The British Journal for the History of Science (2021), **54**, 403–422
doi:10.1017/S0007087421000534

RESEARCH ARTICLE

'A method for safe transmission': the microscope slides of the American Postal Microscopical Club†

Lea Beiermann*

Department of History, Faculty of Arts and Social Sciences, Maastricht University
*Corresponding author: Lea Beiermann, Email: l.beiermann@maastrichtuniversity.nl

Abstract

In the 1870s, microscopy societies began to proliferate in the United States. Most of these societies attracted microscopists from surrounding cities, but the American Postal Microscopical Club, modelled on the British Postal Microscopical Society, used the postal system to connect microscopists scattered across the country. Club members exchanged microscope slides and notes following a chain-letter system. The main objective of the club was to teach its members how to make permanent slides. Preparation and mounting methods required technical skill, which was, as even club members had to admit, difficult to learn without personal instruction. Yet members developed ways to share craft knowledge through the post. Drawing on the private notes of a member and published reports on the slides circulated, this paper challenges the widespread assumption that the generation of craft knowledge depended on the co-location of artisans. It argues that microscopists' knowledge of preparation methods was intertwined with their skill in building and navigating information infrastructures, and that by tracing these infrastructures we gain a better understanding of how craft knowledge travelled in the late nineteenth century.

When Romyn Hitchcock, editor of the *American Monthly Microscopical Journal*, opened a box of microscope slides he had received through the post in 1883, he was 'pleased to find the slide of *Spirogyra* which [he] contributed long ago'.[1] Hitchcock was a member of the American Postal Microscopical Club, which facilitated the exchange of slides among its members. Club members circulated slide boxes, as well as explanatory notes and illustrations, following a chain-letter principle. Every member received microscope preparations and notes and was expected to pass them on to other members in his or her postal circuit in due time. Hitchcock's *Spirogyra*, a freshwater green alga, had been passed on among microscopists for around two years before it finally circled back to him, 'after a varied experience in mail-bags and in different climes'.[2]

When the club was formed in 1875, there were already some twenty microscopy societies in existence in the United States, most of which had been established along the

† This essay was jointly awarded the Singer Prize for 2020 by the British Society for the History of Science.
[1] Romyn Hitchcock, 'Editorial', *American Monthly Microscopical Journal* (1883) 4(4), pp. 75–6, 76.
[2] Hitchcock, op. cit. (1), p. 76.

Northeast Coast and in the Great Lakes region in the early 1870s.[3] Although several societies lasted only a couple of years, by 1893 their overall number had risen to fifty-four.[4] Society members were usually based in the same city or its close surroundings and met regularly. The American Postal Microscopical Club, however, drew members from all over the country. It consisted of only around 140 members during most of its history, but it was not the only postal club of its kind. It was explicitly modelled on the British Postal Microscopical Society, founded in 1873, which facilitated the exchange of microscope slides on the other side of the Atlantic.[5] In the German lands, at least two large postal exchanges of slides had been organized by the microscopy society of Giessen in the 1850s.[6] Nineteenth-century postal clubs were not confined to microscopy either – several postal photography societies were established in the United States and Britain in the 1880s and 1890s.[7]

The declared mission of the American Postal Microscopical Club was to educate microscopists on how to make microscope preparations. Scientifically noteworthy specimens were much valued, but members of the club were equally interested in making permanent slides. Hitchcock's *Spirogyra* was not a very remarkable plant, being commonly used in schools to illustrate the process of conjugation between algae, but club members who received his slide were curious to know how Hitchcock had stained his alga with carmine.[8] The editor readily explained the method in his journal, giving detailed instructions and pointing out possible pitfalls.[9] When Hitchcock received his slide back in 1883, 'just as perfect as when it left [his] hands', he saw it as proven that his slide was durable.[10]

Preparing and mounting microscope specimens required technical skill, a kind of craft knowledge that was difficult to learn through written instructions. Illustrating the benefit of practice for mounting specimens, Hitchcock's journal cited the English slide maker Edward Ward in 1883: '[We] have, early in our work, learned that there is a difference, and a vast one, between knowing that an object is mounted in Canada Balsam and being ourselves able to mount in this medium'.[11] Ward emphasized the importance of collaboration, recalling how several English gentlemen had met to practise mounting together, with their 'fingers being Canada Balsamed up to the knuckles'.[12] In a similar vein, the president of the British Postal Microscopical Society, J.W. Measures, declared

[3] John Harley Warner, '"Exploring the inner labyrinths of creation": popular microscopy in nineteenth-century America', *Journal of the History of Medicine and Allied Sciences* (1982) 37(1), pp. 7–33.

[4] John Phin, 'Microscopical societies in the United States and Canada', *American Journal of Microscopy and Popular Science* (1876) 1(6), pp. 72–3; Charles W. Smiley, 'List of microscopical societies', *The Microscope* (1893) 1(8), pp. 119–22.

[5] Frederic Ward Putnam and Alpheus Spring Packard, 'Microscopy', *American Naturalist* (1875) 9(4), pp. 249–51, 249.

[6] 'Tauschverkehr mit mikroskopischen Präparaten', *Archiv für pathologische Anatomie und Physiologie und für klinische Medicin* (1858) 14(5–6), pp. 556–7.

[7] For the American Postal Photographic Club see C.W. Canfield, 'A postal photographic club', *Anthony's Photographic Bulletin* (1885) 16(4), p. 105. An English postal photography club for boys is mentioned in Jochen Petzold, 'Victorian gendered photography in the *Boy's Own Paper* and the *Girl's Own Paper*', *Victorian Periodicals Review* (2019) 52(1), pp. 57–79, 63. Another postal club for exchanging animal photographs was founded in Selborne, England; see 'Selborniana', *Nature Notes: The Selborne Society's Magazine* (1899) 10(114), p. 104.

[8] For an example of *Spirogyra* being used in education see Asa Gray, *Gray's School and Field Book of Botany*, New York: American Book Company, 1887.

[9] Romyn Hitchcock, 'Notes', *American Monthly Microscopical Journal* (1881) 2(8), pp. 158–9, 158.

[10] Hitchcock, op. cit. (1), p. 76.

[11] 'Mounts and mounting', *American Monthly Microscopical Journal* (1883) 4(8), pp. 149–56, 149.

[12] 'Mounts and mounting', op. cit. (11), p. 150. Stephen Jacyna has shown that Edinburgh histologists sought to cultivate an intimate relationship between instructors and students to teach microscopy. L. Stephen Jacyna, '"A host of experienced microscopists": the establishment of histology in nineteenth-century Edinburgh', *Bulletin of the History of Medicine* (2001) 75(2), pp. 225–53.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

in 1887 that 'the beginner is unable to learn from the books on the microscope all the minutiae of so fine an art as mounting'.[13] However, members of postal clubs and societies could not meet in person. How, then, did the American Postal Microscopical Club still make it possible for members to learn preparation methods?

The following sections will answer this question by drawing on both archival and published materials. Many of the notes and illustrations accompanying the club's circulating slides between 1875 and 1887 were copied by a club member, Eugene A. Rau, amounting to approximately three hundred notebook pages.[14] There seems to be no trace of the club's original collection of slides, but between 1884 and 1891 the club added commercial slides to its boxes, made by the English slide manufacturer Arthur C. Cole. Cole's slides are commonly found in public and private slide collections today, and some of his slides, owned and digitized by a private collector, inform my analysis of the preparations exchanged among members of the club.[15] Moreover, this paper draws on microscopy journals issued between 1875 and 1900, which published extracts of the notes circulated, as well as annual reports. Besides serving as a source on the activities of the club, these journals shed light on how the regular publication of notes complemented the chain-letter system.

There is a growing literature on the circulation of scientific objects in the nineteenth century, but historians of nineteenth-century science have paid much less attention to the spread of skill or craft knowledge along with these objects.[16] Historians of early modern knowledge, however, have studied the production of craft knowledge in some depth. Pamela Smith, considering 'alternative taxonomies of knowledge-making', provides a comprehensive definition of craft knowledge as collaborative, empirical, particularistic – adaptable to the particularities of local materials and environments – and open to public scrutiny.[17] Moreover, Smith has identified the collaborative workshop as a prime site of making craft knowledge in the early modern period. This is in line with a general tendency among historians to consider the generation of craft knowledge as depending on formal or informal encounters among artisans.[18] While this paper builds on Smith's

[13] Henry Leslie Osborn, 'Editorial: postal microscopical clubs', *American Monthly Microscopical Journal* (1887) 8(2), pp. 33–4, 33.

