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# PhotoResearcher

# Three-Colour Photography around 1900

*Technologies*

*Expeditions*

*Empires*

*Guest Editor*
Hanin Hannouch

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COVER IMAGE: Jan Szczepanik, *Poppies* (detail), 1903, colour print. Private collection of J. Szczepanik-Dzikowski.

# Editorial

*Look back at the nineteenth century when colour photography did not exist – apart from some marginal exceptions that had little influence on the understanding of photography.*[1]

The prerequisites for producing, recognizing, and experiencing colour photography as an aesthetic, medial and visual language were disclosed at the turn of the 19th and 20th centuries, conquering the world like wildfire. Scientists, photography amateurs and professionals used colour photographic methods in a variety of disciplines and investigative fields, such as anthropology, medicine, and geography. They also disseminated their knowledge and images to interested audiences and potential sponsors in local and international networks, out of which their colourful practice emerged.

fig. 1
H. C. Tibbetts, *Untitled* (Panama-Pacific World's Fair in San Francisco), 1915, Color Paget. Private collection of Mark Jacobs, Madison, WI.

One such method was three-colour photography. Despite the enthusiasm for it at the time, comparatively few publications about it exist, with E. J. Wall's *The History of Three-Colour Photography* (1925) and Jordi Cat's *Maxwell, Sutton, and the Birth of Color Photography: A Binocular Study* (2013) being the only monographs. Crucial scholarship has explored how Charles Cros (1842–1888) and Louis Ducos du Hauron (1837–1920), without knowing each other, used three-colour photography to solve the medium's oldest problem, the absence of the world's shades on the photographic surface, but this research remains restricted to the French Empire.[2] Hence, photography historians and aficionados today have limited secondary literature providing an insightful overview of this medium or guiding them through its complex and multi-layered specificities beyond a single regional focus (→ fig. 1).

*PhotoResearcher No. 37* is the first publication in recent times to investigate the rich material-scientific-political uses of three-colour photography at the turn of the last century. It maps the shifting expressions of its technologies, tracing the various expeditions during which it was deployed, the neighbouring disciplines it serviced, and problematizing its imperial entanglements. It does so on a larger scale than what is often afforded this medium, connecting countries through three-colour practices.

The difficulty of researching three-colour photography partly stems from the ambiguity of this wording. "Three-colour photography" does not refer to a unified medium but is an umbrella term encompassing a large variety of heterogeneous colour photographic processes. Though they differ in materiality, aesthetics, and history (and may not be identifiable to scholars working on photographic collections),

1 → Peter Geimer, 'Testimony of Things Past: Testimony and the imagination', in: Sybille Krämer and Siegried Weigel (ed.), *Testimony/Bearing Witness: Epistemology, Ethics, History and Culture,* London 2017, 212.

2 → Nathalie Boulouch, *Le Ciel est bleu. Une histoire de la photographie couleur,* Paris 2011, 26–31. Nathalie Boulouch., 'Peindre avec le soleil?: Les enjeux du problème de la photographie des couleurs', in: *Études Photographiques,* vol. 10, 51–75.

fig. 2
Bermpohl, *Prof. Dr. Miethes Dreifarben Camera* (three-color camera), 2008. Harald Renbjør's estate, Levanger Museum of Photography. Photographed by Nils Torske.

they roughly follow the same principle: An object is recorded when the light that hits it goes into three colour filters (red, blue, green), and then reaches three different photographic (and usually) panchromatic glass plates inside the camera (__fig. 2). Hence, the colour is split or 'analysed' into three separation negatives. In order to 'restore' the colour, photographers issued three glass slide positives and projected them through the same colour filters. In this case, the colour is only visible when projected through a dedicated three-colour projector (this is "the additive method" combining the above mentioned primary spectral colours; see Geoffrey Barker's text about Colour Paget, Rachel Wetzel on Ives' Kromograms). Colour printing (referred to as a subtractive method since it often combines subtractive primary colours cyan, magenta, yellow) was feasible through several labour-intensive strategies: Dye imbibition processes relying on the creation of print matrices based on the negatives (see Janine Freeston on the War-Type and the Pinatype, and Inga Lára Baldvinsdóttir on Sanger-Shepherd) (__fig. 3), dye destruction (see Dominika Sulińska on the bleach-out method), chromogenic or pigment processes.[3] A new variation to Three-colour photography has recently emerged: Digital trichrome reconstruction (__figs. 4a, b, c) by which museum workers replace the projector – with its inherent risk of damaging glass plates – with software to help reclaim the image's hues (see interview with Nils Torske).[4]

Another predicament researchers face when studying this medium is that three-colour photography's cultural importance is often negated, as the quote at the beginning of this editorial reveals. This medium exists within a theoretical and historiographic vacuum: The theoretical vacuum is expressed by the fact that, unlike its monochrome counterpart, trichrome photography's scientific impact is downgraded due to its supposed inability to operate as evidence.[5] Yet, three-colour photography is underpinned by a physical understanding of human colour vision which began in the late 18th century[6] in a triangle between scientists Thomas Young (1773–1829), Hermann von Helmholtz (1821–1894), and James Clerk Maxwell (1831–1879). In 1801, Young's trichromatic theory of vision was based on the premise that primary colours are three and on light's nature being undulatory. His work "had just enough plausibility to stimulate continuing discussions,"[7] especially those undertaken by Helmholtz whose notion that most people require only three wavelengths to be able to perceive the complete spectrum of visible colours[8] became known as the Young-Helmholtz theory. Crucially for three-colour *photography,* Helmholtz distinguished between two different physical processes of additive and subtractive colour mixing; the fact that colours in light rays act differently than colours in pigments, respectively.[9] In 1861, during a Royal Institution lecture, Maxwell

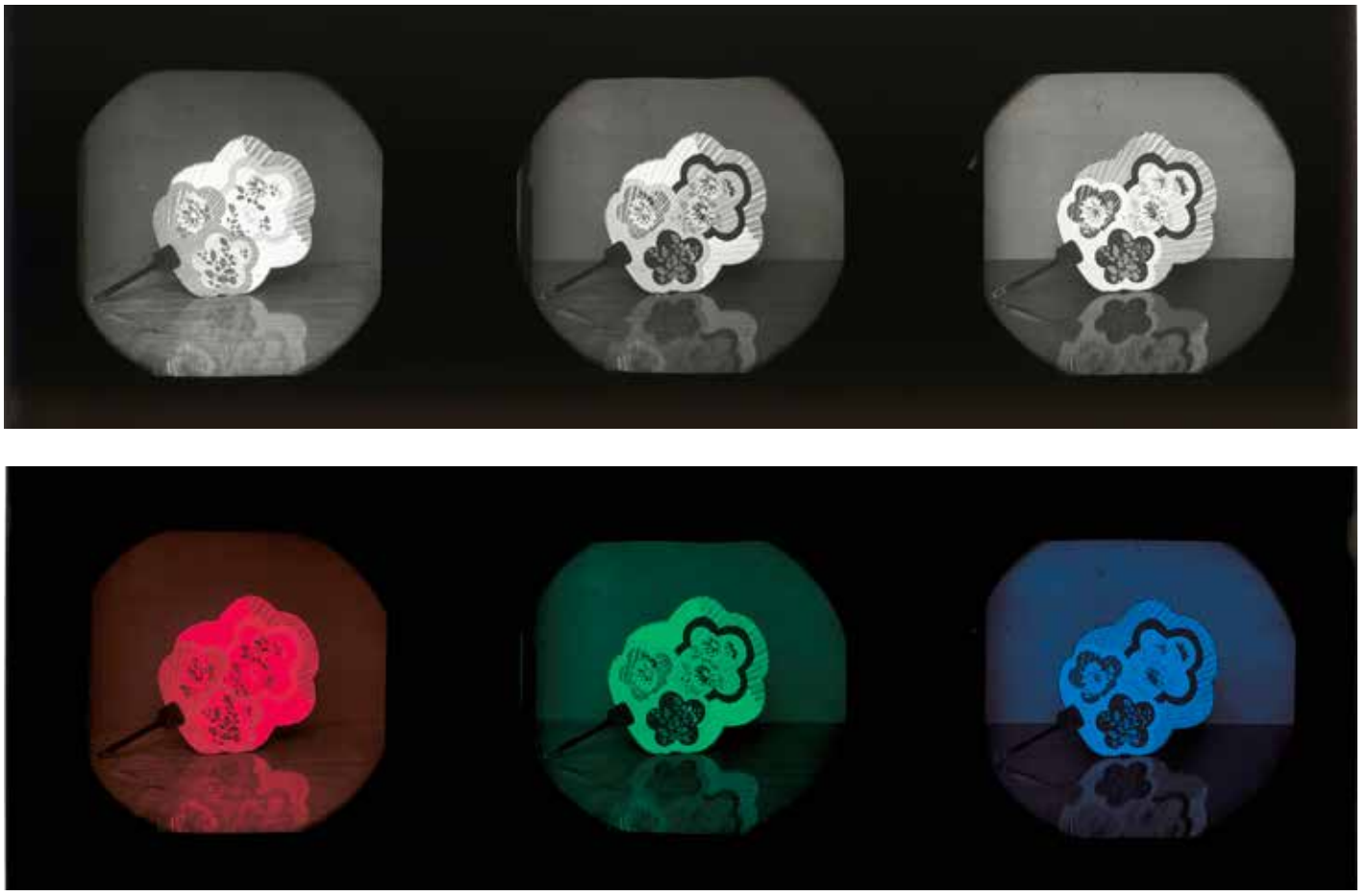
3___ Sylvie Pénichon, *Twentieth Century Colour Photographs: The Complete Guide to Processes, Identification & Preservation,* London 2013.
4___ Victor Minachin, Dmitry Murashov, Yury Davidov, Dmitry Dimentman, 'A Technique for Restoration of Triple Colour Images' <http://www.ccas.ru/dmmur/doc/Murashov_TMO2008.pdf> (20. 01. 22).
5___ Monika Wagner and Helmut Lethen, *Schwarz-Weiss als Evidenz: "With black and white you can keep more of a distance",* Frankfurt am Main 2015.
6___ While some authors claim that ecclesiastic Marco Antonio de Dominis' (1560–1624) theory that all colours could be mixed out of red, green, and violet rays is the starting point of the medium, Gert Koshofer, *Farbfotografie. Band 1: Alte Verfahren,* Munich 1981, 23.
7___ Paul D. Sherman, *Colour Vision in the Nineteenth Century: The Young-Helmholtz-Maxwell Theory,* Bristol 1981, ix.
8___ Pénichon 2013 (reference 3), 5.

fig. 3
Unknown photographer, Courtyard with Sun Dial, Sanger-Shepherd three-color process plate
10.25 × 13 cm. Private collection of Hugh Tifft, United States.

