
Using PSNR thresholds to modulate the degree of lossy compression in JPEG2000 files

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Disclaimers & disappointments

- I'm not an image scientist, a computer scientist, or a signal processing specialist.
- Any detailed technical definitions that I provide should be double checked.

A report from the field

- PSNR encoding JP2 files
- The benefits
- The failings
- Measuring and detecting difference
- Our trick for guarding against PSNR failings
- Statistics

Peak Signal to Noise Ratio

The phrase peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

[Wikipedia entry](#)

Peak Signal to Noise Ratio

The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc. It is most easily defined via the mean squared error (MSE) which for two $m \times n$ monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as:

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} \|I(i, j) - K(i, j)\|_2^2$$

The PSNR is defined as:

$$PSNR = 10 \cdot \log_{10} \left(\frac{MAX_I^2}{MSE} \right) = 20 \cdot \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right)$$

[Wikipedia entry](#)

Peak Signal to Noise Ratio

My Take:

In expressing PSNR as an lossy image encoding parameter, you are making explicit the difference that you are willing to accept between the source image and the lossy compressed copy that you are creating.

Other options?

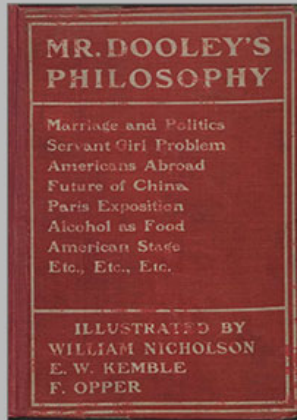
- Fixed file size
- Fixed compression ratio (encoded file to source file)

Why did we elect to control compression using PSNR?

- PSNR is a smart control.
- It adjusts compression based on the content of the image.
- Image content: The arrangement and distribution of pixel-to-pixel differences within the source image.
- PSNR is a smart control, but it isn't perfect.

IT WORKS

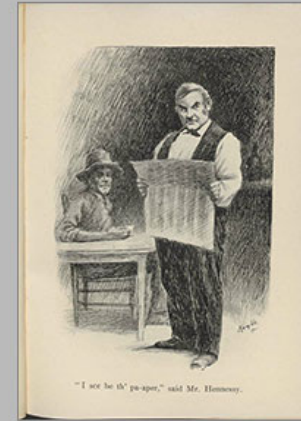
5 least compressed page images



0001.jp2
Today, 6:47:42 PM



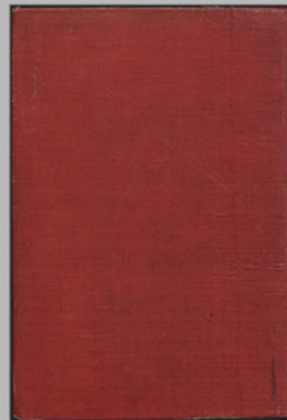
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Today, 6:47:46 PM



