TITLE: The ‘janitor-geologist’ and the ‘cold materialistic scientific men’: James Croll’s navigation of scientific societies

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RUNNING HEAD ABBREVIATION: James Croll’s navigation of scientific societies

ABSTRACT: Scientific societies played a crucial role in the emergence of a professional culture of science in Britain in the mid- to late-nineteenth century. At first sight, James Croll's membership of a limited number of scientific associations may be assumed to be the result of his lack of social credit and scientific connections. In this article, by examining Croll's correspondence, I demonstrate that Croll's select participation in scientific clubs and associations reflected his strategic pursuit of a vision of science set apart from party or societal affiliation. I focus on the contrasting histories of the Royal Society of Edinburgh and the Geological Survey, as well as the institutional history of the *Philosophical Magazine*. Situating the institutions in their respective social and cultural contexts, I argue that the more meritocratic, inclusive social structure of the Survey and *Magazine* helps explain Croll's choice to avoid affiliation with the Royal Society of Edinburgh.

KEY WORDS: associationalism, Geological Survey, Glasgow Geological Society, history of science, *Philosophical Magazine*, professionalisation of science, Royal Society of Edinburgh

Historians of science have typically used one of three ideal-types to identify individuals who pursued knowledge about nature in nineteenth-century Britain. The first is the 'gentleman of science', for whom science was a vocation, and whose reputation was staked upon their financially disinterested pursuit of knowledge; from mid-century, there emerged 'men of science' who practised science as a paid career; and finally, there were collectors, writers, and correspondents, including many women and working-class individuals, whose contributions to the production of knowledge have gradually been recovered by historians since the late twentieth century.[1] All of these groups recognised the importance of scientific societies and associations to the production of scientific knowledge. As Ruth Barton has argued, 'participation in gentlemanly networks and alliances with gentlemanly amateurs were means by which the new professionals exercised cultural leadership'.[2] Women were able to attend meetings of the British Association for the Advancement of Science (BAAS) and, when expedient, they were allowed to join associations such as the Botanical Society of London (f. 1836) and the field naturalists' societies that flourished in the second half of the century.[3] Meanwhile, for working-class practitioners, meeting in clubs, such as mutual improvement societies, and in public houses was a means of distributing the costs of buying books and sharing knowledge about nature.[4]

James Croll was conspicuous by his absence from scientific 'clubland'.[5] Croll accepted fellowships and honorary memberships of eight societies (Appendix I), including the most prestigious award of all, Fellowship of the Royal Society (FRS) in 1876, but almost never appeared at any scientific meetings. As a predominantly self-educated man, who worked variously as a millwright, insurance agent, newspaper clerk, tea-shop keeper, and museum janitor, Croll may be assumed to have lacked the requisite connections to navigate his way into social networks in science. However, an examination of Croll's correspondence reveals Croll's strategic navigation of clubs and associations according to his own, very different vision of science, unfettered by party or sect.

[1] Barton (1998), (2003); A. Secord (1994a), (1994b); Desmond (2001); Endersby (2008).
[2] Barton (1998), 410; see also Endersby (2008), 7.
[3] On the Botanical Society of London, see Allen (1986).
[4] A. Secord (1994a), 277-8. On mutual improvement societies more generally, see Vincent (1981), 111-13 and Rose (2010, 2nd edn.), 21, 30, 58-91, 132, 349.
[5] On 'clubland' see Milne-Smith (2011).

Despite being one of Scotland's leading philosophical physico-geologists, Croll did not engage with the Royal Society of Edinburgh (RSE). In this article, I will investigate the reasons behind Croll's choices. This is best done by comparing the RSE with the scientific associations Croll most favoured. I shall therefore situate the RSE, the Geological Survey, where Croll was employed as resident surveyor and office clerk, and Croll's preferred journal, the *Philosophical Magazine*, in their respective social and cultural contexts, arguing that the more socially inclusive context offered by the Survey and *Magazine* proved more conducive to Croll's vision of science: a collaborative enterprise, united across emergent disciplines, and unaffiliated with party or sect. I conclude by suggesting how analyses of Croll and figures like him offer to nuance prevailing understandings of models of authority in mid- to late-nineteenth century science.

1. Contexts of Conviction: Croll's vision of science

By the later nineteenth century, the disinterested pursuit of knowledge, primarily the privilege of gentlemen of independent means, was no longer the only path to establishing trust and authority in science. There were increasing numbers of professional men of science, who tended to share standardised educational experiences, institutionalised disciplines, and laboratory training. They differed from men from humble backgrounds, such as Michael Faraday, the son of a blacksmith, and later John Tyndall, born to a shoemaker who then joined the Irish constabulary, who had forged careers as scientists, and were paid for it.[6] The new professionals were gentlemen such as Joseph Dalton Hooker, who stressed their philosophical approach to science.[7]

Historians have paid close attention to the self-presentation of those working-class men who rose to prominence in science. It is argued that their acceptance by a professionalising scientific community was facilitated by their conformity to a set of standard practices. In this way, Alice Jenkins analysed Faraday's 'artisan essay circle', finding Faraday's

[6] On Faraday, see Jenkins (ed.) (2008); on Tyndall, see Dawson (2007) and DeYoung (2011).
[7] On Hooker, see Endersby (2008). On the 'complex and contingent' process of professionalisation, see Bellon (2005), 49; Barton (2003); Waller (2001).

attempts to improve his literary style a part of his larger project to develop the skills needed to support and promote his scientific work. Jenkins argues that Faraday sought to eliminate evidence of his low social status when communicating his research in publications, correspondence, and lectures, in order to become a man of science.[8] Consolidating these skills and forming strategic allegiances with fellow men of science, institutionalised in the form of scientific societies, has been seen as key to the emergence of a professional sphere.

Croll's trajectory, from similarly humble beginnings, did not follow the same path as Faraday's to professorships and memberships of select societies in Britain's scientific establishment. This was not purely the result of snobbishness on the part of rising professional men. In 1874, the Rev. Cunningham Geikie asked Croll, then living in Edinburgh, 'Why don't you come to the front now? A man with your brain & power of expression might do pretty much what he liked in making a name for himself in scientific matters, and in serving his day'.[9] Yet, in what had by then become a typical response, Croll demurred. This cannot be attributed to Croll's illness in 1873 (although that had resulted in a notable gap in his otherwise extensive publication record of between five and seven scientific articles per year) because even in periods of good health, he refused most invitations to attend scientific meetings in person.[10]

In 1870, Croll refused an invitation from the Royal Institution 'to give a short course of three lectures on any geological question, or on ocean currents, or on any other subject'.[11] Having to travel to London may have put Croll off, but the following year, he also declined an invitation to attend the BAAS meeting when it was to be held in Edinburgh. Writing to Professor George Carey Foster at University College, London, Croll explained that he had been off duty from the Geological Survey due to ill health for two months and 'could not',

[8] Jenkins in Jenkins (ed.) (2008), 1-5. On the 'public images of Faraday', see also Cantor in Shortland and Yeo (eds.) (1996).