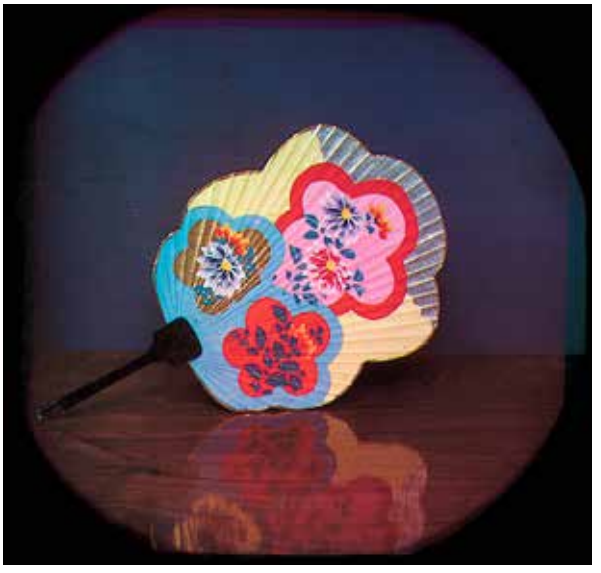
presented the world's 'first' practical demonstration of the Young-Helmholtz principle through a trichrome photograph. His collaborator Thomas Sutton (1819–1875) shot a tartan ribbon against a black background four times, through red, green, blue, and yellow filters. Three of the four resulting glass slide positives (the yellow plate was discarded during the actual demonstration) were each projected through the same filter they were captured through and superimposed to produce a single colourful image (→ fig. 5). This iconic projection session marked the scientific roots of trichrome photography.[10]

Furthermore, during the past twenty years, the history of photography has experienced an 'Autochrome turn', which is the increased investigation of the history of the Lumière Brothers' colour process which they patented in 1903 and marketed four years later.[11] This investigation, surprisingly, has not fuelled in-depth explorations of other colour photographies, whose analysis remains particularly exacting. Yet, three-colour photography coalesced with the Autochrome and with Gabriel Lippmann's interferential colour photography. Together, they shaped visual culture – each in their unique fashion. Lippmann's method was first made public in 1891, garnering interest for almost two decades. It initially relied on a silver-halides in albumen emulsion, one that is ultra-fine grained enough to be able to resolve the standing waves of light *without* needing either colour separation or added dyestuff.[12] For example, Frederic Eugene Ives (1856–1937) researched both the Lippmann process[13] and three-colour photography, as did the Lumière Brothers,[14] before eventually turning to the Autochrome. Although both the Autochrome and three-colour processes generated a colour image, the differences between them were numerous: For example, photographers needed one click to release the shutter of the camera when shooting an Autochrome but three clicks for three-colour photography (during its initial stages), which in turn delayed the latter's exposure time.[15] The Autochrome generates a one-off transparency demanding either projection or diascope viewers to be made visible. Also, since it is a direct positive, printing an Autochrome was challenging and costly, often only weakly

9 → Sherman 1981 (reference 7), 86.
10 → Jordi Cat, *Maxwell, Sutton, and the Birth of Colour Photography: A Binocular Study,* New York 2013,114.
11 → Trond Erik Bjorli and Kjetil Ansgar Jakobsen, *Cosmopolitics of the Camera. Albert Kahn's 'Archives of the Planet,* Bristol 2020 ; Caroline Fuchs, *Das Autochrom in Großbritannien Revolution der Farbfotografie,* Berlin 2017; Lionel Nathan de Rothschild and Victor Gray, *The Colours of Another Age: The Rothschild Autochromes 1908–1912,* London 2007; Paula Amad, *Film, the Everyday, and Albert Kahn's Archives De La Planète,* New York 2010.
12 → Hanin Hannouch, *Gabriel Lippmann's Colour Photography: Science, Media, Museums,* Amsterdam 2022 (forthcoming).
13 → Susan Gamble, 'Lippmann (1845–1921) & Frederick Ives (1856–1937): the Physicist versus the American Amateur in the pursuit of 3-Dimensionality', in: *International Journal on Stereo & Immersive Media,* vol. 5, issue 1, 38–57.
14 → The Lumiere brothers attempted to commercialize Lippmann's method between 1892 and 1896 but due to the complexity of its technical genesis and its irreproducibility (among other reasons), they turned to other colour media.
15 → The exposure time of the Autochrome were relatively long (over one second) because the processed plates were dense with less than 8 % of the light reaching them. Then again, Miethe's method needed at least 3 seconds in bright sunlight for all three exposures. Therefore, exposure time was not a discounting factor for either process.



figs. 4a–c
Frederick Eugene Ives, *Japanese Fan,* circa 1898, Projection Kromogram, digital reconstruction by Jan Hubička. Private collection of Mark Jacobs, Madison, WI, United States.
4b: Kromogram without colour.
4c: Kromogram with digitally-added colour.



rendering colours. These material conditions gave the Autochrome a suggestive and painterly (pointillist) appearance which secured its broad use among amateur photographers.[16] Three-colour photographs, however, are anchored in their separation negatives and are thus reproducible. In the German Empire, for example, they were printed starting 1902. Moreover, Autochrome screens were constituted of translucent red, green and blue dyed starch granule components in equal proportions whose "random distribution meant that inevitably there would be clumping – groups of grains of the same colour,"[17] whereas three-colour photography, depending on the process, used a grid, mosaics, or a striped pattern to be able to separate light giving it various microscopic structures and disparate aesthetics. For example, such is the unique 'striped' appearance of the plate seen in fig. 6, made by Irish scientist John Joly (1857–1933) using his line screen process. Beyond the turn of the last century, trichrome photography remained the dominant photographic principle for years to come. Kodak's subtractive three-colour Kodachrome process, developed between 1917 and 1935, expanded the medium's materiality from three glass slides to a three-layered film creating a novel colour aesthetic with rich hues and a wide dynamic range.[18]

fig. 5
James Clerk Maxwell and Thomas Sutton, *untitled* (Tartan Ribbon), digital reconstruction of Maxwell's 1861 experiment made from D.A. Spencer's duplicates of Maxwell and Sutton's original glass slide positives circa 1937, 20 × 25.4 cm, digital reconstruction by Jan Hubička. Private collection of Mark Jacobs, Madison, WI.

*Three-Colour Photography around 1900: Technologies, Expeditions, Empires* historicises three-colour photography in its changing manifestations, exploring what its different media express and the entangled conditions (technological, institutional, and scientific) under which they do so in a given moment. The articles are organized in pairs analysing a use of a trichrome process as either embedded in a surrounding network of local camera clubs, commercial manufactures, financing institutions 'at home', or on expeditions abroad where photographers faced different practical, political, and theoretical challenges. The tension between both levels is particularly fruitful for studying how empires shaped their own self-image, either through renowned photographers or famous travellers, or both, and how the latter visually constructed (and at times depended on) imperialism for their practice.

Janine Freeston's article explores Agnes Warburg's determination to establish herself as a key figure in the British photography scene, by building her own networks of highly-skilled amateurs, designing a printing process – the War-Type – and by causing journalistic controversy with her print *Carnival*. Geoffrey Barker's examination of Australian photographer Frank Hurley's use of the Colour Paget process

16 William R. Alschuler, 'Colour Theory and Practice', in: John Hannavy (ed.), *Encyclopedia of Nineteenth Century Photography,* New York 2008, 321.
17 Brian Coe, Colour Photography: *The First Hundred Years 1840–1940,* London 1978, 52.
18 Nicolas Le Guern, 'La recherche à long termedu Kodachrome trichrome: la collaboration scientifique entre Mannes, Godowsky et Eastman Kodak', in: *Support/Tracé,* vol. 19, 2019, 183–193.

fig. 6
John Joly, *untitled,* ca. 1894, screen line process 8.2 × 8.2 cm, inv. no. NMFF.FR.000502
Preus Museum: National Museum of Photography, Norway. Photographed by: Ana Gonçalves/Preus museum.

between 1908 and 1911 centres on the place of colour in Antarctic photography. It also reveals how the messiness of major national expeditions to Antartica leads to competing narratives about the role of the photographer. Rachel Wetzel presents American photographer Frederic Eugene Ives who, throughout the 1890s, contributed to three-colour photography on both sides of the Atlantic with his Kromogram images and Chromoscope product lines thanks to his unique combination of science and technology.

Hanin Hannouch links the empirical research of German anthropologist Gustav Fritsch on the eyeball as racial marker with his theory and practice of three-colour photography, centring on his rivalry with photochemist Adolf Miethe and the eventual victory of the latter's methods. Inga Lara Baldvinsdóttir focuses on Karl Grossmann, a German ophthalmologist working in Liverpool. He relied on the Sanger-Shepherd process to capture the ravages leprosy caused to patients' faces in Iceland in 1904, and whose identities the author reveals. Grossmann's work marks some of the earliest uses of three-colour photography in a medical context.

Dominika Sulińska's research centres on photographer and all-round scientist Jan Szczepanik who worked across numerous media in Poland and central Europe. He was acclaimed for his unique use of textile as a material for photographic printing and, despite commercial challenges, still innovated in three-colour photography creating a bleach-out process on paper, and later turning to glass and film.

Rolf Sachsse explores Sergei Mikhailovic Prokudin-Gorskiĭ's lengthy documentation project of the Russian Empire, its shifting stakeholders, and some of its most iconic images, after highlighting the photographer's brief but formative stint in Berlin. Prokudin-Gorskiĭ is known to scholars today thanks to Viktor Minachin's digital reconstruction of the colours of his separation negatives. Photographer and former technical conservator Nils Torkse details the continued importance of Norwegian chemist and photographer Harald Renbjør and his estate at the Levanger Museum of Photography, presenting some of Norway's earliest three-colour photographs. Torske explains the centrality of linking historical three-colour photography with current digital technologies enabling the virtual reconstruction of three-colour negatives. Also, he shows that this centuries-old colour principle exerts fascination on contemporary analogue photographers eager to secure it a future trajectory.

*Hanin Hannouch*
*Vienna, April 2022*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# Gustav Fritsch around 1900: Anthropology and Three-Colour Photography in Imperial Germany

*Hanin Hannouch*

fig. 1
Paul Broca, 'Échelle chromatique des yeux', chromolithograph, in: Paul Broca, *Instructions générales pour les récherches anthropologiques à faire sur le vivant,* Paris 1879.

"It is difficult, indeed, impossible to extract and preserve fresh eyeballs within one hour after death in order to preserve them." [1] This quote is taken out of the obituary of comparative anatomy professor, anthropologist, and photographer Gustav Fritsch (1832–1927). It was written by his former student, anatomist Victor Graf Haller von Hallerstein (1887–1953), who also refers to him as "a good German" although Fritsch succeeded in weaving an international web of violence and deceit that enabled him to illegally acquire and transport, from several parts of the world, hundreds of human retinas, which he termed "racial eyes" (Rassenaugen).[2] Nevertheless, most scholars today barely mention his engagement with the retina as a racial marker,[3] while some omit it altogether [4] although it began in 1890 and dominated his research for two decades. Within this overarching and time-consuming investigation of the retina which obsessed Fritsch, can his short-lived theory and practice of three-colour photography (1901–1904) be awkwardly located. The entanglement of ocular racial science with three-colour photography is unique to Fritsch since no other anthropologist in the German Empire at the time attempted such a sinister juxtaposition. This juxtaposition is not only crucial to a more nuanced history of anthropology but also of colour photography.

The scholarship about the history of colour photography has often excluded the latter's relationship to science and experimentation in favour of technical narratives, as Francois Brunet noted.[5] Such narratives have also, I argue, minimized the epistemological ties that bind three-colour photography to its coeval disciplines, such as anthropology, and the way in which one influences the conditions under which knowledge about the other is produced, generating a double-feedback loop. As I will demonstrate, Fritsch, partly financed by the chemical industry, broke entirely with physicist Hermann von Helmholtz's (1821–1894) theory of three-colour vision in order to address three-colour photography through more empirical methods whose importance for colour research increased at the turn of the last century. Fritsch transferred empirical practices from anthropology to three-colour photography, specifically histology, studying the microscopic tissue of the eyeball, an organ he thought of as a definitive racial marker *and* equated with the camera. This

1 ___ Graf Haller, 'Gustav Fritsch zum Gedächtnis', in: *Anatomischer Anzeiger,* vol. 64, Nr.14-15, 1927–1928, 263.
2 ___ Haller 1927–1928 (reference 1), 262–263.
3 ___ Andrew Bank, 'Introduction. The life and photographic career of Gustav Theodor Fritsch, 1838–1927', in: Keith Hamilton Dietrich, Andrew Bank, *An Eloquent Picture Gallery: The South African Portrait Photographs of Gustav Theodor Fritsch, 1863–1865,* Auckland Park 2008, 15. Harry Grundfest, 'The Different Careers of Gustav Fritsch (1838–1927)', in: *Journal of the History of Medicine and Allied Sciences,* vol. 18, 1963, 128.
4 ___ Annette Lewerentz, 'Der Mediziner Gustav Fritsch als Fotograf. Dokumentation seiner Anthropologisch-Ethnografischen Untersuchungen in Fotografien der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte', in: *Bässler-Archiv: Beiträge Zur Völkerkunde,* 2000, no. 48, 271–309.
5 ___ François Brunet, 'The International Historiography of Early Color Photography', in: Symposium on 19th Century Color Photography, National Museum of American History, Smithsonian Institution: *Experiments in 19th-Century Color Photography,* 8 November 2009.

equivalence, however, was not metaphorical since, for him, the three-colour camera has to operate *like* a living eye on the minutest of levels in order to contribute to the medium's advancement. The unusual route Fritsch used to examine three-colour photography was distinct to him and it conflicted with rival Adolf Miethe's (1862–1927) reliance on another empirical method to propel his famous career in the same field: Photochemistry. The extent to which Fritsch's methodology furthered three-colour photography and racial science is the subject of this article.