0095.jp2
Today, 6:47:49 PM

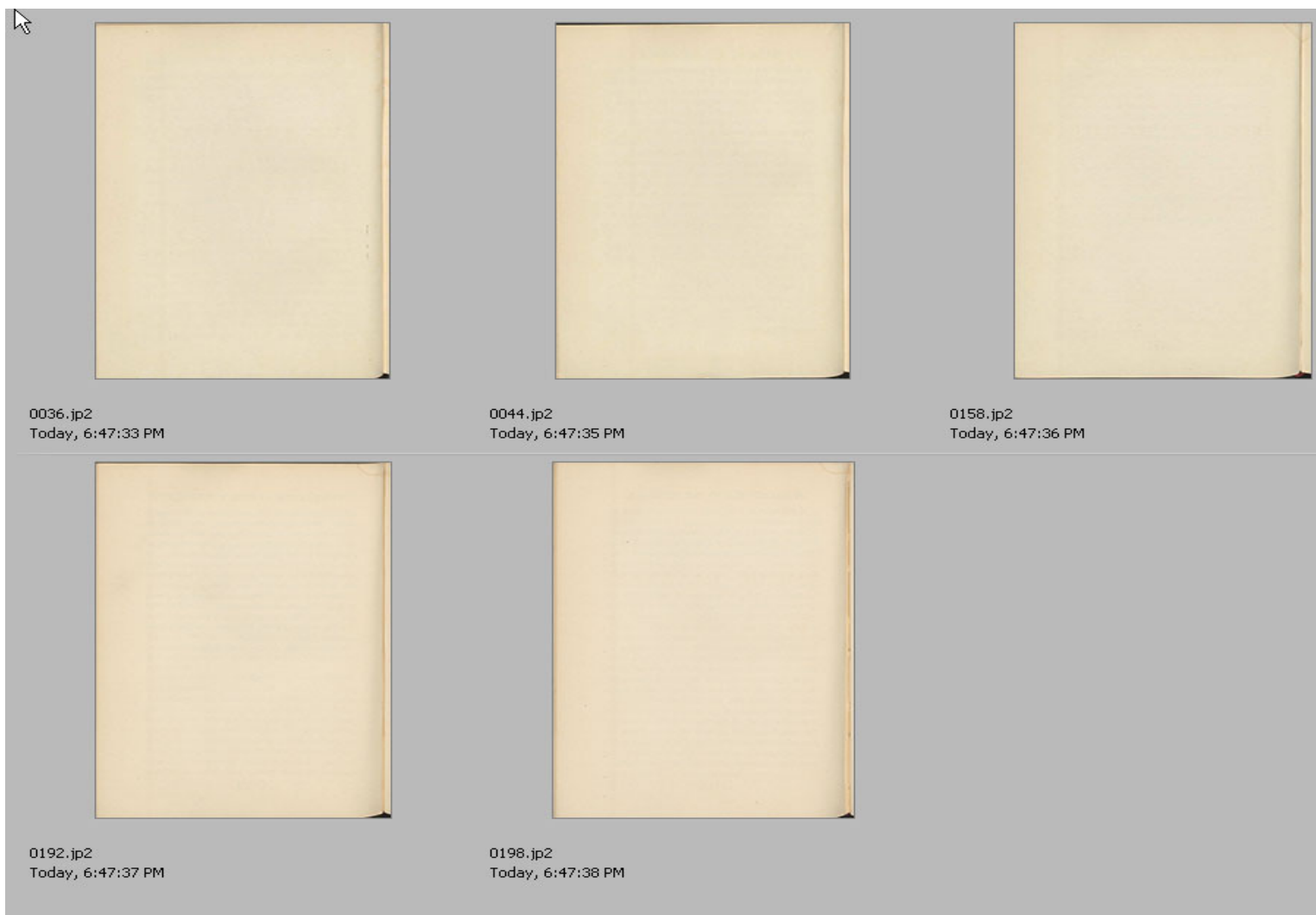


0217.jp2
Today, 6:47:52 PM

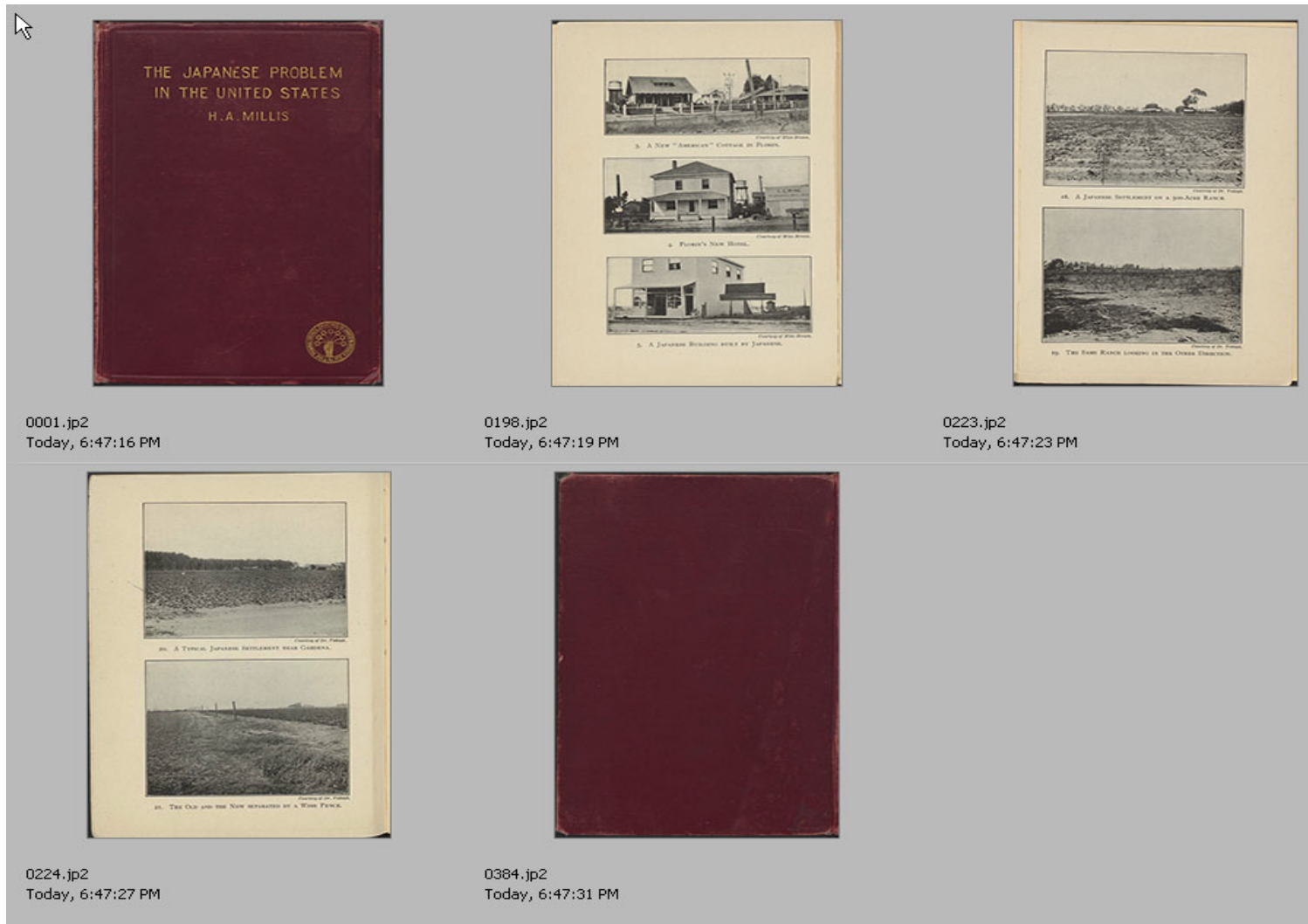


0274.jp2
Today, 6:47:55 PM

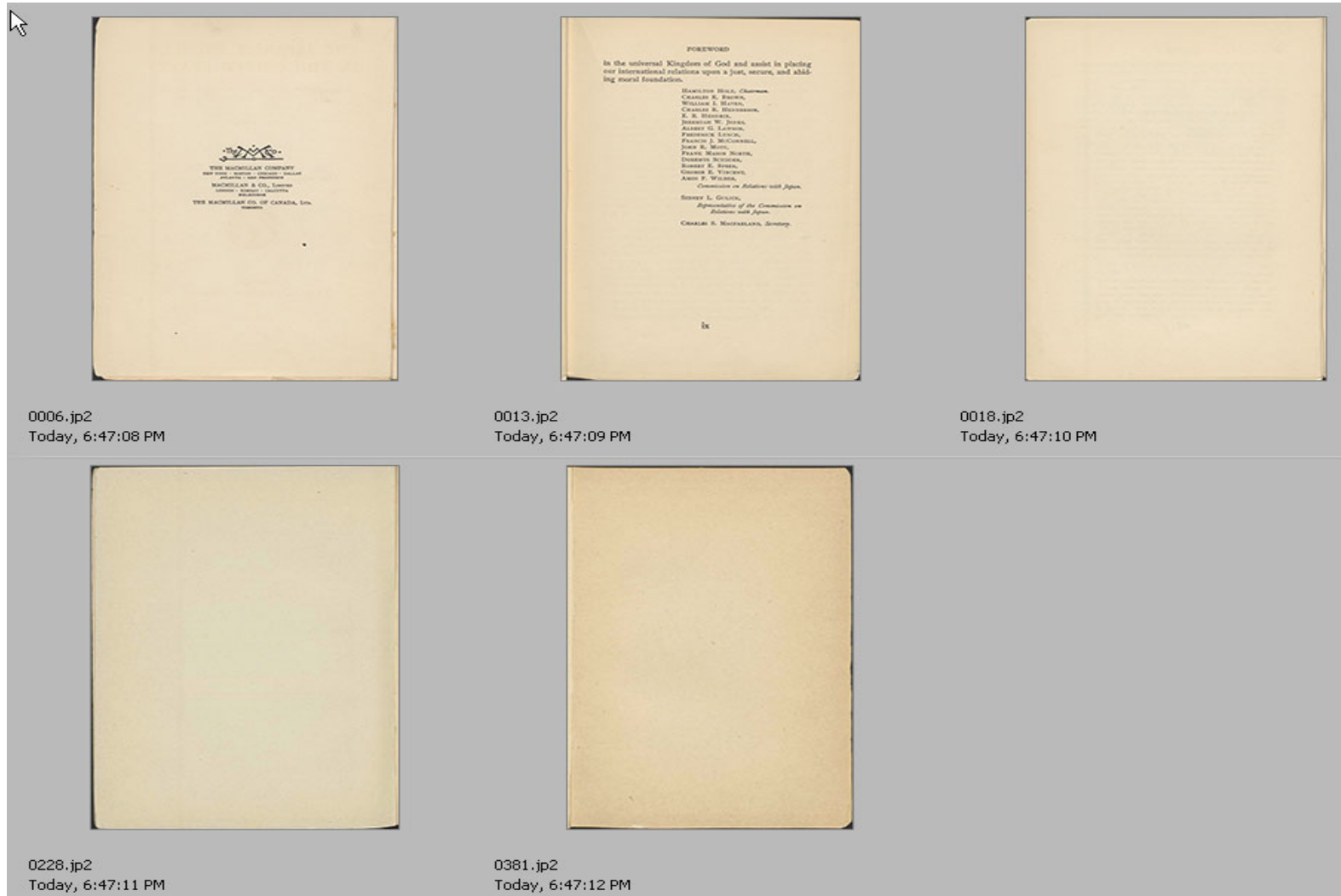
5 most compressed page images



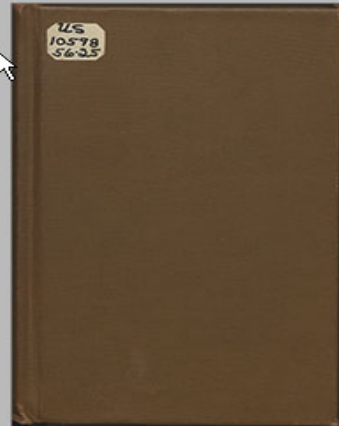
5 least compressed page images



5 most compressed page images



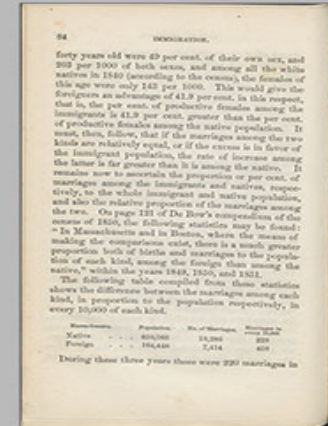
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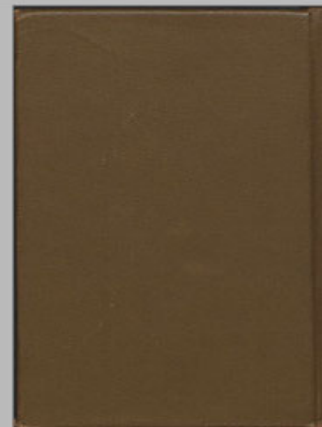
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Today, 6:47:00 PM

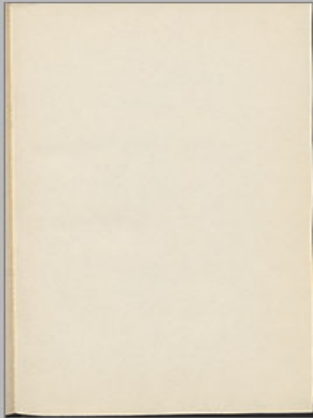


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0176.jp2
Today, 6:47:06 PM

5 most compressed page images



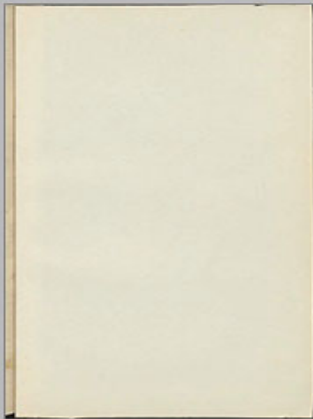
0005.jp2
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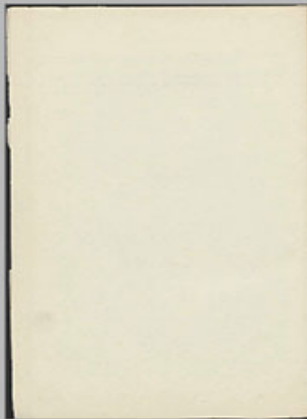
0008.jp2
Today, 6:46:49 PM



0073.jp2
Today, 6:46:51 PM



0171.jp2
Today, 6:46:52 PM



0172.jp2
Today, 6:46:53 PM

5 least compressed page images



0001.jp2
Today, 6:46:35 PM



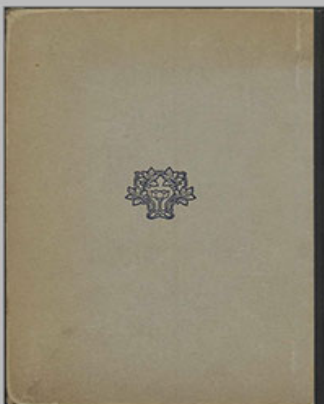
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0042.jp2
Today, 6:46:41 PM

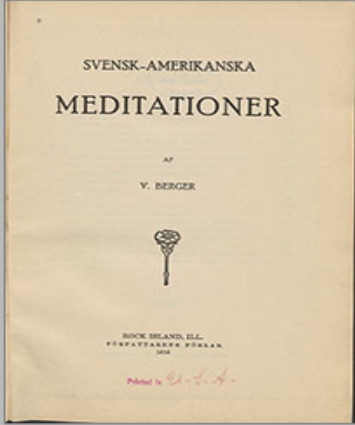
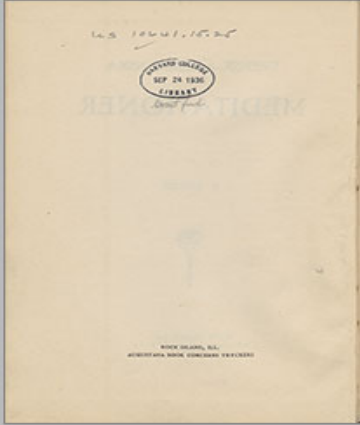
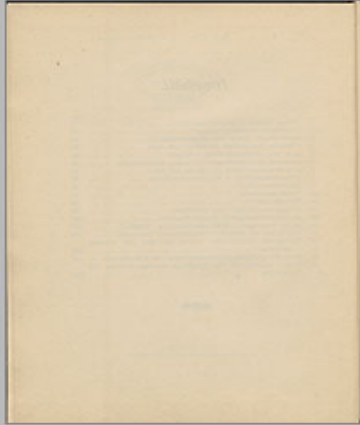
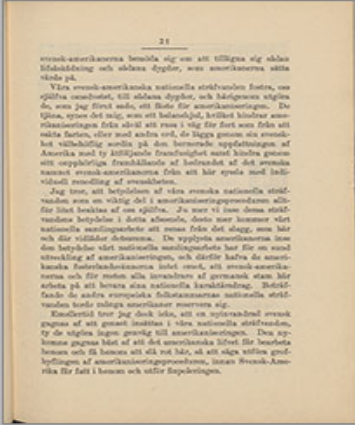



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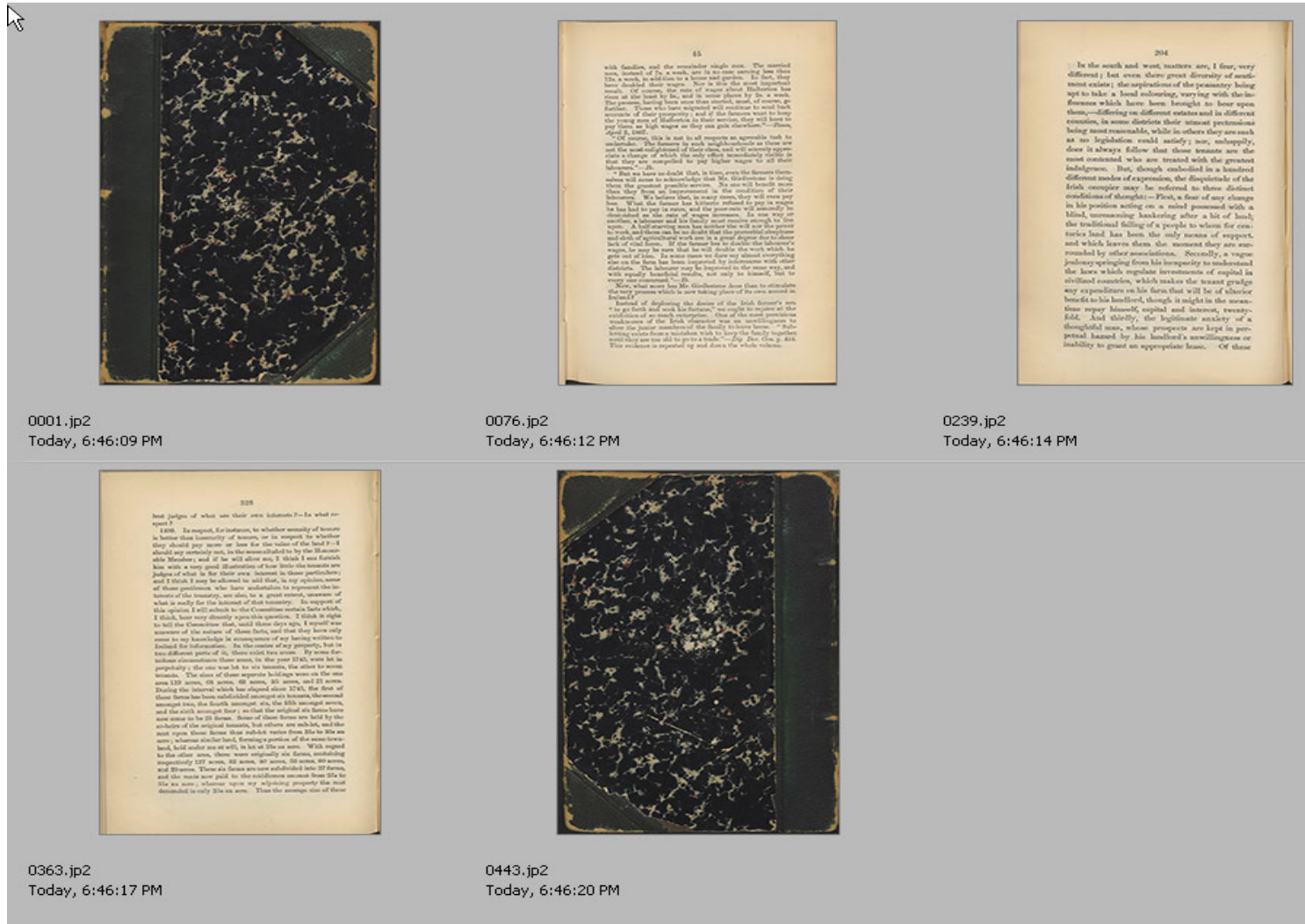


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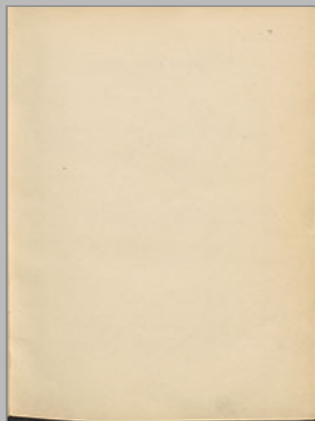
5 most compressed page images