[9] The British Library (BL). ADD.MS.41077. Western Manuscripts. 'LETTERS, chiefly from men of science, to James Croll, F.R.S., LL.D.' Letter from Rev. John Cunningham Geikie to Croll, 13 January 1874, f.71. See also letters from Henry Home Jones to Croll, 20 November 1870, inviting Croll to lecture at the Royal Institution, in Irons (1896), 250 and Keith Johnston to Croll, 28 May 1872, inviting Croll to present at the Geographical Section, in Irons (1896), 270.

[10] Irons (1896), 275; BL. Royal Literary Fund Loan 96 RLF 1/2220, Registered Case, No. 2220, James Croll, f.14, 'List of Scientific Works and Papers by James Croll'.

[11] Irons (1896), 249-50. In the letter from Henry Bence Jones, the Secretary of the Royal Institution, Jones's name has been misprinted.

therefore, 'with a clear conscience, ask for a leave of absence to attend'.[12] However, in 1872, Croll was again invited to speak at the BAAS meeting, this time in the Geographical Section. Specifically, Croll was asked to deliver a talk on his views on oceanic circulation and currents with William Carpenter, then President of the BAAS, and against whom Croll had been engaged in a protracted debate in the *Philosophical Magazine* for two years.[13] Once again, Croll declined. Finally, in 1876, the BAAS meeting was due to be held in Glasgow and Croll was invited to present. Characteristically, Croll submitted a paper but declined the offer to attend in person.[14]

There were many reasons why Croll may have sought to avoid attendance at the BAAS, among which may have been fear of experiencing condescending treatment on account of his low social status. Just one generation earlier, naturalist, Charles Peach read papers on fossils at the 1844 meeting in York. Peach's attendance was described in *Chamber's Edinburgh Journal*: 'But who is that little intelligent-looking man in a faded naval uniform, who is so invariably seen in a particular central seat of this section?'[15] Peach was considered 'one of the most interesting men who attend the Association,' chiefly because:

> he is only a private in the mounted guard … at an obscure part of the Cornish coast, with four shillings a day … most of whose education he has himself to conduct. He never tastes the luxuries which are so common in the middle ranks of life, and even amongst a large portion of the working classes.[16]

The article concluded, 'thou art an honour to human nature itself; for where is the heroism like that of virtuous, intelligent, independent poverty? and such heroism is thine!'[17] It would be easy to suppose that Croll was highly conscious of his low rank, regional accent, and 'nervous disposition', which would detract attention from his scientific work and direct focus

[12] Letter from Croll to George Carey Foster, 27 November 1871, in Irons (1896), 261.
[13] Letter from Keith Johnston to Croll, 28 May 1872, in Irons (1896), 270; letter from Francis Galton to Croll, 12 June 1872, in Irons (1896), 270-1; Croll (1874); Croll (1875).
[14] Letter from Croll to Rev. James Morison, 17 August 1876, in Irons (1896), 312; BAAS (1877), 30, 88-89.
[15] Chambers and Chambers (1844), 323; also quoted in Smiles (1879), 246-47.
[16] *Ibid*.
[17] *Ibid*.; Smiles (1879), 248. On Peach, see also Finnegan in Lightman (ed.) (2004) and Naylor (2010), 73-79.

instead to his social background.[18] This is what happened when Samuel Smiles published a biography of Thomas Edward, the shoemaker-naturalist, who was instructed to avoid public appearances in order to preserve the reputation Smiles had created for him in print.[19] Croll demonstrated a perceptive disdain for the genre of working-class biography and was extremely reluctant to collaborate in any kind of autobiographical or biographical work. One generation after Peach's appearance at the BAAS, however, Croll was working on the Geological Survey of Scotland alongside Peach's son, Benjamin, who had attained the rank of Geologist just one year before Croll, in 1868.[20] Benjamin Peach was largely able to avoid the class-based judgements experienced by his father after Roderick Murchison noticed Benjamin's abilities and arranged for him to attend the Royal School of Mines, where he studied under Thomas Henry Huxley and Andrew Crombie Ramsay.[21]

Croll resisted being cast into the ideal type of a working-class practitioner both in print and in his early correspondence. As early as 1849, Croll had told his friend, mentor, and lifelong correspondent, the Rev. James Morison, 'You express at the end of your note a wish to know something concerning me. This I am happy to do, though I am sure that, when you know it, it will be of little service to you'.[22] In this way, Croll resisted identification with working-class men who began correspondence with scientific men of higher social rank by offering biographical information, their candour about their poverty a means of conveying their trustworthiness.[23] Presenting himself as worthy of reply on account of his intellectual merit alone, Croll began a practice he pursued throughout his life.

Through his resistance to being cast in the same mould as a working-class autodidact, Croll also demonstrated a desire shared by many scientific men of the period to efface 'the self' from science.[24] In a letter to Croll in 1871, the clergyman and geologist Rev. Osmond Fisher confessed himself 'much pleased to find that you think much as I do about the self-

[18] Irons (1896), 168.
[19] A. Secord (2003), 164.
[20] Flett (1937), 255.
[21] Oldroyd (2004).
[22] Letter from Croll to Morison, 24 November 1849, Irons (1896), 73-75 on 73.
[23] A. Secord (1994a), 396.
[24] Gagnier (1991), 256-65.

assertion now so much in fashion in the scientific world'.[25] By beginning each new epistolary relationship with an introduction to his theories as opposed to biographical information, Croll 'wrote in order to have no face'.[26] In this way, William Clark described Thomas Henry Huxley, who 'considered personal autobiography irrelevant, even self-indulgent', ultimately writing only nine pages under protest.[27] Likewise, an incomplete draft of Croll's 33-page 'autobiographical sketch' was written only at the tireless insistence of Croll's future biographer James Campbell Irons and due to the patience of Croll's wife Isabella, who acted as Croll's amanuensis.[28] Avoiding in-person meetings and confining his scientific engagements to publications and correspondence, Croll nevertheless cultivated a 'professorial persona', an 'essential feature' of which was a voice that combined charisma and traditional authority, 'which coexist with and condition' objectivity in science.[29]

While they shared a desire to pursue knowledge objectively, Croll and the emerging men of science had very different ideas about what constituted 'traditional authority'. Croll's own convictions are revealed through his correspondence with the Rev. Morison. On the topic of his invitation to attend the BAAS meeting in Glasgow in 1875, Croll wrote:

> I shall have a paper in Section A. but will not manage to be present. […] I have not been at a scientific meeting for upwards of half a dozen of years. The real truth is, there is a cold materialistic atmosphere around scientific men in general, that I don't like. I mix but little with them.[30]

'Materialism' was a 'slippery signifier' in this period, typically marshalled to attack the character of a scientific practitioner and the wider, deleterious social consequences of the type of scientific work they pursued.[31] In the minds of nineteenth-century auditors and