[14] Eugene A. Rau's Floral Diary, also a list of slides & remarks upon objects sent through the Micro-Cabinet Club, 1875–1887, Collection 67, Papers of the American Postal Microscopical Club, Archives of the Academy of Natural Sciences, Philadelphia, PA, USA. Subsequently Rau (1875–87).

[15] Steve Gill kindly provided me with images of his collection of Cole's slides.

[16] James Secord's widely cited 2004 article 'Knowledge in transit', considering science as emerging through communication, translation and other forms of movement, spurred the turn towards the circulation of historical scientific knowledge. Some notable recent publications on the circulation of scientific objects in the long nineteenth century are Stefanie Gänger, *Relics of the Past: The Collecting and Study of Pre-Columbian Antiquities in Peru and Chile, 1837–1911*, Oxford: Oxford University Press, 2014; James Poskett, *Materials of the Mind: Phrenology, Race, and the Global History of Science, 1815–1920*, Chicago: The University of Chicago Press, 2019; Alison D. Morrison-Low, Sara J. Sechner and Paolo Brenni, *How Scientific Instruments Have Changed Hands*, Leiden: Brill, 2016. For more theoretical studies of the concept of circulation see Stefanie Gänger, 'Circulation: reflections on circularity, entity, and liquidity in the language of global history', *Journal of Global History* (2017) 12(3), pp. 303–18; Kapil Raj, 'Beyond postcolonialism … and postpositivism: circulation and the global history of science', *Isis* (2013) 104(2), pp. 337–47.

[17] Pamela H. Smith, 'In a sixteenth-century goldsmith's workshop', in Lissa L. Roberts, Simon Schaffer and Peter Dear (eds.), *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, Amsterdam: Edita KNAW, 2007, pp. 33–58, 35.

[18] Smith, op. cit. (17). While historians of early modern knowledge have extended their view beyond universities and academies by looking at workshops, households or marketplaces, they tend to argue that knowledge generation depended on in-person encounters. See, for example, Alix Cooper, 'Homes and households,' in Katharine Park and Lorraine Daston (eds.), *The Cambridge History of Science*, vol. 3, *Early Modern Science*, Cambridge: Cambridge University Press, 2006, pp. 224–37; Anna Simmons, 'Trade, knowledge and networks: the activities of the society of apothecaries and its members in London, *c.*1670–*c.*1800', *BJHS* (2019) 52(2), pp. 273–96. Notable exceptions are recent studies of craft in early modern print culture. See Sven Dupré,

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

characteristics of craft knowledge, it reconsiders her definition in the context of nineteenth-century science, when postal reforms in the United States and Europe, as well as a surge in popular-science periodicals, opened new opportunities for microscope slide makers to work together remotely.[19]

Since members of the American Postal Microscopical Club were not able to transmit knowledge through 'the imitation of bodily gestures' in a workshop setting, the club crafted its own infrastructures, a virtual workshop of sorts, to allow for preparation methods to be shared among its members.[20] These infrastructures consisted of slides, notes, mounting tools, popular-science journals, tradespeople, their trade papers and catalogues, and, importantly, the postal system, as club members effected a change of the American postal law to facilitate the exchange of slides.[21] Thus, when we look at the spread of preparation methods in the late nineteenth century, people and objects come to the fore that are under-researched in the history of science, but are crucial if we want to understand what it took for craft knowledge to travel.

Usually, as Susan Leigh Star and Geoffrey Bowker have observed, infrastructures, such as the chain-letter network of the American Postal Microscopical Club, are 'arrangements that, by design and by habit, tend to fade into the woodwork'.[22] Despite their important role in facilitating and shaping knowledge exchange, infrastructures remain in the background and are only rarely recognized by those familiar with them, at least as long as they function smoothly. The club's chain-letter network, however, was a fragile infrastructure, often disrupted by the breakage of slides or members forgetting to forward them. It is in these moments of disruption or breakdown that infrastructures become visible. In the words of Star and Bowker, disruptions can cause an 'infrastructural inversion', a laying bare of infrastructures, making them visible not only to the historical actors but also to the historian.[23] Since the chain-letter exchange remained fragile, its vulnerability was frequently addressed and well documented by club members, making it possible for us to research the club's knowledge infrastructures.

This paper argues that infrastructural inversion can help us understand how microscopists exchanged craft knowledge at a distance. In trying to circulate a diverse range of artefacts – slides, letters, notebooks, catalogues and periodicals – across long distances,

'Doing it wrong: the translation of artisanal knowledge and the codification of error', in Matteo Valleriani (ed.), *The Structures of Practical Knowledge*, Cham: Springer International Publishing, 2017, pp. 167–88; Heidi Hausse, 'The locksmith, the surgeon, and the mechanical hand: communicating technical knowledge in early modern Europe', *Technology and Culture* (2019) 60(1), pp. 34–64.

[19] Nineteenth-century postal reforms are discussed in Jean-François Fava-Verde, 'Victorian telegrams: the early development of the telegraphic despatch and its interplay with the letter post', *Notes and Records: The Royal Society Journal of the History of Science* (2018) 72(3), pp. 275–92; Richard R. John, *Spreading the News: The American Postal System from Franklin to Morse*, Cambridge, MA: Harvard University Press, 1998; Cornelius Neutsch, 'Standardisierungen im Postverkehr zwischen 1815 und 1914', in Gerold Ambrosius, Christian Henrich-Franke, Cornelius Neutsch and Guido Thiemeyer (eds.), *Standardisierung und Integration europäischer Verkehrsinfrastruktur in historischer Perspektive*, Baden-Baden: Nomos Verlagsgesellschaft mbH & Co. KG, 2009, pp. 59–80. For studies of the surge in popular-science periodicals in Great Britain and the United States see Bernard Lightman, 'Popularizers, participation and the transformations of nineteenth-century publishing: from the 1860s to the 1880s', *Notes and Records: The Royal Society Journal of the History of Science* (2016) 70(4), pp. 343–59; Warner, op. cit. (3), p. 17.

[20] Smith, op. cit. (17), p. 41.

[21] This paper thus also contributes to research at the intersection of the history of science and communications, much like Laura Newman's recent '"Death germs through the post": postal pathology and workplace experiences of disease in Britain, *c.*1895–1935', *Social History of Medicine* (2020) 33(4), pp. 1211–32.

[22] Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences*, Cambridge, MA: MIT Press, 1999, p. 34.

[23] Bowker and Star, op. cit. (22).

members of the American Postal Microscopical Club had to make sure that both their skills and their infrastructures were perfectly attuned to the task. A microscopist's skill in making slide preparations was inextricably entwined with their skill in navigating knowledge infrastructures, which materialized, for example, in the development of weather-resistant mounts of specimens and a reduction in the type of preparations that might break or spill during their travels. Consequently, infrastructural inversion, tracing the infrastructures built and used by craftspeople, allows us to examine not only the infrastructures themselves but also the craft knowledge they accommodated.

The remainder of this paper is loosely organized around Pamela Smith's characteristics of craft knowledge. The following two sections explore how nineteenth-century infrastructures allowed for collaborative, particularistic and empirical skills to travel, with the first section tracing the emergence of a postal exchange system – a precondition for the club's collaborative work – and the second zooming in on the production of slides. The final section looks at how microscopists' craft came under public scrutiny, not in a public exhibition of crafted artefacts, as Smith has shown for the early modern period, but in the virtual forum of popular-microscopy periodicals. The paper concludes by reconsidering Smith's characterization of craft knowledge in the context of nineteenth-century microscopy, and by summarizing the strategies microscopists developed to meet the challenge of working together despite being scattered across the country.

Sending slides through the post

According to Smith's characterization of craft knowledge, early modern artisans learned their craft through 'collective problem-solving', resulting in 'a body of techniques and knowledge that was transmitted in an integral and coherent way' through apprenticeship and other forms of on-site collaboration.[24] Similarly, the American Postal Microscopical Club was based on the idea that it would facilitate collaboration among microscopists and enable them to collectively solve problems associated with slide making. However, unlike the on-site collaboration described by Smith, club members' slide exchange hinged on the postal system, which turned out to be less reliable than the club's officers had hoped. During the first four years of its existence, the American Postal Microscopical Club not only established its own postal circuits but amended the American postal law to better suit its members' needs.