		
0005.jp2 Today, 6:46:22 PM	0006.jp2 Today, 6:46:24 PM	0008.jp2 Today, 6:46:25 PM
		
0025.jp2 Today, 6:46:28 PM	0055.jp2 Today, 6:46:31 PM	

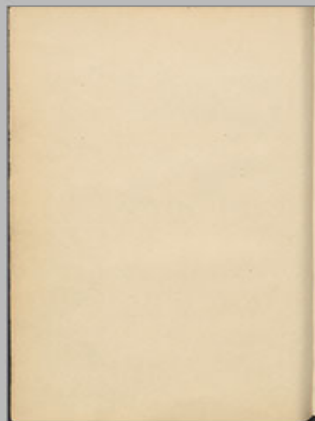
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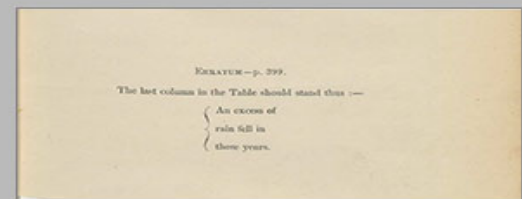
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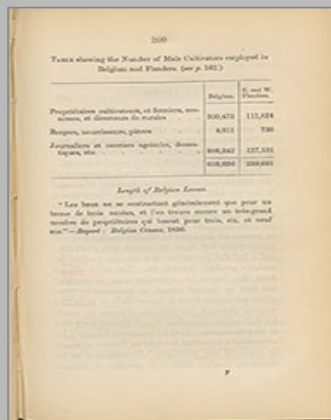
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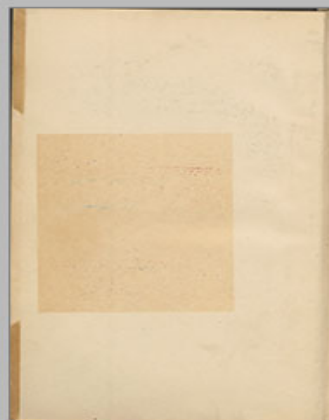
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Today, 6:46:02 PM



0009.jp2
Today, 6:46:03 PM

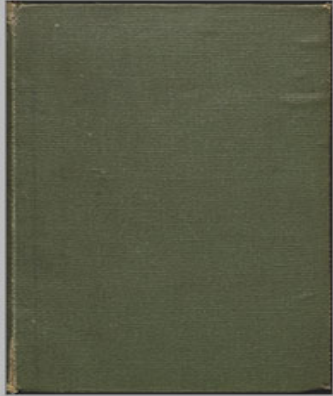



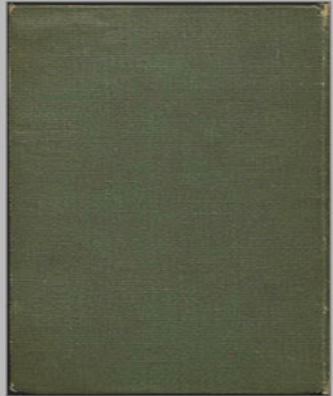


0244.jp2
Today, 6:46:04 PM

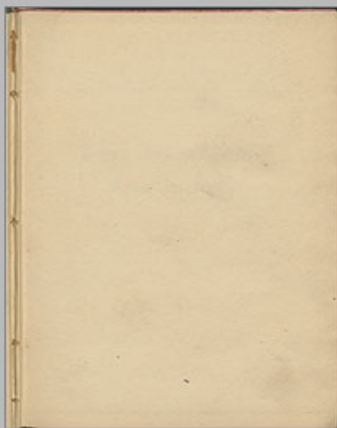


0441.jp2
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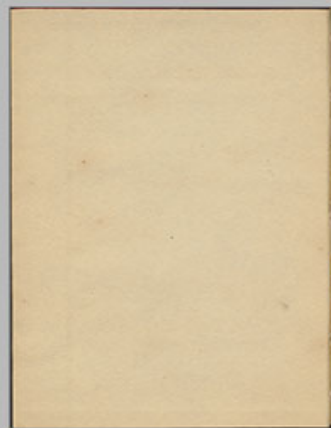
5 least compressed page images

		
0001.jp2 Today, 6:45:47 PM	0068.jp2 Today, 6:45:50 PM	0276.jp2 Today, 6:45:52 PM
		
0288.jp2 Today, 6:45:55 PM	0376.jp2 Today, 6:45:59 PM	

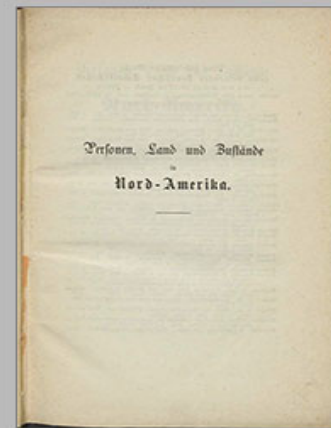
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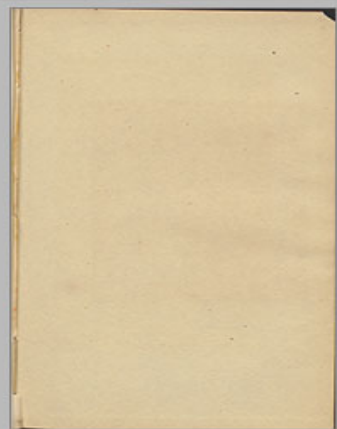
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Today, 6:45:37 PM



