Article:
Kaalund, NKL (2017) A frosty disagreement: John Tyndall, James David Forbes, and the early formation of the X-Club. Annals of Science, 74 (4). pp. 282-298. ISSN 0003-3790

https://doi.org/10.1080/00033790.2017.1379559

A frosty disagreement: John Tyndall, James David Forbes, and the early formation of the X-Club

Abstract

How do glaciers move? This seemingly straightforward question provided the backdrop for a heated debate between the physicists John Tyndall (1820-1893) and James David Forbes (1809-1868) in the late 1850s and early 1860s. Forbes described the motion of glaciers as that of a viscous fluid. After visiting the Alps, Tyndall proposed an alternative theory that combined fracture and regelation. The glacial controversy ensued. Yet, the debate was never simply about whether glaciers moved like honey, or if they moved by continuously breaking and re-attaching. This paper shows that the glacial controversy formed an important prelude to the strategies used by the X-Club in reforming science and establishing cultural authority. There was a central difference in the way Forbes and Tyndall presented their scientific arguments. Tyndall and his allies used the changes in the periodical press as part of their strategy for establishing and maintaining cultural and scientific authority. By contrast, Forbes and his supporters, including the North British physicists, were not as quick to make use of this new medium. This paper, therefore, examines in detail the significance of these two publishing strategies in shaping the nature and results of the glacial controversy.

Key words

John Tyndall, James David Forbes, Thomas Henry Huxley, X-Club, North British physicists, glacial motion, viscous theory

1. Introduction

> You, instead of being tortured by the ice, like Dante's worst sufferers, have put the ice to the torture of experiment and it answered your question most satisfactorily. The viscous theory, which was a great stumbling block – and must have been truly repugnant to the feelings of every one, may be now considered as relegated to the same lumber-room of obsolete theoretical apparatus, in which the crystalline spheres of the old astronomy, phlogiston, and various other similar things which have done their temporary work may be supposed to repose.[1]
>
> \- W. F. Pollock to John Tyndall, January 24 1857

The viscous theory of glacial motion, which William Frederick Pollock (1815-1888) considered as antiquated as the theory of phlogiston, proposed that the motion of glaciers resembled that of a viscous fluid, such as tar, honey or lava. Yet, in spite of what Pollock's letter to the lecturer, physicist, and scientific naturalist John Tyndall (1820-1893) would suggest, the question of glacial motion was very much *sub judice* in 1857. The originator of the viscous theory of glacial motion was the physicist and naturalist James David Forbes (1809-1868), and it was for several years considered the best explanation of the phenomena. This began to change in the mid-1850s when Tyndall outlined a divergent theory of fracture and regelation to explain the movements of glaciers.[2] Together with his friend the biologist and fellow scientific naturalist Thomas Henry Huxley (1825-195), Tyndall set out on a campaign to dismantle both the viscous theory, and the scientific credibility of Forbes. However, as several contemporary commentators observed, the difference between Forbes and Tyndall's theories appeared to be nothing but a matter of semantics. Why then, did the issue of glacial motion become such a huge controversy, that Tyndall and Forbes, as well as their supporters, addressed the issue in numerous papers, pamphlets, and books?

---

[1] William Pollock, 'Pollock to Tyndall', 24 January 1857, Royal Institution of Great Britain.

[2] Tyndall argued that glaciers moved by perpetually fracturing and re-attaching (relegating). According to Tyndall, viscosity was a character of glacial motion, not the explanation for how glaciers moved.

As Crosbie Smith has shown, the controversy over the viscous theory became part of a wider competition for cultural authority between two groups of scientific practitioners; the emerging X-Club – a group committed to promoting scientific naturalism and advancing a research programme free from political and theological control – and the North British physicists who maintained the role of religion in experimental science.[3] J.S. Rowlinson has noted, that the debate can be seen as a 'prevision' of Tyndall's long lasting dispute with the North British physicists over the principle of conservation of energy.[4] The controversy over thermodynamics has received a significant amount of scholarly attention, and has in many ways overshadowed the debate between Forbes and Tyndall over glacial motion. For example, Daniel Brown has noted that 'The unfinished controversy over glaciers was soon accompanied by a further, more radical and consequential, conflict between the Metropolitans and the North Britons over thermodynamics.'[5] This paper aims to show, that the controversy between Tyndall and Forbes was significant in its own right, and that it furthermore provides important insights into the early professionalization strategies of Tyndall and Huxley, as well as the role of the British periodical press in construction scientific authority. Drawing particularly on Ruth Barton's concept of the 'X Network' to signify the emerging X-Club, this paper further argues that the debate over glacial motion could also be considered a prevision of the function and nature of the X-Club.[6]

---

[3] Crosbie Smith, *The Science of Energy: A Cultural History of Energy Physics in Victorian Britain* (Chicago: University of Chicago Press, 1998), pp. 2–6; Peter Harrison, Ronald L. Numbers, and Michael H. Shank, *Wrestling with Nature: From Omens to Science* (University of Chicago Press, 2011), pp. 351–54; Michael S. Reidy, *The Age of Scientific Naturalism: Tyndall and His Contemporaries* (Routledge, 2015), pp. 42, 185.

[4] J. S. Rowlinson, 'The Theory of Glaciers', *Notes and Records of the Royal Society of London*, 26.2 (1971), 189–204 (p. 19).

[5] Daniel Brown, *The Poetry of Victorian Scientists: Style, Science and Nonsense* (Cambridge University Press, 2013), p. 106.

[6] Ruth Barton, '"Huxley, Lubbock, And Half A Dozen Others": Professionals And Gentlemen In The Formation Of The X Club, 1851-1864', *Isis: A Journal of the History of Science*, 89 (1998), 410–444 (pp. 416–17). Gowan Dawson has also explored aspects of how alliances and friendships were built

Frank Turner has famously argued that the nature of scientific authority went through a period of change in the middle of the nineteenth century.[7] The future members of the X-Club were on the lookout for opportunities to establish themselves as leading researchers within their respective fields and reform science, and one way of accomplishing these aims was through scientific debates that put forward their favoured kind of science with themselves as the natural authorities. Jonathan Topham has shown that when a young Forbes considered his career options in 1830, his mentor David Brewster (1781-1868) advised him against becoming a scientific author, as 'Brewster feared, for instance, that Forbes's desire to make a living by writing would impel him into premature publication, and would consequently have disastrous implications for his scientific reputation.'[8] Forbes took seriously Brewster's advice, and it shaped the way he approached scientific authorship. Brewster's advice was founded in the prevailing view of how best to establish and maintain scientific and cultural authority in the first part of the nineteenth century. For figures like Brewster, as well as William Whewell (1794-1866) and John Herschel (1792-1871), the proper and most effective way to establish oneself as an authority was through the mobilization of scientific elite institutions and networks, books, and specialized scientific journals. This approach, or model, was also linked to specific views about the publics for science, and, crucially for the controversy between Tyndall and Forbes, to ideas about the popularization of science, and the function of the periodical press. The communication revolution in the second quarter of the nineteenth century in

---

in the late 50's and early 60's, for example how Huxley used the war-rhetoric associated to the X-Club already in the 1850s within palaeontology. See, Bernard Lightman and Gowan Dawson, *Victorian Scientific Naturalism: Community, Identity, Continuity* (University of Chicago Press, 2014), p. 29.

[7] Frank M. Turner, *Contesting Cultural Authority: Essays in Victorian Intellectual Life* (Cambridge University Press, 1993).

[8] Jonathan R. Topham, 'Scientific Publishing and the Reading of Science in Nineteenth-Century Britain: A Historiographical Survey and Guide to Sources', *Studies in History and Philosophy of Science Part A*, 31.4 (2000), 559–612 (p. 595); John Campbell Shairp, Peter Guthrie Tait, and Anthony Adams-Reilly, *Life and Letters of James David Forbes, F.R.S.* (Macmillan, 1873), p. 59.

