish, had responded to the discovery of rich gold seams on the Witwatersrand in the South African Republic (later Transvaal). The connection between Cornwall and South Africa was particularly strong, not only in terms of labour, but also in the export of plant and machinery. Before taking up his position at Dolcoath, Thomas, like many other Cornish mine managers, had also worked on the Rand.[132]

The widespread use of mechanized drills in the hard siliceous gold bearing rock and the practice of 'cut and round' in the same shift (returning to the working face before the dust from the blast had settled) exposed the men to greater concentrations of fine dust. Following the outbreak of the Boer War in 1899, many miners, having already contracted the disease, returned home to work locally, and found that their condition deteriorated rapidly in the cold damp British climate. Oliver Thomas had also observed a similar effect in returning migrant colliers.[133]

Such an aggressive form of the disease began both to provoke unrest amongst the gold miners and to attract international humanitarian interest and the attention of the medical and mining press.[134] The end of the Boer War paved the way for investigation instituted by the Transvaal Mines Department in May 1902 and shortly after Akers-Douglas agreed to Martin's request, Viscount Milner, the South African high commissioner, also appointed a Miners' Phthisis Commission. These early inquiries certainly informed Haldane's research.[135] Moreover, the Royal Commission on Metalliferous Mines and Quarries that reported in 1914, and was instrumental in establishing the differential effects of a wide variety of dusty materials, also made reference to this body of knowledge, and to the investigations underway in Australia and New Zealand.[136] In spite of the strong connection between South Africa and Cornwall, there remains a gap in the historiography. With the exception of comparative studies of compensation policy initiatives, labour relations, and emerging medical knowledge, historians have noted, but largely missed, the opportunity to explore fully how this linkage may

[129] BPP Annual report of the chief inspector of factories 1900, Cd 668, pp. 487–94.
[130] BPP *Cornish miners*, tables 1 and 2, pp. 5, 6, and 8.
[131] Ibid., pp. 8–9.
[132] Burke, 'Disease', p. 80.
[133] Article originally published in the *Lancet* and reproduced in the *Mining Journal*, cited in Williams, 'High mortality', p. 29.
[134] Mills, 'Safety and health', pp. 277–8.
[135] BPP *Cornish miners*, pp. 22–5.
[136] BPP *Metalliferous mines*, report, p. 139.

have influenced government regulation of the hazardous underground environment in Britain and internationally in this early period.[137]

Arguably Akers-Douglas must have been swayed by the South African context particularly when he returned Haldane to complete the Cornish inquiry. The men's rapid deterioration was attracting widespread concern in much the same way colliery explosions had in the first half of the nineteenth century. Although the response of labour to their plight remained muted, men were being urged to claim as 'a duty and a right' that as much as possible be done to prevent labour in 'bad air'.[138] The rapid deterioration in the Cornish miners' health, however, coincided with rising tin prices on the world market. Effective health interventions would potentially protect worker productivity, and ensure the sector was in a better position to compete in the international arena. This was an important consideration when the growth of the British economy was slowing down, and production relative to Germany and the United States was in decline. Recruitment for the Boer War and empirical studies by Booth, Rowntree, and others exposed the poor physical health of the nation, and many contemporary commentators argued that a healthy population was necessary for defending the empire and preventing relative decline becoming absolute.[139]

VI

At first glance, government interest in the health of the Cornish miners is hard to place within existing historiography. However, by locating the emergence of hygiene initiatives within the historical development of mining reform a distinctive pattern of institutional expansion emerges that broadly parallels MacDonagh's model. The loss of mine, machinery, and manpower in colliery explosions released a 'runaway train' of social progress. Government interventions slowly snowballed from the regulation of methane in coal mining into a more generalized concern for safer working practices in all underground extractive industries and eventually into mine hygiene.