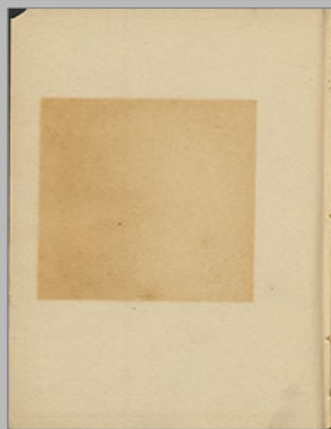
0004.jp2
Today, 6:45:39 PM



0005.jp2
Today, 6:45:40 PM



0373.jp2
Today, 6:45:41 PM



0374.jp2
Today, 6:45:42 PM

5 least compressed page images



W362726_1.jp2
Today, 10:33:17 PM



W362729_1.jp2
Today, 10:34:10 PM



W362740_1.jp2
Today, 10:36:30 PM

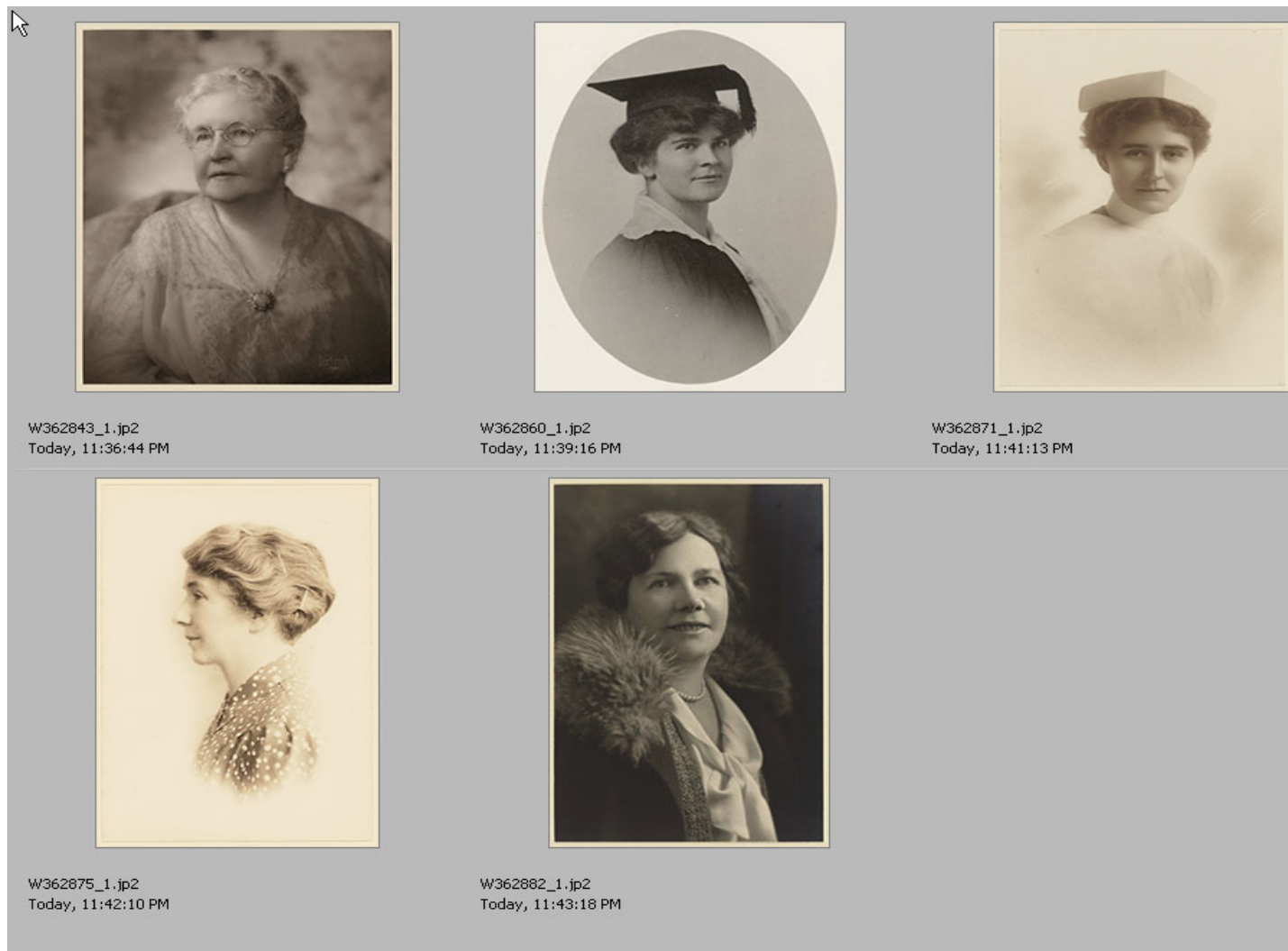


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Today, 10:45:34 PM



W362874_1.jp2
Today, 11:41:50 PM

5 most compressed page images



IT FAILS

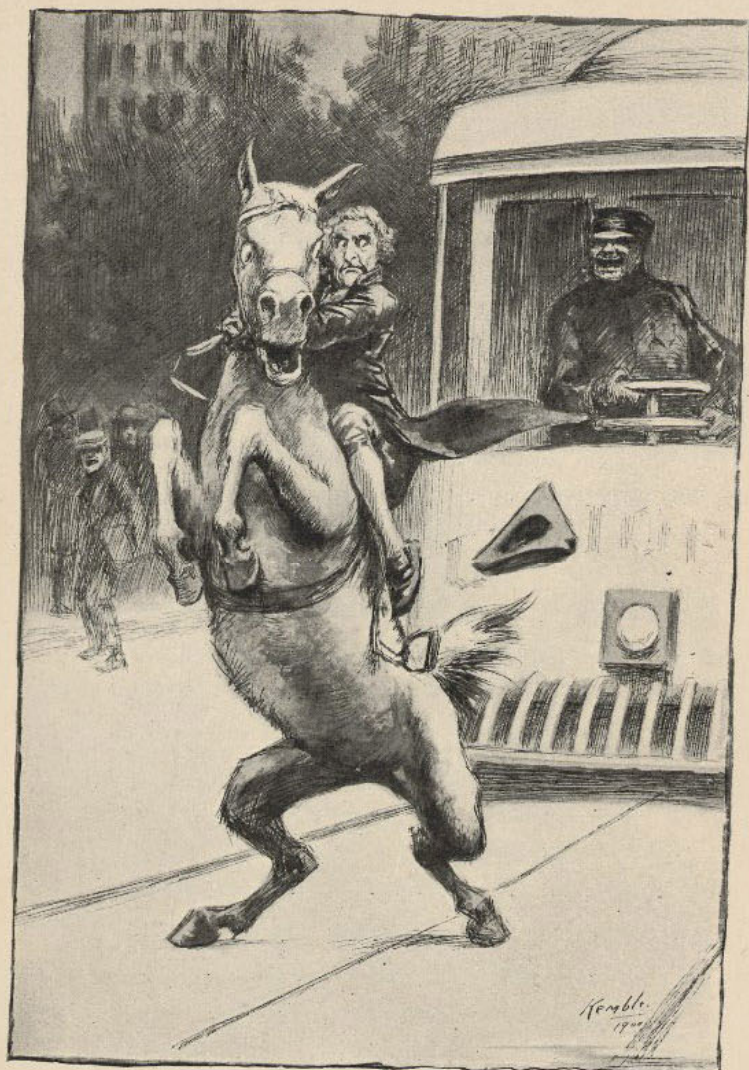




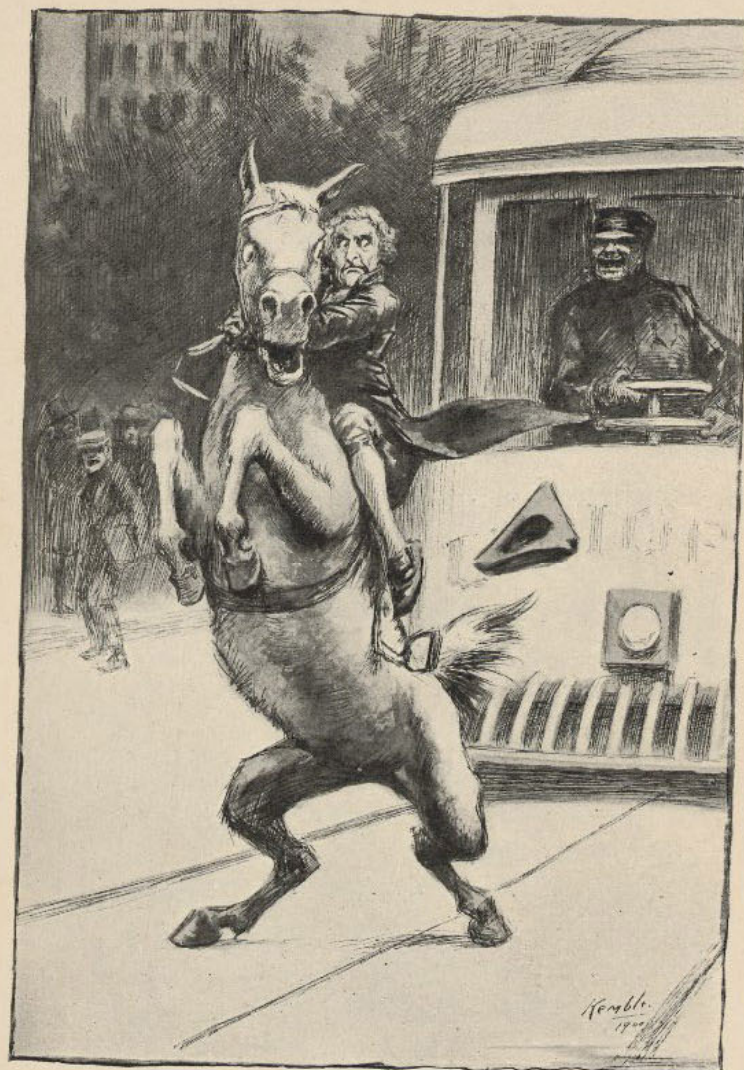






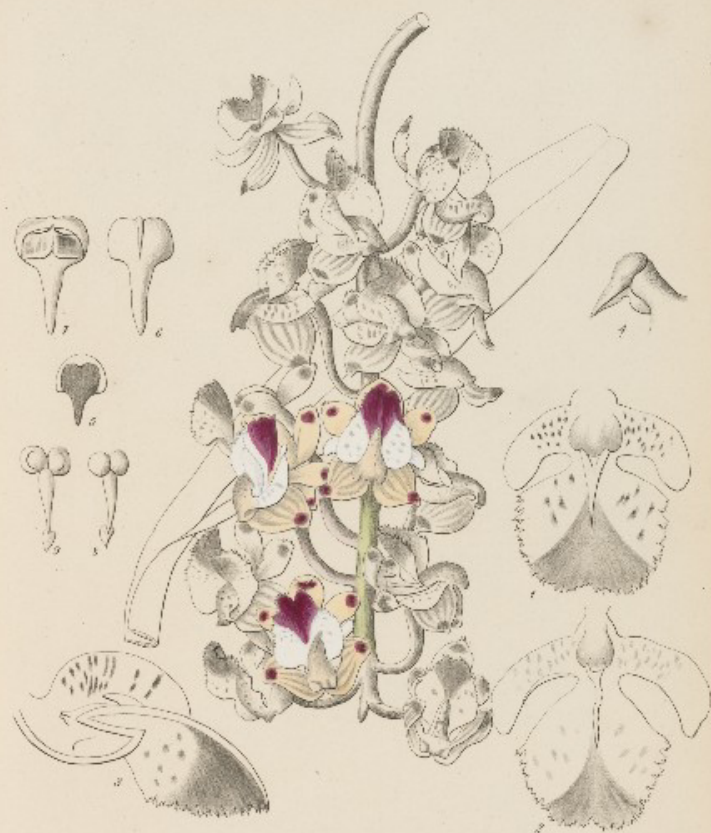


"But suppose Thomas Jefferson was to come back here now."

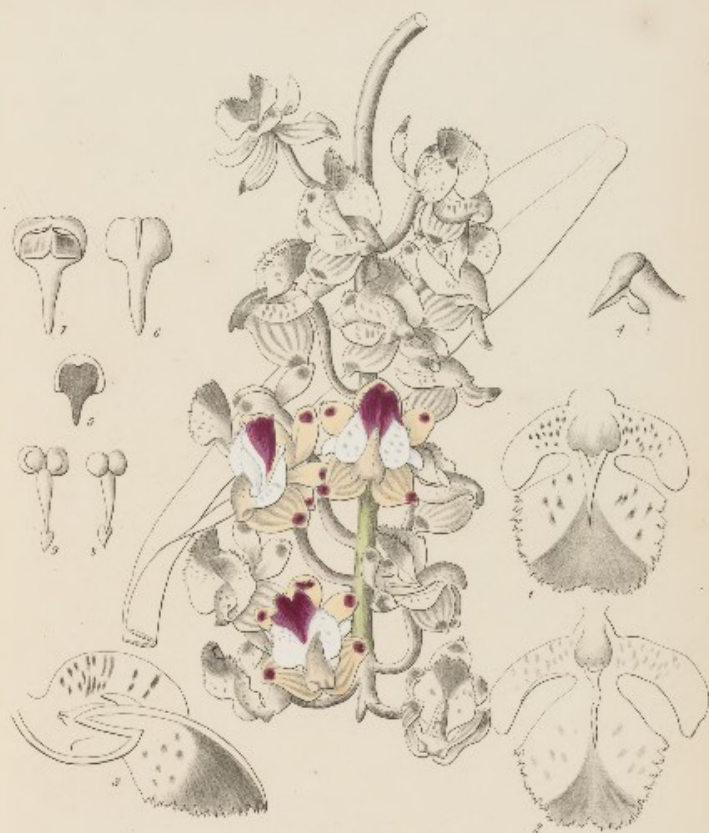


"But suppose Thomas Jefferson was to come back here now."





Anodes Houlletianum Robt. fil.



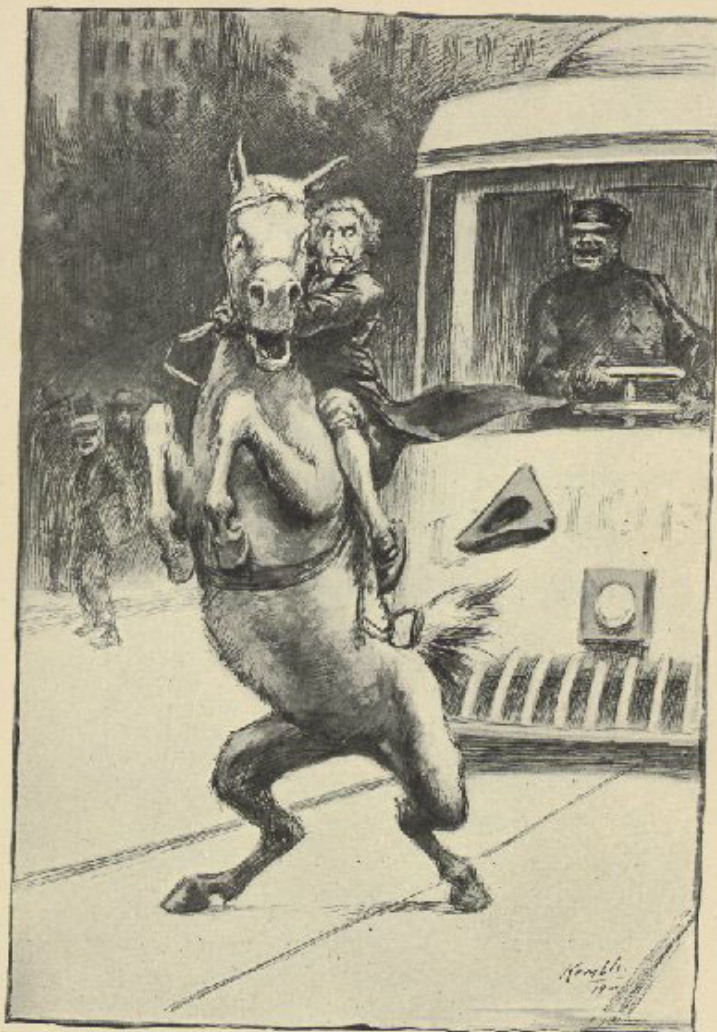
Anodes Houlletianum Robt. fil.

M. Berthold sc.

M. Berthold sc.

Measuring Difference

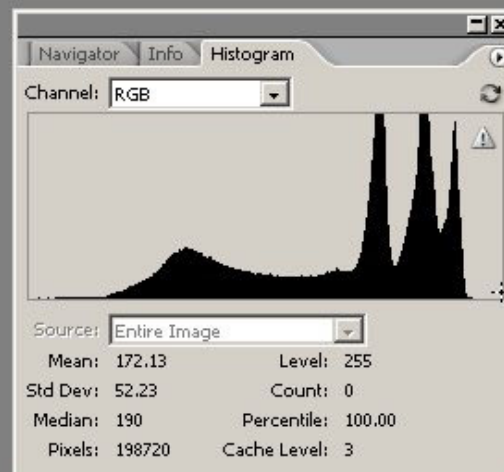
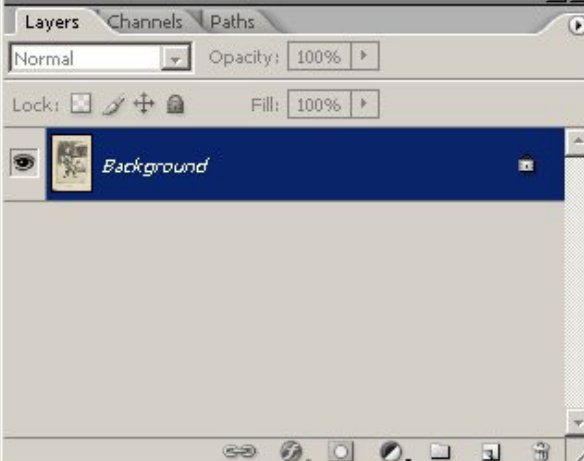
0217.tif @ 33.3% (RGB/8)

