

“Focus Stacking”

How To Get More Depth Of Field,
Sharper Subjects,
And/Or Smoother Backgrounds

Rik Littlefield

Northwest Outdoor Writers Association, Richland WA, May 2, 2015

“Focus Stacking”

How to get more depth of field, sharper subjects, and/or smoother backgrounds?

- Step 1) Shoot multiple images with changing focus.

Step 2) Run all those through a computer to “pick out the sharp bits”.

- This only works with subjects that don’t move.

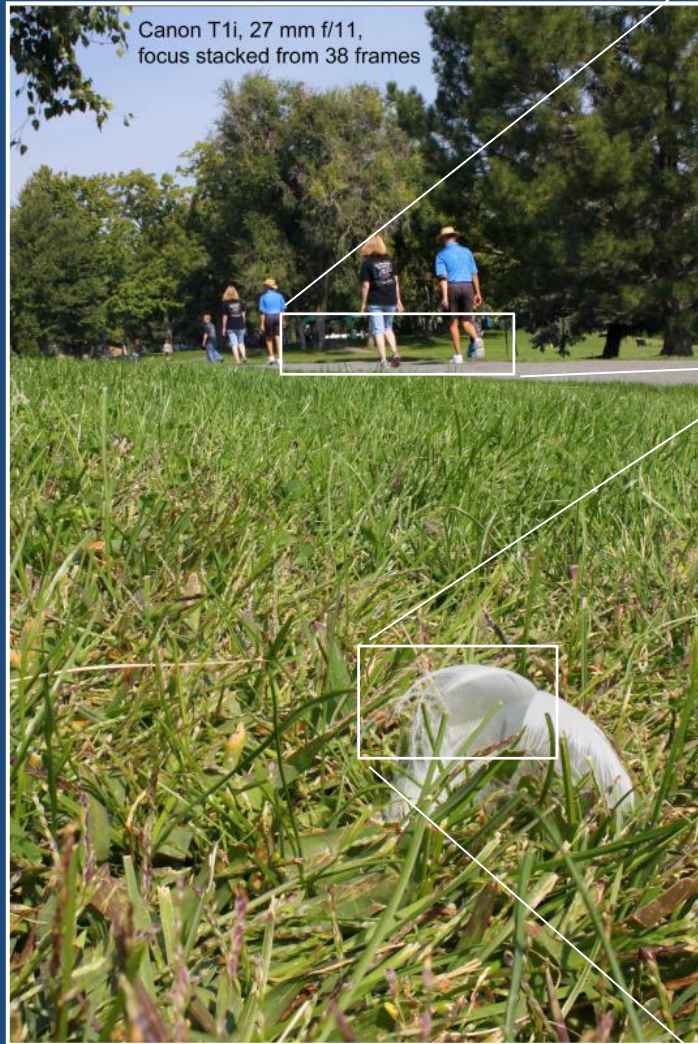
Introduction to Focus Stacking



Computer
Software
→



You Can Make It Sharp Everywhere

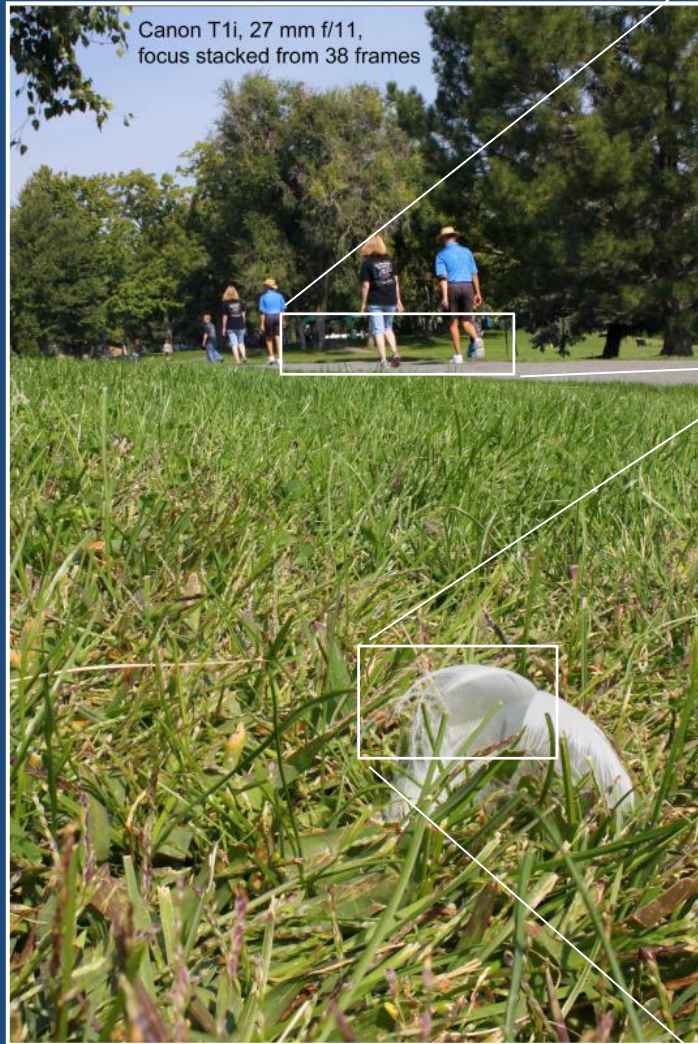


Or Sharp Just Where You Want It

Canon T1i, 27 mm f/11,
focus stacked from 15 frames



f/11 and 38 frames, isn't that like f/380?



No, it's not. There was some fine print...

“Let there be light!” **

** Caveats and disclaimers:

- 1) Stopping down loses light, but you can make that up with longer exposures.
- 2) Stopping down also loses resolution, and there's no way to get that back. (It's one of those “laws of physics” things.)

Stopping Down Causes Diffraction Blur



$f/8$,
stacked
(2 images)