Britain created unprecedented opportunities to reach broad reading audiences through a variety of print media. But the general periodical press, including newspapers and magazines, did not become part of the repertoire of scientific practitioners overnight.[9]

This paper explores the strategies employed by Tyndall and Forbes to delegitimize each other and further their own interpretations as a way of establishing authority in their research field. Forbes and Tyndall had similar views on what constituted scientific authority. For example, as section two shows, they both emphasised their first-hand experience through mountaineering, their skills in theoretical and experimental laboratory research, and they drew upon a large network of supporters. There was also a key difference in their approach. While Tyndall and Huxley utilized the changing functions of the periodical press in the 1850s as part of their techniques for creating scientific and cultural authority, Forbes lagged behind in the ability to successfully manipulate his reputation through the general periodical press. This difference in their approach exposes the transforming conceptions of what was considered the most effective way of gaining scientific authority in the second half of the nineteenth century. Forbes relied to a large extent on the book and pamphlet format to communicate his views, a technique that was quickly becoming antiquated.

Section two compares the representation of glacial phenomena in Forbes' *Travels through the Alps of Savoy* (1843) and Tyndall's *Glaciers of the Alps* (1860). Prior to the publication of *Glaciers of the Alps*, Tyndall and his supporters published several articles in the periodical press, and section three examines a selection of these articles to see how they functioned to establish Tyndall's theory of glacial motion. Section three follows the controversy in chronological stages and argues that whereas Forbes hesitated to publish his arguments before they were fully formed, Tyndall readily put the issue before the entire public, and not just the scientific community, as a way of establishing both his cultural and scientific

[9] Topham, 'Scientific Publishing and the Reading of Science in Nineteenth-Century Britain', pp. 559–62; Bernard Lightman, *Victorian Popularizers of Science: Designing Nature for New Audiences* (Chicago: University of Chicago Press, 2009), pp. 13–17.

authority as quickly as possible. Section four shows that this allowed Tyndall and Huxley to control the direction of the controversy, which they shifted away from the validity of the term 'viscosity' to whether Forbes had plagiarized the concept. It is well documented that the X-Club members were particularly skilled at utilizing the periodical press to their advantage.[10] Another central feature of the X-Club was the way they challenged those whom they perceived as antiquated scientific practitioners to redefine the meaning of science, and what it meant to be a professional scientist.[11] Tyndall and Huxley experimented with these key professionalization strategies in the controversy with Forbes. The debate over glacial motion quickly moved beyond the question of whether the viscous theory, or the theory of fracture and regelation, best explained the phenomena, into broader questions over who had the right to speak on behalf of science and what it meant to do field-based experimental physics. In this way, the glacial controversy provides insights into the role of print culture in the early identity formation of what would become the X-Club, and it brings out the dynamics of professional rivalries and ambitions for scientific authority in the middle of the nineteenth century.

2. The controversy begins: Heated exchanges on icy subjects

[10] See for example: Aileen Fyfe and Bernard Lightman, *Science in the Marketplace: Nineteenth-Century Sites and Experiences* (Chicago, London: University of Chicago Press, 2007); Bernard Lightman, 'Victorian Sciences and Religions: Discordant Harmonies', *Osiris*, 16 (2001), 343–66.

[11] See for example: Fyfe and Lightman; Frank M. Turner, 'The Victorian Conflict between Science and Religion: A Professional Dimension', *Isis*, 69.3 (1978), 356–76; J. Vernon Jensen, 'The X Club: Fraternity of Victorian Scientists', *The British Journal for the History of Science*, 5.1 (1970), 63–72; Roy M. MacLeod, 'The X-Club a Social Network of Science in Late-Victorian England', *Notes and Records of the Royal Society*, 24.2 (1970), 305–22; Adrian Desmond, 'Redefining the X Axis: "Professionals," "Amateurs" and the Making of Mid-Victorian Biology: A Progress Report', *Journal of the History of Biology*, 34.1 (2001), 3–50; Ruth Barton, '"An Influential Set of Chaps": The X-Club and Royal Society Politics 1864-85', *The British Journal for the History of Science*, 23.1 (1990), 53–81; Barton, 'Huxley, Lubbock, And Half A Dozen Others'. For a critique of the term professionalization, see for example Jim Endersby, *Imperial Nature: Joseph Hooker and the Practices of Victorian Science* (Chicago, London: University of Chicago Press, 2008), pp. 22–30.

In the summer of 1856 Tyndall toured through Grimsel, the glaciers of the Aar, the Rhone, Grindelwald and the glaciers of the Tyrol. His friends Huxley, the botanist Joseph Dalton Hooker (1817-1911), and the chemist Edward Frankland (1825-1899) accompanied him at different points. Prior to departing, Tyndall told his close friend the mathematician Thomas Archer Hirst (1830-1892) of his intention to examine Forbes' viscous theory during this trip: 'I have read the "travels" and "letters" of Forbes, and made myself thorougly [sic] acquainted with his theory. The impression left upon my mind by his writing is that the matter needs closer looking after. So this I intend to combine with my journey.'[12] Tyndall wasted no time in presenting his views through the periodical press, but Forbes was hesitant in publishing any responses. This was partially because Forbes did not think that Tyndall's interpretation differed significantly from his ideas, and therefore did not pose a threat to his research reputation. Rather, Forbes believed that Tyndall's concept of fracture and regelation complemented his own theory. As late as 1859, Forbes reiterated that "The explanations which I now offer will tend, I hope, towards a reconcilement of our conclusions, and not to controversy" in one of the only more direct public communications to Tyndall.[13] Forbes was not alone in this view, and several contemporary commentators questioned exactly how Tyndall's interpretation differed from Forbes' viscous theory. A central concern was what did viscosity mean?

Forbes began in earnest his research into glaciers in the early 1840s. He was invited by the Swiss biologist and geologist Louis Agassiz (1907-1873) to join him in making observations on the Lauter-Aar Gletscher during the summer of 1841, after the two had met at the 1840 Glasgow meeting of the British Association for the Advancement of Science.[14] Forbes had at this point already visited the Alps, and was 'familiar with the general aspect of glaciers'.[15] Following his visit to the Lauter-Aar

[12] John Tyndall, 'Tyndall to Hirst', 9 August 1856, Royal Institution of Great Britain.

[13] James David Forbes, 'XXXI. Remarks on a Paper "On Ice and Glaciers" in the Last Number of the Philosophical Magazine. In a Letter to Prof. Tyndall', *Philosophical Magazine*, 17.113 (1859), 197–201.

[14] Shairp, Tait, and Adams-Reilly, p. 256.

[15] Shairp, Tait, and Adams-Reilly, p. 256.

Gletscher, Forbes wrote his first paper on glaciers. This publication led to a bitter dispute over priority and credit with Agassiz, and the two did not conduct research together again – something that would later be brought up in Forbes' conflict with Tyndall.[16] Undeterred by the situation with Agassiz, Forbes continued his research into glaciers, and he made several visits to the Swiss Alps to mountaineer and research. Forbes' early training was at the University of Edinburgh, an institution he would remain attached to until he became the Principal of St Andrews in 1860, first as the Professor of Natural Philosophy from 1833 onwards, and later as the Dean of the Faculty of Arts. He wrote several papers on glacial phenomena, as well as vivid travel accounts of his experience mountaineering. Bruce Heyly has showed that Forbes was one of the first to exploit the image of mountain travel as a means of forming a scientific argument.[17] Yet, Hevly argues that Forbes was not very successful in employing this strategy in his controversy with Tyndall.[18]

Tyndall was, by contrast, certainly very skilled at presenting himself as an able and brave mountaineer. In his writings, he emphasized the danger involved in climbing the treacherous ice, and the skills it took not only to ascend the mountains but also to undertake scientific experiments while engaged in this dangerous sport.[19] Working in the field was well-charted terrain for Tyndall, as his early career had been in surveying, first in the Ordnance Survey of Ireland from 1839, and in the English survey from 1842. After a brief period as a teacher of mathematics and surveying at Queenwood College in Hampshire, Tyndall travelled in 1848 to the University of Marburg in Germany with Edward Frankland to study mathematics, chemistry and physics for his doctorate. Tyndall's education provided him with the skills and contacts that were necessary to position himself at the centre of the British scientific scene. Germany was considered to be the home of some of

[16] For more a detailed account of the dispute between Forbes and Agassiz see Frank F. Cunningham, *James David Forbes: Pioneer Scottish Glaciologist* (Scottish Academic Press, 1990).