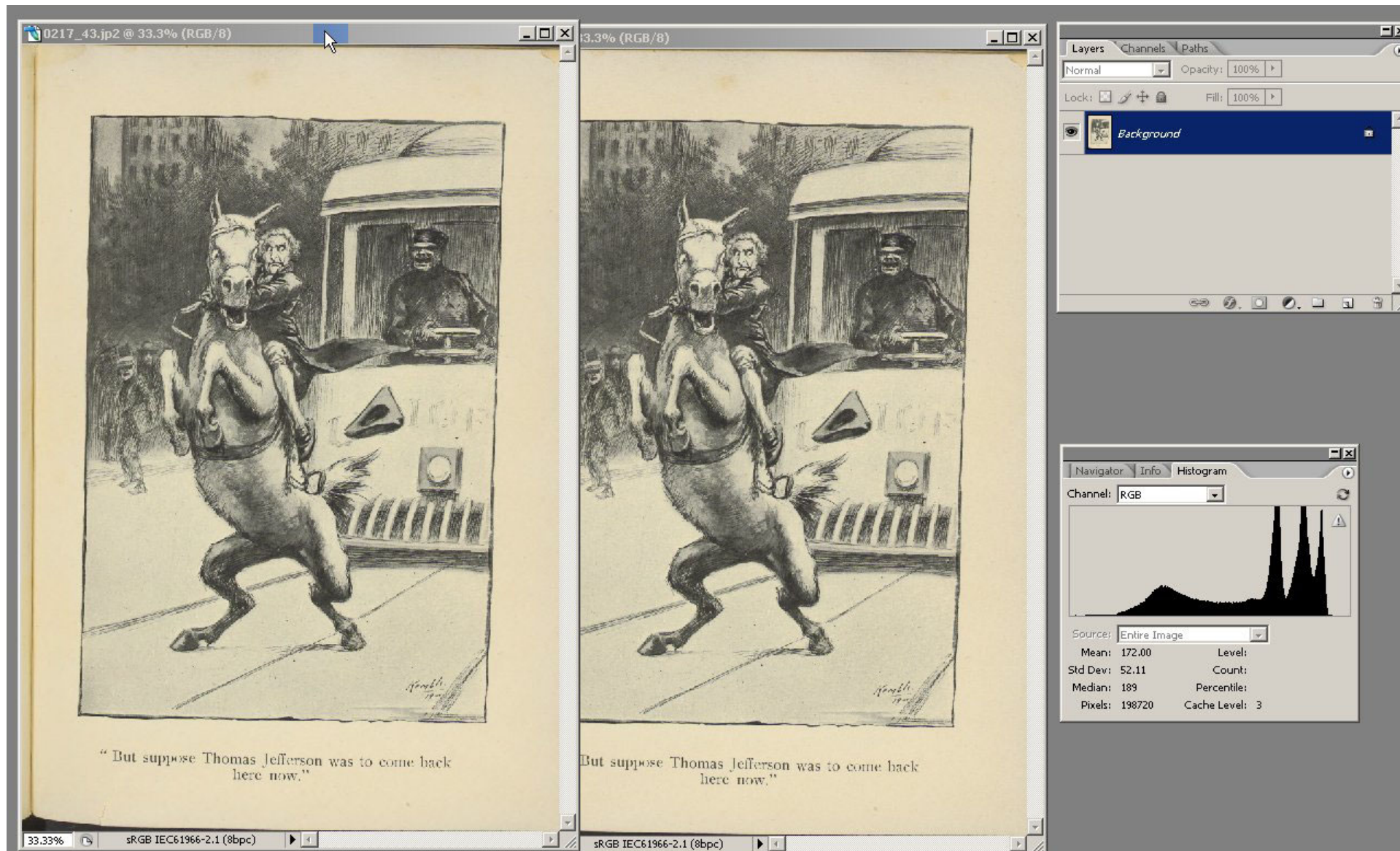


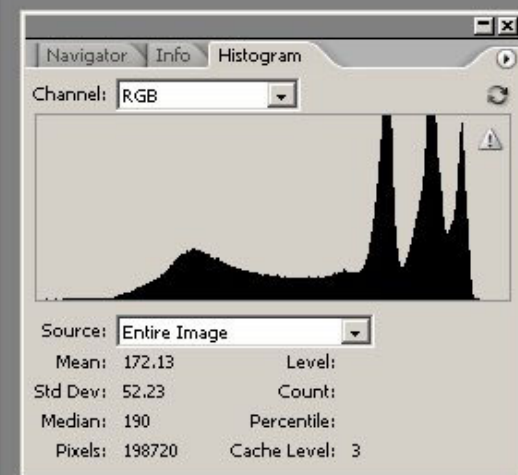
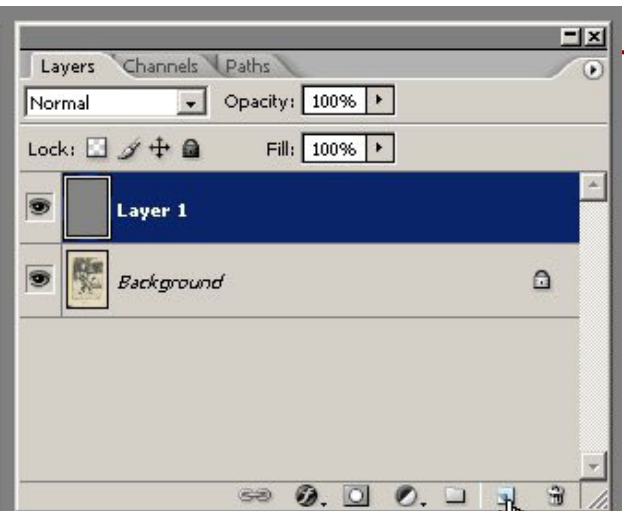
"But suppose Thomas Jefferson was to come back here now."

33.33%

sRGB IEC61966-2.1 (8bpc)



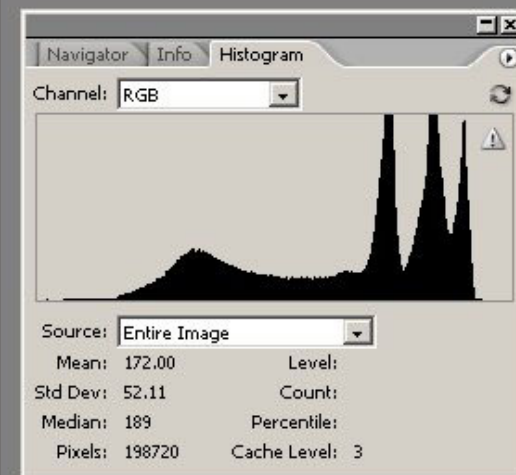
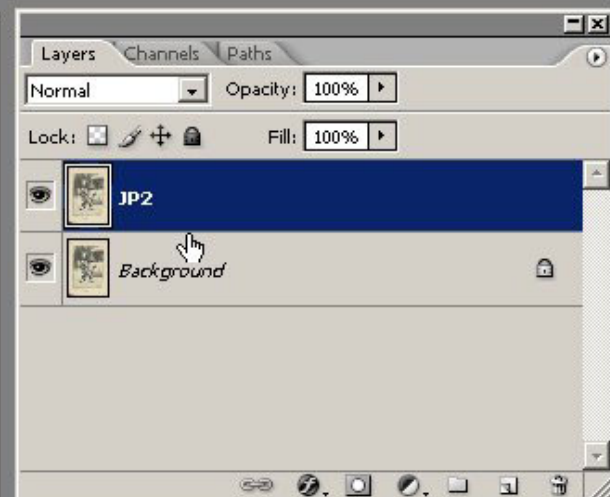




0217.tif @ 33.3% (Layer 1, RGB/8)

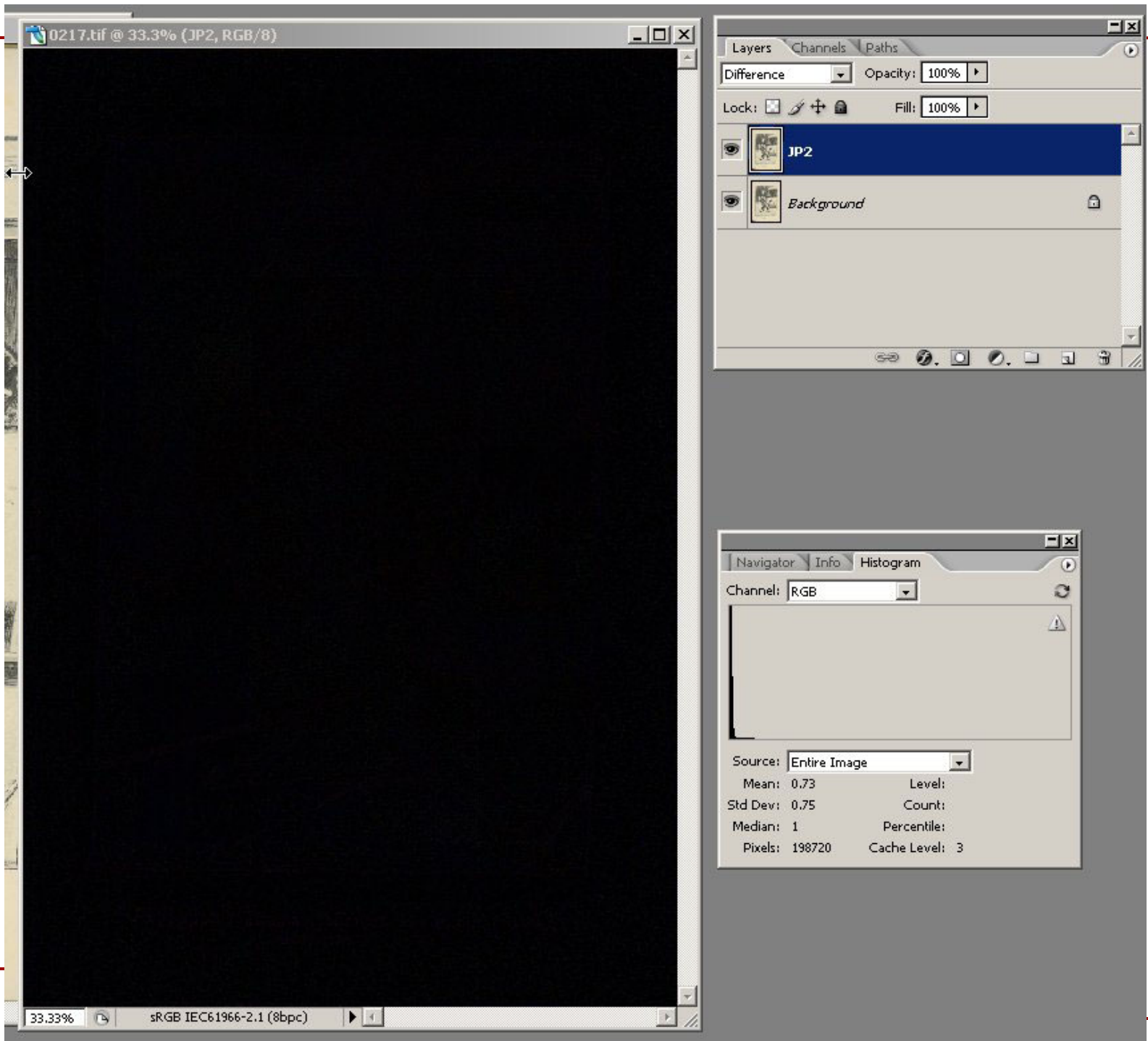


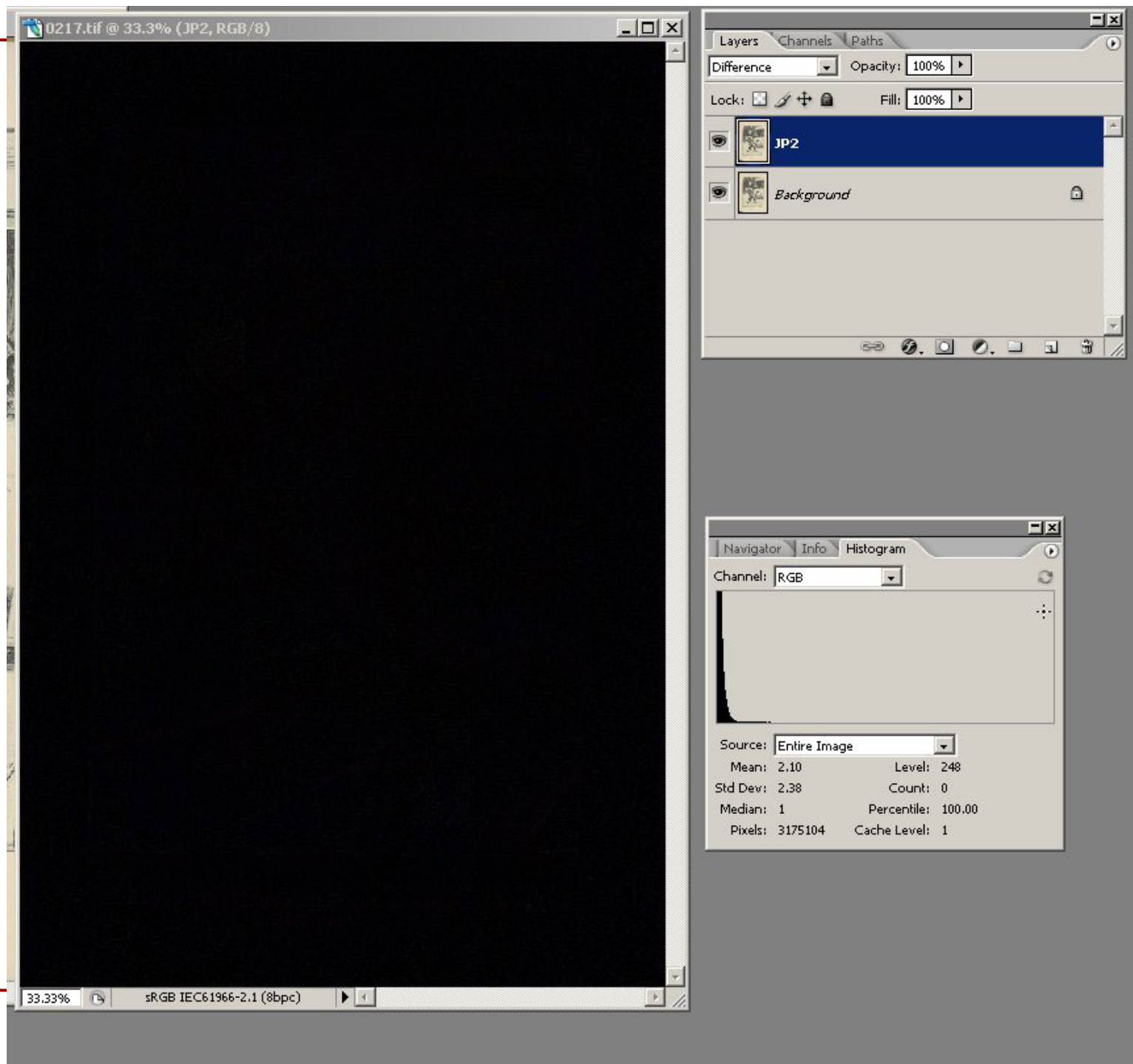
“But suppose Thomas Jefferson was to come back here now.”

