Steven David Johnson

Steven David Johnson is a conservation photographer and Professor of Visual and Communication Arts at Eastern Mennonite University in the Shenandoah Valley. His photography of the natural world has appeared in *Orion*, *Ranger Rick*, *Virginia Wlidlife*, National Science Teachers Association Press books and numerous conservation publications and journals. Johnson is vice-president of the Virginia Wilderness Committee and an Affiliate of the International League of Conservation Photographers. When not in the office, one will probably find him crouched next to a vernal pool photographing Appalachian salamanders. View more of his photographs at www.stevendavidjohnson.com and https://www.flickr.com/photos/stevendavidjohnson/albums

Daniel Kariko

Daniel Kariko is an Associate Professor of Fine Art Photography in School of Arts and Design at East Carolina University. His images investigate environmental and political aspects of landscape, use of land, and cultural interpretation of inhabited space. Inspired by his childhood during the civil war in Balkans, his interests in history and science inform his artwork through inquiry in geopolitics, and the disappearing and changing landscape. Kariko's work has been shown nationally and internationally in galleries, museums, and photography festivals. He received his MFA from Arizona State University, and from 2002 to 2010 served as a photography faculty at Florida State University.

Nancy M. Mahoney

Nancy Mahoney currently lives in Bozeman, Montana where she is an instructor in Anthropology at Montana State University. She holds a B.A. from Emory University, a M.A. from George Washington University, and is a doctoral candidate in American Studies. Her research focuses on identifying the relationships among social power, ritual authority, and economic advantage in ancient communities following the principles of structuration and practice theory. Mahoney's passion for travel has taken her to Cyprus, Morocco, Turkey, South Africa, Thailand, New Zealand, Namibia, Ecuador, Peru, Belize and Iceland.

Jennifer Tucker

Jennifer Tucker is a cultural historian of science specializing in the study of technology, law, photography, and visual culture. The author of *Nature Exposed: Photography as Eyewitness in Victorian Science*, has also published numerous articles and book chapters and recently completed a book manuscript about photography and facial likeness in the Victorian courtroom. Her current projects include a study of photographic chemistry and the Victorian alkali industry. The editor in 2009 of an issue of *History and Theory* about photography and history, she is co-editor of a forthcoming *Photography and Law Reader* and served as co-editor of "Politics of Technoscience," for *Radical History Review*.

Ian van Coller

Ian van Coller was born in 1970, in Johannesburg, South Africa, and grew up in the country during a time of great political turmoil. His most recent work focuses on environmental issues related to climate change and deep time. These projects have centered on the production of large scale artist books, as well as direct collaborations with paleo-climatologists. Van Coller's work has been widely exhibited and is held in many significant museum collections, including The Philadelphia Museum of Art, The Getty Research Institute, The Metropolitan Museum of Art, The Library of Congress, and The South African National Gallery. His first monograph, *Interior Relations*, was published by Charles Lane Press (New York) in 2011.

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Jennifer Tucker

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PHOTOGRAPHY SCIENCE WONDER

The term "scientific photography" often invokes a familiar list: dazzling iconic photographs of scientific phenomena - stars, x rays, bacteria, the moon. Scratch beneath the surface, however, and a more complex picture emerges of the subjects for the study of science and photograph.

The subject is quite as likely to include photographs of unfamiliar science experiments, visual documents of scientific expeditions, portraits of scientific teachers and students, series of slides used for projection for the purpose of scientific education, photographs of specimens in museums and police departments, scientific photographs used in social and political activism, and images (such as spirit photographs) that circulated for a time as part of counter-science movements, challenging scientific heterodoxies. Their study has, in turn, helped to broaden historical perspectives about the sciences and their integration within a variety of different professional and everyday settings.

Today, the domain of study on photography and science incorporates several distinct but overlapping fields, from the technological histories of photography, to the role of photography in scientific exploration, to the employment of scientific imagery in other sociocultural contexts, to the wide range of subject-specific scholarly debates that surround virtually all such visual conventions and practices. Where once scientific and technical photography were marginalized

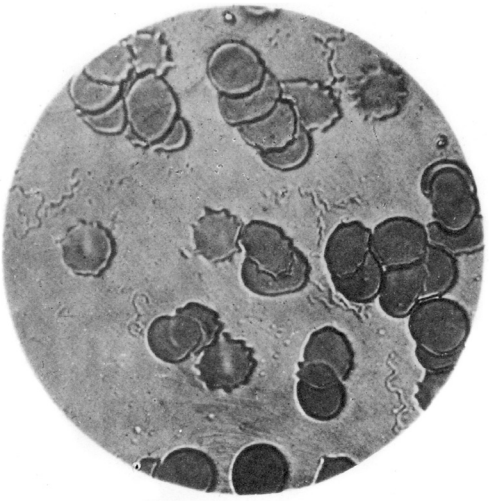

Fig. 3, x 700 Diam.