$f/8$



$f/32$



$f/56$



$f/140$



Let's Look At Some Examples Of Focus Stacking



Mt. Rainier, 3 Frames



Image by Stan Lane

Showing The Focus Variation

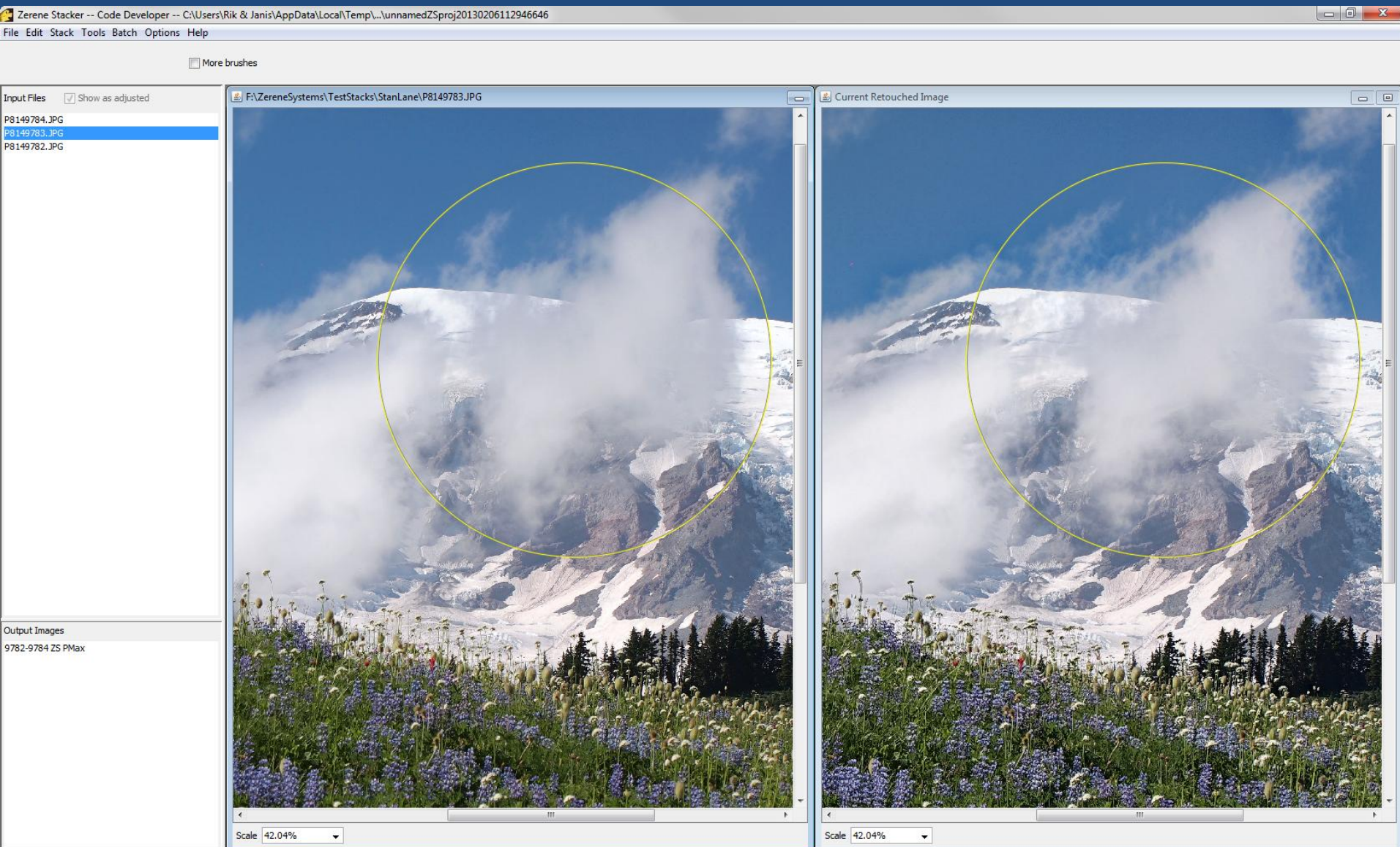


First Output Shows Motion Artifacts

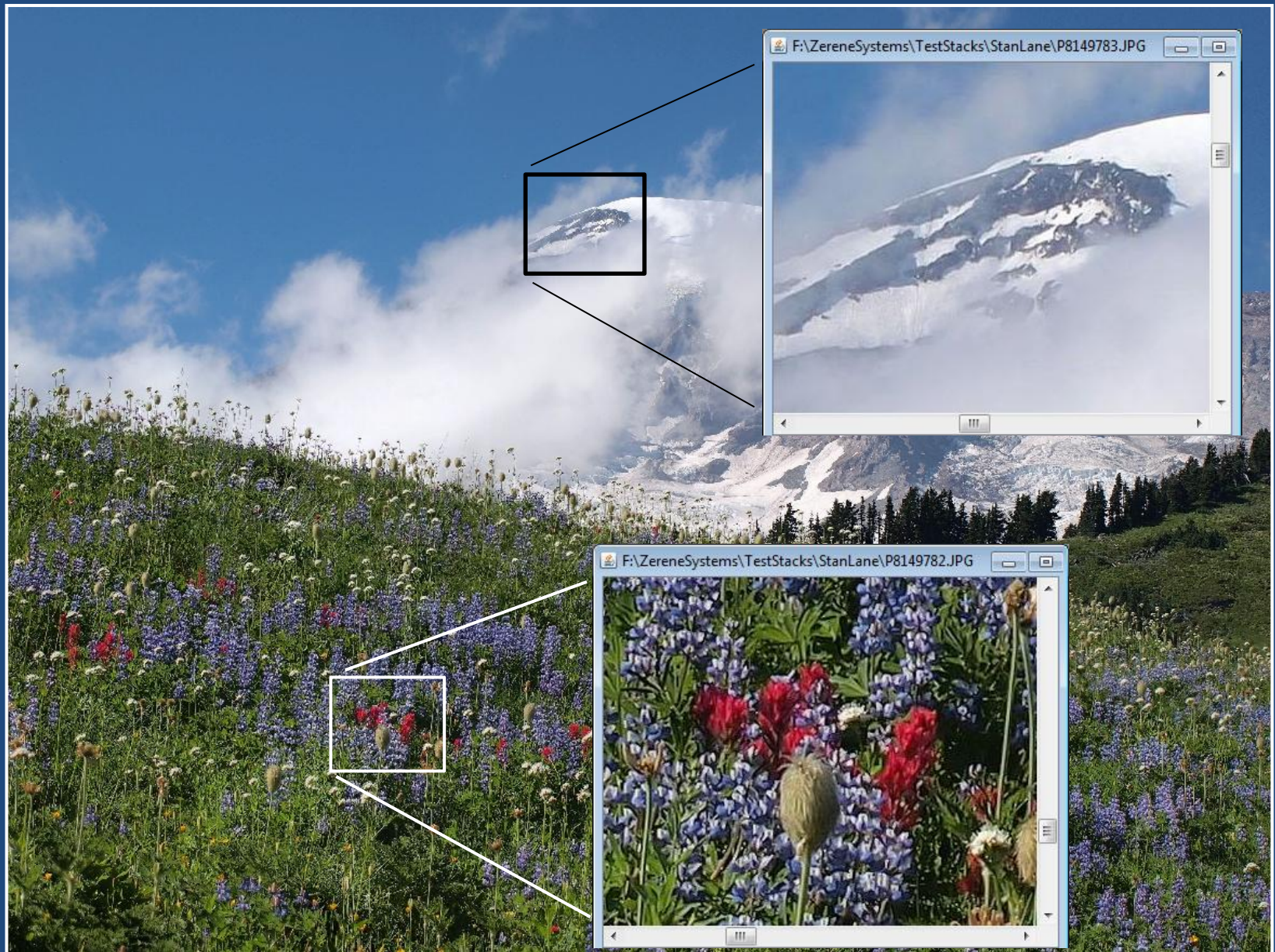
C:\Program Files\ZereneStacker\9782-9784 ZS PMax



Fixing The Sky By Retouching



Finished Composite – Sharp Everywhere

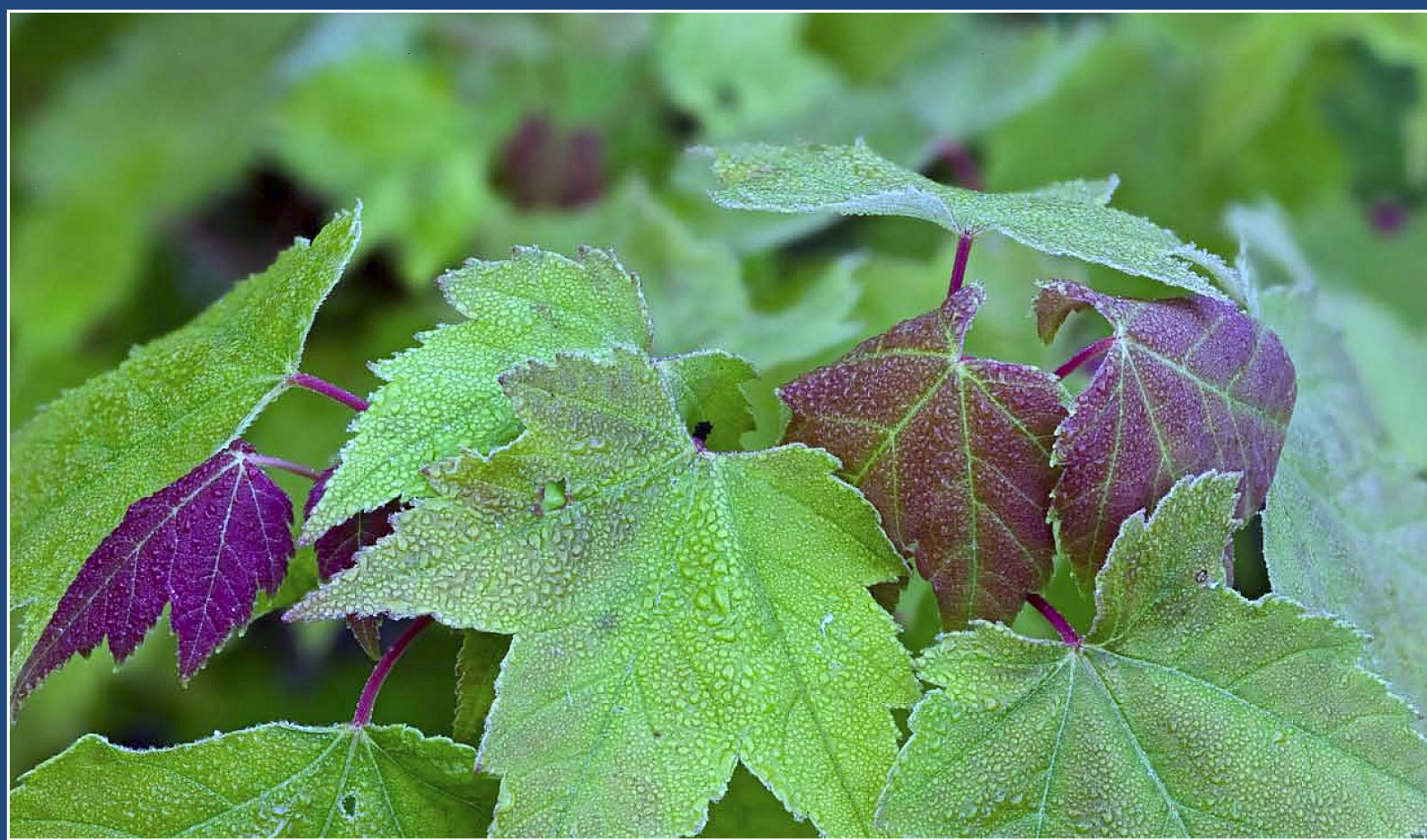


Mt. Rainier, 3 Frames



Image by Stan Lane

Apparently Routine Closeup: DOF Control



From “The Art of Focus Stacking”, Michael Erlewine, <http://macrostop.com>

A Similar Example: Some Forget-Me-Nots



Bart van der Mark, <http://www.flickr.com/photos/bartvandermark/4586315503/sizes/o/in/photostream/>

“Extreme Macro”

Explore, Enjoy, and Protect the Planet



**ENDANGERED?
WHO CARES?**

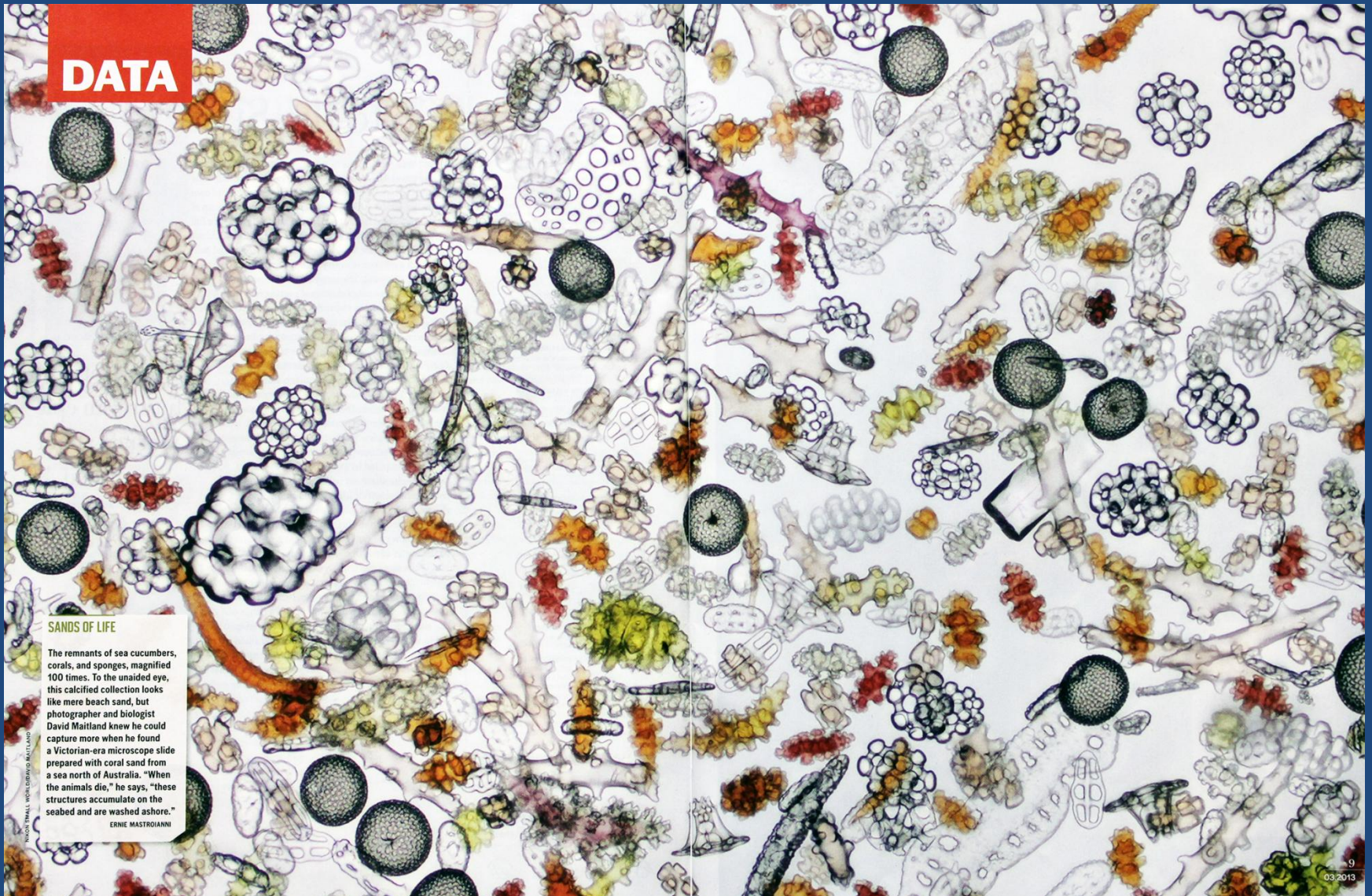
THE MAGAZINE OF THE SIERRA CLUB

MARCH/APRIL 2011

John Hallmén in Sierra Magazine.