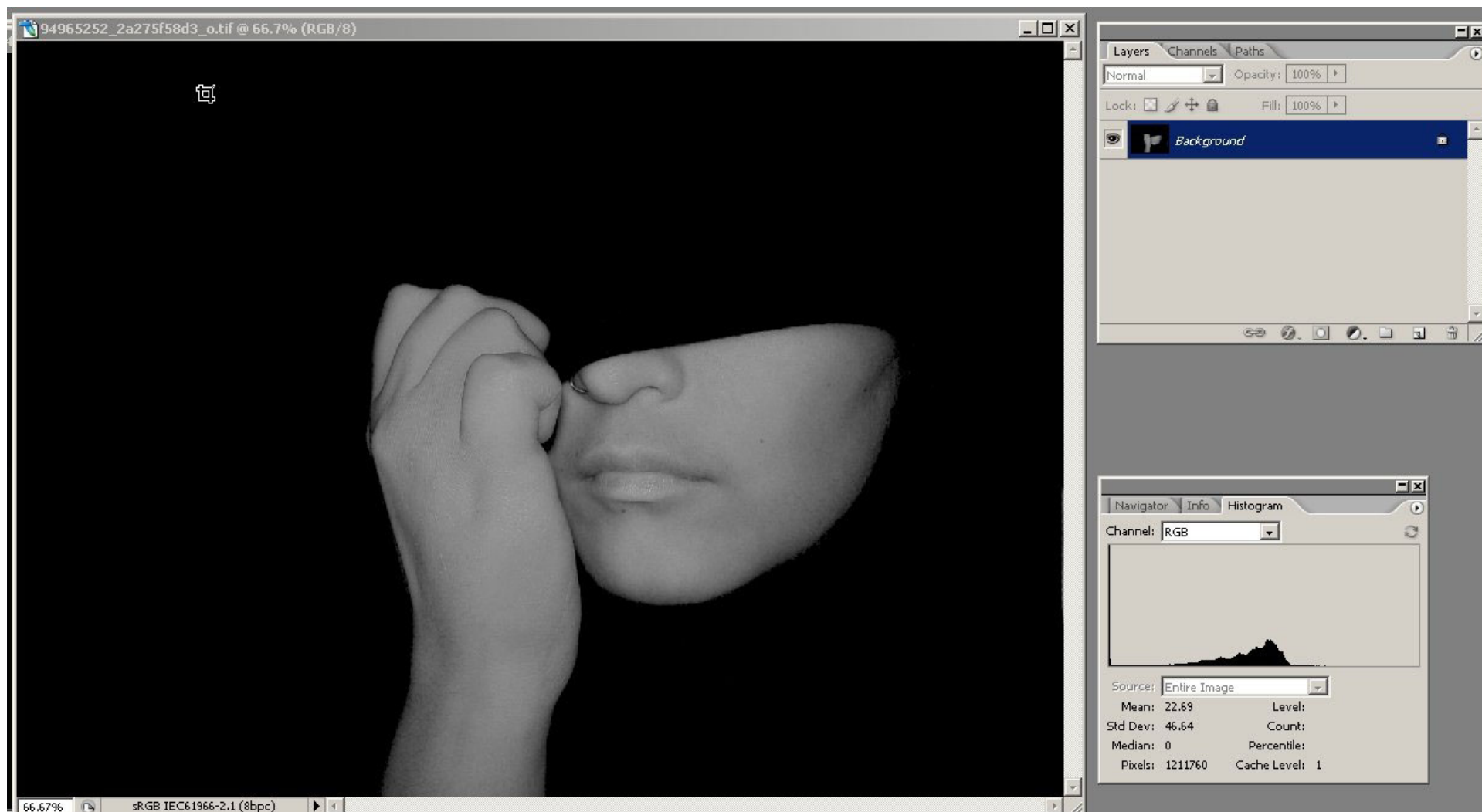


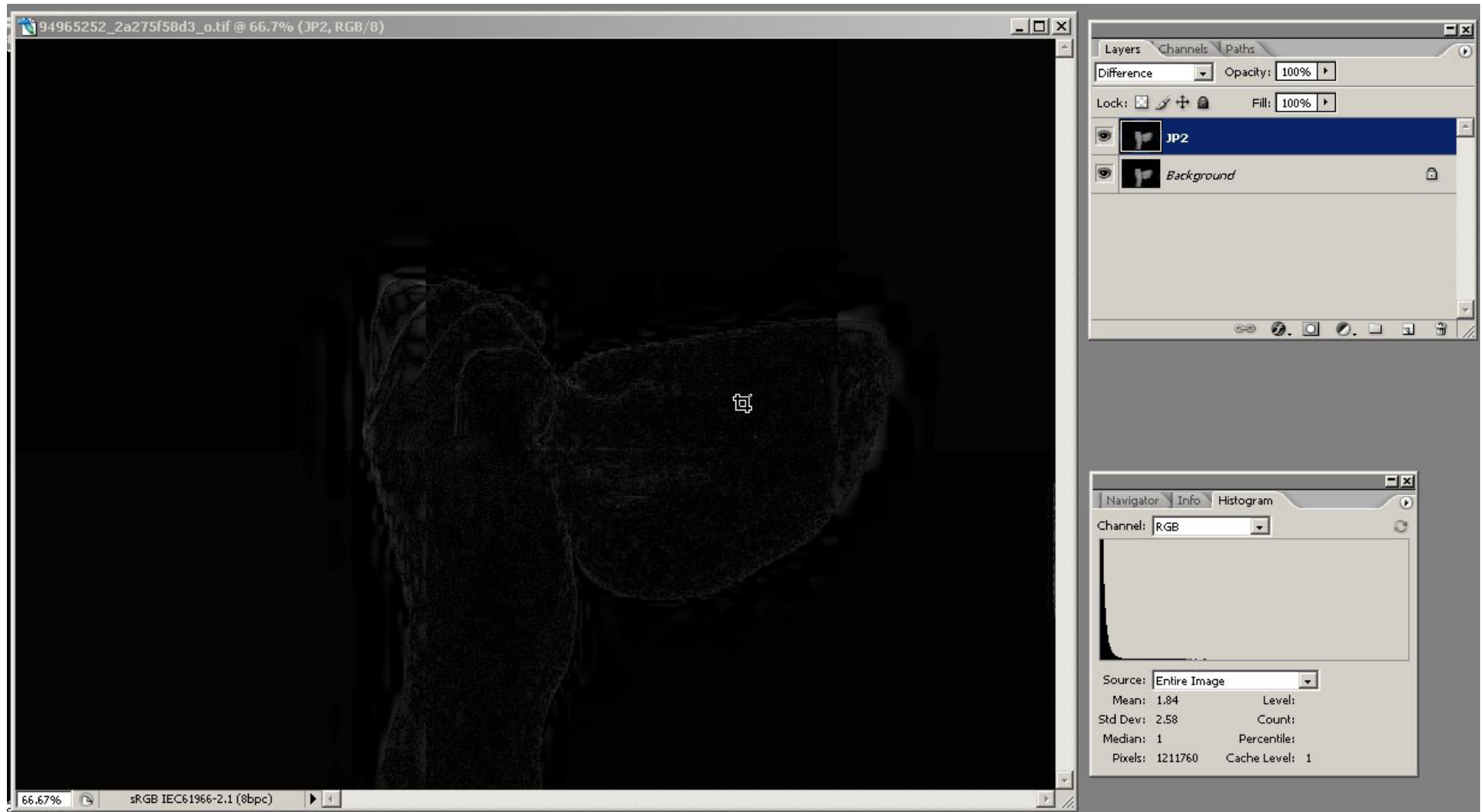
33.33%

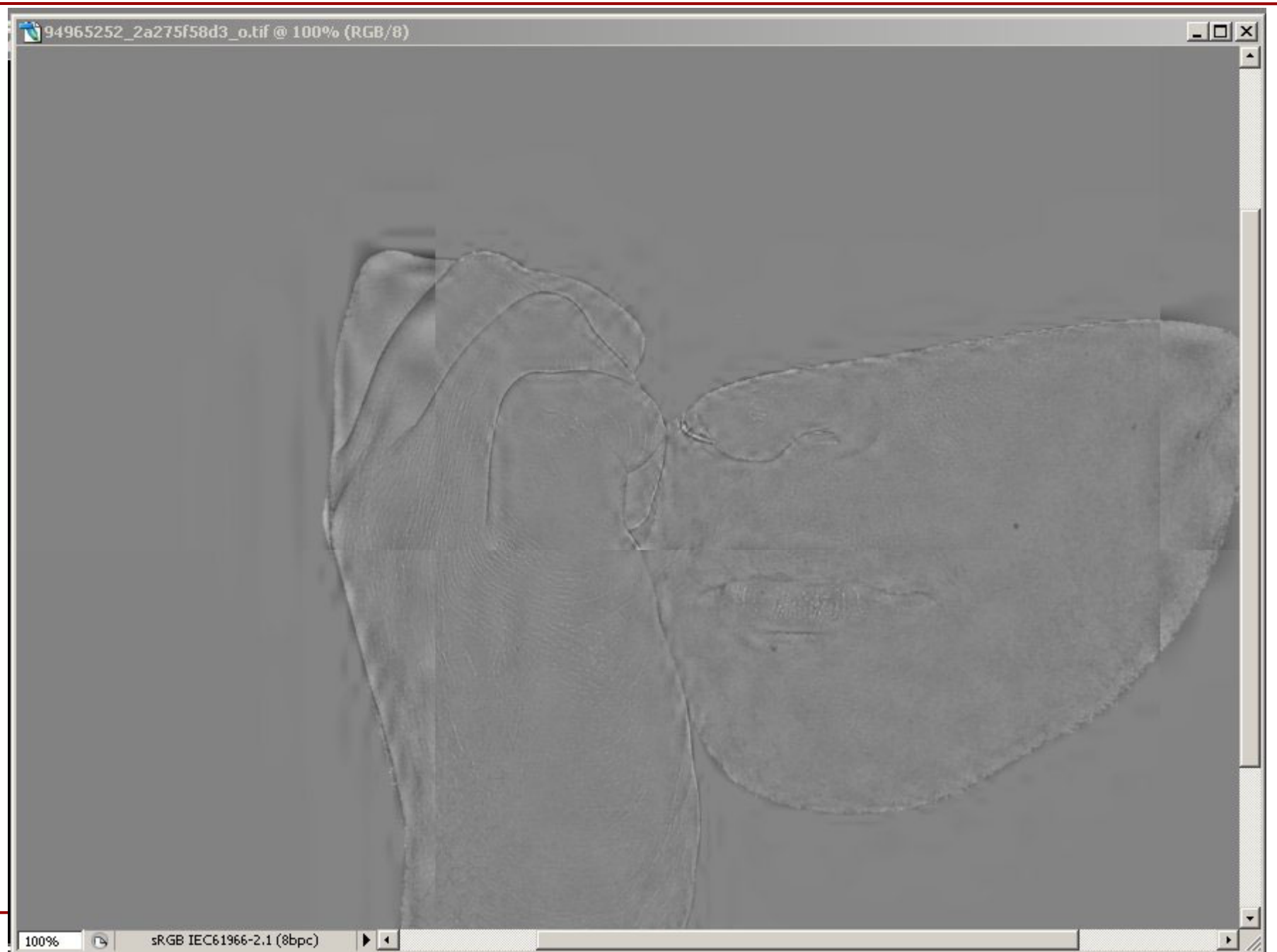
sRGB IEC61966-2.1 (8bpc)