[17] Bruce Hevly, 'The Heroic Science of Glacier Motion', *Osiris*, 11 (1996), 66–86.

[18] Hevly, pp. 66–68.

[19] Michael S. Reidy, 'John Tyndall's Vertical Physics: From Rock Quarries to Icy Peaks', *Physics in Perspective*, 12.2 (2010), 122–45.

Europe's greatest scientists, including the chemist Robert Bunsen (1811-1899), with whom Tyndall studied. It also featured well-equipped laboratories at the centre of their scientific practice. In 1853, he was offered the position of Professor of Natural Philosophy at the Royal Institution in London, where his personal friend and mentor, the influential physicist Michael Faraday (1791-1867), was based.[20] Tyndall quickly rose to fame. He was known as an engaging lecturer and communicator of science, and later as an accomplished mountaineer and physicist.

During his 1856 trip, Tyndall swiftly became confident in his divergence from Forbes' interpretation of glaciers, both with regards to the structure of glacial ice, dirt-bands, and glacial motion, and he wrote to Hirst that,

> Well I think I have smashed up this theory; so utterly annihilated it, that its author will hardly acknowledge it. Of course this may be all self delusion, others must judge of the force of my arguments, but unless I labour under a hallucination altogether new, the theory is killed without the hope of recovery. It is therefore more than an Irish 'killing' from which people recover sometimes.[21]

Soon after their return, Tyndall and Huxley prepared a joint paper for the Royal Society on the observations they had made during their stay in the Alps. Tyndall read this paper before the Royal Society in early 1857, and short versions of the lecture appeared in the periodical press.[22] It was through the periodical press that Forbes first learned of the content of Tyndall and Huxley's joint paper, as he did not receive the number of the *Proceedings of the Royal Society* containing the abstract until the end of February.[23] Shortly after reading the abstract, Forbes wrote to Tyndall to enquire whether Tyndall would be willing to send him a copy of the full paper, noting that he would prefer to wait with commenting upon it 'were there a

---

[20] Ursula DeYoung, *A Vision of Modern Science* (New York: Palgrave Macmillan US, 2011), pp. 14–17.

[21] John Tyndall, 'Tyndall to Hirst', 4 December 1856, Royal Institution of Great Britain.

[22] John Tyndall, 'Tyndall to Clausius', 9 February 1857, Royal Institution of Great Britain.

[23] James David Forbes, 'Forbes to Wills', 11 February 1857, The Alpine Club Library; James David Forbes, 'Forbes to Wills', 25 February 1857, The Alpine Club Library.

prospect of seeing it published in detail.'[24] Tyndall's response made it clear that while he would be happy to forward the *published* copy to Forbes, he did not want comments on the paper prior to this, as it had 'already been 'referred' by the Council of the Royal Society, but whether it is to be printed in the Transactions or not must depend upon the decision of the referees.'[25] In letters to his friends Wills and Alfred Gautier (1793-1881), Forbes expressed confidence that Tyndall and Huxley's views did not in fact differ fundamentally from his own, and that it therefore would be best to delay responding to the circulated abstract until the paper had been published in full.[26]

In his book *Travels through the Alps of Savoy* (1843), and elsewhere, Forbes had compared the motion of glaciers to that of a viscous fluid, such as tar, honey or lava. [27] While his concept of glacial motion was not universally accepted - the geologist and mathematician William Hopkins (1793-1866) notably believed the viscous theory violated the laws of mechanics - it was for a while considered by many to be the best description of the phenomena.[28] Tyndall outlined in his book *Glaciers of the Alps* the main points of his objections to Forbes viscous theory. First, he had observed that crevasses in glaciers formed quickly and opened slowly and that this went against the analogy between glaciers and flood that underpinned the viscous theory.[29] Second, Tyndall questioned whether the viscous theory was in fact a theory.[30] In order for Forbes's theory of glaciers to qualify as a theory, Tyndall

[24] James David Forbes, 'Forbes to Tyndall', 6 March 1857, Royal Institution of Great Britain.

[25] John Tyndall, 'Tyndall to Forbes', 7 March 1857, St. Andrews Letters.

[26] James David Forbes, 'Forbes to Gautier', 24 April 1857, The Alpine Club Library.

[27] James David Forbes, *Travels Through the Alps of Savoy Ant Other Parts of the Pennine Chain with Observations on the Phenomena of Glaciers. - Edinburgh, Black 1843* (Black, 1843).

[28] William Hodson Brock and others, *John Tyndall, Essays on a Natural Philosopher* (Royal Dublin Society, 1981), p. 116.

[29] John Tyndall, *The Glaciers of the Alps: Being a Narrative of Excursions and Ascents, an Account of the Origin and Phenomena of Glaciers and an Exposition of the Physical Principles to Which They Are Related* (John Murray, 1860), p. 327.

[30] Tyndall, *The Glaciers of the Alps*, p. 312.

argued, it must be possible to prove that a glacier exhibits the power of yielding to a force of tension without breaking:

> It cannot be too clearly and emphatically stated that the proved fact of a glacier conforming to the law of semifluid motion is a thing totally different from the alleged fact of its being viscous. Nobody since its first enunciation disputed the former.[31]

To examine this point, Tyndall used stylized representations of slopes at the Mer-de-Glace in Figure 1 and 2 that represented different degrees of steepness.

(Figure 1)

If a glacier was truly viscous, Tyndall argued, the glacier (B-C) would be able to cross the brow point (B) of the Mer-de-Glace without transverse fracture, which it could not.[32]

(Figure 2)

In this way, Tyndall asserted that Forbes had misused the term 'theory', and that viscous was merely a descriptive quality, not a principle.[33] He also stated that Forbes himself had noted that Mer-de-Glace was impassable and thus contradicted himself. As the next section will show, these arguments were similar to those already put forward anonymously by Huxley in the *Westminster Review*.

---

[31] Tyndall, *The Glaciers of the Alps*, p. 327.

[32] Tyndall, *The Glaciers of the Alps*, pp. 313–14.

[33] Tyndall, *The Glaciers of the Alps*, p. 312.

Forbes addressed several of Tyndall's early scientific criticisms in a talk at the Royal Society of Edinburgh. A summary of this talk first appeared in the *Proceedings of the Royal Society of Edinburgh* in April 1858, and soon after in the August volume of the *Philosophical Magazine* and in the *Athenaeum* on 21 August 1858.[34] In this communication, Forbes expressed his frustration with having to make his views public before he had finalized his findings, noting that "Owing to indisposition, I have been obliged to leave my experiments for the present incomplete. But I am desirous, before the session of the Royal Society closes, to place on record some facts which I have observed, and also some conclusions which I deduce from these and other recent experiments and discussions."[35] As Forbes felt it was now necessary to comment upon Tyndall and Huxley's attacks on his theory, he followed the older model of establishing scientific and cultural authority by utilizing the elite scientific networks and publications in Edinburgh. Forbes' talk focused on the character of ice when near 32 degrees Fahrenheit. Figure 3, which was included in the published summary, shows the surface of a block of ice 'AB' containing water at a freezing temperature on a temperature curve.

(Figure 3)

Between 'AB' and 'ab' there is 'NO', which corresponds to 'what may be called the physical surface of the ice' wherein there is '"plastic ice," and "viscid water"'. Forbes argued, that ice at the melting point (32 degrees Fahrenheit) behaves differently

[34] James David Forbes, 'PROF. FORBES ON SOME PROPERTIES OF ICE NEAR ITS MELTING POINT', *Athenaeum*, 1858, 238 (p. 238); James David Forbes, 'Prof. Forbes on Some Properties of Ice near Its Melting Point', *Proceedings of the Royal Society of Edinburgh*, 4 (1858), 103–6; James David Forbes, 'LXI. Intelligence and Miscellaneous Articles On Some Properties of Ice near Its Melting-Point', *Philosophical Magazine*, 16.110 (1858), 544–46.