### Colour, photography, and anthropology

Throughout his career, Gustav Fritsch's research on colour in anthropology and in photography overlapped, especially so at the turn of the last century, when he became increasingly interested in three-colour photography.

Anthropology in the German Empire considered itself a natural science (rather than a humanistic science) studying what it derogatorily referred to as "natural people."[6] Its methodological professionalization starting mid-19th century incited practitioners such as Gustav Fritsch, anthropologist Paul Broca (1824–1880) in Paris, and doctor of medicine Rudolf Virchow (1821–1920) in Berlin to describe and standardize the colours, sizes, and shapes of hair strands, skin, and the iris, in order to map the existence of allegedly different "races of people" across geographies (→ fig. 1).[7] Fritsch also contributed to anthropology's professionalization by stressing the importance of photography in his 1875 article in Georg von Neumayer's pivotal edited volume *Anleitung zu wissenschaftlichen Beobachtungen auf Reisen*.[8] Unlike Virchow who championed the reliance on statistics, drawing, collection of objects, and description for anthropological field research, Fritsch deemed the camera central for objective observation at a time when it "was not a universally applicable representational tool."[9] In doing so, he was the first to create an anthropological iconography that dominated the German-speaking world.[10]

Like many photographers of his time, Fritsch bemoaned the absence of colour in photography and the photographic plate's inability to render degrees of brightness in the image (which was due to the colour blindness of the emulsion, a problem only resolved with panchromatic sensitization almost half a century later). He considered this lack the biggest and sole argument against the use of the medium during expeditions. As a remedy, he had to rely on reproductive media to transmit the colours photography was still blind to.[11] Following his 1863–1866 travels to South-Africa, and his subsequent 1872 book *Die Eingeborenen Süd-Afrikas,* Fritsch featured sixty copper engravings of photographs of people depicted through the anthropological canon, facing forwards and in profile, since half-tone and phototype processes which

6 → Andrew Zimmerman, *Anthropology and Antihumanism in Imperial Germany,* Chicago 2010, 3.
7 → Andreas Schwarz, André Karliczek, 'Mit Haut und Haar. Vom Merkmal zum Stigma – Farbbestimmungen am Menschen Karliczek', in: André Karliczek, Andreas Schwarz (ed.), *Farbe. Farbstandards in den frühen Wissenschaften Mit Haut und Haar,* Jena 2016, 25.
8 → Gustav Theodor Fritsch, 'Praktische Gesichtspunkte für die Verwendung zweier dem Reisenden wichtigen technischen Hülfsmittel: das Mikroskop und der photographische Apparat', in: Georg Neumayer (ed.), *Anleitung zu wissenschaftlichen Beobachtungen auf Reisen,* Berlin 1875, 591.
9 → Andreas Broeckmann, *A Visual Economy of Individuals The Use of Portrait Photography in the Nineteenth-Century Human Sciences,* Berlin 1996, 57.
10 → Katarina Matiasek, 'Überleben im Bild »Rettungsanthropologie« in der fotografischen Sammlung Emma und Felix von Luschan', in: Katarina Matiasek, *Überleben im Bild »Rettungsanthropologie« in der fotografischen Sammlung Emma und Felix von Luschan* (Beiträge zur Geschichte der Fotografie in Österreich vol. 21), Vienna 2020, 48.
11 → Fritsch 1875 (reference 8), 605.

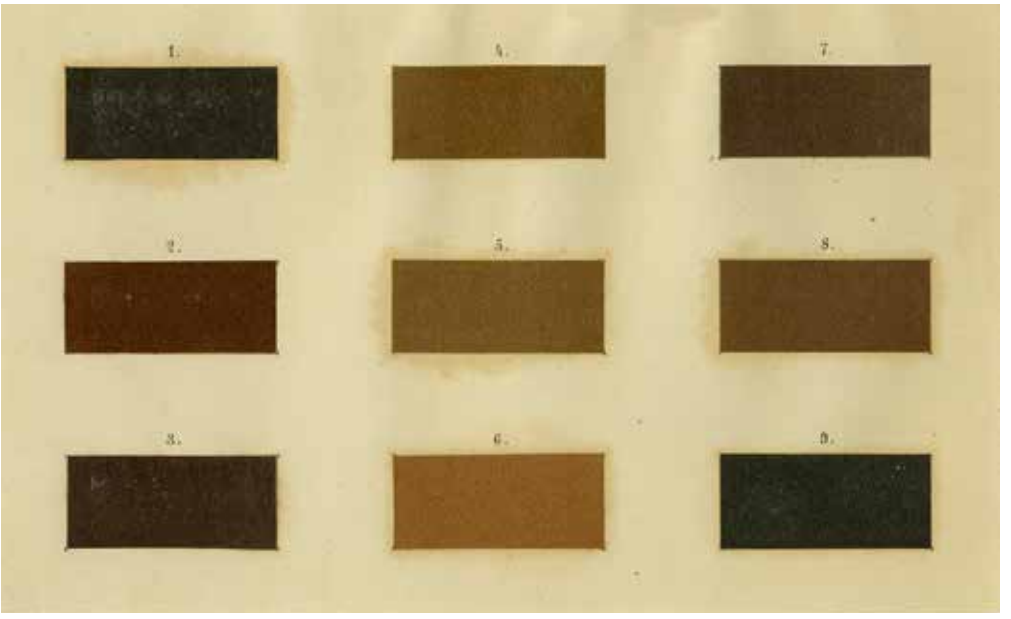


fig. 2
Gustav Fritsch, 'Varietäten der Hautfarbe', chromolithograph, in: Gustav Fritsch, Theodor/Hugo Bürckner, *Die Eingeborenen Süd-Afrika's: ethnographisch und anatomisch beschrieben* (vol. 2), Breslau 1872.

would allow for direct photographic illustration were not yet available. He also included several chromolithographs in his book. One chromolithograph is of a colour chart (Hautfarbentafel) depicting nine skin shades (__fig. 2). It served to imitate and archive the skin colour of the people he met, who are mentioned and depicted in the book, thus building a racial hierarchy among them based on this external marker, an endeavour Fritsch continued well into the 20th century.[12] Though ideally, a three-colour photograph of the colour chart would be printed along with the text as opposed to a chromolithograph, it was only in 1909 that Fritsch would partake in such a project, writing the introduction to Kurd Schwabe's book *Die Deutschen Kolonien* (1909–1910), which featured three-colour photographs on paper from the various colonies of the Kaiserreich (__fig. 3).

Moreover, Fritsch co-founded both the Berlin Anthropological Society (BGAEU) with ethnographer Adolf Bastian (1826–1905) and Rudolph Virchow in 1869,[13] as well as the Free Photographic Union of Berlin (Freie Photographische Vereinigung zu Berlin) with anthropologist Richard Neuhauss (1855–1915) and painter Franz Goerke (1856–1931) in 1889.[14] At the BGAEU meetings, anthropologists extensively discussed skin, eye and hair colour, the naming of colours across languages, and occasionally colour photographic processes considered meaningful for their work. For example, Neuhauss, who was an astute practitioner of Gabriel Lippmann's interferential colour photography, presented the advantages of the Autochrome he planned on using during his expedition to Papua-New-Guinea in 1907, underscoring the medium's distinct painterly ability to transport observers to the place the photograph was shot.[15] Also, Neuhauss revealed his Autochrome-photomicrographs of the red and blond hair of the inhabitants of Papua-New-Guinea in 1913, recognizing the absurdity of images of colourful hair in black and white.[16]

12 __ Schwarz, Karliczek 2016 (reference 7), 32.
13 __ Christian Joschke, *Les yeux de la nation. Photographie amateur et société dans l'Allemagne de Guillaume II (1888–1914),* Dijon 2014, 207.
14 __ Joschke 2014 (reference 13), 126.
15 __ Richard Neuhauss, 'Photographische Hilfsmittel fur den Forschungsreisenden. Sitzung vom 16. November 1907', in: *Zeitschrift für Ethnologie,* vol. 39. H. 6, 1907, 970.
16 __ Richard Neuhauss, 'Das Rotblonde Haar der Papua. Mit Mikrophotographischen Autochrom-Aufnahmen. Sitzung vom 19. April 1913', in: *Zeitschrift für Ethnologie,* vol. 45. H.2, 1913, 259–260.

fig. 3
Robert Lohmeyer, 'Die Kameschlucht bei Misahöhe', three-color relief halftone 10.5 × 12 cm, in: Kurd Schwabe, *Die Deutschen Kolonien,* Berlin 1909.

Other than regularly attending such BGAEU meetings, Fritsch was first chairman of the *Vereinigung,* the epicenter of the production of scientific photography (to which anthropological photography belonged) and of its dissemination to broader audiences. This gave him ample opportunity to keep abreast of photographic technologies, especially colour processes, which began emerging at a faster pace in 1890. Lippmann's method[17] and John Joly's line screen photography were among the many colour photographs presented to the Berlin public starting 1894 through monthly projection sessions organized by the *Vereinigung* at the *Königliches Museum für Völkerkunde,* the Royal Museum of Ethnology of the capital, presided over by Bastian.[18] In this context, anthropologists acted as both presenters and attendees, including Fritsch who revealed his research on three-colour photography at the club's meeting on 16 May 1902.[19]

Therefore, anthropologists' obsession with the determination of colour as a racial criterion afforded a certain openness in their circles to colour photographic processes that might have been useful to such an endeavour. This openness informed ongoing discussions and events surrounding colour photography in camera clubs, which anthropologists also attended. The overlap between these two circles facilitated and accelerated the circulation of knowledge about colour photography in relation to anthropology underpinning Fritsch's theory and practice of three-colour photography.

By the time he turned to three-colour photography between 1901 and 1904, Gustav Fritsch was hardly the only scientist to do so. The increased public interest in this medium revolved around photochemistry professor and industry veteran Adolf Miethe (1862–1927). At the start of 1902, Miethe began producing noteworthy three-colour prints on paper, which he sent to politicians to secure financing for his prestigious university laboratory at the *Königlich Technische Hochschule zu Berlin* in Charlottenburg.[20] That year, with his assistant Arthur Traube (1878–1948), they

17 ___ Hanin Hannouch, 'Richard Neuhauss' Stuffed Parrot: Colour Photography, Taxidermy, and Projection', in: Hanin Hannouch (ed.), *Gabriel Lippmann's Colour Photography: Science, Media, Museums,* Amsterdam forthcoming.
18 ___ Zentralarchiv, Staatliche Museen zu Berlin- Stiftung Preußischer Kulturbesitz, Reference Number 597, MV, IVa, 1893/02020-1920/1043. File Number: 202/93 (Correspondence between Franz Goerke of the *Freie photographische Vereinigung zu Berlin* and Museum für Völkerkunde in 1893).
19 ___ G. d'Heureuse, 'Ordentliche Sitzung am Freitag, den 16. Mai 1902, abends 8 Uhr, im Königl. Museum für Völkerkunde', in: *Photographische Rundschau,* vol. 6, 1902, 1.
20 ___ Geheimes Staatsarchiv Preußischer Kulturbesitz, I.HA.Rep.76.Vc. Sekt. 1.Tit.Di.Teil Vc.Nr.25.Bd.1 (Letter from Prof. Dr. A Miethe to Dr. A. Naumann, 17.01.1902).

patented panchromatic sensitization of a silver gelatin emulsion that allowed for a translation of the shades of coloured objects unto photo-sensitive material while maintaining their degrees of brightness, thus solidifying an essential step in the process of three-colour photography.[21] Though he was an active member in various camera clubs in the Empire, Miethe was not part of the BGAEU and never openly admitted to being Fritsch's rival. However, as this text will disclose, Miethe's political ties were numerous, and he communicated his view that Fritsch's work was ludicrous to key politicians in positions influential enough to prevent any further propagation of his – Fritsch's – methods. Miethe operated from the vantage point of photochemistry, industrial design, and public relations to promote his colourful work, personal fame, and future relevance. Fritsch's three-colour photography, however, emerged out of a mixture of scientific revisionism and histological empirical methods, both of which were entangled with his anthropological research.