See more at <http://www.morfa.se>

Microscopy



David Maitland in Discover Magazine, from
<http://www.nikonsmallworld.com/galleries/photo/2012-photomicrography-competition>

Focus Stacking is Now Accepted by National Geographic...

FOOD

The Future of Food natgeofood.com

This story is part of National Geographic's Future of Food initiative, a special five-year project that seeks to show how what we eat makes us who we are.

Brother Adam must have known he had become a beekeeper at an unlucky time. It was 1915, and he was a 16-year-old novice at Buckfast Abbey in southwest England. Rapid bee die-offs have been recorded for centuries, but the catastrophe that confronted the young monk was unprecedented. A mysterious disease had wiped out almost every apiary on

By Charles C. Mann

Photographs by Anand Varma



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Scientists eventually linked the disease to a previously unknown virus. But the research came too late to save Britain's native dark brown honeybee. Almost all the surviving hives were hybrids, the progeny of local drones that mated with foreign-bred queens. The apparently superior vigor of these blends made Brother Adam think about breeding a disease-resistant bee.

In 1950, after years of preparation, he finally got his chance. Commandeering an old abbey car, he traveled over the next 37 years through Europe, the Middle East, and Africa, collecting more than 1,500 queens: the hardworking bees of northern Turkey, the hyper-diverse bees of Crete, the isolated bees of Sahara oases, the deep black bees of Morocco, the tiny orange bees of the Nile, the supposedly placid bees of Mount Kilimanjaro. He took his exotic menagerie to a remote station in the moors, miles from other bees with their unwanted genes. Performing countless breeding tests in pristine solitude, he created the Buckfast bee—a superbee, as it was quickly dubbed. Tan-colored and robust, it was reluctant to sting, zealously productive, and resistant to what had come to be called Isle

disease, an epidemic centuries

But honeybees were again under assault. An Asian mite with the evocative name *Varroa destructor* had invaded Europe and America. "Only a fully resistant, genetically endowed race or strain," Brother Adam proclaimed in 1991, will be "the ultimate answer to this menace." But before he could begin work, Buckfast's abbot, convinced that Brother Adam's growing fame conflicted with his vocation, removed him from his post. He died, heartbroken, in 1996. "Nobody really took his place at the abbey," says Clare Densley, who two years ago restarted Buckfast's storied beekeeping operation.

All the while, in India. In 2007, a "bee disorder"—a swift, terrible die-off—suddenly struck the Americas. News of the global agricultural catastrophe in the planet's most important pollinator, mostly from honeybees, is critical to one-third of the world's food supply.

Bee researchers, many inspired by Brother Adam, rushed to understand colony collapse. Most have concluded it is not a single problem, as first thought, but a lethal amalgamation of pests, pathogens, habitat loss, and toxic chemicals: varroa mites are a critical component. Most large-scale beekeepers now use pesticides to kill

IMAGE COMPOSED OF 200 DIGITALLY MERGED PHOTOGRAPHS
SOURCE: HARRY H. LAIDLAW JR. HONEY BEE RESEARCH FACILITY

Charles C. Mann's latest book is 1493: Uncovering the New World Columbus Created. Anand Varma is a biologist who raised bees for this story, specializing in photography that illuminates science.

chemicals, some bee researchers are returning to Brother Adam's approach: Superbee Version 2.0. Only this time, they are using the tools of biotechnology, including genetic modification. Others tout the opposite approach, one even more natural than Brother Adam's. No chemicals, no manipulation—let the bees evolve on their own! Unfortunately, none of these approaches has yet produced a sufficiently mite-resistant and

bee that's a game changer. Keith Delaplane, director of the University of Georgia's honeybee program, told me. Meanwhile, he says the pressures on the bee are enormous. "I stand in front of beekeepers and say, 'You all tell me the success stories.' I do not see any hands going up."

HONEYBEES ARE SUPERORGANISMS. Honeybees are hive minds. Honeybees are linguistic networks.

What Is That Thing?

By Charles C. Mann

Photographs by Anand Varma



In 2007 headlines shouted about “colony collapse disorder,” a frightening new phenomenon that was wiping out hives around the world. Most researchers now believe that it is actually a deadly mix of pests, pathogens, pesticides, and habitat loss. The single worst element is *Varroa destructor*, a pinhead-size Asian mite, shown here atop a bee pupa.

It's a *Varroa* mite, one cause of colony collapse disorder.

Summary So Far

Advantages:

- Can have (lots) more DOF while keeping sharpness
- Better control of DOF --
Can have nicely blurred background with whole subject sharp

Disadvantages:

- Static subjects only
- Plan ahead...

Resources For Focus Stacking

- Software:
 - Photoshop CS4 and later, full version only
(most commonly installed, but also the lowest quality for this job)
 - CombineZP (cheapest — freeware)
 - Helicon Focus (most famous — top of Google searches)
 - Zerene Stacker
(most popular — more Flickr postings & Nikon Small World winners than all others combined)

Resources For Focus Stacking

(This list is not exhaustive...)

- Shooting aids
 - AF motor control
 - CamRanger
(Canon & Nikon, wireless to smartphone, tablet, laptop, even desktop)
 - Helicon Remote (Canon & Nikon, multiple platforms, mostly wired, no iOS)
 - Magic Lantern (Canon only, runs inside camera)
 - DslrController (Canon wired to Android tablet or smartphone)
 - qDslrDashboard (Canon & Nikon, multiple platforms, mostly wired)
 - ControlMyNikon (Nikon only, Windows only, but very good)
 - Breeze Systems DSLR Remote Pro & NKRemote
(Canon & Nikon on Windows, Canon only on Mac)
 - Automated focus rail
 - StackShot

Resources For Focus Stacking

- Websites:
 - <http://photomacrography.net/forum>
 - <http://zerenesystems.com>
- Rik Littlefield
 - support@zerenesystems.com

Where I Fit In...

- 1) Manage & edit a strictly non-commercial website dedicated to the photography of small subjects.
- 2) Develop & document ideas for techniques and equipment.
- 3) Design, code, document, and support Zerene Stacker.



Zerene
Stacker

Let's Run Through A Full Example...

- Close up with some flowers in a garden
- Canon T1i DSLR with 18-55 mm kit lens
- CamRanger for wireless focus control
- Process in Photoshop
- Brief comparison with Zerene Stacker

Shooting With The CamRanger

Subject , Camera,
and CamRanger
(on tripod in garden)

Camera Controls and Live View
(on Android tablet in kitchen)



CamRanger Connected To Camera



Camera
(with battery installed)

USB cable

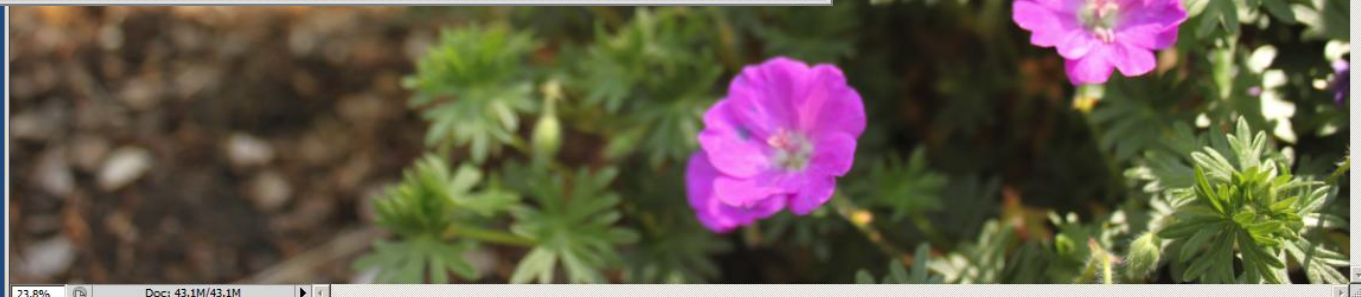
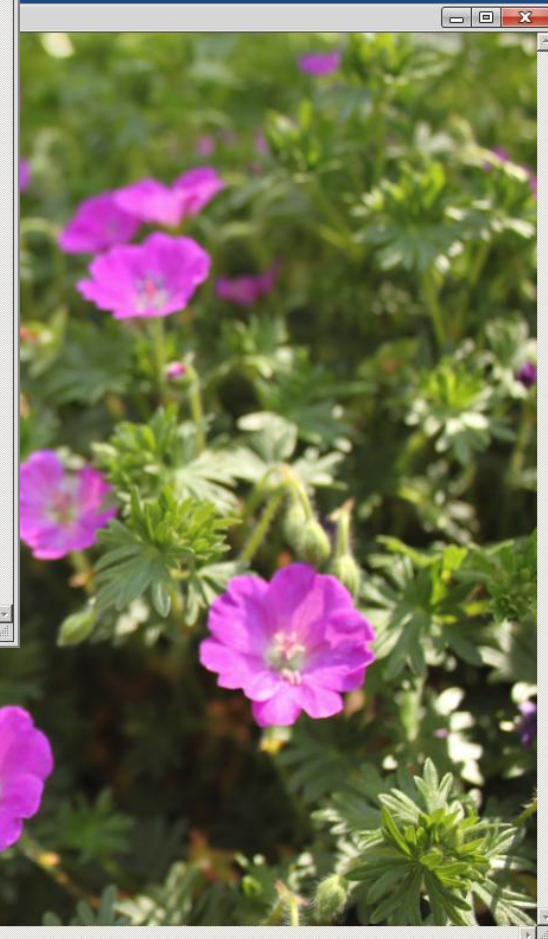
CamRanger
(with built-in battery)