As earlier critics have pointed out, the model clearly does not provide a perfect fit with the realities of mining reform, particularly in relation to its predicted order. Moreover, the notion of progress was much more malleable than MacDonagh originally envisaged. Visibility of occupational risk, economic

[137] Some examples include, Burke and Richardson, 'Profits'; Burke, 'Diseases'; Katz, *White death*; E. Katz, 'Underground route to mining: Afrikaners and the Witwatersrand gold mining industry from 1902 to the 1907 miners' strike', *Journal of African History*, 36 (1995), pp. 467–89; Marks, 'Silent scourge'; and A. Meiklejohn, 'The development of compensation for occupational diseases of the lungs in Great Britain', *British Journal of Industrial Medicine*, 11 (1954), pp. 198–212 at p. 200. Also see J. C. Foster, 'Western miners and silicosis: "the scourge of the underground toiler", 1890–1943', *Industrial and Labor Relations Review*, 37 (1984), pp. 371–85; and D. Rosner and G. Markowitz, *Deadly dust: silicosis and the politics of occupational disease in twentieth century America* (Chichester, 1991), pp. 31–3.

[138] *Cornish Post and Mining News*, 5 Oct. 1889.

[139] Bartrip, *Dangerous trades*, p. 249; Searle, *National efficiency*, p. 60: and Hay, *Liberal welfare reforms*, pp. 29–32.

performance of individual mining sectors, the extent and strength of labour organization and reforming interests, and dominant concerns in the wider economic and political arenas all influenced the timing, nature, and development of the law. These critical factors resulted in coal mining and accident safety taking priority. Conversely their absence effectively reduced the occupational diseases of individualistic Cornish miners labouring in a declining industry to a position of secondary importance relative to coal.

The unhealthy nature of underground labour would have become increasingly visible as the twentieth century progressed. The field of industrial medicine was developing, and some dusty and 'dangerous trades' had received legislative attention. Moreover, by the end of the First World War the mechanization of coal cutting would expose the vital and militant collier to increasingly high levels of coal dust.[140] Arguably, expansion of mining regulation into hygiene would have been an inevitable result. However, the outbreak of hookworm at Dolcoath exposed the vulnerability of the collier to occupational diseases. This pushed MacDonagh's 'runaway train' in the direction of health reform much earlier than would have occurred had the historical process run its natural course, and the national quest for national efficiency essentially 'oiled the wheels'. Set against a backdrop of economic and imperial competition, the Home Office widened its research parameters and the scope of intervention to protect both safety and health in the underground environment. The revival of the tin trade guaranteed the inclusion of the Cornish miner.

As the twentieth century advanced, the price of tin on the world market slumped below the economic threshold at which protecting the Cornish miners' health was perceived viable.[141] The early indifference to the welfare of the non-ferrous men comparative to colliers re-emerged. Although the introduction of special rules regulating hygiene may have been an appropriate response by government in 1905, they were not ideal in the long term. There was no wider application across the metalliferous sectors outside of Cornwall. Moreover, responsibility for enforcement lay with the mining company rather than the state. Amendment and consolidation of colliery regulation in 1911 both extended and incorporated the special rules into the main body of law.[142] By 1914, the Home Office was preoccupied, not just with the outbreak of war, but also with the implementation of the newly strengthened and extended Coal Mines Act and similar recommendations both to strengthen and to ensure universal application of hygiene precautions in the metalliferous mining sectors was overlooked.[143]

MacDonagh acknowledged the limitations of his model and argued for a 'description in convenient general terms' that provided perspective, stimulated thought, and furthered understanding of the process.[144] In this sense, the model

[140] Bryan, *Evolution*, p. 110.

[141] See BPP *Non-ferrous mining*.

[142] Coal Mines Act, 1911, 1 & 2 Geo. 5, ch. 50, Pt III, Provisions to health, rule 78.

[143] BPP *Metalliferous mines*, pp. 133–55; and Bryan, *Evolution*, p. 77.

[144] MacDonagh, 'Revolution', pp. 52–67 at pp. 61 and 67.

has value, particularly when it is considered that after nearly fifty years it has continued to attract debate. Moreover, the emphasis that MacDonagh placed on the significance of the exposure of intolerable circumstances, and the importance of inspection in preparing the ground for subsequent interventions, is particularly pertinent to the history of mining reform. However, as the story behind the early development of mining regulation and the subsequent emergence of hygiene initiatives reveals, the model lacks the flexibility to provide the basis of a detailed analysis of when and how specific extensions and expansions of the law emerged. In much the same way as Paris first argued in 1960, to make the model a more useful analytical tool it needs adaptation to allow for recognition of the potential influence of a wide variety of extraneous factors that determined the direction, speed, and ultimate destination of social progress.[145]

[145] Paris, 'Reappraisal', pp. 35–6.