**Scientific revisionism: Fritsch claims priority over Hermann von Helmholtz**

Gustav Fritsch's ephemeral engagement with three-colour photography was bracketed by his broader anthropological research that was, itself, undergoing an epistemological crisis. His conceptualization of race faced serious challenges such as the choice of a definitive bodily marker based on which the hierarchization of human beings could be upheld, and the determination of a consistent scale capable of providing some insight into this investigation. As Michael Hagner writes: "Whereas the measurement of the skull, brain, skin or pelvis had traditionally dominated physical anthropology – and Fritsch also contributed to this effort – late-nineteenth-century anthropologists were searching for new criteria and shifted from the investigation of the macro-level to the micro-level." [22]

In 1903, Fritsch – as the head of the histology and photography department at scientist Emil du Bois-Reymond's (1818–1896)[23] Physiological Institute of the Royal Friedrich-Wilhelm University in Berlin – wrote to Prussian Minister of Education Konrad von Studt (1838–1921)[24] that he was unhappy with his previous choice of hair as racial marker and his resulting photomicrographs. He emphasized that he must focus on the retina to investigate the elusive difference in visual acuity among humans after the promising preliminary research he had conducted in Egypt in the early 1890s, paid for by du Bois-Reymond at the Royal Prussian Academy of Sciences.[25]

He regretted the poor quality of organs sent to him from abroad through various dubious channels trafficking human remains in the German Empire,[26] adding that his lengthy exploration necessitates financial and institutional support across continents. The retina is fragile and must be brought to him (or he to it) immediately

21 ___ Louis Sipley, *A Half Century of Color,* New York 1952, 36.
22 ___ Michael Hagner, 'Anthropology and Microphotography: Gustav Fritsch and the Classification of Hair', in: Keith Hamilton Dietrich, Andrew Bank (ed.), *Gustav Fritsch. An Eloquent Picture Gallery: The South African Portrait Photographs of Gustav Theodor Fritsch, 1863–1865,* Auckland Park 2008, 163.
23 ___ For an intellectual biography of Emil du Bois-Reymond: Gabriel Finkelstein, *Emil Du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century Germany,* Cambridge 2013.
24 ___ Geheimes Staatsarchiv Preußischer Kulturbesitz, I.HA REP 76. Kultusministerium Sekt 2. Tit.IV.NR.55 bd 3, 271-273. (Letter from Prof. Gustav Fritsch to Dr. Studt, 27. 12. 1903).
25 ___ Archiv der Berlin-Branderburgischen Akademie der Wissenschaften, PAW 1812-1945:II-XI-75 Alexander-von-Humboldt-Stiftung für Naturforschung und Reisen, 225-226. (Two letters from Gustav Fritsch to Emil du Bois-Reymond, dated 11 April 1893, and 16 July 1893). Königlich-Preußische Akademie der Wissenschaften (The Royal Prussian Academy of Sciences) paid Fritsch 2500 RM out of its 7600 RM budget in 1893.
26 ___ Letter from Fritsch to Studt 1903 (reference 24).

after the person's death. But his costly project quickly exhausted the amount of research leaves he could demand from the University and the budgets of most public institutions in the city. Though the Ministry of Education would fund Fritsch's world tour at the end of 1904/1905 to gather eyeballs and other human remains,[27] he had to finance his work as it stood while in Berlin.

He turned again to the Academy of Sciences and to the chemical company *Berlin Gesellschaft für Anilinfabrikation (BGfA)* in 1902–1903[28] to initiate his research on three-colour photography and vision; an inquiry that is challenging to position within the landscape of his overwhelming anthropological research at the time. The circumstances surrounding his cooperation with the BGfA are unclear. But, given Fritsch's scientific status as a pioneer of neurology after his 1870 experiment on the excitability of the motor cortex with Eduard Hitzig (1838–1907),[29] his knowledge of various photographic processes such as photomicrography,[30] and his previous cooperation with manufacturer Seibert & Krafft on the universal photomicrographic apparatus, later sold by Zeiss,[31] it is plausible that the BGfA regarded Fritsch as a suitable candidate for propelling the industrial development of three-colour photography.

But Fritsch's choice of the retina only exacerbated the limits of the scale in his anthropological work: Does measuring visual acuity and colour perception in living people suffice to distinguish the races or is the study of the eye's anatomy necessary? In order to combine his anthropological research interest while delivering the results demanded by his financial supporters, Fritsch decided to pursue both lines of inquiry but invested more effort, I argue, in the latter, extracting from the organ, with the same gesture, the hierarchy of the races, as well as the basis for the optimization of three-colour photography. His work on three-colour photography should thus be understood as a unique layer in the tower of his anthropological fetishization of the eye, and not as a parallel research or as an independent inquiry.

In connecting the pulsating organ to photochemistry, Fritsch builds on the proposition of scientist Wilhelm Kühne (1837–1900) in Heidelberg who asserted that "colour changes in the retina when exposed to light were demonstrated and they were related to the processes of photography."[32] He proved his assertion through optography by slicing the retina of a rabbit, exposing and then developing it to make the imprint of the last image seen by the animal visible. Yet, such a bodily link in relation to three-colour photography was unorthodox and it required Fritsch to instigate a radical rupture with the medium's theoretical foundation in three-colour vision.

27 Clare Anderson, *Legible Bodies: Race, Criminality and Colonialism in South Asia,* Oxford 2004, 199.
28 Gustav Fritsch, *Beiträge zur Dreifarben-Photographie,* Halle 1903, 25.
29 Michael Hagner, 'Aspects of Brain Localization in Late XIXth Century Germany', in: *Clio Medica,* vol. 33, 73–88, Charles G. Gross, 'The Discovery of Motor Cortex and Its Background', in: *Journal of the History of the Neurosciences,* vol. 16, no. 3, 2007, 320–331.
30 Fritsch also cooperated with botanist Georg Ferdinand Otto Müller (1837–1917) on the photomicrographic depiction of Diatoms (single-celled algea) ca. 1870. Cf. Stefanie Dufhues, *Fotografie konstruierter Sichtbarkeit: Bildpraxis der Mikrofotografie. Von den ersten Versuchen bis ins 20. Jahrhundert,* Paderborn 2020, 206–207.
31 Maria Estela Jardim and Marília Peres, 'Photographing Microscopic Preparations in the Nineteenth Century: Techniques and Instrumentation', in: Marcus Granato, Marta C. Lourenço (ed.), *Scientific instruments in the history of science: studies in transfer, use and preservation,* Rio de Janeiro 2014, 308. Robert Koch used the Zeiss-model of Fritsch's apparatus. Said apparatus separated various parts of the photomicroscope such as camera, microscope stand and illumination device, enabling the instrument to be used both horizontally and vertically.
32 Nicolas J. Wade, 'Faces and Photography in 19th-Century Visual Science', in: *Perception,* 2016, 20.

The scientific revisionism practiced by Fritsch is epitomized by his claim to priority over Helmholtz in 1903 when he published a conglomeration of ideas he shared with members of the *Vereinigung* in his text *Beiträge zur Dreifarben-Photographie.* Many historiographies of colour photography – at the turn of the last century, as well as today – consider three-colour photography to be founded on the theory of three-colour vision promulgated by Helmholtz. His *Treatise on Physiological Optics,* published in six parts between 1856 and 1867, predicated that most people require only three wavelengths to be able to perceive the full range of visible colours. Although consistent success with three-colour photography began several decades after Helmholtz's *Optics,* practitioners superimposed three layers of primary colours either to be able to give the illusion of a full chromatic palette on glass when projected, or to be able to reproduce colour in paper prints.

In *Beiträge,* Fritsch professed having uncovered notes in his private diaries, predating Helmholtz's publications, and pertaining to the ability of the eye to combine all colours based on three primary ones. He alleged that the time he spent in South Africa (1863–1866) and the Prussian-Austrian war (1866), hindered him from publishing them before Helmholtz and from openly challenging his esteemed colleague, who – conveniently for Fritsch – had died by the time Fritsch's text appeared.[33] Fritsch also judged that, before his contribution to three-colour photography, colour perception was a mere descriptive science proclaiming the existence of three "unproven"[34] nervous fibers in the eye that are only hypothetically able to combine three primary colours into many. He considered Helmholz's and Thomas Young's (1773–1829) theories unreliable, underscoring how no repeatable experimental method can be extracted from them that can help determine the sensitivity of the eye to individual colours and, by extension, the proper means to generate a three-colour photograph whose shades can emulate those perceived. He hailed the arrival of more robust empirical methods that could demystify the mechanisms of three-colour perception once and for all and close the gap between it and three-colour photography.[35]

As Paul D. Sherman has noted, the burden of empirical proof in relation to colour vision in physics only became manifest around 1870 and not at the time of Helmholtz's *Optics*.[36] The centrality of observation with the naked eye or, in Helmholtz's case, with an ophtalmoscope (Augenspiegel) used to explore light and perception which Fritsch lamented, long characterized the field of physics and is not necessarily indicative of a flawed methodology. Hence, the anachronism at the heart of Fritsch's critique of Helmholtz marks a modern concern with colour less as an external phenomenon subject to the laws of physics alone and more as a repeatable photographic technology and as a bodily neurophysiological phenomenon. This concern was propelled by the increasing importance of the chemical industry and the development of empirical sciences in the Kaiserreich[37] deemed central to the "form of scientism about

33 ___ Fritsch 1903 (reference 28), 2.
34 ___ Gustav Fritsch, *Die Retinaelemente und die Dreifarbentheorie,* Berlin 1904, 3.
35 ___ Fritsch 1904 (reference 34), 4.
36 ___ Paul D. Sherman, *Colour Vision in the Nineteenth Century: The Young-Helmholtz-Maxwell Theory,* Bristol 1981, xiii.
37 ___ Barbara Saunders, *The Debate about Colour Naming in 19th Century German Philology. Selected Translations,* Leuven 2007, 9.

colour [that had] prevailed."[38] Only empirical methods could make authoritative affirmations about reality and about phenomena as complex as sensory processes.

But the centrality of experimental work to colour photography still meant that, at the turn of the last century, no research methodology was yet set in stone or had monopoly over definitive results. This worked in Fritsch's favour since he could freely transmit or at least argue for the transmission of the frenzied "totalizing empiricism,"[39] which characterized anthropology, to the realm of three-colour photography. He could borrow the methodological tools anthropologists required for the study of racial markers such as histological inquiries, collections of human and animal remains, acuity tests, retina photographs, and apply them to colour photography with the aim of imbuing it with more scientism. Following this logic, scientific knowledge about colour vision emanating from anthropological explications could sway the technology of three-colour photography in such a manner as to kill two birds with one stone: namely, to solve the medium's oldest problem (rendering colour), and reproduce an image of the world that upholds the epistemological basis of science.

But Fritsch's anthropological toolbox competed with Adolph Miethe's photochemical practice, a practice no less empirical and arguably more nuanced than Fritsch's. It was enabled by the Prussian State that had considerably invested in the Technical University Charlottenburg's Department for Photochemistry and Spectral Analysis that was presided over by Miethe and was "expected [by politicians] to contribute to industrial development."[40]

Indeed, Miethe showcased his abilities as a laboratory scientist in his canonical book *Dreifarbenfotografie nach der Natur* (1904), and as a highly-skilled technician cooperating with optical engineers on designer-instruments for three-colour photography, such a three-colour camera with carpenter Bermpohl, various colour filters to capture and separate light rays, and a dedicated three-colour projector with optics industrialist C.P Goerz,[41] all of which would make his name (→ fig. 4). He also positioned the medium as one that is not only technical/scientific *but also* painterly which is why Helmholtz's theories of three-colour vision (beyond the basic understanding that three distinct primary colours can be reconstituted into several) proved marginal to his ventures. Fritsch, however, favoured an investigation of three-colour photography more radical than what had been employed in the field thus far.