[35] Forbes, 'Prof. Forbes on Some Properties of Ice near Its Melting Point', p. 103.

and is much softer than ice at lower temperatures and as glaciers are saturated with water, glacial ice takes on certain properties at the melting point. Forbes argued that his experiments with ice explained 'regelation' – a central part of Tyndall's proposed theory for glacial movement – and that this explanation was in accordance with the viscous theory.[36] In the pamphlet *Reply to Professor Tyndall's Remarks, In His Work "On the Glaciers of the Alps," relating to Rendu's "Théorie Des Glaciers"* (1860), Forbes briefly stated that Tyndall's criticism of the viscous theory with reference to Mer-de-Glace was altogether false.[37] According to Forbes, Tyndall was correct in arguing that the Mer-de-Glace glacier did not behave as if plastic but this was not a proof against the viscous theory.[38] The Mer-de-Glace was a different type of glacier, Forbes argued, with a velocity of at least three times that of the glacier of the Aar. Because of this, and not because the viscous theory was wrong, ice and ground could not meet without causing fissures in the ice.[39]

The questions of what was meant with 'viscous' and 'viscosity,' and what constituted a proper scientific theory, were central issues that Tyndall and his supporters repeatedly raised in the periodical press, lectures, and books. Quickly however, the focus shifted from such questions to more serious allegations of plagiarism, priority, and all-round intellectual dishonesty. In 1859, Forbes expected that he would receive the prestigious Royal Society Copley Medal awarded for improving natural knowledge through experiments.[40] However, one week prior to the Royal Society's official decision, Huxley submitted a letter to the council that accused Forbes of having plagiarized his viscous theory from the French bishop and

---

[36] *Regelation* was a key part of Tyndall's argument, but not very clearly defined. It refers, in conjunction with 'fractures', to the perpetual separation and re-attachment of glacial ice.

[37] James David Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'* (Black, 1860).

[38] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, pp. 21–23.

[39] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 21.

[40] Charles Richard Weld, *A History of the Royal Society: With Memoirs of the Presidents* (Cambridge University Press, 2011), p. 384.

glacial researcher Louis Rendu (1789-1859).[41] The manoeuvre was successful. Rendu's pamphlet was not widely available in Britain, and one week was not enough time to procure a copy. This was a huge blow to Forbes. Tyndall repeated these allegations of plagiarism in his book *Glaciers of the Alps*, which was part travel narrative and part an account of glacial phenomena. While Tyndall's *Glaciers* touched upon a wide range of subjects, including the structure and formation of ice crystals, the nature of light and heat, the formation of crevasses, and the motion of glaciers, Forbes' *Reply to Professor Tyndall's Remarks* focused solely on the issue of priority. Tyndall not only argued that Forbes' viscous theory was wrong, but that Forbes had falsely claimed priority of it. These charges were discussed behind closed doors, as well as in the periodical press. Forbes, though, was no novice when it came to scientific debates, and like Tyndall he also made use of his large and influential scientific network to assist him in countering the allegations.

3. Viciousness and viscosity in the periodical press

In February 1857, Forbes wrote about the issue to his friend Alfred Wills (1828-1912), noting that 'It is not my wish to put this in evidence just now. I send it for your private satisfaction. It is only a portion of my case; and, as a lawyer, you know how a case is weakened by bringing it out piece meal.'[42] Such was Forbes' view of how to present a scientific argument; it had to be thorough and complete before it was published. Again, as Topham has shown, this approach was something he learned from Brewster who told Forbes never to rush an argument.[43] Tyndall employed a very different strategy and readily utilized the periodical press to establish his authority on glacial science. This difference in the approach to the periodical press and how to present scientific arguments was a key factor in how the controversy over glacial motion progressed. The British periodical press

[41] Brown, p. 106; A. D. D. Craik, *Mr Hopkins' Men: Cambridge Reform and British Mathematics in the 19th Century* (Springer, 2008), pp. 123–24; Cunningham, p. 267.

[42] Forbes, 'Forbes to Wills'; Forbes, 'Forbes to Wills'.

[43] Topham, 'Scientific Publishing and the Reading of Science in Nineteenth-Century Britain', p. 595.

underwent significant transformations in the middle of the nineteenth century. It grew rapidly, and new types of publications emerged. Topham has argued that the transformations, which took place in British science in the nineteenth century, correlate with changes occurring in print media and its readerships.[44] In Victorian Britain, scientific news was of particular interest. Topham, Gowan Dawson, and Richard Noakes have noted that 'From the perspective of readers, science was omnipresent, and general periodicals probably played a far greater role than books in shaping the public understanding of new scientific discoveries, theories and practices'.[45] Similarly, Lightman has shown using Tyndall's Belfast Address from 1874 that the periodical press provided a battle ground for questions of authority, status, and cultural elitism in Victorian society.[46]

As the changes in publications, readership and function of the periodical press took place, some people were quicker to realize the potential power the medium could have in scientific debates. The periodical press was full of articles concerning the motion of glaciers, and the bourgeoning conflict between Forbes and Tyndall in particular. While Forbes himself was set on waiting to respond to the criticisms of his theory, others did not take this approach. The *Saturday Review* published an article on 31 January 1857 that discussed Tyndall's lectures on glaciers. Tyndall's findings touched upon, and had consequences for, Forbes' theory. The anonymous author reflected upon these implications and concluded that 'we cannot help thinking that much more is needed than was advanced in Dr. Tyndall's

---

[44] See for example: Jonathan R. Topham, 'Beyond the "Common Context": The Production and Reading of the Bridgewater Treatises', *Isis*, 89.2 (1998), 233–62; Jonathan R. Topham, 'Science and Popular Education in the 1830s: The Role of the "Bridgewater Treatises"', *The British Journal for the History of Science*, 25.4 (1992), 397–430.

[45] Geoffrey Cantor and others, *Science in the Nineteenth-Century Periodical: Reading the Magazine of Nature* (Cambridge, New York: Cambridge University Press, 2004), p. 1.

[46] Bernard Lightman, 'Scientists as Materialists in the Periodical Press: Tyndall's Belfast Address', in *Science Serialized: Representations of the Sciences in Nineteenth-Century Periodicals*, ed. by Geoffrey Cantor and Sally Shuttleworth (MIT Press, 2004), pp. 199–237.

lecture to *prove* that Professor Forbes was wrong.'[47] The article in the *Saturday Review* did not outright reject the content of Tyndall's lectures, but it questioned the extent to which Tyndall - and Huxley - had raised enough evidence to actually disprove Forbes' theory of glacial motion. The difference between Tyndall and Forbes' interpretation, the anonymous author argued, was a matter of semantics. Forbes believed that the author of this article was his friend Wills.[48] From early 1857 onwards, Forbes and Wills had a regular correspondence and a large part of it centred on the glacial issue. Forbes asked Wills to read over his published papers on glaciers, and provide feedback on his thoughts regarding the attacks on his glacial theory as the debate with Tyndall and Huxley progressed. On Forbes' request, Wills also published a very positive review of Forbes' 1859 book *Occasional Papers*.

While the anonymous article in the *Saturday Review* supported Forbes' interpretation of glaciers, other publications did not. In April 1857, the radical quarterly *Westminster Review* published an anonymous review of Tyndall and Huxley's report at the RS, and Tyndall's lecture at the RI entitled 'Glaciers and Glacier Theories,' which also contained reflections on three of Forbes' books: *Travels in the Alps of Savoy, Visit to Norway and its Glaciers, and Letters on Glaciers 1 to 13*.[49] During the 1850s, Huxley contributed a regular science column to the *Westminster Review* that Tyndall assisted him with.[50] As was revealed in private letters, the author of this anonymous review was in fact Huxley.[51] A footnote in Forbes' *Reply* shows that he was aware of this, and on the topic of this article he wrote, 'professor Tyndall can hardly have failed to recognize the hand of a zealous

[47] Anon, 'Dr. Tyndall's Theory of Glaciers', *The Saturday Review*, 3.66 (1857), 102–3 (p. 103).

[48] James David Forbes, 'Forbes to Wills', 7 February 1857, The Alpine Club Library; Shairp, Tait, and Adams-Reilly, p. 368.

[49] Anon (Thomas Henry Huxley), 'Glaciers and Glacier Theories', *Westminster Review*, 67.132 (1857), 418–44.