[25] Letter from Rev. Osmond Fisher to Croll, 1 September 1871, in Irons (1896), 262.
[26] Clark (2003), 52; Daston and Sibum (2003), 4.
[27] Gagnier (1991), 258; Huxley (1909).
[28] Irons (1896), Preface.
[29] Clark (2003), 43; See also Darwin Correspondence Project 'Letter no. 7908', James Croll to Charles Darwin, 17 August 1871 [available online at http://www.darwinproject.ac.uk/DCP-LETT-7908, accessed 25/02/2021], in which Croll was explicit that he did not aim not to educate 'general readers'.
[30] Letter from Croll to Morison, 17 August 1876, in Irons (1896), 312.
[31] Dawson (2007), 18.

readers, the term had long been associated with the godless, revolutionary philosophy that had underwritten France's violent revolution at the end of the eighteenth century.[32] Accusations of 'materialism' became particularly polarising after John Tyndall's infamous address at the Belfast BAAS meeting in 1874, in which Tyndall 'discern[ed] in … Matter … the promise and potency of all terrestrial Life'.[33] As Darwinian men of science grappled with the perceived implications of their convictions, a large proportion of their time and energy was spent dissociating themselves from this highly-charged epithet in print.[34]

To the Rev. Fisher, Croll confessed that there were 'several reasons' for his absence from BAAS meetings. The 'chief reason', Croll admitted, was 'that I dislike all such public displays'. But 'the truth', Croll confessed, was that he had 'very little sympathy with the leading idea of the British Association, viz., that science is the all-important thing'. 'You can hardly expect', Croll continued,

> one who has devoted twenty years of the best part of his life to the study of mental, moral, and metaphysical philosophy to have much sympathy with the narrow-mindedness of the British Association.[35]

Croll shared his optimism with Fisher and Morison that 'there is, however, indication of a reaction beginning to take place towards something more spiritual in science', and, adapting a phrase from Thomas Dick's *Christian Philosopher*, a work that had inspired Croll in his early course of self-education, Croll concluded, 'the day, it is to be hoped, is not far distant when religion, philosophy, and science will go hand in hand'.[36] In contrast to his distaste for meetings with 'materialistic' men of science, Croll declared that he would be 'delighted to come through to Glasgow and spend an afternoon' with Morison.[37] For Croll, the pursuit of knowledge was the pursuit of a spiritual truth, unfettered by worldly nepotism or political

[32] *Ibid*.
[33] Tyndall (1874), 55. For the wider debate, see DeYoung (2011) and Dawson (2007), especially 82-115 on how Tyndall had attempted to compare the ancient Greek philosophy of Epicurus and the Roman poet Lucretius with modern science.
[34] On these issues, see Moore (1991).
[35] Letter from Croll to Fisher, 28 August 1871, in Irons (1896), 261-62.
[36] Letter from Croll to Morison, 17 August 1876, in Irons (1896), 312; Irons (1896), 58; Dick (1826), 136.
[37] Letter from Croll to Morison, 17 August 1876, in Irons (1896), 312.

affiliation. It was with this attitude that Croll navigated the landscape of scientific associationalism.

2. Edinburgh Societies

In his study of Charles Lyell's navigation of London institutions, J. B. Morrell began, 'it is too easy to assume, with naïve optimism, that if [scientific societies] existed they must have been functionally effective for scientists. This was not necessarily so.'[38] While many societies played a crucial role in the emergence of a professional culture of science in the nineteenth century, Morrell's description held true for a number of other associations which claimed to be engaged in the pursuit of scientific knowledge. In his seminal study of the founding of the RSE in the eighteenth century, Steven Shapin revealed that the 'inherent requirements of intellectual scientific activity were a negligible factor in the establishment of a major scientific organisation'.[39] As practitioners, including Fellows of the Society, perceived the pursuit of knowledge about nature as 'a constituent of general literate culture', it followed that 'the institutions in which men of science functioned, whether university, academy, or scientific society, were subject to many of the same social, political, and cultural forces as the institutions that sustained the practitioners of belles-lettres, medicine, antiquarian studies, or law'.[40] Deeply and inextricably embedded in Edinburgh's cultural landscape, a study of the RSE is at once 'a study of the local politics of culture'.[41]

Founded in 1783 by distinguished practitioners like William Cullen, John Hope, and John Pringle, already by the end of the eighteenth century, the RSE was regarded as the second most important scientific society in Britain.[42] The Society's membership base was unaffected by the demographic disruptions experienced in Britain's industrialising cities. As Britain's middle classes sought to transform their newfound economic capital into cultural self-expression, medical men, dissenters, and factory owners came together to form clubs,

[38] Morrell (1976), 132.
[39] Shapin (1974a), 2.
[40] *Ibid*., 1-2.
[41] *Ibid.*, 2.
[42] *Ibid.*, 2.

most notably 'Literary and Philosophical Societies'.[43] The period became renowned as a 'golden age' for 'membership-based organisations' and the phenomenon of 'associationalism' flourished in the rapidly urbanising towns and cities of Glasgow, Newcastle-upon-Tyne, and Manchester.[44]

While Britain's industrial cities grappled with the polarising social and economic impacts of industrialisation, Edinburgh's economy remained predominantly culture- and service-based throughout the eighteenth century.[45] While at the beginning of the nineteenth century, Edinburgh was the second-largest city in Britain, by 1831, it had been overtaken by Glasgow, Liverpool, and Manchester.[46] Edinburgh's population increased from 168,145 to 185,145 between 1861 and 1871, while Glasgow's population climbed from a significantly larger base of 403,394 to reach 490,000 by 1871.[47] Edinburgh's much smaller population reflected its unchanged demographic make-up. Its cultural activities remained largely controlled by élites in established institutions, which, as Shapin pointed out, included the Faculty of Advocates; the Society of Writers to His Majesty's Signet; annual meetings of the General Assembly of the Church of Scotland; and the Town Council, which controlled the University of Edinburgh and represented 33 craft guilds, including the Royal Colleges of Physicians and Surgeons.[48]

Edinburgh thus remained a city whose old, established classes continued to dominate. While Britain's lower middle classes had been establishing a foothold in metropolitan scientific institutions from the mid-nineteenth century, Edinburgh remained an exception. As late as the 1870s, contributions to the RSE's *Transactions* were authored exclusively by professors, Fellows of the Royal Society, and titled men of science.[49] This is not surprising given that the laws of the Society enforced heavy economic and social barriers to access. Revised in October 1871, membership rules stated that every Ordinary Fellow had to pay a total of five guineas within three months of his election, and three guineas annually thereafter

[43] *Ibid*., 3.
[44] *Ibid*. On eighteenth-century associationalism, see Allan (2013), 160-161.
[45] Shapin (1974a), 3.
[46] *Ibid*.
[47] *Post Office Glasgow Directory* (1871), xv.
[48] Shapin (1974a) 4.
[49] RSE (1872), i-iv.

for 10 years.[50] Non-resident fellows were required to pay a hefty £26 5*s*.[51] As with the Royal Society of London, a candidate's economic capital had to be matched by his social and cultural capital, as he was required to provide a certificate of recommendation signed by at least four other Ordinary Fellows, 'two of whom shall certify their recommendation from personal knowledge'. The certificate had to state:

> A. B., a gentleman well versed in Science (*or Polite Literature, as the case may be*), being to our knowledge desirous of becoming a Fellow of the Royal Society of Edinburgh, we hereby recommend him as deserving of that honour, and as likely to prove a useful and valuable Member.[52]