Fig. 1, 2 (orig. 3), 3. Yale Peabody Museum, Division of History of Science & Technology. Courtesy of Alexi Baker, Curator of the Collections.

in histories of nineteenth- and twentieth-century photography and science, studies over the past two decades have provided strong empirical foundations and critical frameworks for renewed histories of the role of photography in scientific investigation, from the early nineteenth century to the present.
What were the historical conditions of production and circulation? How were photographs used, interpreted, and, later, reinterpreted by others? What epistemologies authorized (or undermined) photography's uses? What sorts of meanings did photography compel, for which viewing audiences, and with what results? What is a 'scientific' photograph? What counts as 'science' in any given historical time or place?

Material and social traces of photography in science

From the start of their entanglements, photography and science were united through their common roots in the physical and natural sciences: photography was both an art and a science. The very representation of scientific objects in pictures, the use of photography to detect and measure phenomena, and the development of photography as a science drew upon material and intellectual forms of knowledge, from chemistry to optics to physics. Furthermore, contemporary artists have long addressed science as a focal point for their art, through their incorporation of scientific photographs into art institutions or art market; the investigation of scientific iconography in art; and the use of scientific concepts, such as observation experiment and archiving) in their making of art.

Yet from its earliest days, the reckoning of the importance of photography to society was also reckoned in terms of its contribution (not merely its indebtedness) to science. In 1839, the astronomer François Arago, director of the Paris Observatory, predicted astronomical applications for Daguerre's new process, and advocated its use to obtain an improved map of the moon. The French chemist J. L. Gay-Lussac echoed Arago's enthusiasm, declaring boldly that same year that photography promised to lead to scientific progress:

> [T]hrough Monsieur Daguerre's invention physics is today in possession of a reagent extraor-

> dinarily sensitive to the influence of light a new instrument which will be to the study of the intensity of light and of luminous phenomena what the microscope is in the study of minute objects, and it will furnish the nucleus around which new researches and new discoveries will be made (qtd. in Darius 11).

By 1860, British photographer F. F. Statham wrote that "To give a just and accurate idea of all that photography has done for science would be to write anew the whole history of the art" (qtd. in Darius 11). Editors of photographic trade journals, because they were exposed to a broad cross-section of early users of photography, recognized the complexity of networks of technology and the arts, as well as their applications in the new astronomical, medical, and biological sciences (see fig. 1-3). As a reviewer noted in 1864, despite the camera's impact on art, "It is to science…that photography, the child of science, renders, and will unceasingly render, the most valuable aid," adding that:

> There is scarcely one in the whole list of sciences which is not largely indebted to it. Astronomy and microscopic observations have benefited singularly from the increased accuracy that has been secured. It is a boon of enormous value to be able in any instance to eliminate that fruitful source of error, the fallibility of the observer. Photography is never imaginative, and is never in any danger of arranging records by the light of a preconceived theory (qtd. in Darius 11).

Fig. 4. Yale Peabody Museum, Division of History of Science & Technology. Courtesy of Alexi Baker, Curator of the Collections.

The French astronomer, P. J. C. Janssen argued in an 1888 speech that photography was useful to science not only because it promised (in theory, at least) a neutral, mechanically objective record, but also because it was able to conserve and propagate images for many other viewers—a point that the critic, Walter Benjamin would later develop in his 1936 essay "The Work of Art in the Age of Mechanical Reproduction." Janssen wrote: "The sensitive photographic film is the *true retina of the scientist*," he declared:

> for it possesses all the properties which Science could want; it faithfully preserves the images which depict themselves upon it, and reproduces and multiplies them indefinitely on request; in the radiative spectrum it covers a range more than double that which the eye can perceive and soon perhaps will cover it all; finally, it takes advantage of that admirable property which allows the accumulation of events, and whereas our retina erases all impressions more than a tenth of a second old, the photographic retina preserves them and accumulates them over a practically limitless time (qtd. in Hannavy 1255, italics added).