CamRanger Screen On Tablet

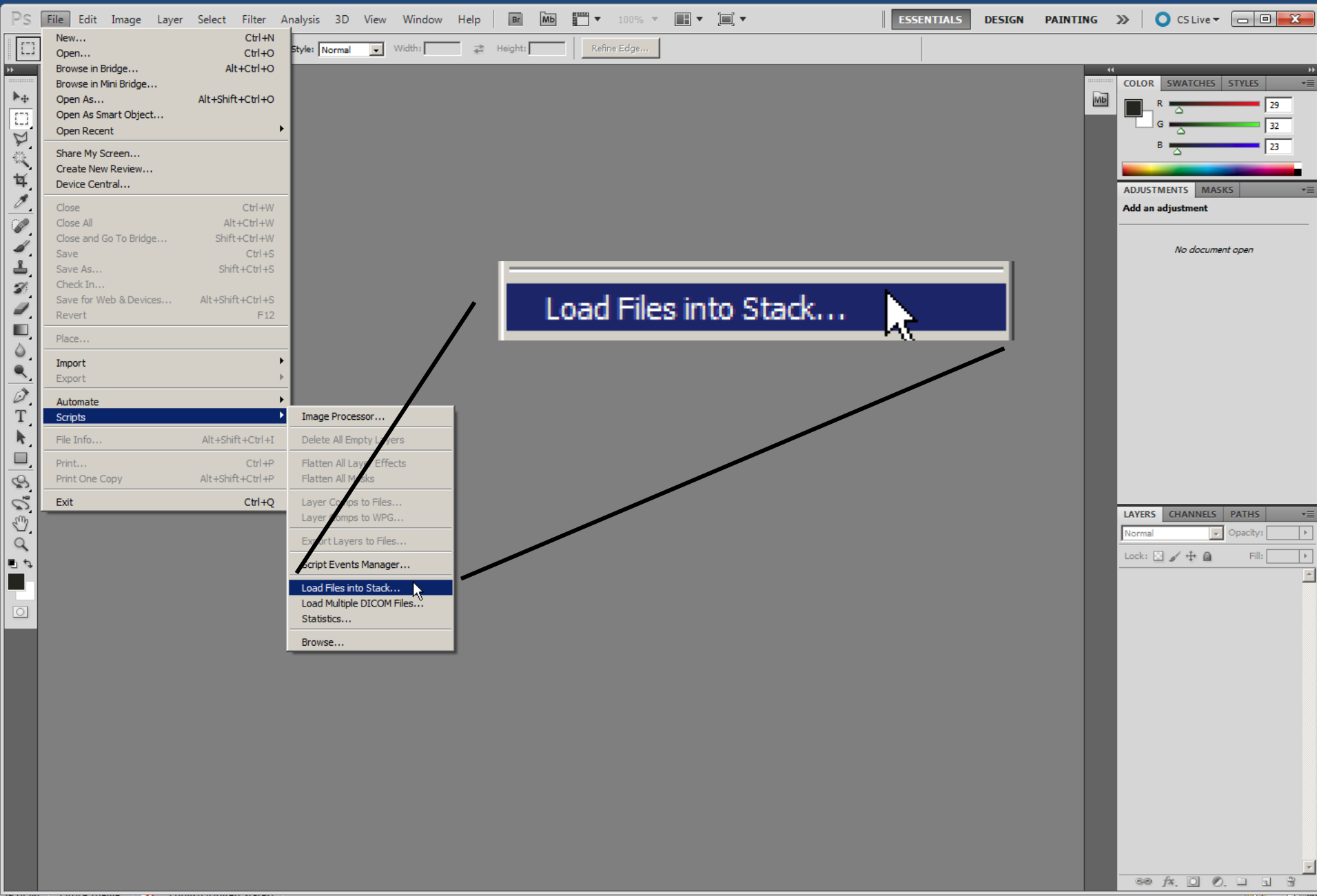


We Now Have A Stack

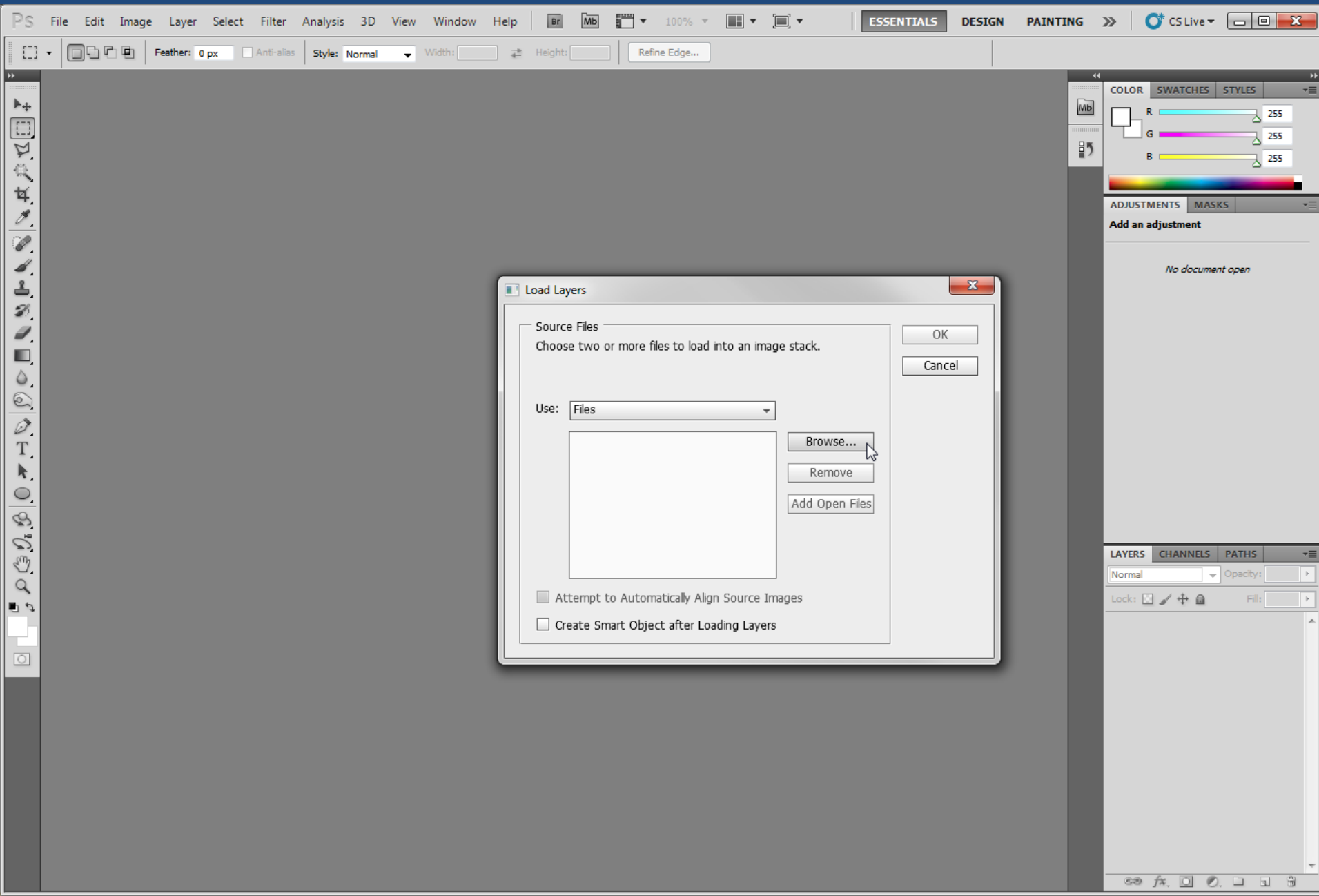
15 frames



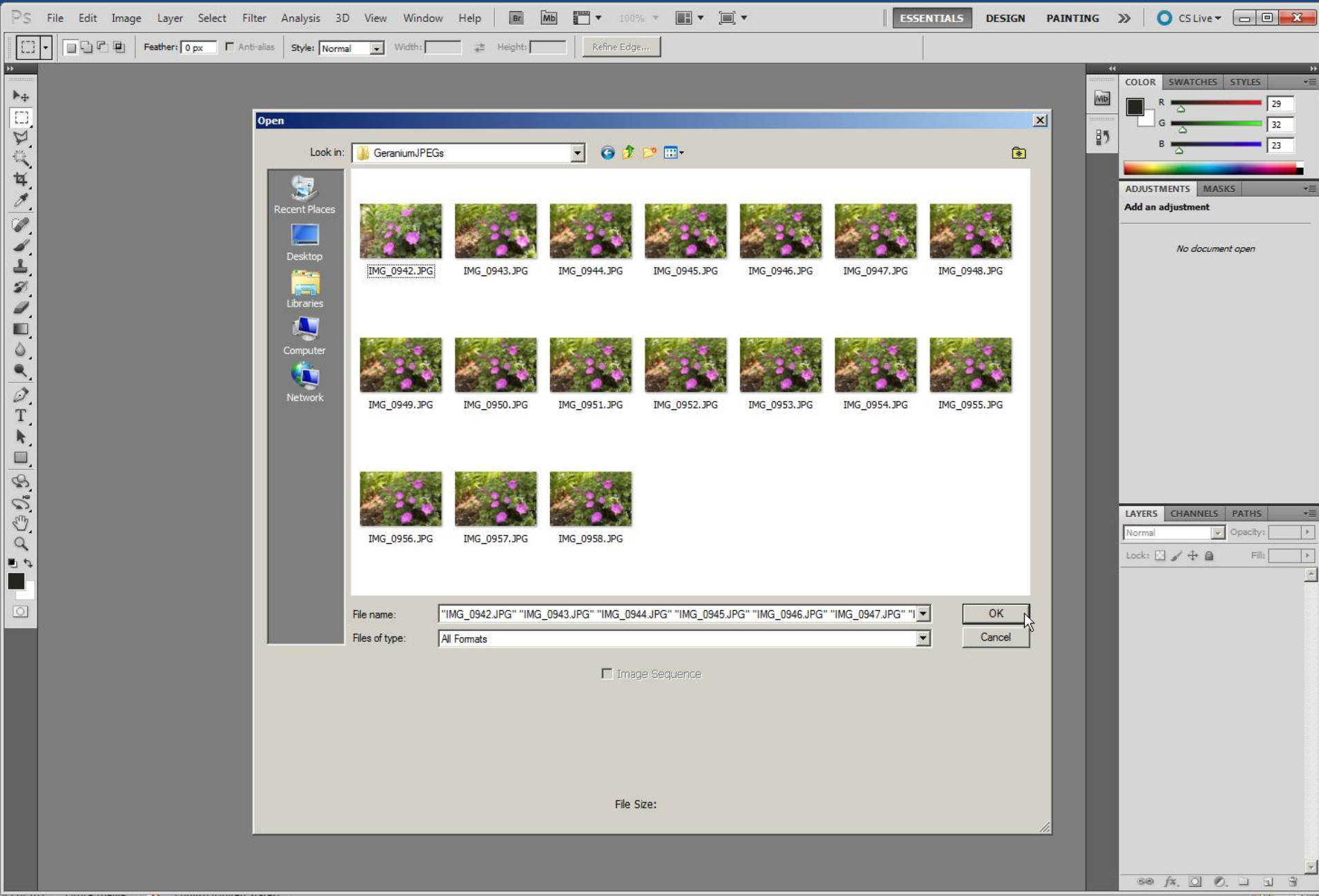