[50] *DNCJ: Dictionary of Nineteenth-Century Journalism in Great Britain and Ireland*, ed. by Laurel Brake and Marysa Demoor (Gent and London: Academia Press, 2009), pp. 299, 642.

[51] Leonard Huxley, *Life and Letters of Thomas Henry Huxley* (D. Appleton, 1900), p. 170.

supporter of his own'.[52] Frances Hooker, the wife of Joseph Dalton Hooker, jokingly noticed the strangeness of Huxley reviewing his own work in a letter to Tyndall:

> Also I brought away the Westminster, and have been looking at Mr Huxley's article – I liked his winding up very much indeed. But what an odd idea, for a man to review his own writings! for such it is theoretically – at least it would have that effect to the world, if he signed his name to the review.[53]

As Frances Hooker's letter suggested, had Huxley signed the article, it would have changed the tone of the piece. The supposed omniscient nature of the anonymous reviewer helped Huxley and Tyndall in the debate.[54] They took advantage of the shield of anonymity, to support themselves without it being obvious that this was the case. Furthermore, it meant that Huxley could write several articles where he pushed their agenda. Unsurprisingly, Huxley's review strongly favoured his and Tyndall's interpretation of glaciers. Huxley's anonymous review explained that Forbes had showed that as far as its motion is concerned, a glacier resembled a viscous fluid. However, this did not mean that glaciers were viscous.[55] Huxley asserted that Forbes' theory could only be considered true, if all parts of the theory could be directly verified by physical observations of ice, which Tyndall and himself had shown was not the case.[56] Forbes' viscous theory was not a theory, but a principle, Huxley argued. These arguments were later repeated and expanded upon in Tyndall's *Glaciers of the Alps*.

---

[52] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. footnote §6.

[53] Frances Hooker, 'Hooker to Tyndall', nd nm ny 1, Royal Institution of Great Britain.

[54] For more on the role of anonymity and authorship, see: James A. Secord, *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation* (Chicago: University of Chicago Press, 2000); Adrian Johns, *The Nature of the Book: Print and Knowledge in the Making* (Chicago: University of Chicago Press, 1998).

[55] Anon (Thomas Henry Huxley), pp. 427–28.

[56] Anon (Thomas Henry Huxley), p. 438.

In a letter to the editor of the *Westminster Review* in 1857, Huxley stated that 'I am entirely responsible for the essay and that my friend did not see a line of it until its publication.'[57] Huxley wrote another piece in 1857 for the *Philosophical Magazine and Journal of Science* entitled, 'Observations on the Structure of Glacier Ice.' which Tyndall also claimed to not have seen before it was published.[58] This paper was signed, and addressed as a letter to Tyndall. In this way, Huxley used two different formats of the periodical press to the same end. The signed letter exploited the letters to the editors section, and drew on his role as Lecturer on General Natural History at the Government School of Mines.[59] While Huxley later focused his research in the human sciences, he was at this point a scientific authority on geological surveying and glacial science was therefore a natural focus point for him. The letter was long and bold, accounting for all the experiments and observations Huxley had undertaken at the Montanvert in 1857. Huxley here primarily took issue with Agassiz' interpretation of glacial water-chambers, and Forbes' description of the veined structure of glaciers. In the spring of 1857, Frances Hooker remarked in a letter to Tyndall, that she believed the debate with Forbes would end 'with the substitution of the name of Forbes for that of Huxley.'[60]

Frances Hooker's letter brings to the fore a central aspect of the debate over glacial motion in the second half of the 1850s: it was not only Tyndall who was looking to expand his scientific authority into glaciology, but Huxley too. Ruth Barton has demonstrated the significance of the X-Club prior to its formation in 1864, calling the emerging group the 'X Network'.[61] Barton shows that the X-Club

---

[57] Thomas Henry Huxley, 'Huxley to Editor of the Westminster Review', July 1857, The Huxley File by Charles Blinderman.

[58] T. H. Huxley F.R.S, 'XXIX. Observations on the Structure of Glacier Ice', *Philosophical Magazine Series 4*, 14.93 (1857), 241–60.

[59] Bernard V. Lightman and Bennett Zon, *Evolution and Victorian Culture* (Cambridge University Press, 2014), p. 245.

[60] Frances Hooker, 'Hooker to Tyndall', nd nm 1857, Royal Institution of Great Britain.

[61] Ruth Barton, 'John Tyndall, Pantheist: A Rereading of the Belfast Address', *Osiris*, 3 (1987), 111–34 (p. 114); Barton, 'Huxley, Lubbock, And Half A Dozen Others', pp. 416–17.

developed out of two groups of friends; the philosopher of science Herbert Spencer (1820-1903), politician, entomologist and archaeologist John Lubbock (1834-1913), and mathematician and physicist William Spottiswoode (1825-1883) joined later. The first consisted of Tyndall, Hirst and Frankland, the second of Huxley, Busk and Hooker. In the 1850s, the focus for many in the X Network was on finding areas of science in which they could claim expertise, and secure paid scientific employment.[62] The North British group was also engaged in shaping the structure and content of scientific practice - particularly in energy physics. Their science was deeply imbued with Presbyterian doctrines, positioned simultaneously against both biblical literalism and evolutionary materialism.[63] Energy physics for the North British group was linked with the Presbyterian belief that God gave energy as a 'gift of grace', which could not be destroyed.[64] Because of their religious position, the North British group was in many ways similar to the Cambridge Anglicans, another group that the scientific naturalists were attempting to delegitimize.[65]

The core group of these North British scientists included James Joule (1818-1889), William Thomson (later Lord Kelvin) (1824-1907), Macquorn Rankine (1820-1872), and James Clerk Maxwell (1831-1879). Forbes was a key ally. Tyndall wanted to appropriate the new theories on conservation of energy into scientific naturalism by removing it from the authority of the North British group. It was central for the North British group, Crosbie Smith argued, to perceive of the universe in terms of 'continuous matter possessed of kinetic energy' that was 'governed by basic laws of matter and energy ordained by God'.[66] As a scientific naturalist, this was an untenable position for Tyndall. Scientific naturalism sought to develop naturalistic conceptions of nature and humans.[67] It included creating a

[62] Barton, 'Huxley, Lubbock, And Half A Dozen Others', p. 421.

[63] Smith, p. 6.

[64] Smith, pp. 21–22.

[65] Bernard Lightman, *Victorian Science in Context* (University of Chicago Press, 1997), p. 3; Lightman, *Victorian Popularizers of Science*, pp. 6–7.

[66] Smith, p. 2.

[67] Barton, 'John Tyndall, Pantheist', p. 114; Lightman and Dawson, pp. 1–2.

separation between religion and science as part of its quest for establishing the independence of science, and securing the professionalization of science through the availability of state resources and funding. [68]

In 1854 Huxley was given employment at the Royal School of Mines and the Geological Survey. As a research field, glaciology was not limited to physicists such as Tyndall and Forbes, but was intimately linked with geology. It was not strange that Huxley wanted to expand his research field in this direction. On the topic of Huxley's letter in the *Philosophical Magazine and Journal of Science*, Tyndall wrote to Hirst that,

> Your feelings regarding that communication of Huxley's are precisely my own. We had agreed that he should write me a letter upon the subject, but when the document came into my hand I was perfectly astonished. ... I think however that it would be far safer if he had more inertia, and chewed the cud of thought more patiently. I confess I should have feared to publish all that he has published on the grounds which his observations furnish.[69]

While Tyndall claimed to be unaware of the nature of Huxley's activities (and even seemed to disapprove of Huxley's premature publication of his observations) in the periodical press prior to their publication, his correspondence shows that he discussed the validity and consequences of Huxley's arguments with several physicists, in particular Hopkins. In addition, Tyndall stressed the issues raised by Huxley in the periodical press in a signed article in the *Athenaeum* published on 10 July 1858.[70] In the article, Tyndall asserted that the term viscosity 'appeared to him to be wholly inapplicable as expressive of the physical constitution of glacier ice.'[71]

---

[68] For more on the X-Club see: Edward Caudill, *Darwinian Myths: The Legends and Misuses of a Theory* (Univ. of Tennessee Press, 2005); Desmond, 'Redefining the X Axis'; Adrian Desmond, *Huxley: From Devil's Disciple to Evolution's High Priest* (Perseus Books, 1997); DeYoung; Lightman, *Victorian Science in Context*; Lightman and Dawson.