Almost immediately after its invention, the camera was being described as a 'handmaiden' of science, in part because it could perform such a wide variety of different tasks within the natural sciences. The author of "The Art Question" in *Photographic News*, published in 1872, described photography as "handmaid of the visible world," while in an essay titled "What Photography Does for Science," published in 1882 in the British journal The *Photographic News*, a photographic correspondent narrated the evolution of photography's role, from tool of discovery to routinized instrument of everyday science, explaining the transition as one from "upper-servant" to "handmaiden" (terminology of domestic service with which many of its middle- and upper-class readers were familiar): "Fifteen years ago she [photography] was a species of upper-servant performing valuable services enough, but rather of a light order. To-day she is a maid-of-all-work, put upon, on every occasion, to discharge all sorts of functions, whether manual or high-class'. Where nature had once been 'fugitive,' wrote Joseph Auguste Belloc in the *Photographic News* in 1858, it was now 'subservient to our will."

Scientific and medical atlases, illustrated with photographs and other images, became a prominent means for disciplines to educate the next generations of practitioners and present a consolidated (if limited) picture of their objects of empirical study (e.g. stars, bones, fossils) (see fig. 4, 5). Scientific atlases

were vitally important in defining historically changing regimes of epistemic virtues to which scientists were encouraged to aspire. Yet in practice, photographers and scientists also negotiated and, importantly, contested the prescriptive meanings of photography through other, less expensive media, such as correspondence and conversations, and even in the burgeoning technical literature aimed at amateur and professional photographers.

Not only were inventors and scientific experimenters among the shapers of photographic processes, they were also among the very first individuals to create historical narratives about scientific photography. Eager to situate the new medium in relation to longer artistic and technological traditions, the earliest histories of photography quickly acquired a set of historical narratives. These, and other, scientific experimenters promoted an image of the new medium of photography as a scientific tool—an aspiration that followed the medium as photographic technologies and processes spread quickly around the world. Nineteenth-century journals such as *The Photographic News* frequently published reports of the use of photography in various domains of scientific exploration as photography became a large outlet for artistic and scientific works of all kinds, across a range of social backgrounds and creative settings. Technical journals, too, informed members of scientific communities about possible uses of photography in research or teaching, giving suggestions for scientific applications, such as high-speed photography. Scientific publications are, therefore, an important and often neglected source for early historical accounts of photography.

Fig. 5. Yale Peabody Museum, Division of History of Science & Technology. Courtesy of Alexi Baker, Curator of the Collections.

These and other studies reveal the existence of extensive historical sources for the study of the relationship between science and photography. Primary sources for the study of photography and science include a rich and, in many ways, barely explored ranges of laboratory and field books, material apparatus, correspondence, patens, and scientific publications.

Above all, the findings of recent research on science and photography has led to the recognition that visualization within the sciences is *not a single kind of practice* or practices. The concept of the "black box"—a metaphor borrowed from cybernetics denoting a piece of machinery that "runs by itself"—became widely used in science and technology studies of photography. Latour used photography as a leading case in his 1990 essay, "Drawing Things Together," in which he cited Reese Jenkins, the author of the 1987 publication *Images and Enterprises: Technology and the American Photographic Industry*, 1839-1925. Latour used Jenkins' example of the simultaneous invention of the Kodak camera and the mass market for amateur photography in trying to explain why technology is such an enigma for social theory - showing that the domination of the Eastman company was visible only at the *end* of the process. The concept of "boundary object" was introduced to describe information such as specimens, field notes, drawings, photographs, and maps that were used in different ways by different communities. While objects might have "different meanings in different social worlds," their structure is "common enough to more than one world to make them recognizable, a means of translation" (Starr and Griesemer 387).

Key concepts like these, focusing as they do on the complex historical meanings of social practices surrounding the making, viewing and circulation of images, have great potential for future studies of photography and science. They promise to advance the subject of scientific photography beyond the previous focus on individual photos and their discoverers, and to lay groundwork for future work on scientific photography.

Sciences and Photographs in Everyday Life

We often think of science photography in the context of the lab, exploration, discovery, and so on. Yet, as the works in this special issue make clear, "scientific" photographs are also deployed, circulated, and consumed (and disputed) in popular culture. Moving forward, therefore, future studies of the relationships between photography and the sciences must continue to forge new understandings of the relationships between pho-

tography and science beyond the laboratory, in the myriad settings beyond the field and the laboratory where scientific photographs were made to do work: for example, in forensics, advertising, teaching, and communication and investigation activities. By forging new understandings about the historical conditions and processes through which new forms of knowledge arise and are legitimatized in the first place, such approaches can lead to new ways of thinking about science and photography.