Persons 'eminently distinguished for science or literature' could also be made Honorary Fellows.[53] While the process for election was marginally simpler, success hinged upon a candidate possessing the tacit skills required to navigate an élite social network. The candidate then had to be recommended by Council or three Ordinary Fellows, and the proposal communicated *viva voce*, printed in the circulars for two ordinary meetings, and put to election by ballot.[54]

The RSE's tightly-guarded network was reflected in the highly selective distribution of its published *Transactions*. In Scotland, distribution was limited to the four ancient universities and six Edinburgh libraries, each of which was patronised by a highly élite demographic: The Advocates' Library, College of Physicians, Highland and Agricultural Society, Royal Medical Society, Royal Physical Society, and Royal Scottish Society of Arts.[55] The Botanical Society of Edinburgh, Geological Society of Edinburgh, Meteorological Society of Edinburgh, and, notably, the Philosophical Society of Glasgow, received the *Proceedings*

[50] *Ibid.,* i: Law II.
[51] *Ibid*., Law IV.
[52] *Ibid*., iv: Rule IX.
[53] While Honorary Fellows were not to exceed 56, 'Personages of Royal Blood' could be elected Honorary Fellows without regard to such limitations. *Ibid*., iv-v: Rules X, XI.
[54] *Ibid*., v, Rule XII.
[55] *Ibid.*, xvii.

only.[56] The *Proceedings* would therefore have been available to Croll when he worked as janitor of Anderson's College in Glasgow and made unorthodox use of the library where the Philosophical Society's collections were held.[57] Given his familiarity with this publication, why, then, did Croll choose not to engage with the RSE or its publications during his later career?

Given the RSE's élite social composition, it is unlikely that Croll would ever have been invited to apply for membership and no record exists of him in the RSE's extensive archives. But it is still more likely that Croll would have refused association with the Society had he been invited to join it. Croll's response to an invitation to join another club in 1869 provides some insight into how he might have responded.[58] The 'prospectus' Croll received read:

> It has been thought desirable to organise in Edinburgh a CLUB similar to the "Cosmopolitan" and "Century" Clubs in London.
>
> The Members of the Cosmopolitan and Century Clubs are, for the most part, men distinguished in, or at least [displaying] a marked taste for Art, Literature, or Science …
>
> The following list of Gentlemen who have already consented to join the proposed Club, will give some indication of its character and aim … [59]

Among the list of 'Gentlemen' were many Fellows of the RSE, including Sanskrit Scholar, John Muir (1810-82), Curator of the National Gallery James Drummond (1816-77), future Edinburgh MP Robert Wallace (1831-99), and future St Andrews University Principal James Donaldson (1831-1915), as well as 14 advocates.[60] Edinburgh Professor of Natural Philosophy, Peter Guthrie Tait (1831-1901), was responsible for introducing 70 guests to this élite group of gentlemen, men of science, influential politicians, and intellectuals; they included Thomas

[56] *Ibid.*, xviii.
[57] Irons (1896), 31.
[58] National Library of Scotland (NLS), MS.1704, ff.74-6.
[59] *Ibid*., f.74. 'Prospectus' [undated]. On the 'evening club', see Knott (1908), 347-9.
[60] NLS. MS.1704, ff.74-6; Waterston and Macmillan Shearer (2006, II), 672; Knott (1908), 347.

Henry Huxley, James Clerk Maxwell, and, when the BAAS met in Edinburgh in 1871, James Croll.[61]

Tait's biographer claimed the association 'had a direct bearing on scientific activity', as 'it was probably in the free and easy conversation of this Evening Club' that its first treasurer George Barclay and Thomas Stevenson began many of their contributions to the physical sciences.[62] Correspondence between members provides a rather different image of the organisation's function. In response to Tait's invitation, W. J. Macquorn Rankine replied that he would be 'very happy to join' Tait's 'Capnopneustic Club'.[63] Referring to the smoky atmosphere for which the Cosmopolitan and Century Clubs were renowned, Rankine's trope was widely shared by members. Another invitee replied that he would be 'delighted to join if smoking & good listening without much talk will qualify'.[64] It was well known that Tait's club met on Saturday and Tuesday evenings and on Monday evenings immediately after the RSE's meetings, 'purely for social intercourse [and] cards and serious subjects of debate being taboo'.[65]

The Century Club, upon which Tait's society was to be modelled, was composed of an extremely narrow social circle, including mostly old Etonians, Harrovians, and Rugbeians, who had typically attended either Balliol College, Oxford, or Trinity College, Cambridge and became barristers, 'though not necessarily with a view to practising'.[66] Renowned as 'a talking club', the Century imposed an annual guinea subscription, which included free tobacco, whisky, and brandy.[67] A much higher contribution was required at Tait's club – £2 annually, to cover all expenses – and the society otherwise proved a good copy of the Century and Cosmopolitan. Nothing could persuade Croll to join its ranks. Croll responded to Tait:

> I feel much obliged for the honour of being requested to become a member of a Club so select. At some future time I

[61] Knott (1908), 349; NLS. MS.1704, ff.74-6.
[62] Knott (1908), 349.
[63] NLS. MS.1704, f.75. Letter from W. J. Macquorn Rankine to P. G. Tait, 29 October 1869.
[64] *Ibid*., ff.74-5. Letter to P. G. Tait, 25 October 1869.
[65] Knott (1908), 348.
[66] Kent (2006a).
[67] *Ibid*.; see also Harrison (1908), 369-77.

> may think of applying for admission, but in the mean time I cannot make up my mind to do so.[68]

Croll's refusal reflected his vision of science, namely its unification with religion and philosophy. Croll had little time for talking and smoking clubs, having become a teetotaller and given up tobacco around the age of 30.[69] He found more like-minded practitioners in an institutional network with a very different social structure.

3. Geological Survey of Scotland

Croll's first exposure to scientific societies was gained while working as a janitor. Croll had attended 'two or perhaps three sessions' at the Parish School, Cargill, but left 'about 15 or 16 years of age'.[70] At the age of 22, he paid to attend a winter course of algebra lessons at a private school in Guildtown, St Martins.[71] As Croll later wrote, 'the greater part of my education has however been self acquired'.[72] At the age of 36, Croll wrote to several professors at the ancient Scottish universities asking for a bursary to study, and sent his first publication, *The Philosophy of Theism* (1857) as proof of his aims and abilities.[73] Principal of Glasgow University, Thomas Barclay, sympathised with Croll's 'desire to have the benefit of a university education'.[74] With Barclay's assistance, alongside that of James Frederick Ferrier, who was then Professor of Moral Philosophy at St Andrews, Croll became Keeper of Anderson's College and Museum, part of the University of Glasgow, from 1859 to 1867.[75] The post came with a salary of almost £100 per annum and accommodation. The Museum was open only between 11am and 3pm and had few visitors; Croll had little to do with arranging or classifying specimens; and he delegated many of his duties to his brother.[76] Thus, Croll was