Stacking In Photoshop



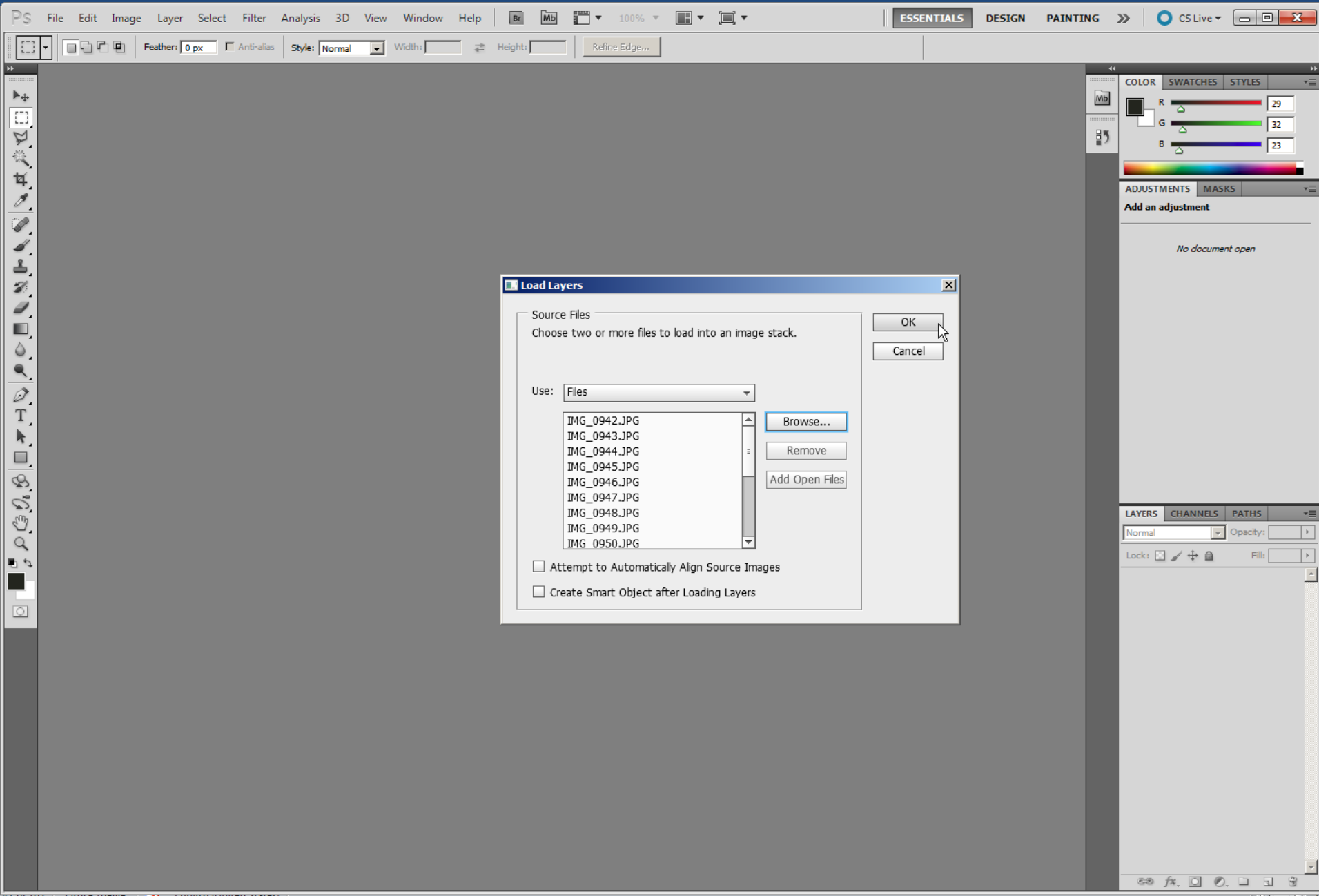
Stacking In Photoshop



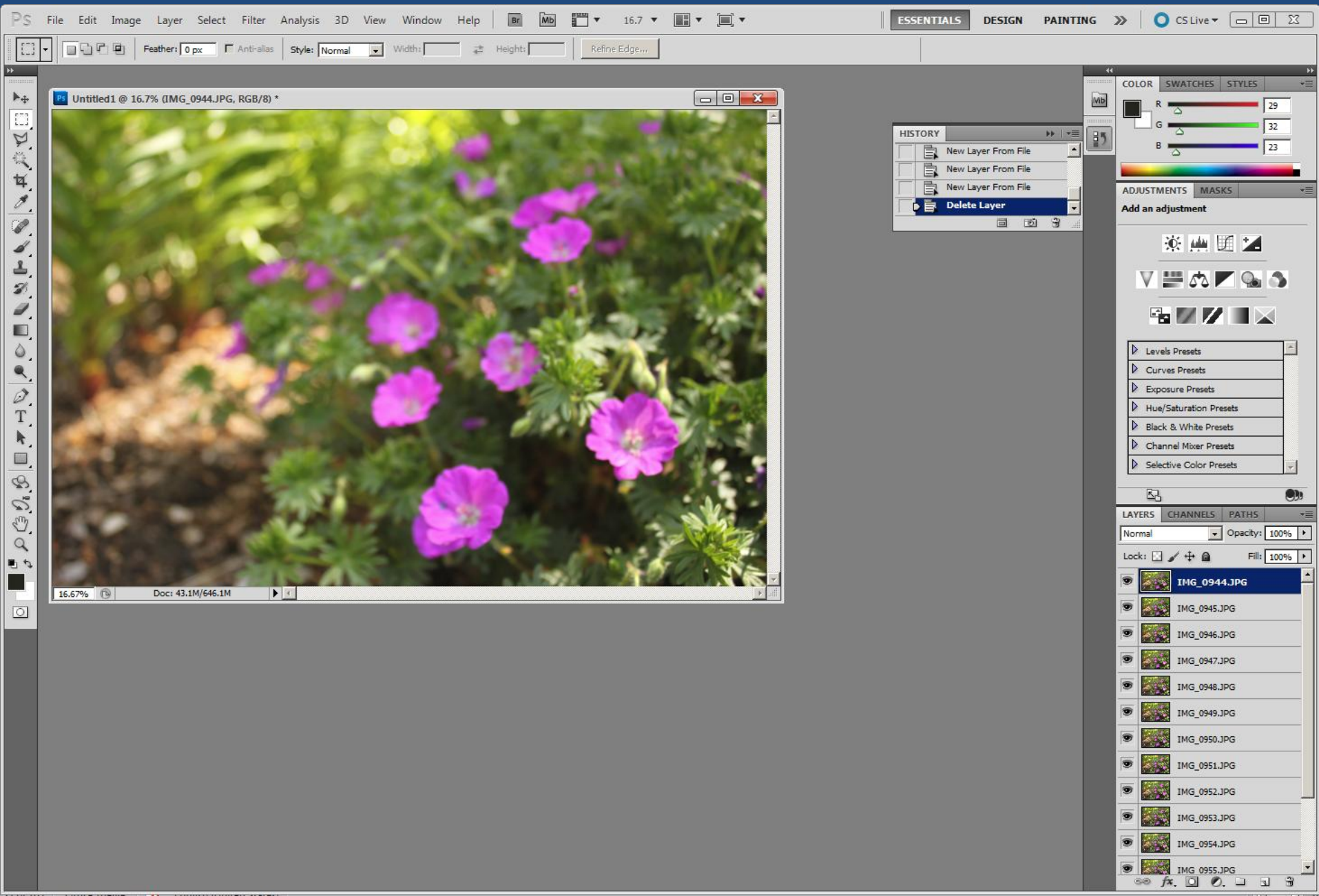
Stacking In Photoshop



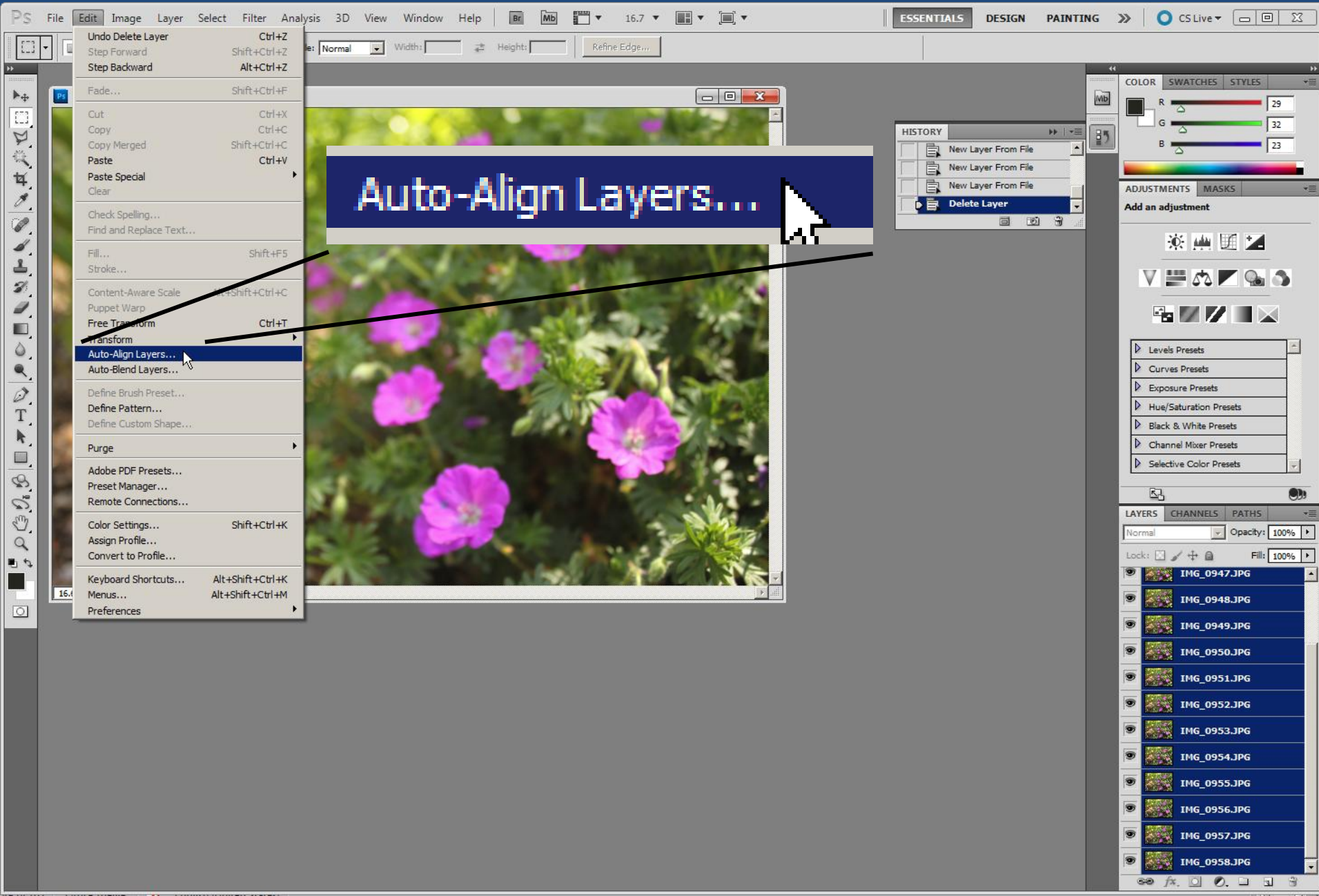