Fig. 6, 7. Yale Peabody Museum, Division of History of Science & Technology. Courtesy of Alexi Baker, Curator of the Collections.

Among the variety of rising topics that are currently being studied that may be included in this category are investigations of the use of lantern slides for scientific gatherings and instructional settings, as scientific education expanded and often stressed direct study of objects over "book knowledge" (see fig. 6, 7). Periodicals are being studied for knowledge of how photography of natural phenomena was deployed for mass readerships. Studies of metaphors of science and medicine in photography highlight the cross-fertilization of language and technologies, and studies of science as a business puts the analysis of capital and labor at the center.

Relevant here, too, are studies that build upon, and extend, explorations of the "biographies of scientific objects", which question "how a heretofore unknown, ignored, or dispersed set of phenomena is transformed into a scientific object that can be observed and manipulated" (Daston 5). Historians of science and photography may also make new findings by investigating how and why photographs "travel" in the company of other images. By studying the way photographs circulate, we may learn about many new aspects of their "character and means of production' (Howlett and Morgan 28).

Generally speaking, photographic studies have a way to go to address the persisting problem that historians too often make, of assuming, or taking for granted, that the boundaries of science in the past were clear to practitioners when, in fact, what has counted as properly 'scientific' knowledge is continually negotiated and evolving as new fields emerge and rival forms of knowledge are disputed. Photographs were not merely used 'in' science; their employment helped demarcate, and sometimes confuse, the very meaning of 'science' in a given place and historical period. In fact, the majority of leading histories of science today argue that the forms, demarcations, and contours of knowledge were shifting and continually contested and reformed. As photographic studies and historical studies of science travel together more, we can expect many more studies than heretofore about alternative and contested forms of scientific knowledge.

Need for historical conservation

Moving forward, however, one of the biggest challenges facing scholarship about science and photography may be collecting and conserving historical sources. The majority of scientific photographs—to the extent that they survive at all—are often organized in ways that make them hidden to researcher, for photographs made for scientific purposes often are unattributed or attributed in ways whose context has been lost. Individual photographers in the sciences did not establish their authorship of the images in some of the conventional ways that are familiar to fine art photographs that had a commercial market. There is a tendency to view individual scientific images or their collections as exemplifying "old" (and, therefore, irrelevant) science—and not worth preserving.

Universities, libraries and museums continue to be an important site for collection, preservation and circulation and public interpretation of materials—and much important critical work on photography and scientific archives emerges from this site. These have looked at a variety of uses of photography in science, "from the official announcements of the medium's invention in 1839 to its maturation as an industrialized process by the end of the nineteenth century" and considered "what it meant to 'see' photographically." Keller (20) urged that, "It is crucial to point out that neither science nor photography can be considered a fixed or monolithic category during this formative period. In order to fully understand these pictures and the issues that surrounded them, we must not only attempt to recover the vast conceptual distance between ourselves and the nineteenth century, but also acknowledge the important changes that occurred between the early 1800s and its later decades."

Historical research on scientific photography also could also benefit greatly from increased collaboration among archivists and academic scholars. More collaboration and partnership among scholars and curators are necessary to ensure that photographic collecting does not occur in the field of fine arts, alone (or primarily). Historical research on scientific photography may also benefit from the development of studies that focus not so much on individuals or particular photographs, but on the use of photography and photographs by institutional cultures such as the Royal Society, the American Association for the Advancement of Science, and the like.

Conclusions

Over one hundred and fifty years after its invention, the practices of science and photography still afford an excellent vantage point from which to consider more generally the historical uses of photography. From a comparatively small field of study focused on a small handful of inventors and applications in the laboratory and field, the study of the changing historical relations between science and photography has grown into a rich body of work about the forms that scientific images take, what they reveal, how they transform the disciplines they serve, and the lives they influence. ■

Portions of this essay will appear in Tucker, "Photography and the Making of Modern Science," in *The Photography Studies Handbook*, ed. Gil Pasternak (London: Bloomsbury Academic Press, 2019).