The club was founded in 1875, when the *American Naturalist* issued a call to recruit members for a postal microscopical club. The journal published the rules of the club and informed its readers that applications for membership could be sent to the journal or the club's provisional secretary.[25] Initially, the club's postal circuits consisted of twelve members each. The club's secretary would send an empty slide box to one member in each circuit, who was supposed to fill the box with at least one microscope preparation, add explanatory notes or illustrations in a separate letter package, and then pass both on to the next member. Members were urged to send the box and notes to the next person after no more than four days.[26] Once the box and notes had completed the circuit, they were sent back to the secretary, who sent them to the next circuit, and so on. In the beginning, the annual membership fee was fifty cents, which was later raised to one dollar.[27]

[24] Smith, op. cit. (17), p. 39.

[25] Putnam and Packard, op. cit. (5).

[26] See Putnam and Packard, op. cit. (5), p. 250. This was later changed to three days; see 'Queries', *American Monthly Microscopical Journal* (1888) 9(8), p. 155.

[27] Fifty cents is the sum mentioned in the *American Naturalist* by Putnam and Packard, op. cit. (5). The raise is documented in 'Queries', op. cit. (26).

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

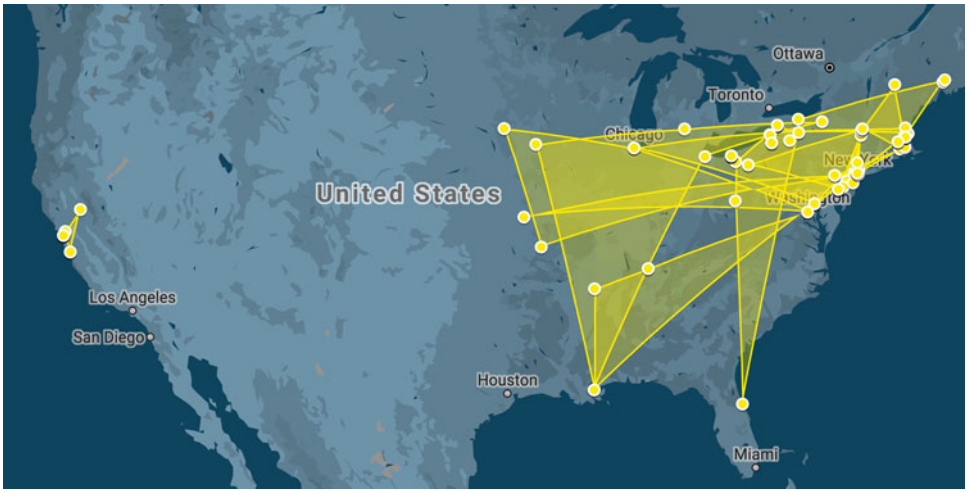

Figure 1. Intercity circuits of the American Postal Microscopical Club, 1876. Map data: Google, INEGI.

Only one year after its foundation, the club consisted of twenty-four circuits, then counting six members each, who received one or two boxes of slides per month (Figure 1). As stated in the club's report of 1876, it took 'two years for a slide to make the entire round, and in doing this it must travel not less than thirty thousand miles by mail'.[28] The number of circuits seems to have remained relatively stable over the following fifteen years.[29] The officers of the club were careful only to admit members if there were vacant spots available in existing circuits, or if the new members could form a circuit of their own.[30] Members were expected to contribute at least one slide per year, 'preferably one illustrating some new method of preparation, or result of study'.[31] Slides had to be numbered corresponding to the owner's position in the circuit, so they could easily be attributed to them. From the outset, women could join, yet there were no female microscopists in the circuits established by 1876.[32]

The first officers of the club – the president, secretary and two managers – were John Peirce, Alpheus B. Hervey, Richard H. Ward and Charles M. Vorce.[33] Peirce was professor of chemistry at Harvard and Yale; Hervey taught theology and natural history at St Lawrence University. Ward was a practising physician and professor of botany at Rensselaer Polytechnic Institute, the first polytechnic in the United States, while Vorce was a patent lawyer who made microscope slides in his spare time. The officers are a fair sample of the members of the club in 1876, almost half of whom were either professors, physicians or clergymen.[34] When the club was founded, both Ward and Hervey were based in Troy, New York, which was made the headquarters of the club. Thus Troy, at the

[28] Charles R. Dodge, 'Editorial pencillings', *Field and Forest* (1877) 2(8), p. 147.

[29] There were twenty-three circuits in operation in 1891. Queen Mab, 'Reports on the postal club boxes – XI', *American Monthly Microscopical Journal* (1891) 12(1), pp. 13–14.

[30] Romyn Hitchcock, 'Notes', *American Monthly Microscopical Journal* (1880) 1(1), pp. 17–18, 18.

[31] Dodge, op. cit. (28), p. 147.

[32] List of members, circuits and officers of the Postal Microscopical Club for 1876, Collection 67, Papers of the American Postal Microscopical Club, Archives of the Academy of Natural Sciences, Philadelphia, PA, USA.

[33] List of members, op. cit. (32).

[34] According to Warner, op. cit. (3), p. 17, 26 per cent of the members were physicians, 11 per cent professors, 8 per cent clergymen.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

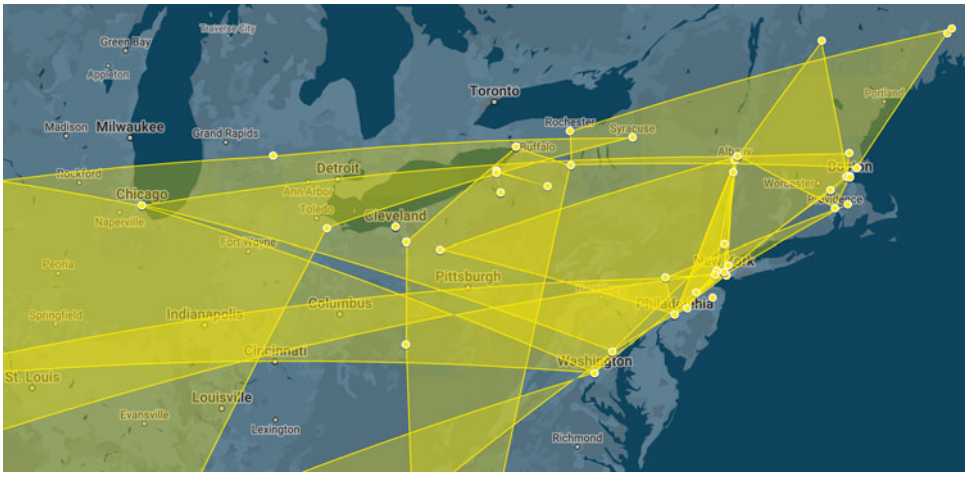

Figure 2. Close-up of intercity circuits in the Northeast, 1876. Map data: Google, INEGI.

time a wealthy industrial city and home to Rensselaer, became the central node in the postal network. Five of the club's circuits passed through Troy, more than through any other city (Figure 2).

There were concerns, however, that the club was less successful in making its slides available to microscopists located outside the scientific and industrial centres. *Field and Forest* observed that many of the club's circuits were local, 'no less than three circuits being located at Cleveland, Ohio, two at San Francisco, California, two at Boston and suburbs, one at New York City, and one mostly from its suburbs'.[35] Yet there is evidence that the club did keep its promise of providing more isolated workers with slides. While most circuits established by 1876 cumulated along the Northeast Coast, some did stretch to the South and Midwest, and there was one intercity circuit on the West Coast. In 1900, an anonymous member thanked the club, saying those 'who live in the East do not appreciate how valuable the boxes of slides are to those of us who are farther removed from contact with the best scientific work'.[36]

From the beginning, the club's operations relied on the American postal system. As Cameron Blevins has shown, the post expanded at an astounding pace after the Civil War, spurring the colonization and integration of the West into the rest of the nation.[37] Blevins argues that the sprawling postal network was only partly dependent on the expansion of material infrastructures, such as roads and railways. Much like the American Postal Microscopical Club, the post itself depended on the organization of people, using 'a system of commissions, fees, and contracts to graft public functions onto the private operations of storeowners and stagecoach companies', and creating, in Blevins's terms, a malleable 'gossamer network'.[38] The flexibility of this network, together with a long tradition of government support for the distribution of educational

[35] Dodge, op. cit. (28).