[69] John Tyndall, 'Tyndall to Hirst', 14 October 1857, Royal Institution of Great Britain.

[70] John Tyndall, 'Prof. John Tyndall on the Mer-De-Glace', *The Athenaeum*, 1858, 49–51.

[71] Tyndall, 'Prof. John Tyndall on the Mer-De-Glace', p. 51.

In 1850, Faraday had performed experiments with ice as part of a lecture at the Royal Institution. He had put ice under pressure, moulded it and thereby reforming pieces of ice into one solid. Tyndall incorporated this phenomena, 'regelation', into his theory of glacial motion to explain the consolidation of ice under pressure and the motion of glaciers. The suddenness of the formation of crevasses of glaciers and the slowness by which they widen shows that ice is not viscos. The analogy between a river and a glacier falls short, Tyndall argued, as a river can 'sweep round its curves without rupture of continuity.'[72] Forbes had mixed together 'two classes of facts [that] present themselves to the glacier investigator' that of pressure and tension.[73] Tyndall asserted that only the former, pressure, is in harmony with the idea of viscosity, while the other, tension, is opposed to it and that this was evident in the formation of crevasses.

The *Athenaeum* was an influential journal and carried extensive reports from scientific meetings such as that of the British Association for the Advancement of Science.[74] It was also a journal that Huxley and others of the scientific naturalists wrote for frequently.[75] While Forbes did not respond directly to any of Tyndall's, Huxley's or others' criticisms in the periodical press, he was not blind to the potential power that the periodical press could hold in forming opinions. When the *Athenaeum* published a very negative review of Forbes' *Occasional Papers* in 1859, Forbes wrote to Wills that reading it made him feel 'how lowly at a disadvantage I am placed with relative to the Scientific World of London.'[76] Although Wills considered the criticisms in the review worthless, what mattered to Forbes was 'how much it will pass with a large number of sensible people who are habitually swayed by such authority.'[77] In July 1860 Forbes wrote to Wills that he realized the *Athenaeum* would be the best organ for reaching the broadest group of glacial

[72] Tyndall, 'Prof. John Tyndall on the Mer-De-Glace', p. 51.

[73] Tyndall, 'Prof. John Tyndall on the Mer-De-Glace', p. 51.

[74] Brake and Demoor, p. 26.

[75] Caudill, p. 442.

[76] James David Forbes, 'Forbes to Wills', 12 April 1859, The Alpine Club Library.

[77] James David Forbes, 'Forbes to Wills', 14 April 1859, The Alpine Club Library.

researchers and mountaineers, and that he would like to publish a letter addressing what was now the biggest issue for Forbes, the allegations that he had stolen his theory from Louis Rendu, 'But would the Editor insert it? I doubt.'[78] Forbes clearly felt at a disadvantage, both geographically and socially, to Tyndall and his influence with the periodical press. This feeling further solidified when Tyndall and Huxley began accusing Forbes of intellectual dishonesty.

4. Rendu and the charge of plagiarism

In a letter to his friend Clausius from December 1859, Tyndall asked if Clausius knew anything about the timeline for Agassiz and Forbes' separate experiments on the speed by which the Aar glacier moved, and the publication of these, and if he was aware of other writers aside from Agassiz and Forbes who had asserted that the sides of glaciers move more quickly than the centre.[79] Tyndall was of the opinion that Forbes had falsely claimed Agassiz' observations and experiments relating to the physics of glaciers as his own, and noted to Clausius that he would address this issue in his future book, *Glaciers of the Alps*:

> I am anxious to put Agassiz's labours on the glaciers in a fair light before the English public as I think he has been neither justly nor generously treated. … I tell you frankly my impression that judged of by the laws tacitly adopted by scientific men, the proceeding of Forbes in this matter was not generous; and Agassiz has suffered from it in England up to the present time. I am anxious to do him justice in my little book[80]

Why was Tyndall so intent on proving that Forbes had behaved in a less than honest matter with regards to Agassiz? A letter from Hopkins to Tyndall suggests that the answer lay with Louis Rendu. Tyndall and Hopkins had extensive communications on the glacial issue, and Hopkins made no attempt at hiding his contempt for Forbes. Forbes' treatment of Rendu, Hopkins pointed out, was with 'the same want

[78] James David Forbes, 'Forbes to Wills', 15 July 1860, The Alpine Club Library.

[79] John Tyndall, 'Tyndall to Clausius', 7 December 1859, Royal Institution of Great Britain.

[80] Tyndall, 'Tyndall to Clausius'.

of candour which he showed towards Agassiz.'[81] By showing that Forbes had a history of plagiarism, Tyndall could simultaneously make his accusation that Forbes had stolen his viscous theory from Rendu more plausible, and portray himself by contrast as an honest and trustworthy authority on glacial research. This was a powerful strategy.

During the summer of 1859, Tyndall was at work trying to procure a copy of Rendu's essay upon glaciers.[82] Through a friend, Clausius obtained 'The only copy that I could find in Zurich'[83] for Tyndall in June.[84] On 2 November, Forbes wrote a distressed letter to Wills.[85] Robert Murchison and William Whewell had both sent letters informing Forbes that he was being formally accused of 'a barefaced plagiarism … by the friends of Dr Tyndall last Thursday … in a series of charges in writing'.[86] The decision about the Copley Medal was to take place the following day, on 3 November. In an attempt to counter the accusation of plagiarism, Forbes sent to all the members of the council of the Royal Society a copy of an 1844 review of his *Travels in the Alps of Savoy* written by Scottish physicists and mathematicians David Brewster (1781-1868), wherein Brewster had noted 'in a prophetic spirit the very use which "spiteful critics" would one day make' of Rendu's work.[87] Forbes also forwarded his copy of Rendu's paper to Whewell.

Two days later, Forbes expressed his concerns that the decision of the Council of the Royal Society would not be in his favour 'I have not yet learned the decision of the R.S. Council yesterday', Forbes wrote, 'but I do not expect it to be favorable.'[88] Forbes worried that Tyndall was 'too deeply rooted' in the London scientific scene for him to receive a fair hearing. But he was heartened that 'Huxley

---

[81] William Hopkins, 'Hopkins to Tyndall', 29 May 1860, Royal Institution of Great Britain.

[82] John Tyndall, 'Tyndall to Clausius', 1 June 1859, Royal Institution of Great Britain.

[83] Original German: Das einzige Exemplar in Zürich von dem ich erfahren konnte

[84] Rudolf Clausius, 'Clausius to Tyndall', 9 June 1859, Royal Institution of Great Britain.

[85] James David Forbes, 'Forbes to Wills', 2 November 1859, The Alpine Club Library.

[86] Forbes, 'Forbes to Wills'.

[87] Forbes, 'Forbes to Wills'.

[88] James David Forbes, 'Forbes to Wills', 4 November 1859, The Alpine Club Library.

would be made to retract some of his insinuations.'[89] As with Huxley's papers in the *Philosophical Magazine and Journal of Science* and *Westminster Review*, Tyndall claimed to have been unaware that Huxley's letter to Frankland was intended to be read at the Council of the Royal Society accusing Forbes of plagiarism.[90] Yet, two central circumstances cast serious doubt on the validity of this claim. First, in a private letter to Tyndall, Huxley informed Tyndall that Brewster's 1844 review of Forbes' *Travels* was currently being circulated among the members of the Council of the Royal Society. The letter is undated, but Forbes' letter to Wills shows that the circulation of Brewster's review took place at some point during the week leading up to the decision of the Copley Medal, after Huxley had submitted his letter to Frankland.