[68] NLS. MS.1704, f.75. Letter from Croll to P. G. Tait, 26 October 1869.
[69] Irons (1896), 24-25, 73.
[70] The National Archives (TNA). Records of the Civil Service Commission (CSC). 'CROLL, James'. File Number: 89263. CSC/11/73, f.004. 'Form A'. 29 June 1867.
[71] Irons (1896), 66.
[72] TNA. CSC/11/73, f.004. 'Form A'. 29 June 1867.
[73] Irons (1896), 87-90.
[74] Letter from Thomas Barclay to Croll, 6 May 1858, in Irons (1896), 90.
[75] Irons (1896), 90-1.
[76] Irons (1896), 31, 91-2. Andersonian Library, Archives and Special Collections, University of Strathclyde. OB/1/1/4. Minute book, c. 1860, f.445 shows that Croll was appointed with a 'salary at the rate of one pound

able to attend George Cary Foster's Natural Philosophy class and immerse himself in the 'fine scientific library' of the institution.[77] The Andersonian housed the entire collection of the Glasgow Philosophical Society; 4,000–5,000 volumes on science for evening classes; and the private library of the founder of the institution, which consisted of more than 2,000 works.[78]

The Andersonian also provided a meeting place for the Geological Society of Glasgow. A 'Special Notice' issued by the Society for 1864–5 directed 'persons desirous of joining the Society' to apply to 'Mr. James Croll, Janitor'.[79] In March 1866, one year before Croll left his position as janitor, he read his first paper at the Society, 'On the reason why the change of climate in Canada, since the glacial epoch, has been less complete than in Scotland'.[80] By 1867, Croll had been elected an Honorary Associate of the Society.[81] Gaining his first exposure to scientific associationalism by sitting in on meetings as a janitor (and thus presumably avoiding paying subscription fees), Croll's highly unorthodox and egalitarian exposure to scientific societies left him with a view of how scientific institutions ought to operate, which he maintained for the rest of his scientific career.

In 1867, Archibald Geikie, the recently appointed Director of the Geological Survey of Scotland, invited Croll to accept a position with the Survey.[82] Much like the post Barclay and Ferrier had helped secure for Croll at the Andersonian, the Survey position was to be 'very easy' administrative work, its chief purpose to provide a modest income so that Croll could be relatively free to pursue his own geological researches.[83] The job consisted mainly of

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per week, with house, coal, and taxes paid.' OB/1/1/5. Minute Book, c. 1867, f.27 reveals that Croll successfully applied for a pay rise to £84 per annum. In TNA. CSC 11/73, f.005, 'Form A', 29 June 1867, Croll states his 'total income' as 'nearly £100'. On Croll's relationship with Foster, see Irons (1896), 259. Foster acted Croll's mentor, assisting him in publishing, gaining his position on the Survey, and supporting his election to the Royal Society. See: The Royal Society. GB117. EC/1876/08. 'Croll, James'. Foster was known for his progressive views on education. See Gooday and Hempstead (2004) on Foster's support for women's rights to higher education; his work founding the first physical laboratory in Britain offering systematic instruction in experimental physics to undergraduates; and his 'quiet, unassuming' character. For a comparative study of the role of a janitor at the University of Edinburgh's Natural History Museum, see Swinney and McGowan (2018).

[77] Irons (1896), 31, 92.

[78] *Ibid*.

[79] University of Glasgow Archive Services. Records of the Geological Society of Glasgow. ACCN 2561/3/1. Glasgow Geological Society, *Special Notice*, 1864-5, 7.

[80] Geological Society of Glasgow (1866), 138-41.

[81] Geological Society of Glasgow (1883), 225-231.

[82] Irons (1896), 34, 165-6.

[83] *Ibid*., 167.

forwarding letters, ordering maps, and keeping the accounts. When Croll failed his Civil Service examinations in mathematics and English composition — which had recently been made a necessary requirement for Survey employees — Geikie, Murchison, and William Thomson ensured that this was overlooked.[84] Croll's rank was technically that of Assistant Geologist and he was paid accordingly, at a rate of 7*s*. a day which would rise to 12*s.* (including Sundays and a month of holidays), with the prospect of later increasing to £350 a year.[85]

Of all scientific institutions, Croll praised the social structure of the Geological Survey most highly. One of the aims of the Survey's founding Director, Henry De la Beche, had been 'to rid English science of aristocratic favouritism through the adoption of a system of public funding'.[86] As James Secord has outlined, De la Beche's view of science in England was one in which incompetence and favouritism reigned, as demonstrated by the influence of the aristocracy and Anglican church over the ancient universities.[87] De la Beche sought to restructure scientific institutions by vesting authority in a 'professional class of technical experts chosen solely on meritocratic grounds'.[88] Recruits were unusual for the period for their diverse educational backgrounds and the fact that they tended to acquire most of their training on the Survey. Once the men joined the Survey, De la Beche was renowned for making 'every effort to weld them into a cohesive social unit'.[89]

By the time Croll joined in the 1860s, the research programme De la Beche built to unite the Survey had all but disappeared, but clubbability remained central to the Survey's philosophy.[90] In 1869, District Surveyor James Geikie proposed to Geologist Benjamin Peach:

> What do you think of starting a club or annual meeting of the Survey fellows (without the Director) to have a quiet and moderate priced supper, where each could do as he chose. The object of the feed being to promote kindliness and a good

[84] *Ibid*., 167-69.
[85] *Ibid*.; J. Secord (1986), 235-36.
[86] J. Secord (1986), 226.
[87] *Ibid*., 230.
[88] *Ibid*.
[89] *Ibid*., 239.
[90] See *Ibid*., 259 on the decline of De la Beche's 'research programme'.

> understanding? I think it would do. It might be the means of doing a vast of good in the future. Should it precede or succeed the Survey Dinner?[91]

The ethos evoked by 'moderately priced suppers' and 'kindliness' contrasted significantly with Croll's view of the 'materialistic' BAAS meetings and the smoking clubs proliferating elsewhere in Edinburgh and London. In much the same way that Croll had been helped by Surveymen while working as a janitor, so Croll later aided fossil collector, James Bennie. Bennie had devoted his spare time to collecting fossils and studying deposits while working in a paper factory.[92] After Bennie sent his results to Croll in 1867, Croll helped Bennie publish his findings, and two years later Bennie was recruited to the Survey.[93] Croll advised Bennie on which classes to attend, noting that 'Mr [Archibald] Geikie's lectures at the Museum' – which were held in the evenings to allow members of the public to attend – 'were the best lectures I have yet heard on physical geology'; Croll criticised Bennie's writing style, directing him to erase sections 'where you speak in a disparaging sort of way of your own labour'; and Croll helped Bennie 'add a good few shillings' to his weekly income after hearing that William Thomson was looking for an assistant, and put in a good word for Bennie.[94]

It was in this spirit of openness and genuine friendship, unaffiliated with materialism and unfettered by sectarian loyalty, that Croll expressed himself most comfortable practising the pursuit of knowledge. In contrast to the persona Croll presented to men of science in print, in his correspondence with philosophical allies he openly styled himself as 'a plain, self-educated man'.[95] Croll referred to the Surveymen – amongst whom Peach, Bennie, and farmer's son John Horne were from similarly humble backgrounds – as 'our men' and his 'geological friends'.[96] The Surveymen positioned themselves in opposition to the élite, metropolitan clubs. In 1881, two decades after Geikie proposed the founding of a 'quiet and moderate' club, he wrote to Peach:

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[91] British Geological Survey (BGS). GSM/1/321, f.20. Letter from J. Geikie to B. N. Peach, 9 September 1869.
[92] Guppy (2000), 17.
[93] *Ibid.*
[94] Letters from Croll to Bennie, 15 February 1868, 17 April 1868, 28 March 1868 in Irons (1896), 182, 187, 184. Flett (1937), 99-100 argues that the lateness of Geikie's classes after 4pm enabled 'the outside public' to attend.
[95] Letter Croll to Alexander Winchell, 25 May 1888, in Irons (1896), 451.
[96] Letter from Croll to Bennie, 14 January 1868, in Irons (1896), 178.