[36] Richard H. Ward, 'Report of the American Postal Microscopical Club', *American Monthly Microscopical Journal* (1900) 21(3), pp. 83–9, 85.

[37] See Cameron Blevins, 'The postal West: spatial integration and the American West, 1865–1902', PhD dissertation, Stanford University, 2015. Blevins elaborates this argument in his recent book, *Paper Trails: The US Post and the Making of the American West*, New York: Oxford University Press, 2021.

[38] Blevins, 'The postal West', op. cit. (37), p. iv.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

materials through the post, made it possible for microscopists to tailor the post to their needs.[39]

When the Postal Microscopical Club was founded in 1875, the American postal law technically prohibited the mailing of glass, including microscope slides.[40] The *United States Official Postal Guide* of 1876 elaborated that packages 'containing liquids, poisons, glass, explosive chemicals, live animals, sharp pointed instruments, sugar, or any other matter liable to deface or destroy the contents of the mail, or injure the person of anyone connected with the service', could not be sent through the post.[41] The club therefore depended on the lenience of post office clerks, who usually did not consider the slides unsafe and allowed them to be sent.[42] Before the club was established, its officers had been assured by members of Congress that a future revision of the postal law would consider the needs of the club and allow for the mailing of slides.[43] However, over the three years following the foundation of the club, incidents of slides being confiscated by the post increased, which ultimately forced the club to suspend its circulation of slides.[44]

Moreover, from the mid-1870s, the United States Post Office Department faced a growing debate over the classification of mail, which revolved around the question of which printed materials should be considered of public interest and therefore qualify for reduced postal rates.[45] In 1878, the law division of the Post Office Department, represented by Arthur H. Bissell, conferred with a number of East Coast publishers to discuss a revision of the classification system.[46] As microscopists saw it, the focus on print in the proposed revision of the postal law disregarded the needs of their postal club. They argued that, considering the club's commitment to scientific education, it was in the public interest to support microscopists in exchanging microscope slides, too, and not only printed matter. The seemingly biased revision of the postal law advocated by Bissell and the publishers, combined with the stricter enforcement of the ban on glass, were met with protest by microscopists.

John Phin, editor of the *American Journal of Microscopy and Popular Science*, published a scathing editorial in March 1878, 'A new postal law for the discouragement of science'. Phin found it intolerable that the delivery of slides depended on the goodwill of individual post office clerks, and he complained about the bias towards print in the classification of mail. He went so far as to turn the club's plea for a lift of the ban on glass into a more general argument about the value of objects in scientific education:

> [why] should seeds, specimens for scientific study, or samples of goods, be charged more than *Missionary Heralds*, *Atlantic Monthlies*, or *Golden Rules*? Do not flowers exert as elevating an influence as Boston transcendentalism? Do not scientific exchanges

[39] John, op. cit. (19), p. 30, emphasizes the educational rationale underlying the establishment of the American postal system.

[40] This was set out in Section 133 of the postal law concerning mailable and unmailable matter. See United States Post-Office Department, 'Mailable Matter', Section 133, *The Postal Laws and Regulations*, Washington, DC: Government Printing Office, 1873, pp. 62–3.

[41] 'Rates of postage on domestic mail-matter', *United States Official Postal Guide* (1876) 1(9), pp. 13–18, 18.

[42] Richard Ward, 'Annual address of President R.H. Ward', *Proceedings of the National Microscopical Congress, and of the American Society of Microscopists* (1880) 1, pp. 35–51, 38–9.

[43] Ward, op. cit. (42).

[44] Ward, op. cit. (42).

[45] Richard B. Kielbowicz, 'A history of mail classification and its underlying policies and purposes', paper presented at the Postal Rate Commission's Mail Reclassification Proceeding, MC95-1, 1995.

[46] See Kielbowicz, op. cit. (45), p. 37. Kielbowicz writes (p. 40) that Bissell met with 'representatives from *Scribner's Monthly*, *Christian Union*, *The Grocer*, *American News Company*, *The New York Times*, and Harper's magazine and book publishing house'.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

> and specimens promote the diffusion of knowledge quite as much as *Journals of Education*?[47]

Phin's article was a rhetorical blow to the proposed changes to the postal law. It made a case for considering tradespeople and their commodities – 'seeds, specimens for scientific study, or samples of goods' – as equally important as theoretical literature in educating the American people on scientific methods. At the same time, however, Phin glossed over the irony that the officers of the Postal Microscopical Club never grew tired of reminding members to send explanatory texts along with their preparations. Slides without notes, as they saw it, were quite useless.[48]

A month later, Phin's polemic was given more political weight by a petition presented to the Senate by members of the American Postal Microscopical Club, asking for a revision of the postal law to the advantage of the club.[49] For a long time, petitions had been a primary way for settler communities to integrate themselves in the nation's postal network and adapt its postal services to their needs.[50] Since the passage of the Post Office Act of 1792, establishing the United States Post Office Department, Congress had been flooded with petitions asking for mail routes to be expanded and post offices to be set up in even the most remote communities.[51] As the expansion of the post was widely regarded as an invaluable means of building a nation and educating its citizens, petitions had considerable support among members of Congress and were hardly ever denied.[52] Moreover, as Blevins points out in describing the post as a gossamer network, new postal infrastructure was swiftly grafted onto existing structures, with general stores being turned into post offices and private stagecoach companies being contracted to work as postal carriers.[53]

It seems that the American Postal Microscopical Club benefited from Congress's long-standing inclination to grant petitions and adapt the nation's postal services accordingly. The petition submitted by the club in 1878 was successful. In 1879, at the first meeting of the American Society of Microscopists, Richard Ward reported that the postal law had been amended to allow for the mailing of slides, and that the club had resumed its circulation of preparations.[54] While there was no reduction of postage for microscope slides, they could now be circulated on the condition that they were carefully wrapped and put into sturdy (and expensive) boxes before they were mailed. This was practicable for the club, but some members, fearing the additional expense, continued to look for another 'method for … safe transmission' to maintain their private exchanges of slides and slide-making businesses.[55]

While the amendment of the postal law allowed for the continuation of the club, it did not put an end to debates over how microscope slides were treated by the post. It did, however, mark the end of the club's success at changing the postal system by law. From the 1880s, as the following section will show, the club's efforts at making

[47] John Phin, 'A new postal law for the discouragement of science', *American Journal of Microscopy and Popular Science* (1878) 3(3), pp. 63–4.

[48] Many reports on the club featured complaints about slides lacking notes. See, for example, Queen Mab, 'Report on the postal club boxes – V', *American Monthly Microscopical Journal* (1889) 10(4), pp. 85–6.

[49] US Congress, *Congressional Record: Containing the Proceedings and Debates of the Forty-Fifth Congress, Second Session*, vol. 7, Washington, DC: Government Printing Office, 1878, p. 2558.

[50] Blevins, 'The postal West', op. cit. (37), p. 174.

[51] John, op. cit. (19), p. 50.

[52] John, op. cit. (19), p. 50.

[53] Blevins, 'The postal West', op. cit. (37), p. 206.

[54] Ward, op. cit. (42).

[55] Mary Ann Booth, 'Breakage of slides in the mail', *American Monthly Microscopical Journal* (1883) 4(2), p. 38.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

preparation methods travel were directed more towards choosing the right materials to make and send microscope slides.

Fragile preparations

The club's original collection of slides does not seem to exist any more. However, beginning in 1884, the club added commercial slides to its boxes, which were produced by the English slide maker Arthur C. Cole. Since Cole's slides were widely distributed through a subscription service in Britain and abroad, copies of the slides still exist, and they can be used to illustrate the kind of skills slide making required. Cole provided his subscribers not only with weekly deliveries of slides but also with texts and illustrations describing the slides and their preparation, as well as bibliographies of works dealing with the specimens his slides contained. These texts and illustrations, too, were circulated by the American Postal Microscopical Club. Taken together, Cole's slides, texts and illustrations were meant to serve as a model of fine craftsmanship and thorough description for club members to imitate.[56]

In 1889, for example, the members received a slide by Cole containing a section of a leaf of *Rhododendron ponticum*, accompanied by a text describing the species and a lithograph (Figures 3 and 4). The rhododendron leaf, as the *American Monthly Microscopical Journal* reported, 'was decolorized in alcohol previous to cutting, was stained with logwood, and mounted in Canada balsam'.[57] The slide demonstrates that turning a microscope specimen into a permanent preparation required a whole range of skills: cutting and staining sections, choosing (and often making) a suitable mounting medium like Canada balsam, and sealing the slide with a ring of cement and cover glass.