Stacking In Photoshop



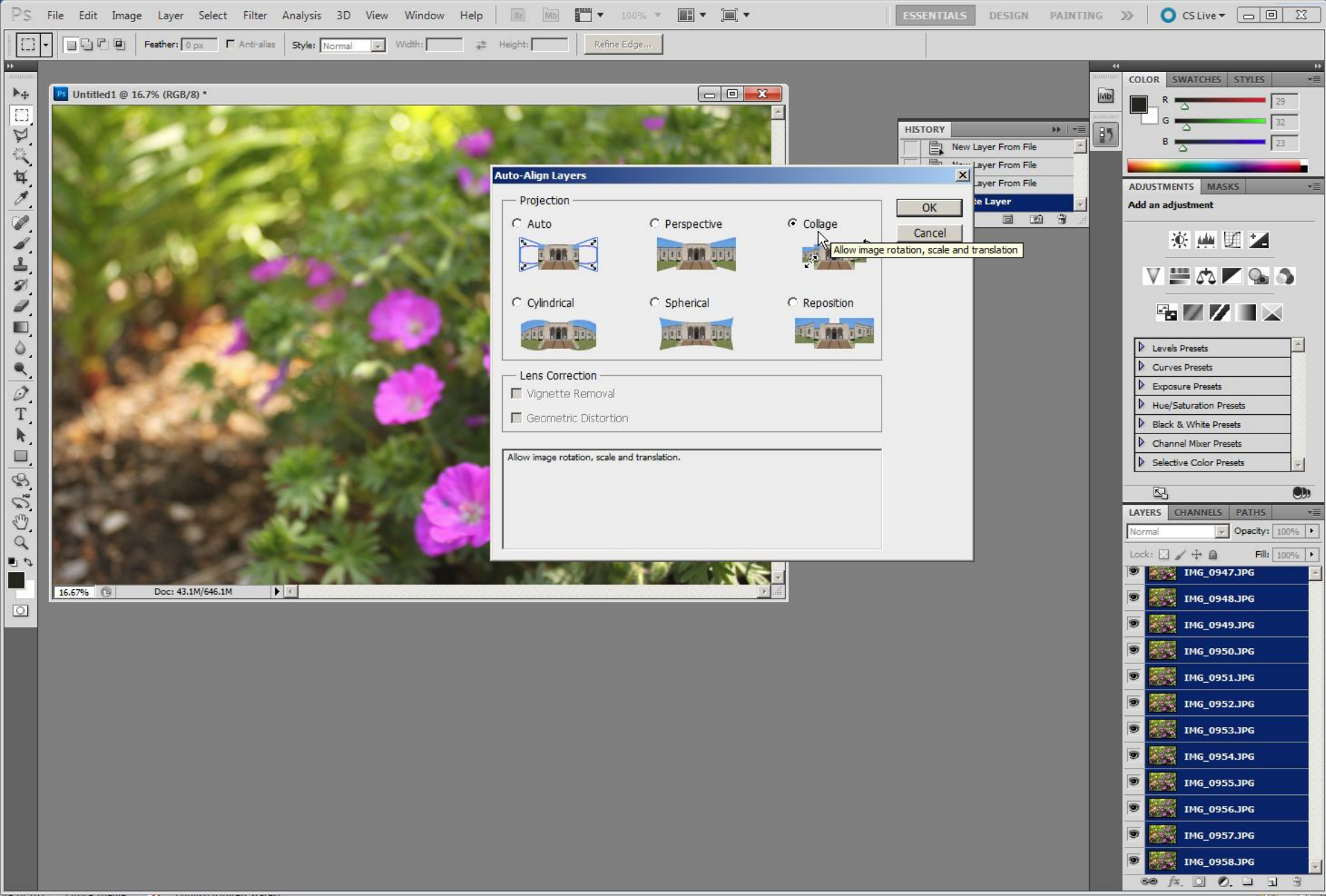
Stacking In Photoshop



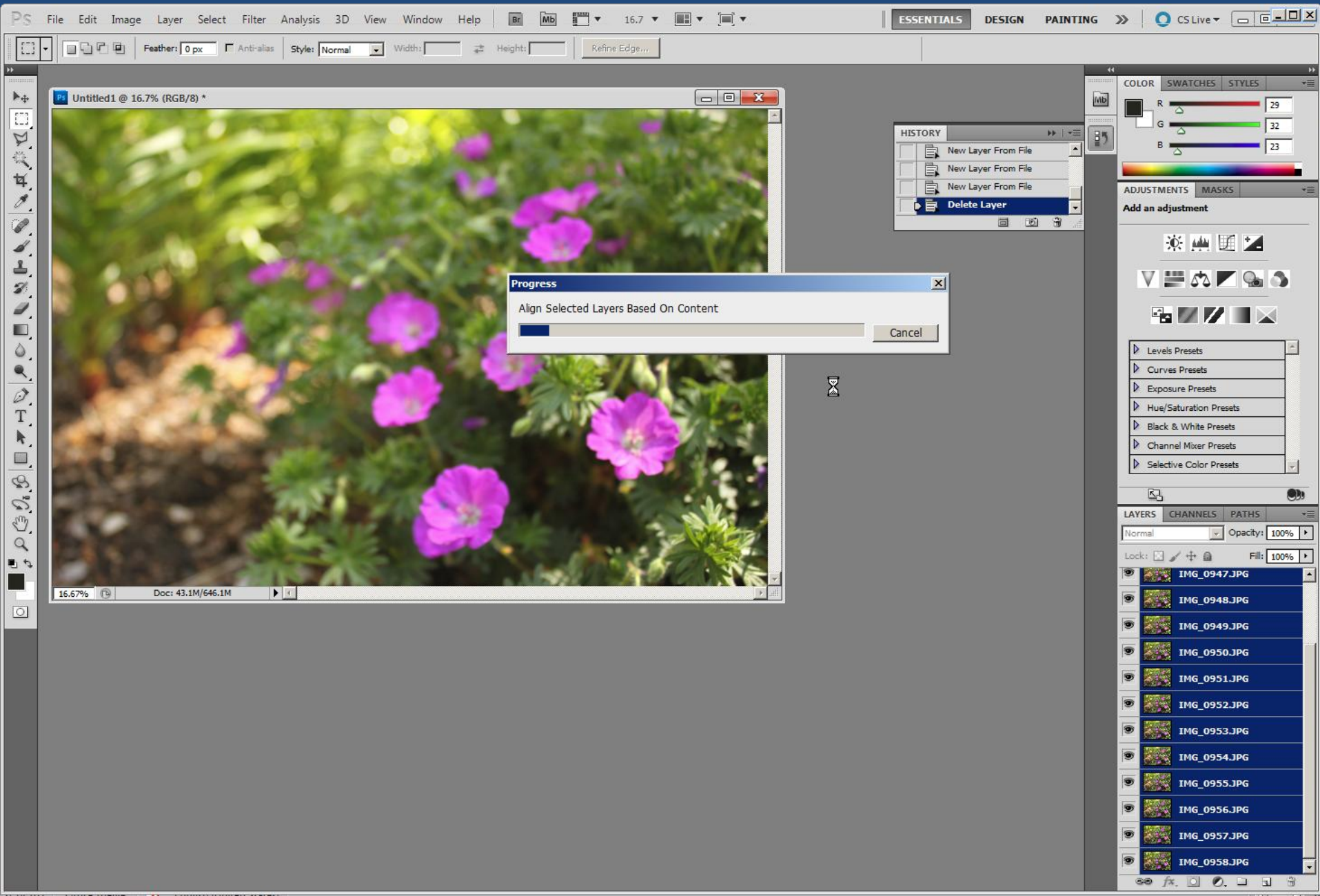
Stacking In Photoshop



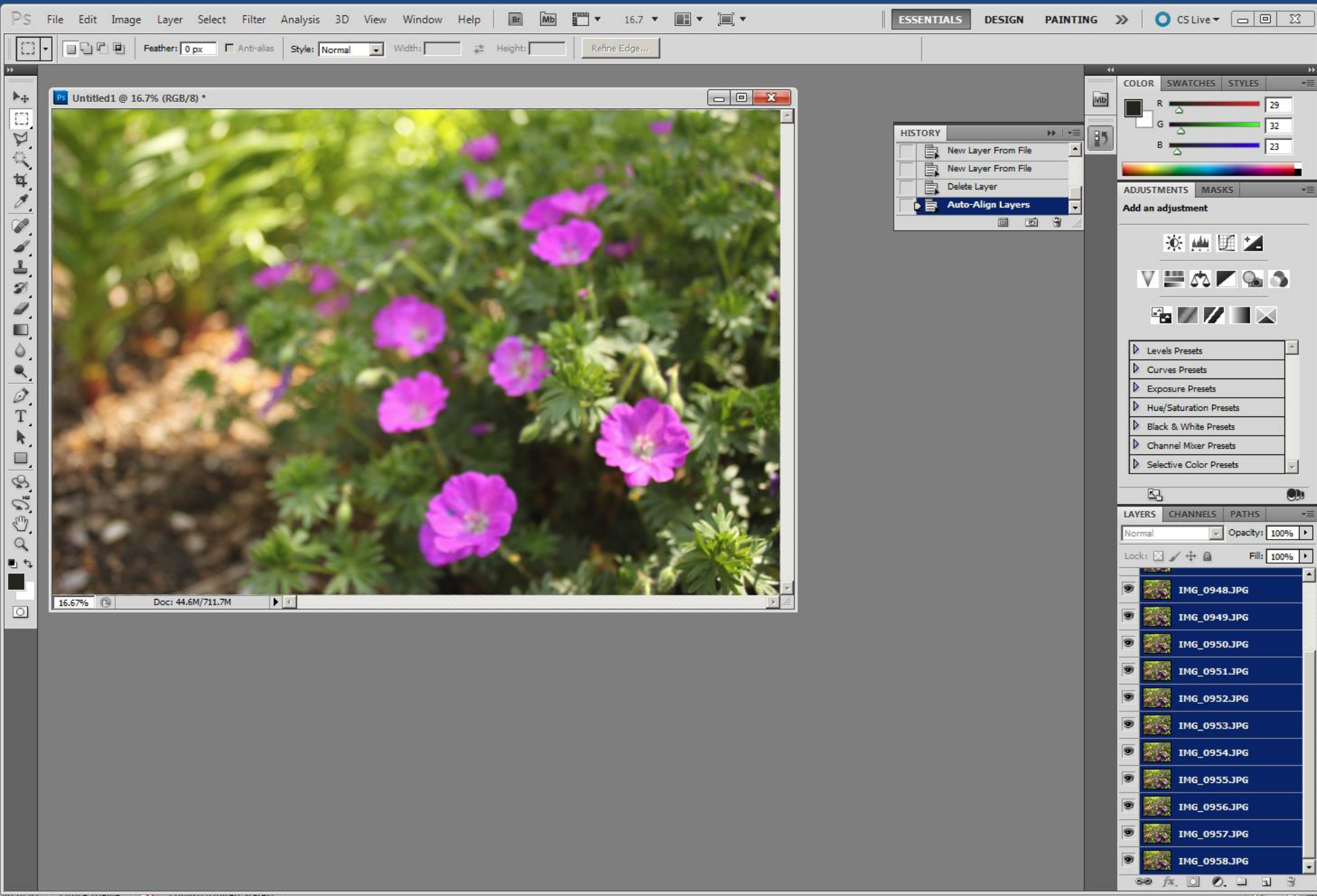