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The Materiality of Scientific Photographs and Those Who Make Them: An Interview with Chitra Ramalingam

by Azher Jaweed

Chitra Ramalingam is the Associate Curator of Photography at the Yale Center of British Art and Lecturer in the History of Science and Medicine at Yale. Her research interests include 19th century Victorian visual culture and science, the visual complexity of electricity and the manner by which British scientists grapple with its potentialities, and the history and theory of early photography. Ramalingam is fascinated by the overlaps between the darkroom and the laboratory. In other words, she composes a narrative for a scientific photograph based on the epistemological function of the photograph, the eclectic cadre of experts from various fields involved in its production, and the techniques used to create it. "The history of photography is about more than just the aesthetics and form of a photograph," Ramalingam says. "It is also about photography as a practice, or about disciplinary communities that form around using such techniques for establishing truth."

Plate 18, William George Armstrong, *Electric Movement in Air and Water with Theoretical Inferences* (London: Smith, Elder, & Co, 1897), collotype. Courtesy of the Yale University Library.

How did you become interested in Science and Photography?

I learned black and white photography in high school, as a fun extra-curricular. I wasn't much of a photographer, but I loved the unpredictable chemical magic of the darkroom, which has stayed with me. I went on to double major in physics and philosophy in college and started on the path towards becoming a particle physicist before eventually settling on a PhD in history of science—a field I only discovered at the very end of college. I focused on Victorian physics and found it mind-blowing to encounter the contingent and unexpectedly human histories behind the systems of thinking I'd been trained to take as a given in my physics classes. In my second year of graduate school, I encountered a strange and beautiful book from 1897 called *Electric Movement in Air and Water*, by an influential British engineer and arms manufac-

turer named William Armstrong. It included over 50 beautiful, puzzling photographs of electrical sparks and discharges, and an essay in which Armstrong drew the idiosyncratic but powerful conclusion, based on the photographs, that electricity was ultimately just traces of the movement of a divine mind. I built a whole dissertation around trying to understand how and why this book made sense to me.

What ideas or interests are you most passionate about in your field at this current moment?

Working in a museum has made me more attuned to the materiality of photographs, something that the field has been turning to more and more recently. A photograph's material form can be as central to its meaning as the image it presents. This has become central for me in an essay I'm writing on early x-ray photographs, and in an exhibition and collaborative research project I'm starting on the science and aesthetics of faded photographs.

If you could use any camera or photographic technique from present or past to take a photograph of yourself, what would it be?

I've had the experience of making an ambrotype (collodion positive on glass, a nineteenth-century photographic process) self-portrait of myself a few years ago. I love the solemnity and heaviness of my pose, which comes from having to hold still for an eight-second exposure, and the poor focus, which comes from my not understanding the optics of the replica late-nineteenth-century plate camera I was using, and the various marks, stains, and other imperfections on its surface that resulted from my clumsy manipulation of the photographic materials. You have to clean and polish the glass plate, and then hold the plate in your hand while you pour the collodion onto its surface, gently tilting it

Chitra Ramalingam, self-portrait, ambrotype, 2015

in every direction to allow this gooey substance to spread across most of the plate, before drying it, sensitizing it by immersing it a chemical bath, exposing it almost immediately in a camera while still wet, fixing it, drying it, and varnishing it. More than the picture itself that I'm now left with, I valued the intense physical experience I gained, however brief, of the messiness and magic of these early techniques. I now have a more intuitive, embodied understanding of what I always remind my students: that early photographs were unique handmade objects.

How does your background in history inform your decisions as a curator of photography at the YCBA?

As a historian my primary interest in photographs has always been in their role as historical and cultural documents, rather than as art objects, though I am interested in that

EYES ON MAIN STREET
EXHIBITION

Plate 23, William George Armstrong, *Electric Movement in Air and Water with Theoretical Inferences* (London: Smith, Elder, & Co, 1897), collotype. Courtesy of the Yale University Library.

too. I'm instinctively less interested in the beautiful than I am in the compelling story, and in the mundane ways that photographs are embedded into human lives, and entangled in the ecosystem of culture. At the YCBA I do acquire and curate displays of photographs that were self-consciously made as artworks, but I tend to present them in terms of historical narratives, rather than as aesthetic objects. That's certainly not the only way to understand them and their meaning, but that's who I am in my curatorial persona.

Can you tell us about any upcoming exhibits that will go up at the Yale Center for British Art?

Recently I've started an interdisciplinary, collaborative research project, *Fixing and Fading: Photographic Histories*, which involves historians of art, historians of science, anthropologists, conservation scientists, curators, and contemporary photographers. This project, which will result in a book and an exhibition at the YCBA, poses historical, conceptual, and ultimately political questions about what kind of object a faded photograph is: what kinds of aesthetic possibilities does it offer, how should a museum care for it or display it, and what histories can it tell? ■