> I am awfully vexed to hear about poor Croll. What a sad eclipse! He is the most philosophical physico-geologist we have had since Hutton. Some day that will be recognized: but not by the present race of funny mannikins [*sic.*] who preside over the fortunes of the Geological Society of London.[97]

The mid-century usage of 'mannikin' was extremely depreciative, referring to a 'little man'.[98] Geikie's emasculating depiction contrasts with early nineteenth-century accounts of the Geological Society of London's discussions as 'characterized by manly vigour, tempered always by good manners'.[99] In the first half of the century, even the fiercest of critics of the London institutions, like natural historian William Swainson, had typically exempted the Geological Society from 'his general stricture that the republic of science had degenerated into an aristocracy of wealth'.[100] Although Swainson's characterisation remained a fair assessment of the profile of the Society's presiding officers in 1882, Geikie's vexation was most likely caused by the limitations the Society placed on their recognition of Croll's contributions to science.[101]

Twice-president of the Geological Society and Director of the Survey from 1855 to 1872, Roderick Murchison, had been instrumental in ensuring that Croll's failures in the Civil Service examinations were overlooked, thus enabling Croll to be appointed to the Survey. Murchison did this 'con amore' because he recognised that Croll was 'too wonderful a glacialist' not to be given the opportunity to pursue his work.[102] Moreover, Croll was named the recipient of the Wollaston Fund for 1872, which carried a monetary value of £21. 6*s*. 10*d*., 'for his many valuable researches on the Glacial phenomena of Scotland, and to aid in the

[97] BGS. GSM/1/321, f. 68. Letter from J. Geikie to B. N. Peach, 17 February 1881. On the use of the word 'philosophical', see Endersby (2008), 12-30.
[98] Oxford English Dictionary Online (2020).
[99] Morrell (1976), 138.
[100] *Ibid*.
[101] At the time of Geikie's letter, the President was R. Etheridge; the Vice Presidents were John Evans, J. W. Hulke, Sir Philip de Malpas Grey Egerton, and A. C. Ramsay; the Secretaries were T. G. Bonney and J. W. Judd; the Foreign Secretary was Warrington W. Smyth; and the Treasurer was J. Gwyn Jeffreys. See: The Geological Society of London (1880), [ii], List of Officers.
[102] The Geological Society. LDGSL/789/110, ff. 106-110. Letter from Roderick Impey Murchsion to Archibald Geikie, 6 August 1867.

prosecution of the same'.[103] In 1876, Fellow of the Society Andrew Crombie Ramsay, then Director of the Survey, was entrusted to transmit the balance of the Society's Murchison Fund to Croll, in 'the hope of the Council of this Society that it may prove of service to him in the prosecution of those studies with which his name has been so long and so honourably associated'.[104] While the printed report of the anniversary meeting at which the awards were announced refrained from referring to Croll's personal circumstances, the account published in *Nature* claimed that Ramsay had remarked:

> Mr. Croll's merits as an original thinker are of a very high kind, and that he is all the more deserving of this honour from the circumstance that he has risen to have a well recognised place among men of science without any of the advantages of early scientific training; and the position he now occupies has been won by his own unassisted exertions.[105]

Finally, in 1884, Croll received the Barlow-Jamieson Fund (£20) from the Society, in recognition of 'the value of Dr James Croll's researches into "The Later History of the Earth," and to aid him in further researches of like kind'.[106] Despite being recognised as the intellectual equal of many Fellows and receiving three monetary awards from the Society (Appendix II), Croll was never elected a Fellow. A very different 'ambitious expatriate Scot who felt that he rarely met congenial souls even among geologists', Charles Lyell, had navigated London in the 1830s with 'singular steadiness of purpose', making his aim of gaining geological knowledge commensurate with procuring wealth, 'respect, fame, and command of society'.[107] For Croll, such ambitions in science were unthinkable, and he sought to stake out his reputation chiefly through his correspondence and published writings.

[103] Prestwich (1872), 4-5; Geikie (1895), 310-11.
[104] Evans (1876), 4-5. The Geological Society. Secretary's In-Letters. GSL/L/R/19/6. Letter from Dr James CROLL, 19 Feb 1872. GSL/L/R/19/180. Letter from James CROLL, 22 Feb 1876.
[105] Quoted in Packard and Putnam (1872), 253.
[106] Irons (1896), 421-2.
[107] Morrell (1976), 143.

4. The *Philosophical Magazine*

The scientific world in the second half of the nineteenth century was marked by the enormous proliferation of journals, as writing became 'yet another aspect of scientific practice' and key to the emergence of a professional identity for science.[108] The two publications of the Geological Survey were the *Decades* and *Memoirs*, which De la Beche had produced 'to unite staff under a single banner'.[109] These journals were reserved for the Survey's results, which served both to encourage a sense of collective endeavour among Surveymen, and kept the journals from being 'submerged' into the *Quarterly Journal of the Geological Society*, or 'other independent, individualist periodicals like *Magazine of Natural History* or the *Philosophical Magazine*'.[110] Once again, Croll defied the expectations of his class, contributing to high-level theoretical debates rather than the fossil collecting in which men of lower social rank typically engaged, or the fieldwork usually published in geological journals.[111] Of Croll's 92 publications, 38 were printed in the 'independent, individualist periodical', the *Philosophical Magazine*, which was his single most frequent choice of journal.