Therefore, the commercialization of his research results stood on uncertain ground, and so too did his credibility within the photographic community. His claim to priority over Helmholtz was noted by historians, thus explaining its mention in E. J. Wall's *The History of Three-Colour Photography* (1925)[42] but it garnered him no applause from his contemporaries in the German-speaking world from either discipline. Early 20th century anthropologists were more concerned with

38 — Saunders 2007 (reference 37), 9.
39 — Zimmerman 2010 (reference 6), 68.
40 — Joris Mercelis, Gabriel Galvez-Behar, Anna Guagnini, 'Commercializing science: nineteenth- and twentieth-century academic scientists as consultants, patentees, and entrepreneurs', in: *History and Technology,* 2017, 33:1, 12.
41 — Jens Wagner, *Die additive Dreifarbenfotografie nach Adolf Miethe: Untersuchung des Verfahrens und Wege zur Wiedergabe von Dreifarbendiapositiven,* Munich 2006, 11.
42 — E.J. Wall, *The History of Three-Colour Photography,* Boston 1925, 7–8.

fig. 4
Adolf Miethe, 'Dreifarbenaufnahme: nach der Natur', three-color relief half-tone 11.8 × 13 cm, in: *Photographische Rundschau,* 1903, vol. 3, plate 11.

Helmholtz's brain and the phrenological reasons for his genius[43] than with the veracity of three-colour vision. Also, despite the photographic press thoroughly reviewing claims to priority across Europe at the time, the journals with which Fritsch collaborated, such as the *Photographische Mittelungen,* Josef-Maria Eder's *Jahrbuch für Photographie und Reproduktionstechnik* and the Berlin-based *Photographische Rundschau,* reviewed his publications but eschewed his contention.

**The retina and the colour camera: Gustav Fritsch's histological method**

Fritsch considered the retinas of animals and humans to be the "material basis" (materiellen Unterlagen)[44] of three-colour photography. He understood this "material basis" as sought-after physiological-technological correspondences between the living organ and the machine. He writes: "Colour photography (...) teaches us that nature by its own accord (selbstätig) has created facilities (Einrichtungen), which we have only recently laboriously acquired in the technical field."[45] Taken literally and to such an extreme, this equivalence meant that mimicking the biological structure and the internal mechanism of the organ was essential for developing this colour technology, but the eye's anatomy and sensory operation existed on a scale so small that it was itself beyond the purview of vision. No amount of observation by the naked eye of the eye could tap into the scale Fritsch needed access to.

Hence, just as he went from measuring the body to photomicrographing hair years before,[46] Fritsch changed scales once again, moving from a strict macro-consideration of the visual acuity among living people to histology, which he hoped would afford him a neurological-anatomical understanding of sensory processes. This understanding would, in turn, both steer three-colour photography in a more industrially pertinent direction for the BGfA, and – for Fritsch – settle the question of racial difference once and for all.

Like Kühne, Fritsch argued that the retina's ability to convert electromagnetic energy (light) into electrochemical signals, to be then transferred to the brain for interpretation as an image, is similar to photographic actinity (the effect of light radiation on photographic material) enabled by the operation of the camera.[47] But the operation of the organ's various parts is intricate and open to much speculation,

43 ___ David Hansemann, 'Über das Gehirn von H. v. Helmholtz', in: *Centralblatt für Anthropologie, Ethnologie und Urgeschichte,* vol. 5, Jena 1900, 206–208.

44 ___ Fritsch 1904 (reference 34), 13.
45 ___ Fritsch 1904 (reference 34), 13.
46 ___ Hagner 2008 (reference 29), 163.
47 ___ Fritsch 1904 (reference 34), 13.

so Fritsch identified a section of the eyeball's anatomy of particular interest to him which he mapped definitively in 1908:[48] the area centralis and the fovea centralis present in the retina of some animals and human beings respectively that are responsible for high-resolution binocular vision.[49]

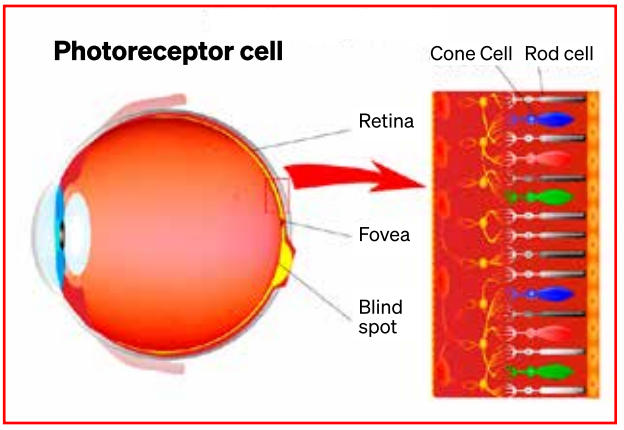



fig. 5
Medical Illustration of a photoreceptor cell, American Academy of Ophthalmology, 2017.

In relation to the area and the fovea, he examined the interaction between the two layers of the retina; the highly-pigmented layer which contains red, green and blue pigments, and the neural layer (specifically its photoreceptors the rods and cones) (__fig. 5). Fritsch uncovered further eye-camera correspondences hidden in the organ, remarking that: "in the most widespread type of bird's eyes, Nature has introduced (eingeführt) light filters in the coloured receptor balls (Kügelchen) (...) that correspond essentially to those used in colour photography."[50] Since the cones have spectral sensitivity to blue, red, and green, the filters inside the three-colour camera should be sensitized to mimic these shades as well. Fritsch experimented with various dyestuffs when seeking the one-colour agent capable of matching the hue of the photoreceptor to be commercialized in the photographic field. He deemed adequate the substantive dye Congo red (Kongorot), which was patented and sold by BGfA to textile companies in 1884,[51] two years after it was first created by chemist Paul Boettiger.[52] In relation to the colour red, Fritsch also criticized Miethe's filters because they let too many red-light rays through. This accounted for Miethe's reliance on aesthetic choices, such as red accessories and autumn landscapes in his photographs, to disguise this technological imperfection (__figs. 6 & 7). While such images may be "surprisingly beautiful" and "pleasant to behold", remarked Fritsch, they are not true-to-nature.[53] Miethe, on the other hand, found that, while too strong a contrast between shadows and highlights in the three-colour photograph image is detrimental to its beauty, a contrast between the various colours of the photograph is foundational for its overall painterly quality.[54] Aesthetics aside, Fritsch's use of Congo red in the filter proved as disappointing to the photographic community as his claim about Helmholtz. Even worse, the choice of dyestuff was hardly novel since back in 1886, Eder had already acknowledged Congo Red's properties for orthochromatic sensitization[55] but favoured Erythrosine because it provided more even results,[56] especially

48___ Harry Grundfest, 'The Different Careers of Gustav Fritsch (1838–1927)', in: *Journal of the History of Medicine and Allied Sciences,* vol.18, 1963, 128.
49___ DH Rapaport, J Stone, 'The Area Centralis of the Retina in the Cat and Other Mammals: Focal Point for Function and Development of the Visual System', in: *Neuroscience.* 11, no. 2, 1984, 290.
50___ Kügelchen are the tips of the rods in the retina, described by Max Schultze. Cf. Max Schultze, 'Bemerkungen über Bau und Entwickelung der Retina', in: *Archiv Für Mikroskopische Anatomie,* vol. 3, no. 1, 1876, 376.
51___ Anthony S. Travis, 'Heinrich Caro and Ivan Levinstein: Uniting the Colours of Ludwigshafen and Lancashire', in: Ernst Homburg, Anthony S. Travis, and Harm G. Schröter (ed.), *The Chemical Industry in Europe, 1850–1914: Industrial Growth, Pollution and Professionalization,* Dordrecht 2011, 263.
52___ David P. Steensma, '"Congo Red" Out of Africa?', in: *Archives of Pathology & Laboratory Medicine – Historical Perspective,* vol. 125, February 2001, 251. Since Böttiger's work took place around the time the Berlin West Africa Conference was unfolding the synthetic dyestuff was called "Congo red" not because any natural materials stem from Congo but for marketing purposes.
53___ Fritsch 1903 (reference 28), 5.
54___ Adolph Miethe, *Dreifarbenfotografie nach der Natur: nach dem Photochemischen Laboratorium der Technischen Hochschule zu Berlin angewandten Methoden,* Halle 1908, 76.
55___ Photographische Gesellschaft in Wien, 'Protokoll der Plenarversammlung vom 6. April 1886', in: *Photographische Correspondenz,* vol. 308, 1886, 295.
56___ 'Orthochromatische Photographie: Panchromatische Platten für Dreifarbenphotographie', in: *Jahrbuch für Photographie und Reproduktionstechnik,* vol. 20,1906, 419.

fig. 6
Adolf Miethe, 'Dreifarbenaufnahme nach der Natur', three-color relief half-tone 10.3 × 11.5 cm, in: *Photographische Rundschau,* 1903, vol. 9, plate 27.

fig. 7
Adolf Miethe, *Naturfarben in den Dünen,* three-color relief half-tone 9 × 4 cm. Miethe-Phot, postcard number 1042.

in the expert hands of photochemist Hermann Wilhelm Vogel (1834–1899) who used it regularly. Fritsch's red filter was reviewed only once in 1905 and, despite being found more saturated than the one produced by Miethe, it did not exceed it in quality so as to justify commercialization or widespread use.[57]

Fritsch uncovered another natural correspondence between the eye and three-colour photography; this time tackling the "visual red" (Sehrot).[58] Visual red is the colour of the retina when adapted to darkness, which physiologist Franz Christian Boll (1849–1879) explored back in 1876.[59] Fritsch found that it resembled a layer of silver bromide gelatine saturated with ethyl red, the sensitizing agent Miethe and Traube used for the panchromatic plate. Since visual red and the photographic plate are analogous as wholes, they should also be analogous as parts, meaning that the plate should be able to capture and render the smallest parts of the retina, the photoreceptor cells. Fritsch used colour photography to test this idea, publishing his three-colour photomicrographic print of the pigeon's retina, seen with a 780 linear magnification (→ fig. 8). This, the only colour photograph produced by him I could find, was published in his book *Die Retinaelemente und die Dreifarbentheorie* in juxtaposition to three other monochrome depictions of various zones of the fovea centralis and its photoreceptors. It depicts the very neurological-physiological conditions of possibility of colour perception in animals, the photoreceptor cells. Among three-colour photographers active in the German Empire at the time, nothing like it had been attempted up to that point, nor is there much evidence to suggest Fritsch repeated this colour photographic representation.

The lukewarm reception of Fritsch's three-colour theory and practice hinged on two factors: His absence from Berlin in 1904–1905, and Miethe's widespread fame. Reviews of Fritsch's colour photography were brief, and they often avoided a too forward critical approach, because none was necessary. Shortly after his publications, towards the end of 1904 and until mid-1905, Fritsch travelled the world to collect eyeballs and other human remains, which was his main concern at the time. He did so in preparation for his *Über Bau und Bedeutung der Area centralis des Menschen* (1908), a book about race and the area centralis in which Fritsch relied on monochrome photography to depict the organ. For his work on the retina (as well as the motor cortex), he was nominated twice, in 1910 and 1911,[60] for the Nobel Prize in Physiology or Medicine, a nomination he personally pushed for, as a 1910 letter to his physician colleague Paul Ehrlich (1854–1915)[61] reveals. Therefore, Fritsch was not in the capital to defend his work and persuade detractors in the photographic press. A critique written by Johannes Gaedicke (1853–1916) (a long-time collaborator of Miethe's on the flash gun) in Eder's *Jahrbuch* appreciated his use of three-colour

fig. 8
Gustav Fritsch, 'Taubenretina aus dem Gebit des rothen Feldes (peripherischer Teil)', three-color print 8 × 10 cm, in: Gustav Fritsch, *Die Retinaelemente und die Dreifarbentheorie,* Berlin 1904.

57 Hans Schmidt, 'Über Dreifarbenphotographie', in: *Photographische Mitteilungen,* 1905, vol. 42. 261.
58 Fritsch 1903 (reference 28), 13.
59 Nicholas J Wade, 'Guest editorial essay', in: *Perception,* 2008, vol. 37, 1468.
60 <https://www.nobelprize.org/nomination/archive/show_people.php?id=3238> (20. 01. 22).
61 Staatsbibliothek zu Berlin – Preußischer Kulturbesitz, Handschriftenabteilung, Slg.D. Afrika, acc. Darmstadter, 1914, 69, letter from Gustav Fritsch to Paul Ehrlich, 4. 8. 1910.

Fig. 1.

Fig. 2.