Huxley's letter to Tyndall included no explanation or details for the context of his disapproving analysis of Brewster's review, which suggests that Tyndall was fully aware of the significance and reasons for the circulation of the review.[91] In another undated letter to Tyndall, Huxley included the passage from Brewster's review that was being circulated. On the back of the note, Huxley wrote that 'Sir D. Brewster has obviously never read Rendu's book - but decides the question on the strength of Forbes's ex parte statements'.[92] The implication was, that in contrast with Brewster, Huxley had read Rendu's work. Rendu's pamphlet was notoriously difficult to obtain but Tyndall had borrowed a copy via Clausius in June 1859, several months prior to the Copley medal affair. This casts serious doubt on Tyndall's innocence, and suggests that he together with Huxley and Frankland had carried out a carefully constructed attack against Forbes. Because Forbes was not situated in London, he was dependent upon the post to bring him news about the scientific scene, including the allegations against him. When he received the letters from Whewell and Murchison, he had little time to write out a defence of himself

[89] Forbes, 'Forbes to Wills'.

[90] John Tyndall, 'Tyndall to Frankland', 13 May 1872, Thomas Henry Huxley Collection, Imperial College London.

[91] Thomas Henry Huxley, 'Huxley to Tyndall', nd nm ny 1, Royal Institution of Great Britain.

[92] Thomas Henry Huxley, 'Huxley to Tyndall', nd nm ny 2, Royal Institution of Great Britain.

and have a copy of Rendu's pamphlet sent to London before the decision on awarding the medal was made. The Copley medal would have cemented Forbes' authority in the field of glacial research, and by this manoeuvre Huxley, Frankland and Tyndall had successfully cast doubt on Forbes' scientific credibility.

While Tyndall claimed to not have had a hand in Huxley's letter to Frankland, he repeated the accusation of plagiarism in his 1860 publication *Glaciers of the Alps*. The book was published by the London publisher John Murray and printed by William Clowes and Sons, (Stamford Street and Charing Cross). Tyndall's choice of publisher was no coincidence. In an undated letter, John Murray wrote to Tyndall's good friend Hooker that he would be happy to publish Tyndall's lectures.[93] In 1858, Huxley sent Tyndall a similar letter, encouraging Tyndall to have Murray publish his lectures.[94] Murray was also Darwin's publisher. Murray was accordingly a friend of friends, and had a reputation for producing fine scientific publications. *Glaciers* was printed in 8vo format, was 444 pages long in addition to the preface, index and a 32-page supplement of the publisher's general list of works found in the back of the book. It cost 14s, and contained 67 illustrations. In his introduction, Tyndall wrote that he did not wish to mix narrative and science, as this would obstruct the reading experience and he had therefore divided *Glaciers* into one 'chiefly narrative' and one 'chiefly scientific' part.[95] Part one illustrated Tyndall's experiences mountaineering, beginning with Tyndall and Huxley's 1856 voyage to the Alps. Part two contained a brief explanation of the properties of light and heat, followed by detailed descriptions of water, ice and glaciers. Tyndall explicitly put forth his arguments against Forbes's interpretation of glacial motion in the chapter 'Cause of Glacier-Motion' in part two of *Glaciers*, and used his descriptions of mountaineering throughout the book to substantiate the chapter. In his introduction, Tyndall wrote that the lively discussions of glaciers, which had taken place prior to the publication of his book, had induced him to become acquainted with the 'historic aspect of the

[93] Joseph Hooker, 'Hooker to Tyndall', nd nm ny 2, Royal Institution of Great Britain.

[94] Thomas Henry Huxley, 'Huxley to Tyndall', nd nm 1858, John Tyndall Correspondence Project.

[95] Tyndall, *The Glaciers of the Alps*, p. i.

question' in order to form a 'just estimate of men whose labours in this field were long anterior to my own.'[96] Both part one and two included such historic considerations that Forbes featured in. Forbes responded to Tyndall's criticisms with focus on the priority question in August that same year with his *Reply to Professor Tyndall's Remarks, In His Work "On the Glaciers of the Alps," relating to Rendu's "Théorie Des Glaciers".* During the summer of 1860, Forbes debated with Wills, whether he should publish his *Reply* or keep it for private circulation. They also discussed which matters in Tyndall's book were of most significance.

The publisher of Forbes' *Reply* was Adam and Charles Black, Edinburgh, who had also published his *Occasional Papers* the previous year. It was a short pamphlet, counting 28 pages plus an advertisement for *Occasional Papers*, and contained no illustrations. With a price of only 1s, it was both significantly shorter and cheaper than *Glaciers*. It was later reprinted in the *Life and Letters of James David Forbes* (1873), wherein the Scottish physicists and mathematician Peter Guthrie Tait (1831-1901) lamented the fact the pamphlet had not achieved a very large circulation.[97] Forbes countered Tyndall's accusations of plagiarism in three ways. Firstly, Forbes argued that Tyndall was not correct in arguing that he was the first to fully proclaim the merits of Rendu's work.[98] In doing so, Forbes gave an account of how after having sought in vain for Rendu's book in Switzerland and in Turin, he had contacted Rendu directly and requested a copy. Rendu had accommodated this request, in a 'polite and friendly answer'.[99] In addition, Forbes included extracts from *Travels in the Alps* to show that he had in fact referenced Rendu on several occasions. Secondly, Forbes reviewed the reception of Rendu's work both in England and abroad and argued that he was the only one who had taken Rendu's

---

[96] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. i.

[97] Shairp, Tait, and Adams-Reilly, p. 11.

[98] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 6.

[99] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 11.

work seriously. Forbes thus asserted, that he had not omitted references to important aspects of Rendu's work in *Travels in the Alps* or elsewhere. Furthermore, he stated that Tyndall had behaved ungentlemanly in stating claims to the contrary. This accusation was later repeated in his *Life and Letters*. Thirdly, Forbes addressed Tyndall's claim that he had purposefully 'omitted matter of *much greater importance*' than what was included in *Travels in the Alps.*[100] Tyndall, Forbes argued, had not only accused him of suppressing his knowledge of the work of Rendu, but had attempted to substantiate this claim by cherry-picking quotations from Rendu and ignoring those parts of Rendu's writing which had later been shown to not be correct. Similarly, it was later noted in *The Life and Letters of James David Forbe*s (1874) that, 'we cannot too strongly insist upon this point, for he has actually been charged with depreciating or suppressing the claims of others. Such charges could not have been made by writers who had taken the trouble to read carefully what they criticized.'[101] Forbes addressed this, by comparing passages of Rendu's work to quotations of Rendu's work in Tyndall's *Glaciers*. Forbes further contrasted the excerpts with passages from Rendu included in his previous work. He argued that he had referenced Rendu as 'the only writer of the Glacier school who had insisted upon the plasticity of ice'.[102] However, he also emphasized that Rendu had neither presented, nor founded his 'speculations as leading to any certain result, not being founded on experiments worthy of confidence.'[103] Tyndall's paraphrasing of Rendu in *Glacier*, Forbes claimed, was selective, and exposed Tyndall's dishonesty.

---

[100] Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 6.

[101] Shairp, Tait, and Adams-Reilly, p. 492.

[102] Forbes, *Travels Through the Alps of Savoy Ant Other Parts of the Pennine Chain with Observations on the Phenomena of Glaciers. - Edinburgh, Black 1843*, p. 382; Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 17.

[103] Forbes, *Travels Through the Alps of Savoy Ant Other Parts of the Pennine Chain with Observations on the Phenomena of Glaciers. - Edinburgh, Black 1843*, p. 382; Forbes, *Reply to Professor Tyndall's Remarks, in His Work 'On the Glaciers of the Alps', Relating to Rendu's 'Théorie Des Glaciers'*, p. 17.

The role of experiments and observation was an important way for Forbes to establish his scientific priority. As Bruce Hevly has shown, both Tyndall and Forbes made use of the image of the heroic mountaineer as part of forming their scientific arguments.[104] In *Glaciers*, Tyndall emphasized that knowledge about glaciers is made through direct observation and extended this emphasis on experiment and knowledge of glaciers to Rendu. Tyndall wrote that Rendu had made important quantitative observations of great accuracy, which proved his scientific abilities:

> Throughout his essay a constant effort after quantitative accuracy reveals itself. He collects observations makes experiments, and tries to obtain numerical results; always taking care, however so to state his premises and qualify his conclusions that nobody shall be led to ascribe to his numbers a greater accuracy than they merit. It is impossible to read his work, and not feel that he was a man of essentially truthful mind, and that science missed an ornament when he was appropriated by the church.[105]

Just as Tyndall presented himself as a skilled observer of glaciers through his mountaineering experience, Forbes also emphasised his own qualifications compared to those of unskilled individuals to assert both the validity of his viscous theory, and his claims to priority in advancing the theory. Tyndall and Forbes both had measurements and data gathered in the Alps through direct experience and went to great lengths to account in detail how these were made. In contrast to Tyndall's account of Rendu, Forbes claimed that Rendu had only recorded one measurement by himself and primarily relied upon the estimates of local travel guides.[106] Forbes questioned whether Tyndall could expect him or anyone else to trust the accuracy of measurements performed by unskilled locals. In this way, Forbes also drew upon the persona of a skilled direct observer of glaciers to reject Tyndall's assertion that he was merely replicating Rendu's work.