Many of Cole's weekly deliveries included extensive manuals on how to cut, stain and mount specimens. However, the notes taken and circulated by club members show that in order to learn how to make slides, it was necessary for members to complement Cole's written instructions with a close observation of slides and illustrations.[58] Pamela Smith, in her work on early modern artisanal workshops, describes craft knowledge as empirical, 'employing observation, precision and investigative experimentation'.[59] Smith primarily refers to the close observation of natural phenomena, as well as experiments with working materials that informed artisanal crafts. Members of the American Postal Microscopical Club carefully observed the slides they received, with notetaking and sketch-making practices becoming a way of acquiring the craft knowledge that resided in the slides.

Eugene A. Rau, a club member and apothecary from Bethlehem, Pennsylvania, copied other members' notes and illustrations by hand and sketched what he saw when he examined a slide through the microscope. Since members could keep a box of slides for only a few days, notes and illustrations helped to virtually extend the time spent with the slides. When a slide was damaged and sent to the headquarters for repairs, illustrations made by members came to replace the missing slide and were just as carefully observed by Rau.

[56] See Queen Mab, 'Report upon the postal club boxes – III', *American Monthly Microscopical Journal* (1889) 10(2), pp. 33–4.

[57] Queen Mab, 'Report upon the postal club boxes – II', *American Monthly* Microscopical Journal (1889) 10(1), pp. 7–8, 7.

[58] Daniela Bleichmar, 'The geography of observation: distance and visibility in eighteenth-century botanical travel', in Elizabeth Lunbeck and Lorraine Daston (eds.), *Histories of Scientific Observation*, Chicago: The University of Chicago Press, 2011, pp. 373–95, describes a similar triangulation of observations in her work on eighteenth-century botany in the Americas, with botanists comparing texts, illustrations and botanical specimens.

[59] Smith, op. cit. (17), p. 42.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

Figure 3. Slide of *Rhododendron ponticum* made by Arthur C. Cole, distributed along with his *Studies in Microscopical Science* (1883) 1. Image courtesy of Steve Gill.

Historian of science Omar Nasim has argued that observation itself was a craft that could only be learned through illustration and note-taking practices.[60] Scientific sketches were

[60] Omar W. Nasim, *Observing by Hand: Sketching the Nebulae in the Nineteenth Century*, Chicago and London: The University of Chicago Press, 2013, p. 4. Lorraine Daston makes the similar argument that 'taking notes entails taking note'. Lorraine Daston, 'Taking note(s)', *Isis* (2004) 95(3), pp. 443–8, 445.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

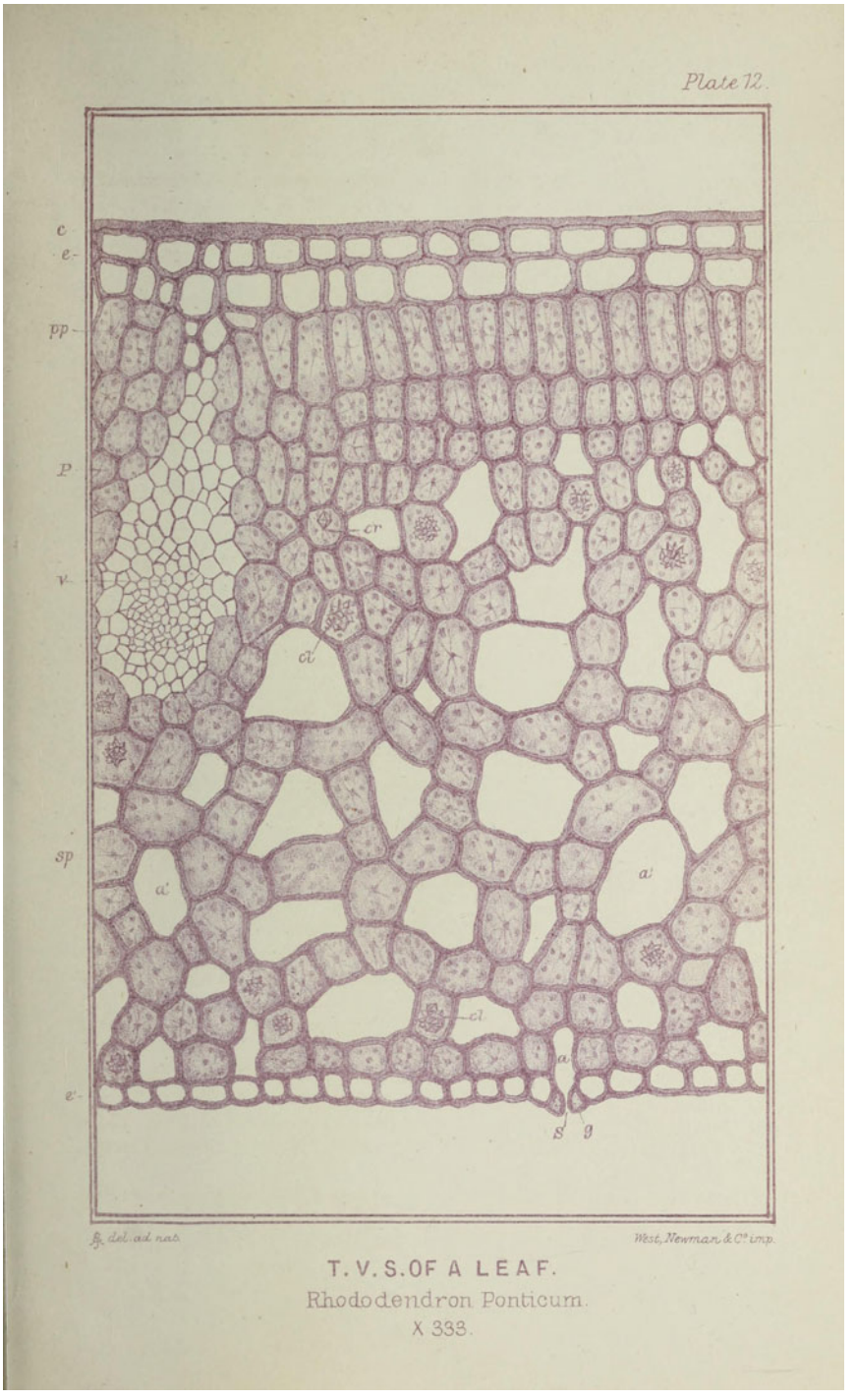

Figure 4. Illustration of *Rhododendron ponticum* in Arthur C. Cole, *Studies of Microscopical Science* (1883) 1. Image from the Biodiversity Heritage Library, contributed by the University of Illinois Urbana–Champaign.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

'working images', a way of observing an object by hand.[61] Similarly, club members' observing by hand, through notes and sketches, was crucial in acquiring craft knowledge of preparation and mounting methods.