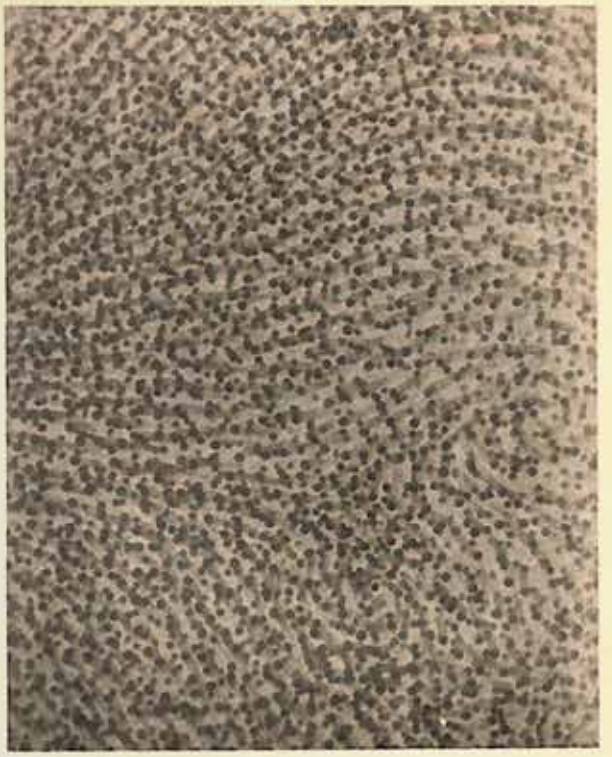
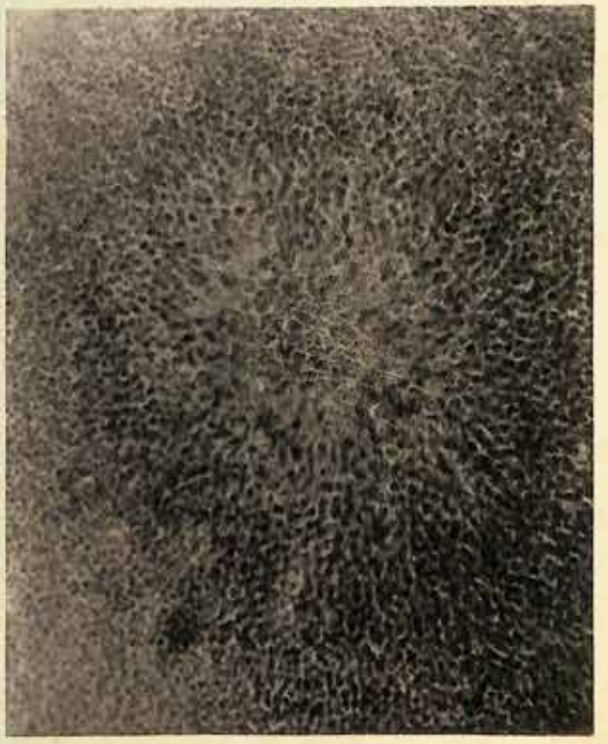


Fig. 3.

Fig. 4.



Lichtdruck von A. Frisch, Berlin W.

**Gustav Fritsch: Die Retinaelemente und die Dreifarbentheorie.**

fig. 9
Robert Lohmeyer, 'Am Sanaga', three-color relief half-tone 20 × 28 cm, in: Kurd Schwabe, *Die Deutschen Kolonien,* Berlin 1909.

photography in the realm of science,[62] a viewpoint reiterated by the *Photographische Mitteilungen* in 1904, but still expected him to deliver photographs that are either technically impeccable (if not promising) or visually readable, but Fritsch provided none. Gaedicke stressed that, while the red and yellow photoreceptor cells were photographically rendered, the green-blue cells were missing due to underexposure although they would have been visible under the microscope. Moreover, such a scientific photograph was not self-explanatory to the average, even well-informed, attendee of a projection session in Berlin as an account of Fritsch's projection session at the *Verein zur Förderung der Photographie* declared, judging his prints (without specifying which one exactly) as "unsuccessful in being satisfactory"[63] and the quality his glass slide positives inconsistent. Members of the *Vereinigung* and other camera clubs did not require histology to grasp three-colour vision whose principle was by then intuitive to most photography aficionados. The *Photographische Rundschau* summarized Fritsch histologically pursuing the eye-camera analogy as a mere "weird fact" (merkwürdige Tatsache)[64] and left it at that.

In a private letter to politician and Privy Councillor Friedrich Schmidt (1860–1956) at the Ministry of Education from 13 February 1903 Miethe, by now exasperated by Fritsch, stated that he would not deign to comment on the quality of Fritsch's three-colour photographs, and indeed refrained from doing so both in public and in private. He asserted that Fritsch had embarrassed himself, often giving a "confused and completely incorrect information about the underlying theories of three-colour

62 ___ Johannes Gaedicke, 'Dreifarbenphotographie', in: *Jahrbuch für Photographie und Reproduktionstechnik,* vol. 19, 1905, 350.
63 ___ Frits Loescher, 'Verein zur Förderung der Photographie zu Berlin. Sitzung vom 8. April 1904', in: *Photographische Mitteilungen,* 1904, vol. 41, 72.
64 ___ 'Bücherschau', in: *Photographische Rundschau und photographisches Centralblatt,* vol. 18, 1904, 178.

printing to the point that any refutation of [his] individual errors does not seem possible at all."[65] He also risked smudging Miethe's name. It had already become synonymous with the medium, and he was by now friends with Kaiser Wilhelm II and his family. "He had also been appointed Privy Councillor (geheimer Regierungsrat), included in Prussia's Order of the Red Eagle, and awarded a knight's cross by the French president – the first of a whole series of honorary titles and memberships granted to Miethe for the provision of services related to his professorship."[66] So Miethe advised Schmidt, in that same letter, against the Kaiser meeting Fritsch at any public projection session in order to make sure that authoritative knowledge about the medium remains in Miethe's hands. The Kaiser later commissioned him to produce three-colour photographs using his own method, by now termed *System-Miethe,* of German agriculture and forests to be projected at the German Pavilion (Deutsches Haus) at the World Fair in St Louis, Missouri in 1904 (__fig. 9). Miethe later published these photographs and many others in the *Stollwerck-Sammelalbum* nr. 7; one of the earliest photography books which included 216 colour photographs that also served as trading cards (__fig. 10). He achieved superb aesthetic results for his time without having to rely on histology whose added value to three-colour photography as theory and as industrial potential remained strenuous to ascertain. When comparing both their empirical methods, with substantial efforts, Fritsch's trichromatic practice achieved results possible through more elegant methods. Ultimately, Miethe cemented three-colour photography as a German technology in service of imperial splendour par excellence, whose history he presented at the Kaiser's 1905 birthday, a major political event, highlighting how the medium is "a building block in the mighty tower of our spiritual culture,"[67] a proposition far more attractive to those with enough resources to finance this technology than anthropology and histology.


fig. 10
Adolf Miethe, St. Louis 1904.
*Das Deutsche Haus. – The German Pavilion,* 1904, Heliochrom. Postcard.

Beyond his investigation of three-colour photography between 1901 and 1904, Fritsch only addressed the medium anew in 1909 in his son-in-law Kurd Schwabe's book *Die Deutschen Kolonien* published with three-colour photographic prints of the various colonies of the German Empire. Fritsch wrote the introduction to this ethnographic publication since "he was a convinced spokesman of German colonialism."[68]

65__ Geheimes Staatsarchiv Preußischer Kulturbesitz, I.Ha Rep. 76, VC, Sekt.1, Tit.Di. Teil Vc, Nr.25, Bd.1.
66__ Joris Mercelis, 'Commercializing academic knowledge and reputation in the late nineteenth and early twentieth centuries – photography and beyond', in: *History and Technology,* vol. 33, no. 1, 14.
67__ Adolf Miethe, *Die geschichtliche Entwicklung der farbigen Photographie,* Berlin 1905, 3.
68__ Hagner 2008 (reference 29), 166.

# Wien.

Gruppe Nr. 318.

### Rathaus.

Das Wiener Rathaus ist eines der schönsten Bauwerke dieser an prächtigen Monumentalgebäuden überreichen Stadt. Dasselbe wurde von Baudirector Friedrich von Schmidt im letzten Drittel des vorigen Jahrhunderts ausgeführt und lehnt sich in seinen reichen Formen an den gothischen Stil an. Der prachtvolle Hauptbau wird von einem 340 Fuß hohen Thurm überragt, der von einer Statue gekrönt ist. Offene Balkons umgeben den massiven Steinbau.



### Naturhistorisches Museum.

An der Ringstraße, welche in Verbindung mit dem Franz-Josefs-Kai einen Prachtstraße bildet, die die ganze innere Stadt Wien umschließt, und die aus den Schottenring, dem Franzensring, dem Burg- und Opernring meistens besteht, erheben sich am Burgringe die Hofmuseen, unter denen das Naturhistorische eine hervorragende Rolle sowohl seiner ganzen architektonischen Ausgestaltung als auch besonders seines Inhalts wegen einnimmt. Hier sind unter anderem die prachtvollen Mineralien aufbewahrt, welche früher in der Hofburg sich befanden, und die zu den großartigsten Sammlungen der ganzen Welt gehören.

### Universität.

Unter den österreichischen Universitäten nimmt die Wiener Universität den ersten Rang ein. Ueber die sehr belebte Rotheburgstraße gelangt man durch die Sonnenfelsgasse zum Universitätsplatz, auf dem sich außer dem alten Universitätsgebäude und der Universitätskirche der prächtige Neubau der Hochschule erhebt. Die Wiener Universität ist die größte höhere Lehranstalt in den vereinigten Monarchien und wird auch von reichsdeutschen Studenten lebhaft besucht.



### Votivkirche.

Am Schottenring, in der Nähe der Währingerstraße, erhebt sich aus weiten Gartenanlagen die prächtige neuere Kirche Wiens, die Votivkirche. Sie verdankt ihre Entstehung einem Aufrufe des Erzherzogs Maximilian, des späteren Kaisers von Mexiko. Der Bau wurde bald nach der Mitte des vorigen Jahrhunderts begonnen und am Ende der 80er Jahre vollendet. Er ist in spätgothischen Formen gehalten und seine beiden gewaltigen Türme sind aus weiter Ferne sichtbar. Prächtige, farbige Glasmalereien zieren die Fenster, und der Innenraum gewährt einen herrlichen, großartigen Anblick.


### Parlamentsgebäude.

Das Parlamentsgebäude der Oesterreich-Ungarischen Monarchie, am Franzensring gelegen, dem es seine Hauptfassade zuwendet, ist in rein-griechischem Stil gehalten. Eine kampanartige Zufahrt führt zunächst unter eine auf acht korinthischen Säulen ruhende Vorhalle, durch welche man das Innere des Gebäudes betritt. In der Nähe dieses Gebäudes befindet sich auch der Kaiserliche Palast, der ebenfalls zu den hervorragendsten Gebäuden der Kaiserstadt an der Donau zählt.


### Kahlenberg.

Unter den Berühmtheiten Europas nimmt Wien durch seine unmittelbare Nähe an den Gebirgen der Tiroler Alpen eine hervorragende Stelle ein. Dicht vor den Thoren der nach in der Ebene gelegenen Riesenstadt erhebt sich bereits das Gebirge, dessen erster kaum 1000 Fuß hoher Gipfel so nahe an der Stadt gelegen ist, daß man von ihm aus eine unvergleichliche Aussicht über die Stadt genießt, die besonders des Abends, wenn sich Tausende und Abertausende von Lichtern entzünden, großartig ist. Der Kahlenberg wird auch eine Zahnradbahn leicht erreicht, die von dem rebenumkränzten Oertchen Nußdorf auf den Gipfel des Berges führt.

Stollwerck's Tierreich-Album.
Zusammengestellt nach Vorschrift von Professor Matschie.

fig. 11
Adolf Miethe, 'Wien', three-color relief half-tone print 9 × 5 cm each, on cardboard 35 × 27 cm. *Stollwerck Sammelalbum Nr. 7. Aus Deutschlands Gauen,* Cologne/Berlin 1904/05.

In it, he refrained from mentioning Helmholtz again, and temporarily let go of promulgating his histological methods, adapting his discourse to the tastes of the upper-class buyers who could afford the book's stupendous price of 200 RM. His text begins with a quote by Heinrich Heine and ends with another quote by Goethe, in the middle of which he announces three-colour photography as the only medium that can guarantee the "accuracy of primary colours".[69] Ironically, the photographs printed in it were made, among others, by Miethe's former student Robert Lohmeyer (1879–1958) whose work I have analysed elsewhere[70] (→ fig. 11) using Miethe's method and not Fritsch's.