Stacking In Photoshop



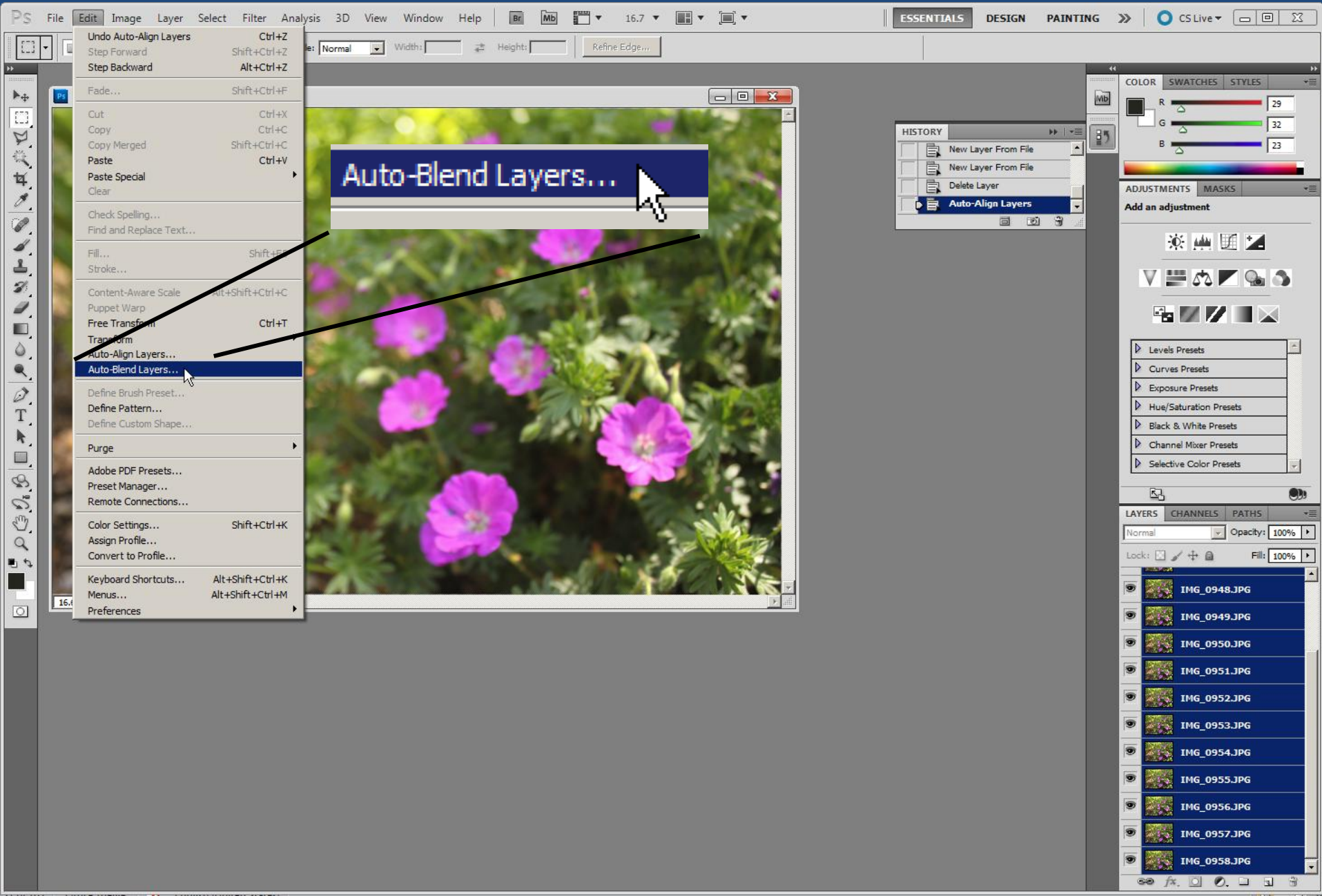
Stacking In Photoshop



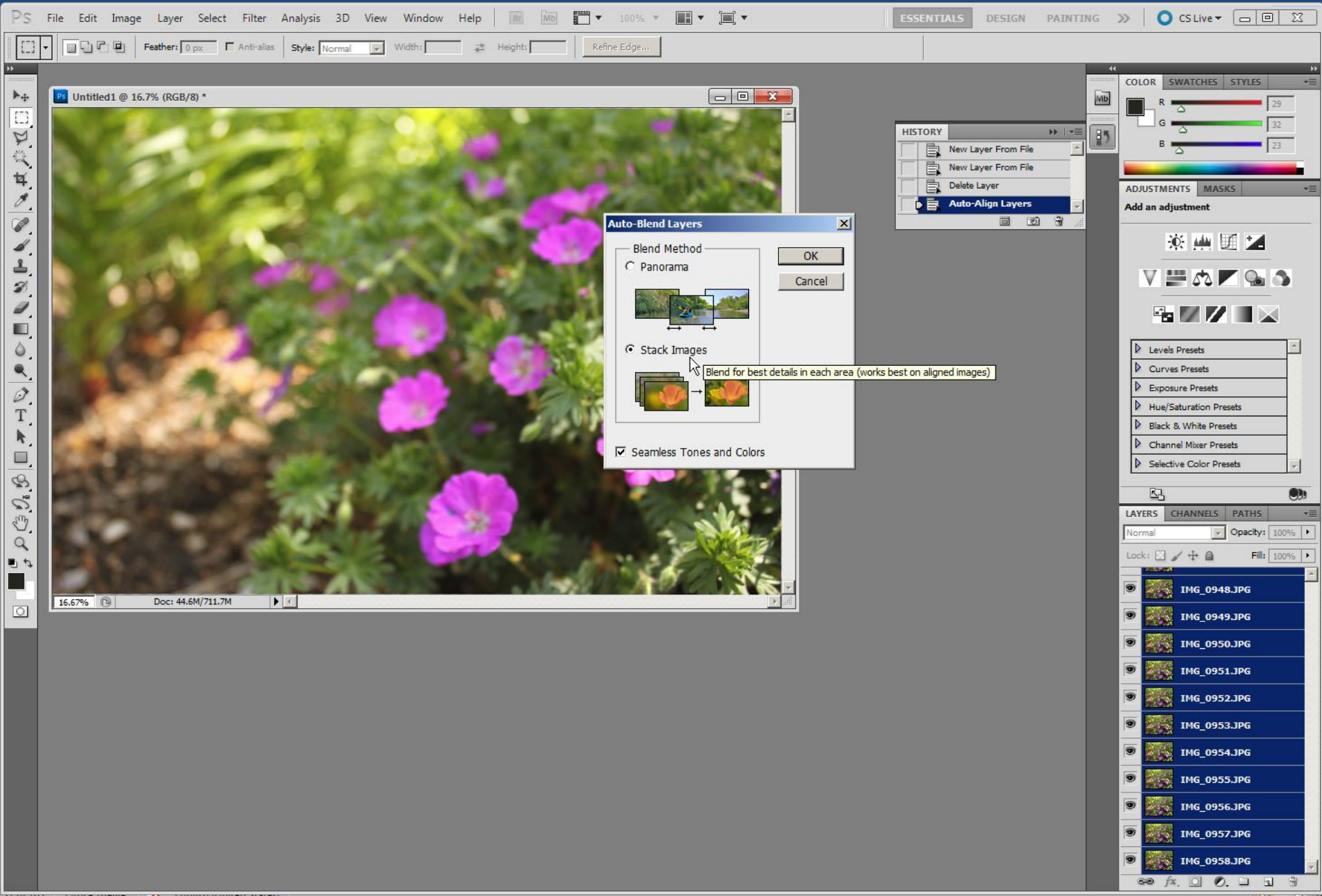
Stacking In Photoshop