By exchanging drawings and notes alongside the slide boxes, members both recorded successful methods and identified sources of error. Rau copied recommended recipes for mounting fluids and sketched features of specimens that struck him as particularly well prepared, indicating the effect of stains in his private notes and adding approving comments to them, 'fine' or 'very fine slide'.[62] In January 1882, Rau received a box that contained a preparation made by Thomas Taylor, who was head of the Microscopy Division at the United States Department of Agriculture. Taylor had contributed a slide showing the foot of a fly, but he was concerned that it looked nothing like the one in Philip Henry Gosse's popular 1859 book *Evenings at the Microscope*. Taylor suspected that Gosse was at fault, but other members were quick to explain that Taylor had 'evidently had all the pad & hairs torn away in the process [of preparation]' and suggested other methods that might lead to better results.[63]

Crushed specimens were often the result of applying too much pressure or using a blunt knife, whereas sections that were too thick at one end and too thin at the other had probably been cut by hand and not with a microtome. Observing both slides and illustrations by hand, microscopists learned to look out for visual hints of why a method had not worked. Rau even included meticulous sketches of broken slides in his notes, noting that these breakages were almost certainly the result of improper packaging.[64] This kind of reverse engineering had a long tradition in microscopy, with microscopists perpetuating the myth that Canada balsam had only become popular after a microscopist '"smelt" his way' to the secret ingredient – resin of the balsam fir – used by a slide maker.[65] Members of the Postal Microscopical Club were similarly eager to find out why someone's method had failed to deliver satisfying results. In fact, although the officers of the club asked members for their best preparations, the members found that failed preparations were often more instructive. An anonymous microscopist explained that there 'is most interest in home-made slides, even if they are not pretty; the mounter learns so much more about the object, and he can explain its preparation so much better'.[66]

Sven Dupré, in studying early modern recipe books, observes that in the seventeenth century, authors began to spell out sources of error and how to avoid them, a process Dupré terms the 'codification of error'.[67] Dupré describes the codification of error as a means of better translating craft knowledge into text, telling readers not only how to, but also how not to, proceed in following a recipe. Jutta Schickore, looking at eighteenth-century microscopy publications, confirms that microscopists, too, discussed sources of error and whether to attribute them to the microscope or the observer.[68] While the reverse engineering undertaken by members of the American Postal Microscopical Club continued this tradition, members identified error not only by following, or failing to follow, someone else's instructions,

[61] Nasim, op. cit. (60), p. 10.

[62] Rau (1875–1887).

[63] Rau (1875–1887).

[64] Rau (1875–1887).

[65] 'Mounts and mounting', op. cit. (11), p. 149. In a similar vein, microscopists fondly recalled the resourcefulness of John Thomas Quekett, one of the founders of the Royal Microscopical Society, who had famously repurposed household items to build a working microscope. See A.D. Michael, 'The president's address', *Journal of the Royal Microscopical Society* (1895) 15(1), pp. 1–20, 7.

[66] Ward, op. cit. (36), pp. 85–6.

[67] Dupré, op. cit. (18).

[68] Jutta Schickore, *The Microscope and the Eye: A History of Reflections, 1740–1870*, Chicago: The University of Chicago Press, 2007, p. 42.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

but also by closely observing another microscopist's slides. Since the slides were fragile but mobile objects and were circulated alongside written notes, the club made it possible for microscopists to judge both artisanal instructions and their execution.

Methodological debates could not always be settled as swiftly as in the case of Taylor's crushed foot of a fly. Many of the methods employed by club members were highly controversial, like the use of zinc white cement for gluing the cover glass onto a slide. Zinc white was notorious for spilling into a mount before it was dry and for becoming brittle once it had dried. One member quipped, 'if it don't [run], then it is because it has been appropriately thrown out of the window'.[69] Others, however, defended zinc white on the basis that its quality depended entirely on the skill of the person who made it, the particular ingredients used, and even local climatic conditions. Pamela Smith has shown that craft knowledge was particularistic, in that it could easily be adapted to local materials and environments.[70] Preparation and mounting methods were equally flexible, and members of the American Postal Microscopical Club often agreed to disagree over the benefits and drawbacks of methods and materials, even when it came to the zinc white cement.[71] As the *American Monthly Microscopical Journal* wrote in a report on the club's slides in 1889, 'so often do authorities disagree … that it is impossible for the individual worker implicitly to follow any set of rules. There is ample room for the development of the individuality and skill of every worker'.[72] At the same time, however, club members observed that some slides were likely to be harmed, or harm others, during their travels, and the club began to investigate spills and breakages.

There is reason to assume that breakages occurred regularly. Rau kept a register of the boxes he received between April 1884 and February 1886. In 1884, seventeen boxes – probably containing six slides each – contained only one broken cover glass. In 1885, he was sent thirteen boxes of slides containing one mended slide and one slide damaged beyond repair. The year 1886 started with three broken slides in three boxes.[73] Twice, mail bags containing one of the club's slide boxes were run over by trains.[74] But even without such dramatic events, slides suffered from their two-year journey through the mail. A correspondent writing to the *American Monthly Microscopical Journal* suspected that heavy packages and careless postal workers were to blame:

> [ordinary] mail packages are limited to four pounds in weight; but public documents passing through the mails are not restricted within any given limits … Glass slides can scarcely be expected to withstand such missiles, when the mail bags are hurled from the mail wagons upon stone sidewalks, or from postal cars to the platform … Does not some over-zealous post-office official open the boxes, as he has a perfect right to do … [and] replace the slides with cells in contact, and packing half left out?[75]

Because of these breakages, club members' preparation and mounting methods were not only geared to preserving a specimen but also chosen for their ability to withstand the

[69] Richard H. Ward, 'Sixteenth annual report of the American Postal Microscopical Club', *American Monthly Microscopical Journal* (1891) 12(2), pp. 53–61, 59.

[70] Smith, op. cit. (17), p. 43.

[71] One member, Mary Ann Booth, made a conciliatory proposal in 1887, writing that although she preferred to use zinc white herself, less experienced microscopists might find King's cement more useful. Mary Ann Booth, 'A thoroughly reliable cement', *The Microscope* (1887) 7(10), pp. 297–8.

[72] Queen Mab, 'Report upon the postal club boxes – VII', *American Monthly Microscopical Journal* (1889) 10(6), pp. 131–2, 132.

[73] Rau (1875–1887).

[74] Richard H. Ward, 'Extract from report of management of the American Postal Microscopical Club for 1893–1895', *American Monthly Microscopical Journal* (1895) 16(4), pp. 105–11.

[75] Booth, op. cit. (55).

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

test of postal exchange. Members were advised not to make dry mounts or water mounts, and not to use materials that were likely to be damaged themselves or damage other slides. In March 1889, the *American Monthly Microscopical Journal* suggested having 'with each box the date when placed in circulation, thus affording, to some extent, a test of the comparative durability of the various modes of preparation'.[76] This suggestion was taken up only three months later. The club thus turned its circulation of slides into a long-term experiment to compare the durability of certain materials. This once more confirms Pamela Smith's argument that craft knowledge emerges through empirical observation, with the postal exchange network itself, and its effect on the slides, becoming the club's object of study.

While preparations were privately evaluated by every microscopist through whose hands they passed, it could easily take two years for written comments to circle back to the maker of a preparation, if they made it back at all. Moreover, after trying to return all notes to the contributor of a slide, the club's officers eventually decided to send 'only the really important notes to the persons directly interested'.[77] The officers soon realized that publishing the club's notes in microscopy periodicals made it possible to give advice to a slide maker and at the same time publicly assess the preparations circulated. Public judgement about the quality of artisanal products was a crucial component of craft knowledge, helping to determine what was considered good practice. In early modern times, an artisan's commissioned work often had to be publicly judged by other knowledgeable craftspeople before the artisan was paid the full fee by the commissioner.[78] In the case of the Postal Microscopical Club, reports on its activities published in various periodicals became the key site for public scrutiny.

The American Postal Microscopical Club in the periodical press

Reports on the club were published regularly in the *American Quarterly Microscopical Journal* (1878–1902, from 1880 the *American Monthly Microscopical Journal*), the *American Journal of Microscopy and Popular Science* (1875–1881), *The Microscope* (1881–1897, then merged with the *American Monthly Microscopical Journal*), the *Journal of Applied Microscopy* (1898–1903), the *Microscopical Bulletin and Optician's Circular* (1883–1902, from 1885 the *Microscopical Bulletin and Science News*) and *The Observer* (1890–1895).[79] Of these six periodicals, none made it past 1903, which makes it difficult to trace the activities of the club after the turn of the century, or even determine when it ceased to exist.[80]

It is important to note that these microscopy periodicals did not address a homogeneous public. The contributors and readers of every periodical constituted a distinct audience, shaped by numerous factors from a journal's circulation to its price, layout, content and materiality.[81] The *Microscopical Bulletin and Science News* and the short-lived

[76] Queen Mab, 'Report upon the postal club boxes – IV', *American Monthly Microscopical Journal* (1889) 10(3), pp. 63–4, 63.

[77] 'Seventeenth annual report of the American Postal Microscopical Club, Troy, N.Y., 1892', *The Microscope* (1892) 12(9), pp. 185–91, 190.

[78] Smith, op. cit. (17), p. 40.

[79] For an overview of nineteenth-century microscopy periodicals see William H. Brock, 'Patronage and publishing: journals of microscopy 1839–1989', *Journal of Microscopy* (1989) 155(3), pp. 249–66.