---

[104] Hevly, p. 68.

[105] Tyndall, *The Glaciers of the Alps*, p. 299.

[106] Hevly, p. 18.

Frank Cunningham has argued that it was because of Forbes' "intention of leaving the choice between Tyndall's and his own scientific proposals for others to judge" that Forbes dealt primarily with the priority issue in *Reply*.[107] However, Forbes had already addressed several of Tyndall's scientific criticisms in the talk at the Royal Society of Edinburgh.[108] This summary shows that Forbes sought to sidestep Tyndall's and Huxley's arguments. Forbes was convinced that Tyndall's interpretation of glacial phenomena only differed from his own in minute ways. His friend David Brewster agreed. Prior to the publication of his positive review of Forbes' *Occasional Papers* for the *North British*, Brewster had contacted Tyndall for clarification on his views. In this letter, Brewster noted that, 'I observe that Prof. Forbes regards your researches as confirming his theory.'[109] By July 1859, Forbes was growing confident in the support to his theory, and wrote to Wills that 'from what I hear, there must be a considerable reaction in my favour in London. I am curious to know whether the "Edinburgh" is to turn out. Sir David Brewster writes on my side in the 'North British"'.[110] Forbes also requested that Wills review his book, and Wills obliged. Forbes read the review prior to its publication.[111]

It was not the case that Forbes failed to respond to Tyndall's – and Huxley's – scientific criticisms, but he did so in talks, in communications to the more elite and specialized magazines, and through his friends, not directly in the general periodical press. This was a major difference in Tyndall and Forbes' strategies for gaining authority. Forbes was not unwilling to engage in a scientific debate with Tyndall, but he followed the methods of figures such as Brewster in not considering it advantageous to publish short defences of his argument in the periodical press. Taken together, as Tyndall's scientific criticisms in *Glaciers* were very similar to those he and Huxley had levelled against Forbes in the periodical press the last

[107] Cunningham, p. 267.

[108] Published as Forbes, 'PROF. FORBES ON SOME PROPERTIES OF ICE NEAR ITS MELTING POINT'; Forbes, 'Prof. Forbes on Some Properties of Ice near Its Melting Point'.

[109] David Brewster, 'Brewster to Tyndall', 1 June 1859, Royal Institution of Great Britain.

[110] James David Forbes, 'Forbes to Wills', 9 July 1859, The Alpine Club Library.

[111] James David Forbes, 'Forbes to Wills', 14 April 1859, The Alpine Club Library.

three years, it suggests that this was the reason why Forbes thought the priority issue was his primary concern. When Tyndall attacked Forbes' personal character with a vengeance in *Glaciers* (1860) Forbes did not respond to these accusations in the periodical press, but in a pamphlet format with a limited circulation. Tyndall understood how to use the press for a means to an end in conjunction with the more established venues such as specialized or elite scientific journals and networks, while it appears that Forbes was resistant to let go of the older methods for establishing scientific and cultural authority modelled by figures such as Brewster, and he did not readily manipulate the content of the periodical press to disseminate his vision of glacial science.[112]

5. The after-math

The glacier controversy extended far beyond a scientific debate between Tyndall and Forbes, and came to include a large network of people. Prior to its formation, several of the X-Club members were either campaigning against Forbes in the periodical press, or assisting behind the scenes, including Tyndall, Huxley, Hooker, Hirst and Frankland. Tyndall and Huxley made active use of the periodical press not only to further their interpretation of glacial movement, but also to question Forbes' scientific authority. It would come to have a significant impact on the careers of several of these men, especially as it became tied up with the debates over the science of energy. The question of whether or not glaciers moved like a viscous fluid came to mean much more than a simple description of glacial behaviour.

The conflict between Tyndall and the North British group is significant for understanding the lines of support for Forbes and Tyndall in the controversy over glacial motion, especially as it reveals Tyndall's ambitions for achieving authority for his version of glacial science. It is an example of the emerging X-Club banding together behind Tyndall as they later did behind Darwin and other allies. As part of the scheme for separating energy physics from the religious associations and

[112] Shairp, Tait, and Adams-Reilly, p. 11.

authority of the North British group, Tyndall delivered a Friday Evening Discourse 'On Force' in June 1862 wherein he attributed priority of key aspects of the principle of conservation of energy to Robert Mayer, and not to Joule.[113] While North British Physicists such as Thomson and Tait did not publicly participate in the controversy between Forbes, Tyndall, and Huxley, when it unfolded, it was brought up in the conflicts between them and the scientific naturalists throughout the 1860s.[114] From the perspective of the North British group, Tyndall's dismissal of Joule's priority was yet another attack on their scientific authority, carried out in a very similar way to the debacle with Forbes. The glacier controversy had wider implications. The difference in how Tyndall and Forbes used the periodical press reveal that changes in scientific authority and in print culture were interconnected.

When viewed as a part of the identity formation and professionalization strategies of members of the 'X Network', it becomes clearer why the glacial controversy was so significant for Tyndall and Huxley in the second half of the 1850s. While Huxley shifted his attention to biological evolution, Tyndall remained as a physicist embedded in research relating to the physical properties of ice. The controversy with Forbes remained present in Tyndall's career long after Forbes passed away in 1868. Forbes was already an established scientific authority when Tyndall and Huxley initiated their campaign against the viscous theory. Yet, this did not keep Forbes from being obsessed with retaining his authority on glacial research. He enrolled his friends to assist him in defending the quality and originality of his research. But Huxley and Tyndall made use of a new key tool to carve out their authority: the periodical press.

The difference between the viscous theory and that of fracture and regelation may have been a matter of semantics, but the difference between Forbes and Tyndall in how they approached the periodical press was very real. Tyndall and the scientific naturalists knew how to take advantage of the periodical press. The combination of drawing on their influence in the elite scientific networks such as

[113] Smith, p. 180; Rowlinson, pp. 197–98.

[114] Reidy, *The Age of Scientific Naturalism*, pp. 173–74; Rowlinson; Brown, p. 105.

the Royal Society, allegations of intellectual dishonesty, and writing on the issue for the periodical press was hugely successful. It was a strategy that was later repeated over and over again. It is suggestive that it was their success with this controversy in the late 1850s and early 1860s that led members of the X-Club to continue to use similar strategies. It was in the pages of the general periodical press that the issues of authority were played out. In the hands of Tyndall and his friends, the periodical press became an unexpected weapon against Forbes.

Figure Captions

Figure 1: Glaciers of the Alps, Figure 22, pg 313. A stylized representation of Glacier de Bois, showing the inclination of the cascade (A-B), and of the glacier above it (B-C). Tyndall argued that a truly viscous substance such as a tar could flow over point B in this illustration, of whereas a glacier cannot do so without fracturing.

Figure 2: Glaciers of the Alps, Figure 23, pg 314. A stylized representation of Mer de Glace, illustrating the inclination of the cascade (A-B) and of the glacier above it (B-C). While the brow (B) is less steep than the brow for the Glacier de Bois, there are also fractures and crevases at this point which, according to Tyndall, proves that glaciers are not viscous.

Figure 3 Illustration of viscosity, *Athenaeum* 21 August 1858 pg 238. 'PQ' indicates the temperature of the water above 32 degrees Fahrenheit (0 degrees Celsius), and 'LM' indicates the permanent and lower temperature in the interior of the ice. 'MNOP' corresponds to the space of partly water, partly ice, in the glacier where the temperature varies between 'LM' and 'PQ'.