## Conclusion

Gustav Fritsch's research on three-colour photography at the turn of the last century was entangled with his anthropological inquiries about the eye, both as a racial marker and as the locus of neuro-anatomic sensory processes. This inquiry which began in 1890 and lasted two decades, I have argued, was central to his scientific practice, and was the underlying reason for his brief engagement with three-colour photography between 1901 and 1904 in the first place. A key aspect was his need to finance his colonial research further through the partial support of the *Berlin Gesellschaft für Anilinfabrikation* that wished to invest in the nascent medium. Yet, just because an experimental practice unfolds in a context deemed scientific for its time does not mean that it provided genuinely new knowledge. Just as his lengthy research about hair as a racial marker merely offered "modest results" and "did not lead to any significant insight,"[71] Fritsch's histological studies of eyeballs offered no real suggestion for the bettering of three-colour photography but was useful for his continued racial hierarchization of human beings. Also, it failed to bring to light new knowledge that was not already explained through the empirical but less resource-intensive methods of photochemistry, championed by politics-savvy Adolf Miethe. This fact underwhelmed Fritsch's colleagues in numerous camera clubs, proving mostly irrelevant to the chemical industry and to technology manufactures. Moreover, his awkward practice of three-colour photography became challenging to place in the history of the medium, when it was first disclosed because it was overshadowed by the immensity of his anthropological endeavours. But from today's perspective, the sinister uniqueness of Fritsch's histological research on trichrome photography makes it pivotal to a more nuanced history of experimental sciences used in colour photography, to the history of German anthropology, and to turn of the century visual culture. It is likewise an exceptional platform to explore three-colour photography's imperial roots and colonial entanglements; entanglements which cannot entirely be accounted for by the clear-cut history of a single isolated field of investigation being visible only through interdisciplinary explorations.

69 — Gustav Fritsch, 'Zur Einführung', in: Kurd Schwabe (ed.), *Die Deutschen Kolonien,* 1909, ix.

70 — Hanin Hannouch, 'The Photographer's Authority and the Tension of Agency: Robert Lohmeyer's Writings and Colonial Photography Archives', in: *Baessler-Archiv,* vol. 65 (2018/19), 7–18.

71 — Hagner 2008 (reference 29), 169.

# A Chemist, Not a Photographer: Harald Renbjør's Three-Color Photography

## *Nils Torske in Conversation with Hanin Hannouch*



fig. 1
Harald Renbjør, *Selfportrait,* ca. 1907, autochrome 12 × 8 cm. Levanger Museum of Photography.

At the turn of the 20th century, extensive chemical research and industrial design led to the emergence of several methods for making colour photographs. Yet these endeavours unfolded in more isolated places as well; for example, in the middle of Norway. Among seven hundred active photographers in the country at the time,[1] in the small town of Levanger, chemist Harald Renbjør (1889–1956) grew up to become a key figure in the history of colour photography (→ fig. 1). His son Per Renbjør donated his father's collection[2] to the Levanger Museum of Photography in 2001. It consisted of around 24,000 images, among them 3000 colour images spanning his lifetime, photographic equipment, his personal library, and his laboratory. Nils Torske, museum photographer and technical conservator began his career at the Levanger Museum of Photography in 1989. He started researching Renbjør's estate with the collection's arrival and continues to do so. This interview reveals some of Torske's research results pertaining to Renbjør's life, his use of the Pinatype printing process, and to the importance of his three-colour separation negatives which are also unique photographic materials. They are glass slides that appear to be monochrome though they were shot through colour filters (red, green, blue) unto a panchromatic photographic plate. Historically, this has been referred to as "the additive method" of three-colour photography. The colours hidden in the negatives only emerge when their positives are either projected through a dedicated instrument from the turn of the last century or when digitally reconstructed. Given that relatively little is known about the history of three-colour photography around 1900, such material remains either unidentified in museum archives or worse, has been discarded. Torske addresses Renbjør's broad knowledge of colour photographic processes which he acquired both locally in Norway and in Vienna with Josef-Maria Eder (1855–1944), and his fascination with three-colour prints, as well as three-colour photography today, as both a contemporary analogue practice and as archival material in need of special attention and of digital reconstruction.

**Hanin Hannouch:** *You were working for decades at the Levanger Museum of Photography. This museum holds Norwegian photographer Harald Renbjør's large estate. Other than your book* "… og det ble farger…" – en ukjent forskers innsats for

1 Hanne Holm-Johnsen, 'Norway', in: John Hannavy (ed.), *Encyclopedia of Nineteenth-Century Photography,* New York 2008, 1009.

2 <https://digitaltmuseum.no/search/?q=LEM.006> (02. 02. 22).

fargefotografiets utvikling Harald Renbjør[3] *from 2003, not much has been published about Renbjør. So please tell us: who is Harald Renbjør?*

**Nils Torske:** I hope this interview and this *PhotoResearcher* issue will make museum workers more aware of the colour photographs from ca. 1900 onwards in their archives, focusing on additive[4] three-colour photography, one of the methods Harald Renbjør practiced. Harald Renbjør was born in Levanger, about 80 km northeast of Trondheim. Levanger has always been a place of trade and commerce thanks to its harbour and Renbjør's family ran an organ factory there, mainly building harmoniums and reed organs, which was started by Harald's grandfather Johan Cornelius Isachsen around 1860. The business was quite successful, and they exhibited and sold their instruments both in Norway and abroad. Isachsen began to use photography to market his products early on as the numerous pictures of the harmoniums held at the Levanger Museum of Photography's archive reveal. In my opinion, it is likely that Isachsen's interest in photography rubbed off on his grandson Harald. The factory also had numerous international business associates and other contacts, which made it easier for Renbjør to keep track of the developments of colour photography internationally and to build skills that matched those of his European colleagues. The company no longer exists today. Renbjør was a competent amateur painter and also played the piano. The Museum has more than a hundred of his paintings, drawings, and a recording of him playing Chopin, and pretty well too!

*Levanger is somewhat far from Western and Central Europe, so how exactly did Renbjør keep track of the knowledge produced in other countries?*

He did so by eagerly reading international periodicals and magazines such as *Jahrbuch für Photographie und Reproduktionstechnik, British Journal of Photography,* and other publications as his extensive library at the Levanger Museum of Photography reveals. He already spoke German since this was a requirement in high schools in Norway. But he was not just self-taught! In 1907, he went to Trondheim to start his apprenticeship to become a photographer, but did not complete it, moving instead in 1909 to the k. k. Graphische Lehr- und Versuchsanstalt in Vienna to study photography and reproduction technologies under Prof. Dr. Josef-Maria Eder in the school year of 1909/1910. Since this was the first school for photography in Europe and he spoke fluent German, there was nothing to hold him back. The Museum has his admission letter, although little is known about his time in Vienna. He went back to Norway and studied chemistry at the Norwegian University of Technology (Trondheim) starting the summer of 1910, and then worked as an assistant at the University of Kristiania (now Oslo) after this time. I do not have the exact date of when he began his work in Oslo because many archival documents were destroyed, but it is clear to me that Renbjør had 'academic' knowledge too. In fact, he considered himself a chemist, and not a photographer.

3___ Nils Torske, *"... og det ble farger..." – en ukjent forskers innsats for fargefotografiets utvikling Harald Renbjør,* Levanger 2003.

4___ Additive colour photography is based on the mixing of red, green and blue light, the additive primaries. By mixing these in various proportions, any colour or nuance of colour can be obtained. Mixed in equal proportions, they give white light. In subtractive colour photography one starts with white light. By transmitting it through filters in the subtractive primaries magenta, cyan and yellow, any colour can be obtained.

fig. 2
Harald Renbjør, *The Skier,* Pinatype print matrices. Levanger Museum of Photography.

*When did he start practising three-colour photography specifically?*

Around the time he was 18 years old, which is quite precocious. Also, he must have acquired the necessary knowledge to be able to print a Pinatype at that age because the earliest print he made is of his brother skiing in 1907 (→ fig. 2). We have a letter at the museum from 1908 written by his sister Agnes in which she mentions a portrait of her which she has put a silver frame on and I think it is the photograph of her which we have in the collection (→ fig. 3). He also took several three-colour photographs in Trondheim around that time; among them is one of three girls walking down the street (→ fig. 4) and, while in Oslo, he took a three-colour photograph from his window, depicting rooftops and trees in the city (→ fig. 5). These images are iconic since they constitute some of the oldest colour photographs of Norway.

*Where did Harald Renbjør buy the chemicals needed to make a print as complex as the Pinatype? Did he use other colour processes?*

There were chemical companies in Norway, one in Oslo; one in Trondheim that he worked with, but he bought extensively from Germany. He purchased Pinatype printing paper directly from Farbwerke Hoechst AG vorm. Meister, Lucius & Brüning, who made them, as an invoice from 1907 in his estate shows. He also read MLB's manual *Pinatypie,* and it is among the ca. 600 titles on photography, optics, and chemistry in his library. But buying the material and making a photograph are two different things. What mattered to him most was printing, so he was more focused on processes that could be transferred on paper (→ fig. 6). The Museum also holds an unfinished Neue Photographische Gesellschaft m.b.H. print[5] made by him. It lacks the last layer but since the image shows a significant relief thickness that is characteristic of this printing technology, I'm sure it is that [NPG print]. Renbjør luckily kept the results he achieved using the Autochrome, Agfacolor, and Dufay etc. but did not commit to these colour photographs as he did to the Pinatype. According to his son Per, he succeeded in producing an interferential colour photograph using Gabriel Lippmann's process but quickly lost interest in this technique. We're still looking for the Lippmann plate in his archives. Maybe it's among the numerous glass negatives.

5 ___ The Neue Photographische Gesellschaft m.b.H. (NPG) was a printing press founded by Arthur Schwartz (1862–1944). It produced 40 million metres of photographic paper. In 1905, the NPG commercialised a "Naturfarben-Photographie System" which is a carbon printing system. See: Michael Pritchard, 'Paper and Photographic Paper', in: John Hannavy (ed.), *Encyclopedia of Nineteenth-Century Photography,* New York 2008, 1053; Sylvie Pénichon, *Twenthieth Century Colour Photographs: The Complete Guide to Process, Identification and Preservation,* London 2013, 84,

fig. 3
Harald Renbjør, *Agnes Renbjør,* ca. 1907–08, three-color image. Levanger Museum of Photography. Digital color reconstruction by Viktor Minachin.

fig. 4
Harald Renbjør, *Children in Trondhjem,* ca. 1908–09, three-color image. Levanger Museum of Photography. Digital color reconstruction by Nils Torske.

*Was Renbjør in contact with other Scandinavian photographers?*

We have an extensive series of slides about colour photography from a lecture he held at the Norwegian Photographer Association (based in Oslo) in the 1930s. We do not know what the title of his lecture was, because he left no manuscript of it, but his slides definitely indicate that he addressed colour. Harald Renbjør also travelled with his wife every autumn, going to the photography fair *Photokina* in Cologne when it first began in 1950 and headed from there to Brussels, Paris, and Rome, which he also photographed on unmasked colour film, only once though in 1952. We also have a lot of photographs he took of Stockholm in 1939.

*Why do you think Harald Renbjør is little known to most photography historians?*

Most photography historians do not research colour photography at the turn of the last century, so this academic preference is important to consider. Also, Renbjør was not the "writing kind of person" and left little text and no publications. We interviewed his son Per Renbjør extensively and the topic of his father making books never came up. I think he was an introverted person, doing his own things, and this was enough for him. It's a challenge to get into his head since he was a bit reclusive. Because Renbjør considered himself a chemist, he did not move around in photographic circles as much as he could have, though his three-colour work was somewhat recognized by said circles. For example: Aged 25 and barely out of university, he won the silver medal in 1914 when he exhibited his Pinatypes at the Great Exhibition in Kristiania (Norges Jubilaeumsutstilling from 5 May to 11 October 1914) celebrating the Norwegian constitution's 100th anniversary. It was arguably the first exhibition with colour photography in Norway.[6] Although his photographs were stolen

6 ___ One of the earliest Autochrome photographers in Norway was botanist Hanna Resvoll-Holmsen (1873–1943) who used this colour process to document vegetation on the island of Svalbard. Therefore, her use was scientific, and her images were not printed and exhibited. See: <https://www.nb.no/search?q=autokrom&mediatype=bilder> (07.02.22) and <https://web.archive.org/web/20070205150201/http://www.apollon.uio.no/vis/art/2006_3/Artikler/Resvoll-Holmsen> (07.02.22)

fig. 5
Harald Renbjør, *View from Kristiania,* not dated (ca. 1916), three-color digital image. Levanger Museum of Photography. Digital color reconstruction by Nils Torske.

fig. 6
The illustration is made for information purposes only. The relative sizes are not accurate.

and never recovered, the Museum has the diploma while the Renbjør family has the medal. So, he was 'known enough' to have his prints stolen!