Croll had already published three papers in the *Philosophical Magazine* while working as janitor at the Andersonian. There were several advantages to the journal's independence from Croll's perspective as a practitioner. As J. J. Thomson reported, 'I think myself that the *Philosophical Magazine* is a better means of publication than even the Royal Society as the circulation is larger and the delay very much less'.[112] Thomson sent papers to the Royal Society only occasionally, 'as it is usually so long before they are in print that one almost forgets what they are about'.[113] The *Magazine*'s rapid turnarounds were part of its market strategy, its independence facilitating its self-presentation 'as a nimble operator and rapid route to publication'.[114] Its independence and reach also suited someone entering science

[108] Fyfe (2005), 192.
[109] J. Secord (1986), 253.
[110] *Ibid*., 239-40. By the 1850s, Geological Survey staff were publishing in a range of outlets.
[111] On the position of 'local collectors' in the hierarchy of practitioners, see Rudwick (1985), 418-421 and diagram.
[112] Quoted in Davis (1997, II), 311. On the *Magazine*'s international contributions and readership, see Brock and Meadows (1998, 2nd edn.), 250. See also Haslemere Educational Museum. LD.8.884. Letter book 1869-71. Letter from Archibald Geikie to James Croll, 15 March 1871: 'The proceedings of the Royal Society are not so useful to us as other publications of which we are in want'.
[113] Quoted in Davis (1997, II), 311.
[114] Clarke and Mussell (2015), 323.

from a background similar to Thomson's moderately humble beginnings, as 'those who did not have direct access to the circles of polite society, because of geography or social class, might gain attention and approbation through careful publication'.[115]

To choose a journal simply because if its wide circulation would be dangerously close to the 'self-assertion' Croll so disdained in the materialistic men of science. The more significant principle behind Croll's selection of the *Philosophical Magazine* was more likely its 'long-established independence'.[116] As Clarke and Mussell have shown, 'although the activities of the learned societies provided useful copy, the success of [the] *Philosophical Magazine* was predicated on its independence: unaffiliated, its editors were free to reprint content wherever they found it and, without the bureaucracy of the societies, could get papers into print fairly quickly'.[117] Founded in 1798 by journalist and inventor, Alexander Tilloch, the journal 'established a readership as a monthly miscellany specialising in scientific news and information'.[118] From 1852, it was published by Taylor and Francis and gradually came to focus exclusively on physics and mathematics. Its front page displayed the names of the leading men of science who served as editors, who included Croll's correspondent, John Tyndall, as well as J. J. Thomson, Nevill Mott, and Croll's patron and fellow member of the Geological Society of Glasgow, William Thomson.[119]

The *Philosophical Magazine's* independence juxtaposed the nepotism and aimless socialising Croll perceived as characteristic of other journals and the societies who published them. The *Philosophical Magazine's* editorial policy contrasted significantly with that of its two closest rivals, the *Proceedings of the Royal Society* and the *Proceedings of the Physical Society*.[120] Contributions to the Royal Society's *Transactions* (1665-) and *Proceedings* (1832-) first had to be read at a meeting, in person if the author was a Fellow, or by a communicator, before the paper could be considered for publication. In further contrast to the *Philosophical Magazine*, the Royal Society had a system of referees whose judgement determined whether

[115] Fyfe (2005), 193.
[116] Clarke and Mussell (2015), 322.
[117] *Ibid*.
[118] *Ibid*., 323.
[119] *Ibid*.
[120] *Ibid*., 322.

or not an article would be accepted.[121] First and foremost a commercial journal, the *Philosophical Magazine's* lack of societal or institutional affiliation meant that it could publish papers without judgement as to the author's background.[122]

Tyndall, a 'leading exponent of evolution and scientific naturalism', was a prominent member of the *Philosophical Magazine's* editorial board.[123] Like Huxley, Clifford, and other Darwinians, Tyndall typically chose to publish in *The Fortnightly Review*, a scientific periodical based upon a non-theological social philosophy.[124] It was typical of Croll to engage in direct intellectual combat with his opponents, and he frequently sent offprints directly to correspondents likely to disagree with his own views.[125] Croll began this practice with his first publication in 1857, sending copies of his Calvinist tract to ministers and professors holding a wide range of philosophical convictions.[126] It seemed to be a custom for which Croll became renowned, as Charles Lyell concluded a letter to John Herschel, in which Lyell discussed Croll's article in the '*Phil Mag*' for 1865, 'I daresay he sent you an author's copy'.[127]

Croll continued in this style of intellectual combat to the very end of his career. In 1871, he wrote to the Secretary of the Royal Geographical Society:

> I wish to send a copy of one of my papers to a few of the members of the Royal Geographical Soc'y but have not their addresses.
>
> If you have a printed List of the names of your members would you be so kind as to favour me with a copy.[128]

[121] *Ibid*.
[122] *Ibid*., 325.
[123] Dawson (2007), 17.
[124] *Ibid*.
[125] On this practice, see Csiszar (2010), (2018).
[126] Croll sent his work to his lifelong friend and philosophical opponent, the Rev. James Morison; Oxford-educated Professor of Moral Philosophy and Political Economy at St Andrews, James Frederick Ferrier; United Presbyterian minister and Professor of Moral Philosophy at St Andrews, John Cairns; and Church of Scotland minister and Principal of Glasgow, Thomas Barclay. See Irons (1896), 86-90.
[127] The Royal Society. HS 11. 431. Letter from Charles Lyell to John Herschel, 31 January 1865. The article was Croll (1864).
[128] Royal Geographical Society. CB6/584. Letter from James Croll, 12 September 1871.

Contrary to the practice of many rising men of science in this period, Croll's aim was not to use his publications to navigate his way into élite correspondence networks and be elected to the Society in order to further his own scientific career.[129] Croll's last and, he declared, 'most important' work was *The Philosophical Basis of Evolution* (1890), a preface to which appeared as 'Evolution by Force Impossible: A New Argument against Materialism', published in the *British Quarterly Review* in 1883.[130] By this time, Croll had lost any kind of institutional access to scientific periodicals and yearned for scientific news. In the spring of 1881, Croll's health had taken a decided turn for the worse. While the Survey encouraged Croll to apply for a prolonged leave of absence, Croll perceived the offer of extended paid leave to be improper, and decided his only option was to retire.[131]

In exchange for providing feedback on their articles, Croll asked the Surveymen to send him scientific journals.[132] In December 1881, Croll pleaded with Horne:

> As I am cut off from all scientific journals and magazines at present, would you let me have a look at your *Athenaeum* when you are done with it? I will return it to you next day. I don't read much, but like to look over that journal, more particularly the advertisements part, as it lets one know what is going on in the book world … but I do not like to ask for the office copy.[133]

It was probably very easy for Horne to persuade Geikie to let Croll have the office copy and Croll's request seems to have led to the regular exchange of the journal. In autumn 1882, Croll replied to Horne, 'I return *Athenaeum* with many thanks. Look at *Literary Gossip* for 23rd September'.[134] There appeared the notice: 'An article by Dr James Croll, F. R. S., entitled "Evolution in Relation to Force: a New Argument for Theism," written before his recent illness,

[129] Croll (1883), 35-71.
[130] Croll (1883); Irons (1896), 379.
[131] Irons (1896), 363.
[132] Letter from Croll to Horne, 22 April 1881 and 21 July 1881, in Irons (1896), 364-65. Darwin sent Croll a presentation copy of his book on earthworms to thank Croll for his help in fielding Darwin's enquiries about glacial periods. See: Letter from Croll to Darwin, 22 October 1881, in Irons (1896), 366.
[133] Letter from Croll to Horne, 21 December 1881, in Irons (1896), 366-67.
[134] Letter from Croll to Horne, 18 October 1882, in Irons (1896), 369.

will shortly appear in one of the quarterlies.'[135] Invoking his scientific credentials, 'F.R.S.', to assert his authority in matters of theology and philosophy, Croll could not have demonstrated his perception of the pursuit of knowledge as a single, unified vocation any more clearly.