[80] Between 1903 and 1973, *Transactions of the American Microscopical Society* was the only microscopy periodical issued in North America. Brock, op. cit. (79), p. 260.

[81] See Margaret Beetham, 'Towards a theory of the periodical as a publishing genre', in Laurel Brake, Aled Jones and Lionel Madden (eds.), *Investigating Victorian Journalism*, Basingstoke and London: Macmillan, 1990, pp. 19–32.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

Journal of Applied Microscopy were published by the scientific instrument-makers James W. Queen & Co. and Bausch & Lomb respectively. Whereas Bausch & Lomb's *Journal of Applied Microscopy*, a monthly priced at one dollar per annum, mainly reported on laboratories that the company had equipped with microscopes, the *Microscopical Bulletin and Science News* was a flimsy trade paper of eight pages, a bimonthly that ran on adverts and cost only twenty-five cents per year. The *American Quarterly Microscopical Journal* was initially published by the New York Microscopical Society and reported on society activities, whereas *The Microscope* started as a medical journal but was soon changed to cater to a broader and presumably larger readership, a similar readership as envisioned by John Phin's *American Journal of Microscopy and Popular Science*.[82] *The Observer*, finally, was a natural-history journal with just a section dedicated to microscopy.

In short, the public gaze that the club's slides were subjected to was fragmented, and it was shaped by the various agendas of the periodicals. Moreover, readers looked at the slides through the eyes of the author, especially when the club's notes were not just reproduced or summarized in print but complemented by a report. Microscopy periodicals chose knowledgeable members to write regular reports, who took different approaches to evaluating both slides and other members' knowledge of preparation methods. The two most prominent and regular commentators, who mainly wrote for the *American Monthly Microscopical Journal*, were Romyn Hitchcock and a writer who used the pen name Queen Mab.

Romyn Hitchcock was the long-time editor of the *American Monthly Microscopical Journal* and a prolific scientific writer, explorer and photographer with chemistry degrees from Cornell and Columbia. Hitchcock edited the *American Monthly Microscopical Journal* from 1878 to 1886, before joining the United States Eclipse Expedition and leaving for Japan the following year. In 1883, Hitchcock felt compelled to start reporting on the slides he received, since 'some members ... while quite willing to avail themselves of the advantages of the club, [seemed] not to regard it as any part of their obligations as members to contribute to the general interest and value of the boxes'.[83]

Hitchcock sought to remedy this by publicly assessing both the quality of slides and the reliability and moral integrity of their makers. Hitchcock held that members should 'feel morally bound' to make valuable contributions to the club.[84] From the early modern period, microscopists had promoted the notion that moral education could be gained by contemplating God's microscopic creatures through the microscope.[85] Hitchcock inverted this argument by claiming that, instead of refining their morals through microscopy, club members had to be trustworthy craftspeople and correspondents from the start. In order to make the club's infrastructure of slides and chain letters more robust, Hitchcock put club members under just as much public scrutiny as their preparation methods. In his reports, Hitchcock listed the names of all contributors to a box of slides and discussed their skill and reliability one by one. Whereas a beginner's ignorance was excusable, Hitchcock made it clear that carelessness was not, and he criticized even esteemed microscopists for contributing slides of low quality.

After Hitchcock left for Japan, the task of writing reports was taken over by an anonymous author whom the new editor of the *American Monthly Microscopical Journal*,

[82] Brock, op. cit. (79).

[83] Romyn Hitchcock, 'The American Postal Microscopical Club', *American Monthly Microscopical Journal* (1883) 4(1), pp. 14–15, 14.

[84] Hitchcock, op. cit. (83).

[85] See Jordynn Jack, 'A pedagogy of sight: microscopic vision in Robert Hooke's *Micrographia*', *Quarterly Journal of Speech* (2009) 95(2), pp. 192–209. On nineteenth-century microscopy and theology see Bernard Lightman, 'The visual theology of Victorian popularizers of science: from reverent eye to chemical retina', *Isis* (2000) 91(4), pp. 651–80; Warner, op. cit. (3).

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

Charles W. Smiley, christened 'Queen Mab, one of the most skilful preparers of material in this country'.[86] Judging by the pseudonym of the writer and the content of the reports, it is plausible to assume that Queen Mab was Mary Ann Booth, the best-known female maker and seller of slides in the United States at the time, and a member of the Postal Microscopical Club since at least 1884.[87] Queen Mab made good use of her new role as public commentator, often adding more general directions for the club to her examination of slides.

In 1889, when a lady member contributed a slide made by a male preparer, Queen Mab asked the ladies in the club to only circulate preparations they had made themselves and declared microscopy a female craft: 'We cannot too warmly urge upon the attention of ladies the fascination and instruction to be found in the use of the microscope, a branch of science for which nature has especially adapted them both mentally and manually'.[88] Queen Mab's reports thus not only assessed microscope preparations and their individual preparers but also established who should be considered a knowledgeable craftsperson. Moreover, Queen Mab positioned club members' work as complementary to the kind of microscopy that was done in laboratories. She claimed that whereas 'the preparation of certain classes of objects … reached a degree of perfection little short of marvellous' in laboratories, 'the permanent preparation of objects … made no such advances'.[89] Instead, she wrote, there was 'an incongruity between skilful preparation and unskilful preservation', which club members could help overcome.[90]

In addition to providing their readers with reviews, microscopy periodicals also made it possible to centralize and synchronize club members' work. Richard John has noted that the American post relied on newspaper reports to stay informed on any disruptions to the postal system that happened 'in the field'.[91] Likewise, members of the Postal Microscopical Club relied on periodicals to learn where their own slides had gone, which slides to expect in the next box, and whether there had been delays. Published reports could also be used to give quick responses to queries made by club members. As Hitchcock explained in one of his reports in 1886,

> The preparer desires to know the name of the specimen. Such questions as this should receive answer in the letter-packet, although, for the information of the inquirer, the answers will be of little value, except through the medium of these notices … since those who once receive a box are not likely to see it again, these columns are always open for replies to such inquiries.[92]

[86] Charles W. Smiley, 'Editorial', *American Monthly Microscopical Journal* (1889) 10(1), pp. 16–17, 17. In a footnote to the first report on the club, Smiley quotes Robert Herrick's (1591–1674) poem 'The fairies', which describes Queen Mab as a fairy who enforces social mores by 'pinching' sloppy housekeepers 'in the toe'. The reviewer 'Queen Mab' had a similar role, ruling over a miniature world of microscope specimens and criticizing careless slide makers. See Queen Mab, 'Report upon the postal club boxes – I', *American Monthly Microscopical Journal* (1888) 9(12), p. 224. Francesca Brittan takes a closer look at the relationship between microscopy and fairies in 'On microscopic hearing: fairy magic, natural science, and the *Scherzo fantastique*', *Journal of the American Musicological Society* (2011) 64(3), pp. 527–600.

[87] 'Mab' may have been an acronym of Mary Ann Booth's initials. Moreover, Mary Ann Booth was widely appreciated for her knowledge of human parasites, and Queen Mab's reports contain long paragraphs about parasites and how to prepare them. Rau (1875–1887) mentions slides circulated by Mary Ann Booth in 1884, but she may have joined the club earlier.

[88] Queen Mab, op. cit. (76), p. 63.

[89] Queen Mab, 'Report upon the postal club boxes – IX', *American Monthly Microscopical Journal* (1890) 11(1), pp. 9–10, 9.

[90] Queen Mab, op. cit. (89).

[91] John, op. cit. (19), p. 76.

[92] Romyn Hitchcock, 'Postal club boxes', *American Monthly Microscopical Journal* (1886) 7(1), pp. 16–18, 17.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

Such exchanges among members were only possible with the help of a periodical, a genre James Mussell has defined as immutable across space, since an issue changed little as it was distributed, and mutable across time, with one issue always being replaced by the next.[93] Hitchcock's report shows that it was exactly this combination of mutability and immutability of periodicals that facilitated the collaboration among club members, making it possible for members to communicate with future recipients of slides and with their manufacturers.