*Quite early in the Renbjør collection history, there was a cooperation with mathematician and computer scientist Viktor Minachin who reconstructed the three-colour photographs of Sergei Mikhailovic Prokudin-Gorskiĭ[7] for the Library of Congress. Could you tell us more about your work with Minachin?*

It was pure joy! I think it was in 2004 when we suddenly got an email from Minachin in Moscow, introducing himself and his work and that he'd like to see Harald Renbjør's three-colour images. He told us about the software he designed and visited the Museum in 2006. Minachin found that Renbjør's collection contained the entire workflow, ranging from negatives, to interpositives (specialized type of negative film stock that is part of the intermediate process that goes from an original negative to a release element), print matrices and intact prints. This makes the Museum, according to him, the only one in the world with a collection encompassing such a technical scope. Minachin's three-colour digital reconstruction software was quite impressive. He photographed a three-colour negative on the light board digitally and then transferred the file to the computer and – just like that – there was a three-colour image on screen. In 2009, we made a joint exhibition titled *Fortidens farger* (The Colours of the Past) with Renbjør's images and Prokudin-Gorskiĭ's from the Library of Congress, putting their work on colour in dialogue. I was in contact with Minachin some time before Christmas [2021] wondering if this software was still up and running but it seems that time and development has bypassed it, so it needed updates. He also wrote to me that there were no more separation negatives to digitally rebuild any more, and therefore hardly any reason to upgrade the software. So, I'm hoping archivists will find some soon!

*Do you notice any difference between Minachin's software and Adobe Photoshop which is also often used for three-colour digital reconstruction?*

I think Minachin's software was superior to Adobe Photoshop because it could identify pixels that were adjacent to each other automatically enabling an automatic overlap between the three-layers of the photographs. Not having to do this manually, like with Photoshop, meant that the resulting image was pristine and absolutely impressive!

*The Levanger Museum of Photography holds complete sets of three-colour separation negatives by Renbjør and is one of the few museums I know of with this kind of material. How did you find these three-colour separation negatives, especially considering how huge Renbjør's estate is?*

We knew about them being in the collection and had located most of them. But back in 2010–2011, a very observant museum volunteer found two extra sets. He had a very good memory for images and remembered nearly every image he saw in

7 ___ See Rolf Sachsse's contribution in this issue on pages 100–113.

the archives and – most importantly – where he saw it. So, when he found two almost identical [separation] negatives, he suspected there must be a third one somewhere in the collection which I ended up finding. After completing the set of three-separation negatives for each subject, we did a digital reconstruction to find out what it looked like in colour. The first three-colour photograph he found was of Renbjør's father standing outside (→ fig. 7), and the second was a view across the river towards Levanger (→ fig. 8). In total, we have 34 complete separation negatives in various physical states [in terms of conservation] (→ fig. 9), while we have less than ten incomplete separation negatives with at least one separation lacking in the sequence of three. A broken negative is no problem if you have all the bits and pieces but if it's completely gone, then the three-colour photograph cannot be reconstructed, since substantial colour information is lost.

*What did Renbjør do during and after WWI? Did he remain a (colour) photographer/chemist?*

From 1917 to 1919 Renbjør taught agricultural chemistry at the Norwegian School of Agriculture, after which he returned home to run the family business. In 1926, the Renbjør family started selling photographic equipment and film, and established a development and printing service. Seven years later, Harald Renbjør built his own chemistry laboratory to experiment and do research as he pleased. He focused on Agfa's new colour reversal film Agfacolor NEU from 1936. During WWII and after the occupation of Norway by Hitler's army which began in 1940, Harald Renbjør ran the family business and was commissioned to process, develop, and print the films made by the German soldiers. His son Per Renbjør leaked the content of these films to the British allied forces since he was helping them as an informant. After World War II, he and his son Per started planning a laboratory for the development of colour film in Levanger. Per told me they had to search almost the entire country to find the materials they needed. It was particularly hard to find chemical resistant materials, such as lead pipes, after the war. It's important to keep in mind that Norway was still a poor country at the time, and completely worn down by the war. But finally, they could open the lab in 1948, the first of its kind in Norway, and developed the Ansco reversal film, which was based on the same technology as Agfacolor NEU, with the colour couplers incorporated in the emulsion. After 1950, they started developing colour negative films. The development service continued into the early seventies.

*Harald Renbjør's chemistry laboratory was also part of the estate which his son Per Renbjør donated to the Levanger Museum of Photography although the laboratory was initially located elsewhere. How did this transition happen?*

Anyone within his senses would not do it but we did it anyhow, despite being a small museum and the collection being a huge mess of items and images. The lab had, by and large, been unused and locked up since Harald's death in 1956. When Per

fig. 7
Harald Renbjør, *Peter Kars Renbjør* (Harald's father), ca. 1906, three-color digital image. Levanger Museum of Photography. Digital color reconstruction by Nils Torske. This may be Norway's oldest existing color photograph.

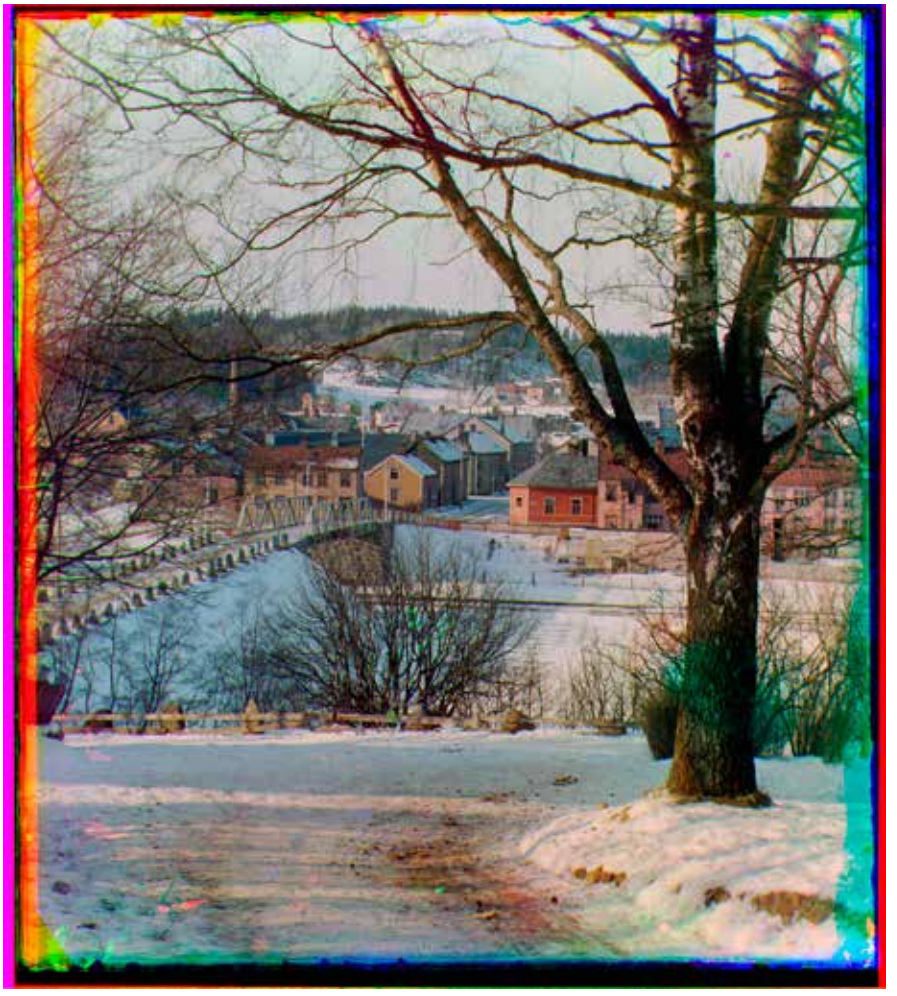


fig. 8
Harald Renbjør, *View of Levanger 2,* undated (probably 1907–10), three-color digital image. Levanger Museum of Photography. Digital color reconstruction by Nils Torske.

fig. 9
Harald Renbjør, *View of Levanger 2,* undated (ca. 1907–10), three-color separation negatives 8 × 9 cm each. Levanger Museum of Photography.

fig. 10
Cecilie Gottfred Petersen and Nils Torske, *Renbjør's Laboratory,* 6 November 2021, three-color image 6 × 9 cm. Digital color reconstruction by Maria Eugenia Calmaestra Vázquez and Nils Torske.

Renbjør offered it to us, along with what was left of his family's firm, we were immediately interested because at that point we realized this place was the start of modern Norwegian colour photography! It was around 200 meters away from the museum and Harald Renbjør built it originally in 1933 to have his own playground, his own domain. Harald Renbjør frequently worked there at night researching colour photography among other things. In the thirties he took a patent on a substance added to glue to make it waterproof. This 'first lab' was pivotal for us to preserve for the city of Levanger because it laid the foundations for the 'second lab' for colour development, which he opened in 1948 where 30–40 people worked. So, people still remembered it and we had to ensure the continuity of this institution somehow. Moving the lab from its original address to the Museum was a lot of work and a matter of very thorough documentation of what was where. In order to do that, we developed a system to identify each shelf with a letter and number, we made measurements, took notes, worked with professional carpenters, raided stores for empty boxes and packed out everything in order. So, when we moved it to the Museum after this long process, it was relatively 'easy' to reconstruct the lab, all things considered (→ fig. 10).

*When you first joined the Museum, you were already a photographer but were you interested in colour photography? Differently put, how did you begin practising analogue three-colour photography yourself?*

Before I joined the museum in 1989, I was an advanced photography amateur and really fond of working in the darkroom, but I considered myself 'a born black-

and-white photographer'. But, while working with Renbjør's collection, I became curious about three-color photography and tried it myself using an analogue camera (like Hasselblad, and Sinar 4 × 5") and old-fashioned black-and-white film; and I still do. When I shoot the image, of a stationary object of course, I calculate the exposure, simply hold the filter in front of the lens, and take the shot, repeating this for each of the three filters. Then I go to my small portable darkroom and load the film in the developer tank. This is simple and pretty straightforward, like developing a regular black and white film. Once developed, I then take photos of the three separation negatives with a digital camera, put them into Photoshop and reconstruct their colours digitally.

*Why go through all the trouble of producing three-colour separation negatives when you could take regular analogue photographs using a colour film?*

This is a special method for colour on film in my opinion. If you use modern tripack colour film, shoot it, develop it, and store it, in twenty years (which is quite a short time, historically-speaking), the difference in colour layers is visible due to the deterioration of the material. But a properly-processed and well-stored black-and-white film remains stable for a much longer period.[8] As far as we know today, three-colour photography and colour separation is perhaps the only method of long-term preservation of photographic colour. This is one of the reasons for my three-colour documentation project at the moment, extensively photographing the centre of Levanger using this method. I will then leave the negatives to the Levanger Museum of Photography because I like the idea that in 200 years or more someone can find my films and re-make colour images from them.

*Thank you Nils for this interview!*

8___ If well-stored, processed black-and-white negatives experience no degradation even after 70 years. See: James M. Reilly, 'A Summary of Recent Research at The Image Permanence Institute (1992)', in: *Topics in Photographic Preservation* 1993, vol. 5, 52–59. <https://resources.culturalheritage.org/pmgtopics/1993-volume-five/05_06_Reilly.html#fig1> (07. 02. 22) When presered at 40 % RH (relative humidity) and 15 degrees C, the film can last for 100 years. See: James M. Reilly, IPI Storage Guide for Acetate Film, New York 1993, 5.