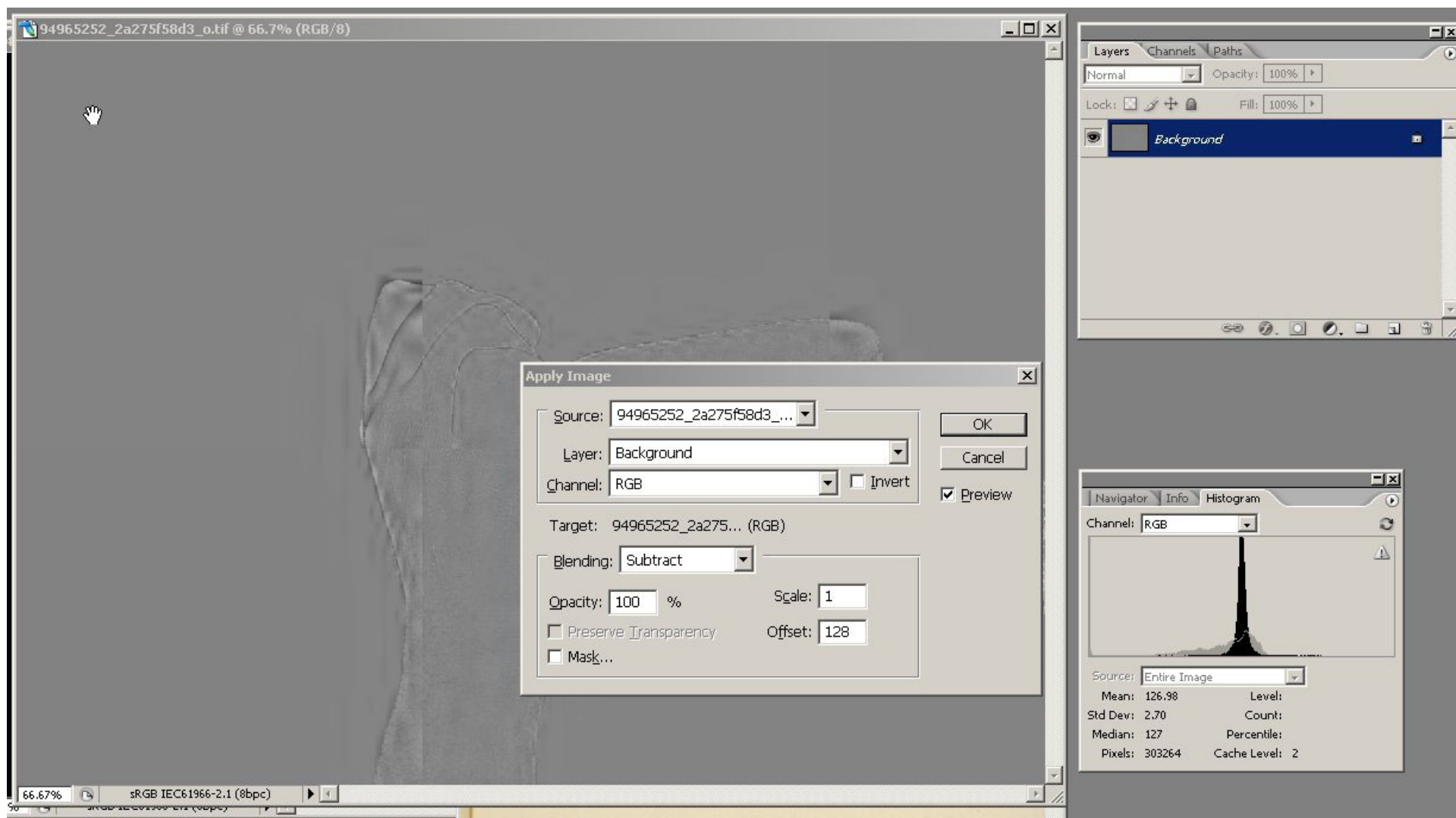


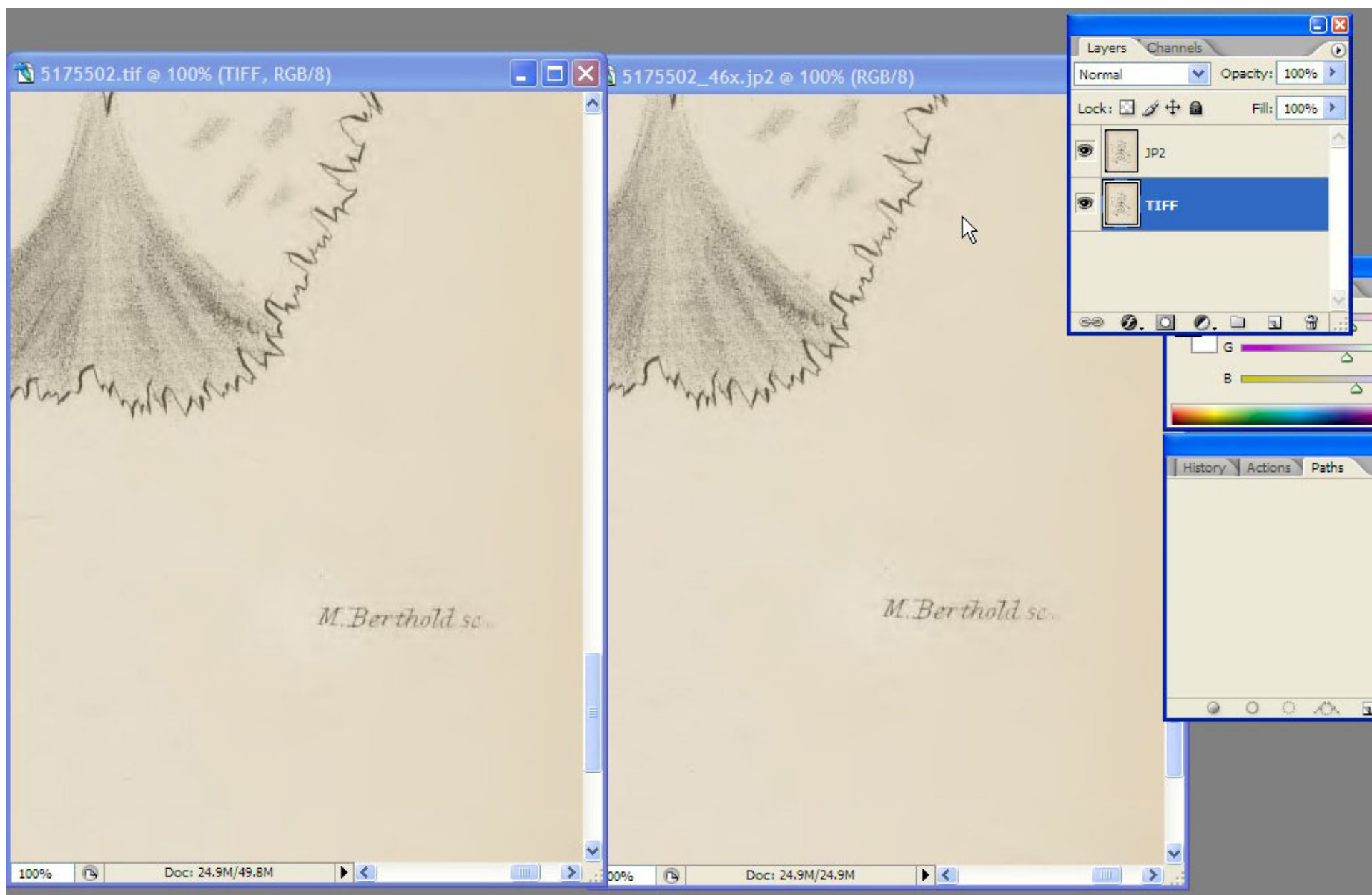


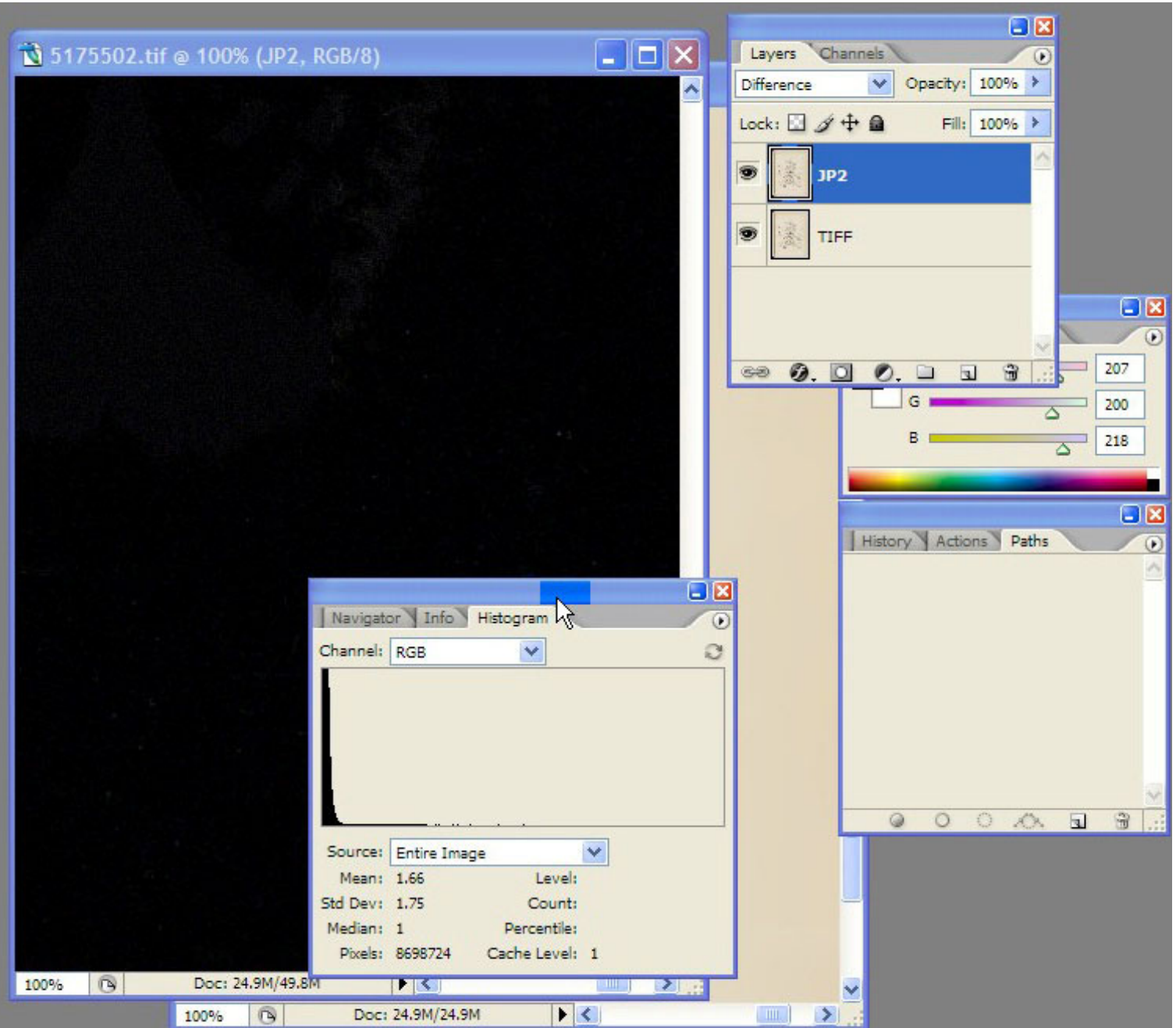


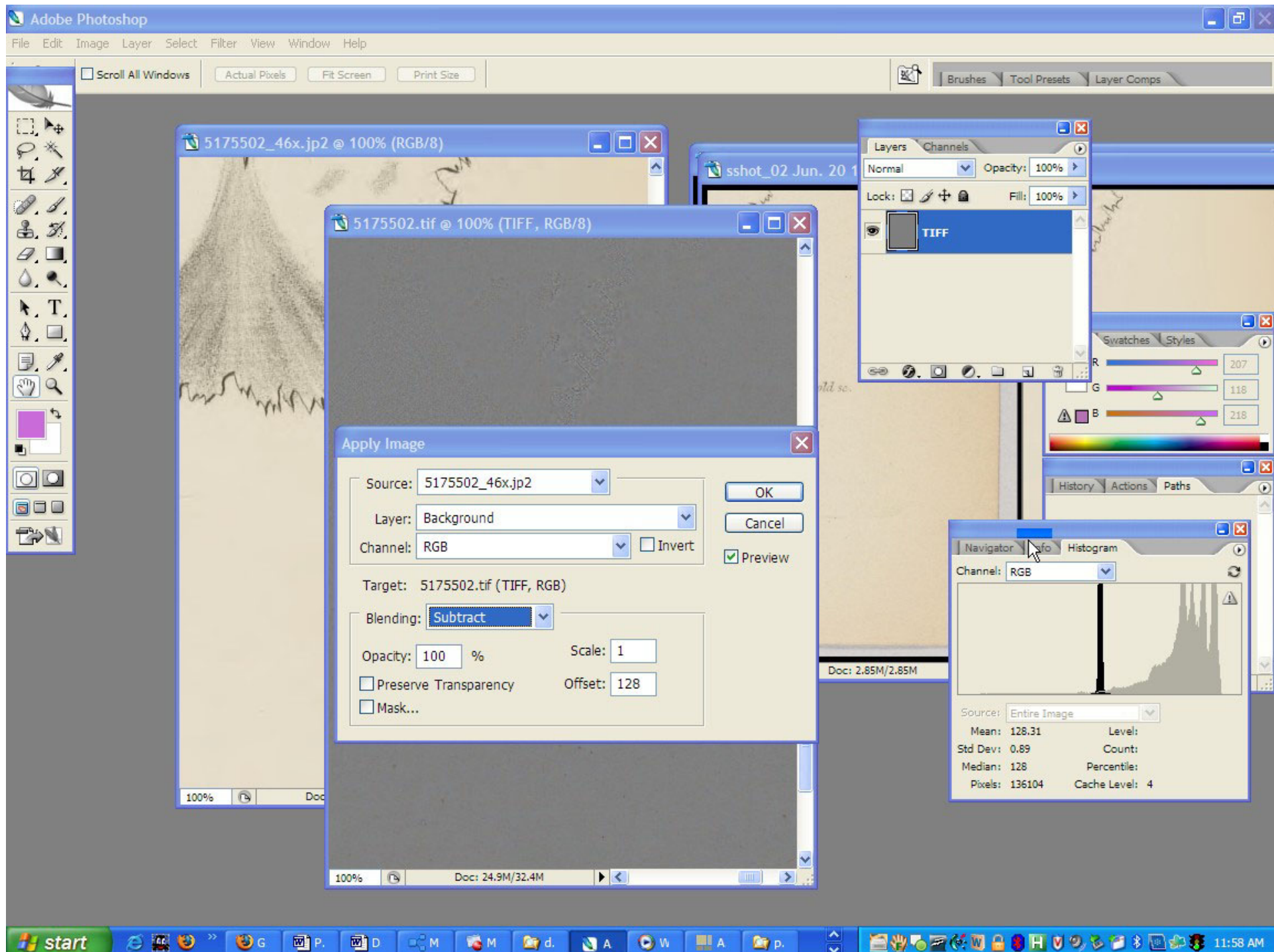










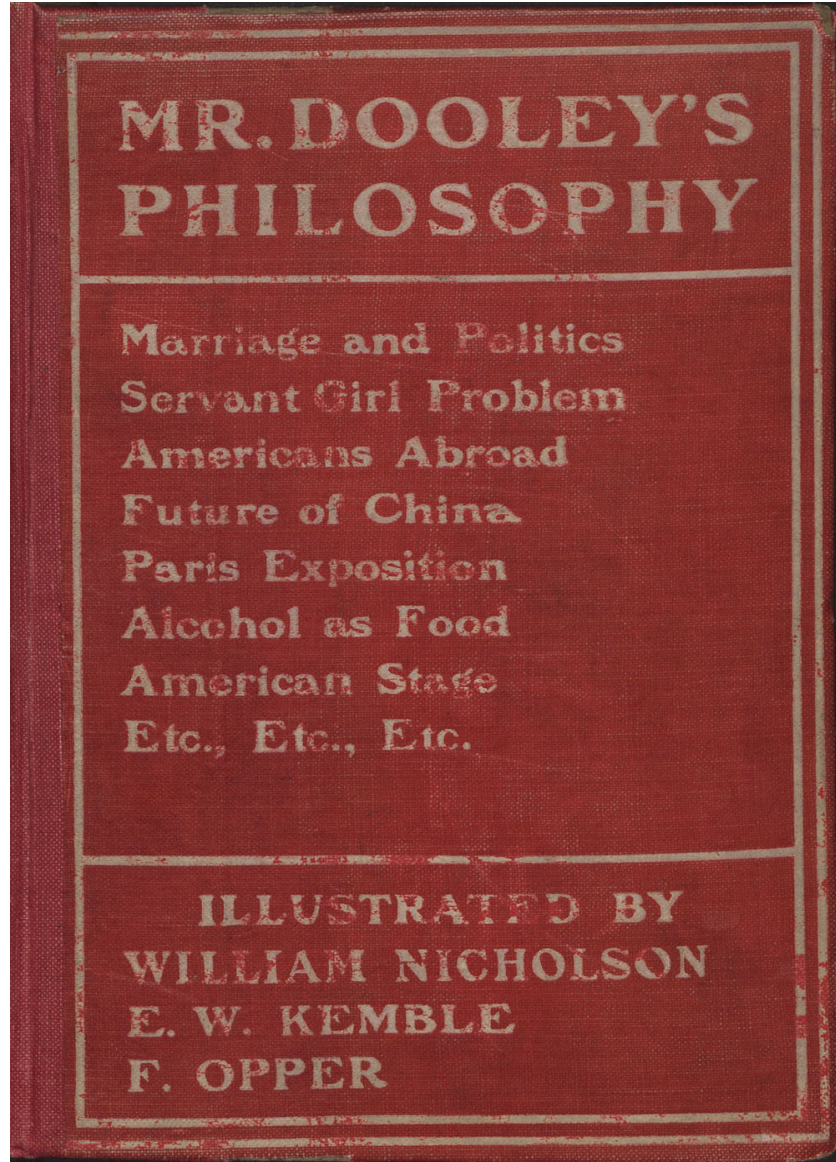




Wrapped in a shell script

OPTIONS

- pm value set the minimum PSNR value
- pt continue on if over maximum ration and PSNR > 50
- rt value set the maximum allowed filesize ratio
- th size set the maximum thumbnail size
- ts size set the tile size
- log generate a summary file
- h display this message



Statistics

- **Compression starting db: 40**
- **Compression ratio boundary: 25**
- **Total compressed files: 274**
- **Average compression ratio: 14.3430656934307**
- **Median compression ratio: 13**

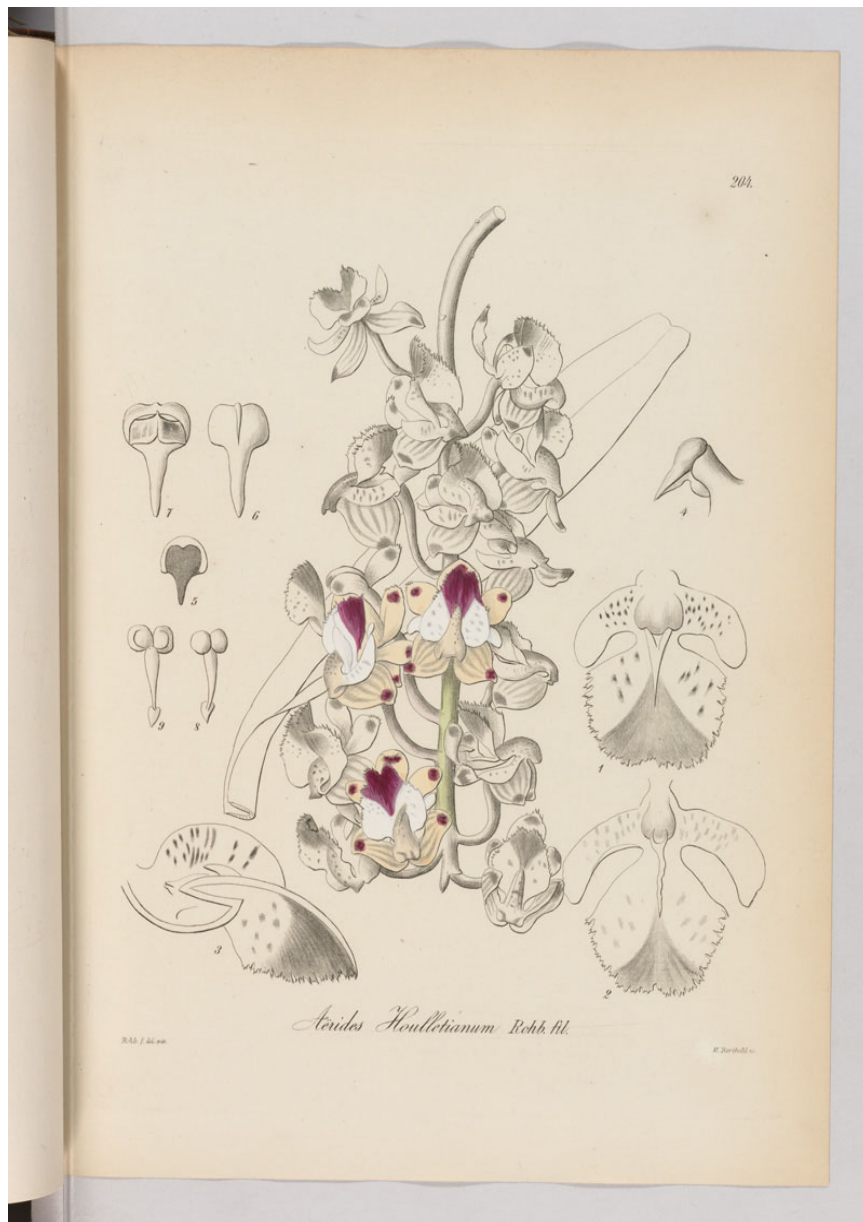
Compression ratio / file count

Ratio	Count
6	1
7	2
8	2
10	9
11	21
12	51
13	58
14	27
15	20
16	21
17	16
18	16
19	8
20	9
21	1
22	2
23	6
24	2
25	2

Compression ratio / file count

db Value	File Count
40	248
41	25
42	1

Statistics



Compression ratio / file count

Ratio	Count
17	3
18	4
19	2
20	1
21	4
22	3
23	1
24	3
25	1

Compression ratio / file count

db Value	File Count
46	3
47	7
48	7
49	5

Tools & Utilities

- Free tools

- [GeoJasper](#): "GeoJasper is a free and open source geo-supporting extension for JPEG2000 [JasPer](#) library and a command line transcoder."
- [JHOVE](#): an extensible framework for format validation.
- [IrfanView](#): Freeware image viewing application (Windows) that supports JPEG2000 rendering. You'll need all the [plugins](#).
- [Cygwin](#): A a Linux-like environment for Windows.

- Commercial applications

- [LuraTech](#): image encoding and server-side decoding software
- [Aware, Inc.](#): image encoding and server-side decoding software

Thank you

- Mingtao Zhao, Systems Analyst and Applications Developer, Harvard College Library
- Ronald Murray, Digital Conversion Specialist, Library of Congress
- Ralph Tiede, CCS Content Conversion Specialist GmbH
- Alexis Tzannes, Senior Engineer, Advanced Products Group, Aware, Inc.