However, while microscopy periodicals certainly fostered a sense of community, sharing craft knowledge in published form remained a challenge.[94] As a trade paper, James W. Queen & Co.'s *Microscopical Bulletin and Science News* took an approach that made it stand out among the periodicals that reported on the club's production of slides. The *Microscopical Bulletin* was edited by Edward Pennock, an entrepreneur based in Philadelphia, who supervised the microscopy department at James W. Queen & Co. Pennock gave the bulletin a strong editorial voice, fashioning himself as a cunning tradesman with a dry sense of humour. He often copied articles published in other journals and republished them in his bulletin, since he believed that he could 'write much better articles with the scissors than with the pen'.[95] For Pennock, writing was an editorial craft that required the hand as much as the mind.

Since the bulletin combined scientific news with price lists of items sold by James W. Queen & Co., its reports on the American Postal Microscopical Club became entangled with all sorts of microscopy accessories, ranging from microtomes to glass covers and stains. Claire Jones, in her work on medical trade catalogues in nineteenth- and twentieth-century Britain, has shown that catalogues were integral to medical and scientific practice. By the 1900s, catalogues contained 'text relating products to medical practice and outlining their relation to medical theory'.[96] Medical practitioners both ordered products and contributed their own designs for medical devices to trade catalogues, while the items and texts in these publications helped to foster the image of medicine as scientific and progressive.[97] Queen & Co.'s bulletin sought to bridge the gap between microscopy products and their application in a similar way. In its reports on the American Postal Microscopical Club, the bulletin pointed its readers to the tools that would enable them to follow the instructions circulated by club members.

In 1889, the *Microscopical Bulletin* published club members' notes on the Peirce cell, a glass cell that could be used to contain dry mounts.[98] In a footnote to the report, the bulletin referred its readers to a description of the cell in the February 1886 issue. The 1886 article, including two illustrations, explained how the cell should be used and promised that Peirce cells would soon be available at Queen & Co.[99] It offered its readers several

[93] See James Mussell, *Science, Time and Space in the Late Nineteenth-Century Periodical Press: Movable Types*, Aldershot: Ashgate, 2007. For a comprehensive study of seriality in nineteenth-century science see Nick Hopwood, Simon Schaffer and Jim Secord, 'Seriality and scientific objects in the nineteenth century', *History of Science* (2010) 48(3–4), pp. 251–85.

[94] On periodicals and the building of scientific communities in the nineteenth century see Patrick Leary, 'A Victorian virtual community', *Victorian Review* (2000) 25(2), pp. 61–79; Geoffrey Belknap, 'Illustrating natural history: images, periodicals, and the making of nineteenth-century scientific communities', *BJHS* (2018) 51(3), pp. 61–79; Gowan Dawson, Bernard Lightman, Sally Shuttleworth and Jonathan Topham (eds.), *Science Periodicals in Nineteenth-Century Britain: Constructing Scientific Communities*, Chicago: The University of Chicago Press, 2020.

[95] Edward Pennock, 'Minutiae', *Microscopical Bulletin and Science News* (1890) 7(1), p. 7.

[96] Claire L. Jones, *The Medical Trade Catalogue in Britain, 1870–1914*, Abingdon and New York: Routledge, 2016, p. 138.

[97] Jones, op. cit. (96), p. 150.

[98] 'American Postal Microscopical Club', *Microscopical Bulletin and Science News* (1889) 6(3), pp. 18–19.

[99] 'The Peirce cell for opaques', *Microscopical Bulletin and Science News* (1886) 3(1), p. 3.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

recipes for cements they should use with the cell, thus effectively tailoring mounting methods to the items offered by Queen & Co. Although the bulletin could not quite re-create the collaborative experience of a workshop, it was crucial in bringing club members, mounting instructions and materials together.

Notably, the August 1886 issue of the *Microscopical Bulletin* contained a correction of a cement recipe published in February, asking its readers to 'strike out the words "Make up only as needed" … as this cement becomes much more adhesive after having been made up for some time'.[100] In the February issue held by the University of California, the words have been crossed out accordingly.[101] It was common for nineteenth-century periodicals to provide their readers with a list of errata to correct mistakes made in a previous issue. As Gowan Dawson has argued, the serial format of the science periodical made it possible for publishers to include corrections in later issues, instead of producing a new revised edition of an expensive scientific monograph.[102] The example of the revised cement recipe in the *Microscopical Bulletin* suggests that the serial format also enabled publishers to share and correct recipes as they changed through experience.

Conclusion

The history of the American Postal Microscopical Club shows that the characteristics of craft knowledge identified by Pamela Smith for the early modern period also shaped artisanal practices in the nineteenth century: club members' knowledge of slide making was collaborative, empirical, particularistic and open to public scrutiny. However, these dimensions of craft knowledge only emerged through the knowledge infrastructures that members of the postal club helped to build and maintain. The members' collaboration relied on the club's chain-letter network and the reports published in microscopy periodicals, and it was only in the virtual forum of the periodical that microscope slides came under public scrutiny.

Craft knowledge of slide making thus came to be entwined with microscopists' skill in navigating the expanding information infrastructures of the late nineteenth century. In order to work with other club members, microscopists had to learn how to align (and adapt) the postal system, periodicals, and their knowledge of how to make durable slides. From its inception, the club not only depended on the American postal system but actively changed it, as demonstrated by its successful 1878 petition. The amendment of the postal law laid the groundwork for a postal system that facilitated the mailing of scientific trade items. Over time, the club's chain-letter network itself became a long-term experiment to test the durability of slides.

Moreover, in tracing the information infrastructures built by the American Postal Microscopical Club, this paper has laid bare strategies microscopists developed to learn how to make microscope slides without being able to meet and practice together. Learning how to prepare and mount specimens depended on the empirical observation of slides and illustrations, and their triangulation with written instructions. Observation was a craft in itself, with members observing materials by hand to understand why methods had succeeded or failed. While this demonstrates that craft knowledge was indeed, as Pamela Smith claims, empirical, it also suggests that one artisanal practice, observing by hand, could compensate for the lack of another collaborative practice, learning how to prepare specimens together. The case of the Postal Microscopical Club also shows that we should pay more attention to how reverse-engineering failure helped to acquire craft knowledge at a distance.

[100] 'Correction', *Microscopical Bulletin and Science News* (1886) 3(4), p. 31.

[101] The issue has been digitized and can be accessed through the HathiTrust library.

[102] Gowan Dawson, *Show Me the Bone: Reconstructing Prehistoric Monsters in Nineteenth-Century Britain and America*, Chicago: The University of Chicago Press, 2016, p. 139.

https://doi.org/10.1017/S0007087421000534 Published online by Cambridge University Press

The serial format of microscopy periodicals helped to turn the production of slides into a collaborative and public endeavour. There are many examples of nineteenth-century societies extending their activities into the pages of periodicals and becoming, at least partly, virtual communities in the process.[103] Microscopy periodicals faced the challenge of reporting on a club that was never more than virtual and needed published reports to function. James W. Queen & Co.'s *Microscopical Bulletin and Science News* matched the club's instructions with suitable tools, ingredients and tried recipes, assisting microscopists both in following the club's instructions and in their use of Queen & Co.'s products. The *American Monthly Microscopical Journal* helped to organize the chain-letter network by reporting on the location of slides, forwarding inquiries, and disciplining unreliable club members. To guarantee that the chain-letter system ran smoothly, the assessment of club members' individual skill and reliability became as important as the public judgement about the quality of slides. Evidently, the club's 'method for safe transmission' was much more than the secure box introduced along with the new postal law. It was a fragile network of people and objects that made the remote learning of craft knowledge possible and required just as much care as the handling of slides.

Acknowledgements. For their feedback on an earlier version, I would like to thank Raf De Bont, Stefanie Gänger and Cyrus Mody. I am also grateful to the organizers of the Logistical Natures workshop (Museum für Naturkunde, Berlin, 13–14 February 2020) for giving me the opportunity to present and discuss my work. Many thanks also to the two anonymous reviewers for their thoughtful and kind comments on my manuscript. The research for this article was funded by the Dutch Research Council (NWO) as part of the Advancing Microscopy project, grant number PGW.18.033/6344.

[103] See, for example, Geoffrey Belknap's discussion of the role of periodicals in building natural-history communities. Belknap, op. cit. (94).

Cite this article: Beiermann L (2021). 'A method for safe transmission': the microscope slides of the American Postal Microscopical Club. *The British Journal for the History of Science* **54**, 403–422. https://doi.org/10.1017/S0007087421000534