Conclusion

Geological Survey
Edinburgh June 5th 1876

Sir,

Your letter of the 2nd inst., informing me that I have had the honour of being elected a Fellow of the Royal Society, is duly received.

I herewith enclose Draft for £14; being £10 for Admission Fee, and £4 for first years [*sic.*] subscription.

I am sorry I shall not be able to be present at next meeting of the Society

I am
Sir
Your obedient servant
James Croll[136]

For most men of science, this letter would symbolise the zenith of their scientific career, serving as evidence of the recognition their work had been afforded by their peers. Croll's missive conveyed the typical news that he would be absent from any formal presentation of the accolade. I hope by now it is clear from my argument that this was unlikely to be due to the geographical distance between Edinburgh and London alone. In this article, I have situated Croll's navigation of scientific societies in a study of the societies' local cultural contexts; in doing so, I have sought to illuminate significant factors in Croll's unconventional

[135] *The Athenaeum* (1882), 404.
[136] The Royal Society. MC/10/404. Letter from Croll to Professor Stokes, 5 June 1875.

trajectory. He sought an education for theistic ends and purposefully navigated his participation in the emerging scientific community, avoiding opportunities which would have granted him professional status or more material comfort. Perhaps the most apt characterisation of Croll was made in a letter to Croll's biographer during their petition to get Croll a Civil List Pension: the Rev. Joseph Parker stated that Croll was known for his 'energy', but lacked 'the kind of wheedling courtesy that goes so far in spineless London'.[137]

Croll did not conform to the ideal-type of a professional man of science who rose from humble origins to make a scientific career for himself; thus, he cannot be cast in the mould of Faraday, an artisan aspiring to professional status. Croll also did not adhere to a Smilesian trajectory, as an autodidact whose participation in science proved conducive to moral improvement. According to Croll – who was recognised as 'the most philosophical physico-geologist we have had since Hutton' – the pursuit of knowledge was measured on a very different scale. Ultimately, Croll – and many like him – resist identification according to historian's ideal-types. While this article has been concerned with James Croll, therefore, its analysis carries broader implications for the history of science. Croll's trajectory calls for more attention to be paid to the 'obligatory amateurs', the 'devotees', and the 'cultivators of science' – terms used to grasp the precarious array of possibilities for non-élite groups who were not afforded gentleman or professional status, to participate in and contribute to the production of knowledge.[138]

In retirement, Croll struggled to access books due to his lack of societal affiliations and suffered from ill health and financial instability. Croll and his wife survived on his pension and her annuity, which amounted to a meagre £83 13*s*. 4*d.*[139] Croll was awarded £130 from two grants from the Royal Society Relief Fund and £100 from the Royal Literary Fund.[140] A petition

[137] BL. ADD.MS.41077, f.153. Letter from Rev. Joseph Parker, Minister of the City Temple, to Irons, 11 February [undated]. Croll is not named explicitly in the letter, but in the context of the archive, which consists of a collection of letters concerning Croll, it is most likely that Parker was also referring to Croll. Parker's review of Irons (1896) is featured in the back of the book.

[138] On 'obligatory amateurs', see M. B. Ogilvie (2000); on 'devotees', see Kargon (2010), 34-85; on 'cultivators of science', see Reingold in Olseon and Brown (eds.) (1976).

[139] BL. Loan 96 RLF 1/2220, f.1, 'Royal Literary Fund Form of Application for an Author', 20 April 1885.

[140] Irons (1896), 482-3. The Royal Society. MC 14/61. Letter from James Croll to Thomas Henry Huxley, 4 July 1885. BL. Loan 96 RLF 1/2220, f.12. Letter from James Croll, 15 May 1885. Croll had earlier received £50 from the Royal Society Fund. Royal Botanic Gardens Kew. JDH/2/1/9, f.183. Letter from A. Geikie to T. H. Huxley, 7 May 1885.

was presented to Parliament in an attempt to increase Croll's pension and a subscription raised in his aid; but both failed.[141] Croll's goal of unifying 'religion, philosophy, and science', to turn opponents into allies, and to rid science of its 'cold materialistic atmosphere', shaped his self-presentation as he navigated science's institutions. As he lived most of his life in material poverty and remained largely neglected by historians for more than a century, Croll ultimately paid the price for his devout adherence to his unorthodox vision of science.

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[141] The Royal Society. MC/14/79. Letter from C. S. Canker to John Evans, 16 August 1885.

Appendix I: Croll's Membership of Scientific Societies
Derived from Records of the Geological Society of Glasgow, ACCN 2561/3/1; Irons (1896), 39; The Royal Society, GB117, EC/1876/08, 'Croll, James'; Edinburgh Geological Society (1870), 238.

Society (date of election if known)	**Position and subscription fee**
Geological Society of Glasgow	Proposed as member 1865-66 and 1867, giving his affiliation as 'Anderson's university'. Made Honorary Associate in February 1867. 2*s*. 6*d*. per annum.
Edinburgh Geological Society (January 1869)	Ordinary Fellow
Royal Society of London (1876)	Fellow
New York Academy of Science (1876)	Honorary Member
Bristol Natural Society	Honorary member
Literary and Antiquarian Society of Perth	Honorary member
Perthshire Society of Natural Science	Honorary member
Psychological Society of Great Britain	Honorary member

Appendix II: Prizes Croll received from the Geological Society of London
Derived from Evans (1872), 4-5; The Geological Society, GSL/L/R/19/6 Letter from Dr James Croll, 19 February 1872; Evans (1876), 5; The Geological Society, GSL/L/R/19/180 Letter from James Croll, 22 February 1876; The Geological Society of London (1884), 11.

Prize	**Year**	**Amount**
Wollaston Donation Fund	1872	£21. 6*s*. 10*d*.
Murchison Fund	1876	£29 3*s*. 4*d*.
Barlow-Jamieson Fund	1884	£20

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GSM/DC/A/C/8/151, 155, 226. J. Croll letter on his promotion.

GSM/DC/A/C/8/270-272, 277. J. Croll letter on his position.

GSM/DC/A/C/8/281-283. J. Croll letter on overpayments.

GSM/DC/A/C/24/370. J. Croll letters on sick leave.

GSM/DC/A/C/25/11. J. Croll medical certificate.

GSM/DC/A/C/25/11, 14-15, 34. J. Croll letter on superannuation.

GSM/DC/A/C/25/14, 15, 34, 48, 246. J. Croll letters about his retirement and pension.

GSM/GL/Cr/1-28. James Croll. Letters to Benjamin N. Peach.

GSM1/407 (i) Benjamin N. Peach letters, 1871-1923.

GSM/1/321 Letters from J. Geikie to B. N. Peach. 1865-1881

GSM/1/345 Letters to B. N. Peach from J. Horne.

GSM 1/8 Entry book of in and out letters 1859-67.

GSM 1/9 Entry book of in and out letters 1867-80.

General GSM 1/25 Correspondence to the Director 1876-80.

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The British Library

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