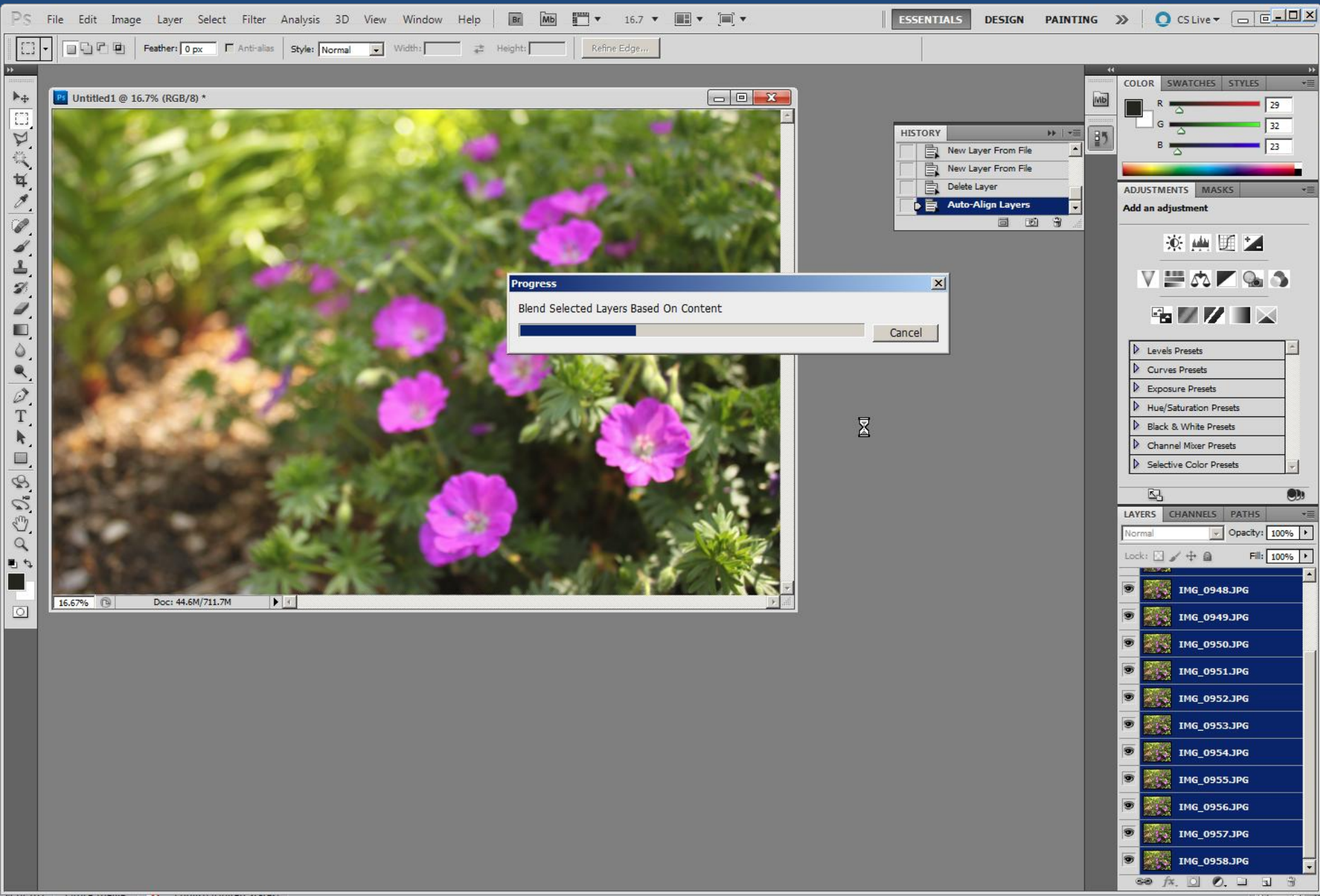
Stacking In Photoshop



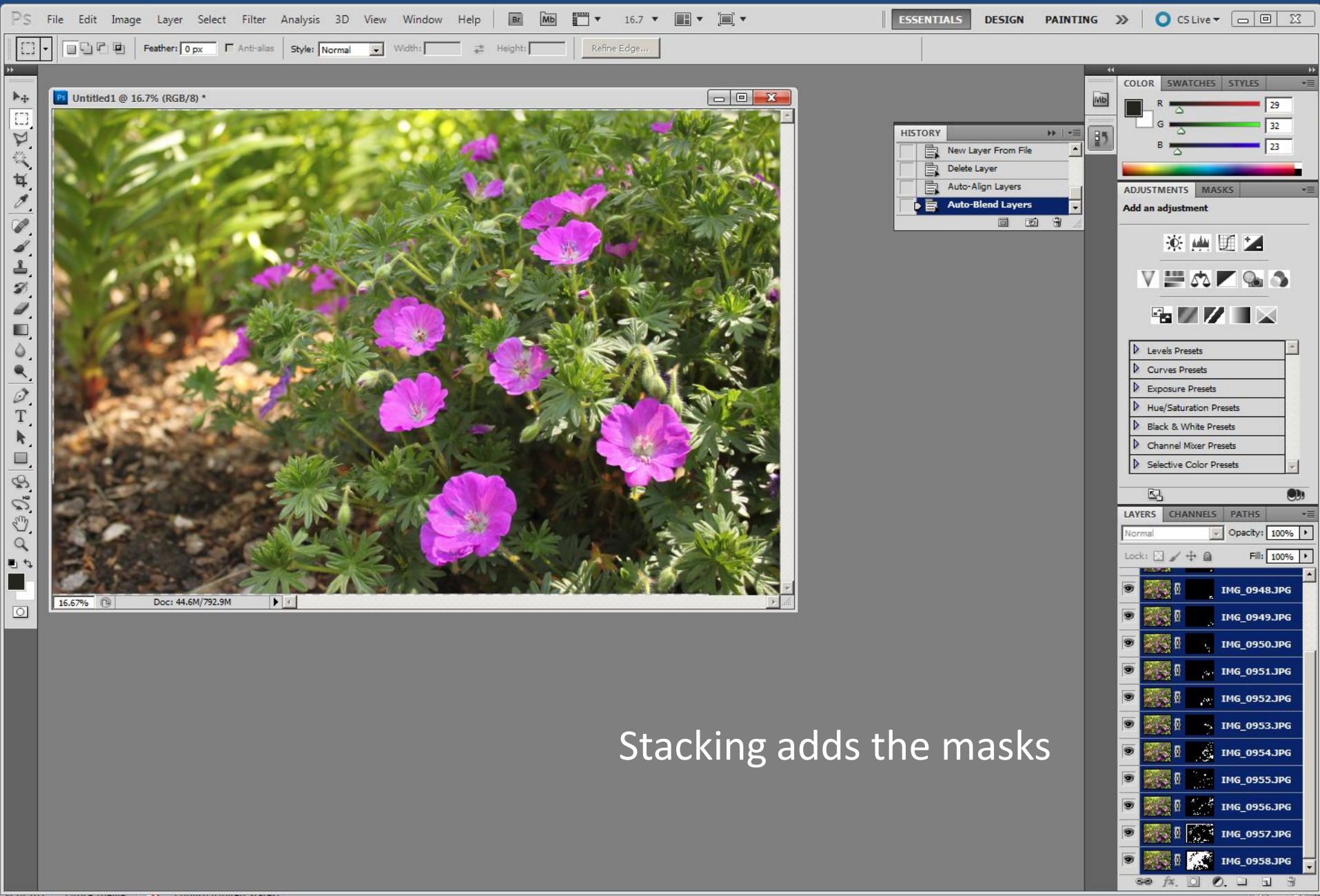
Stacking In Photoshop



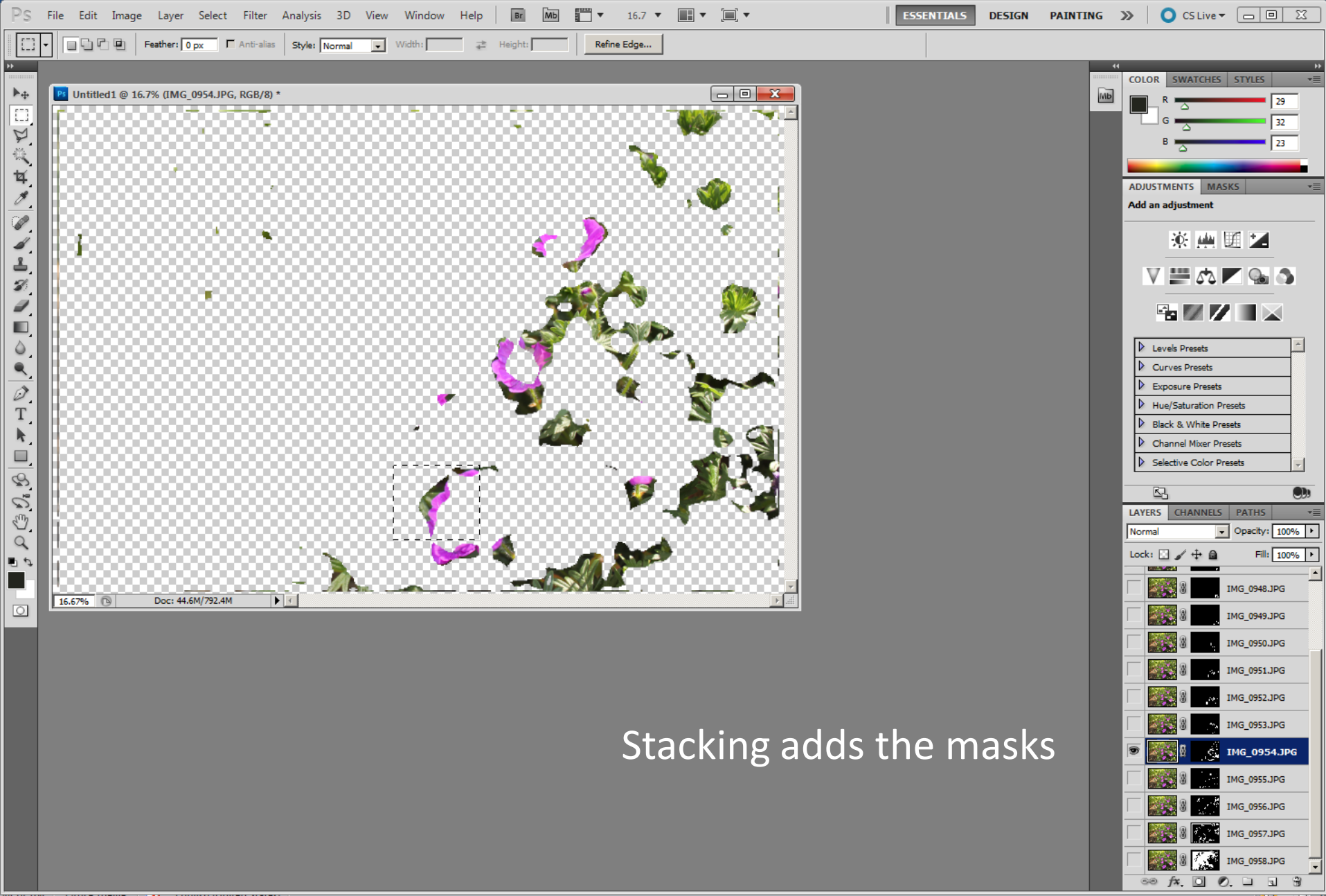
Stacking In Photoshop



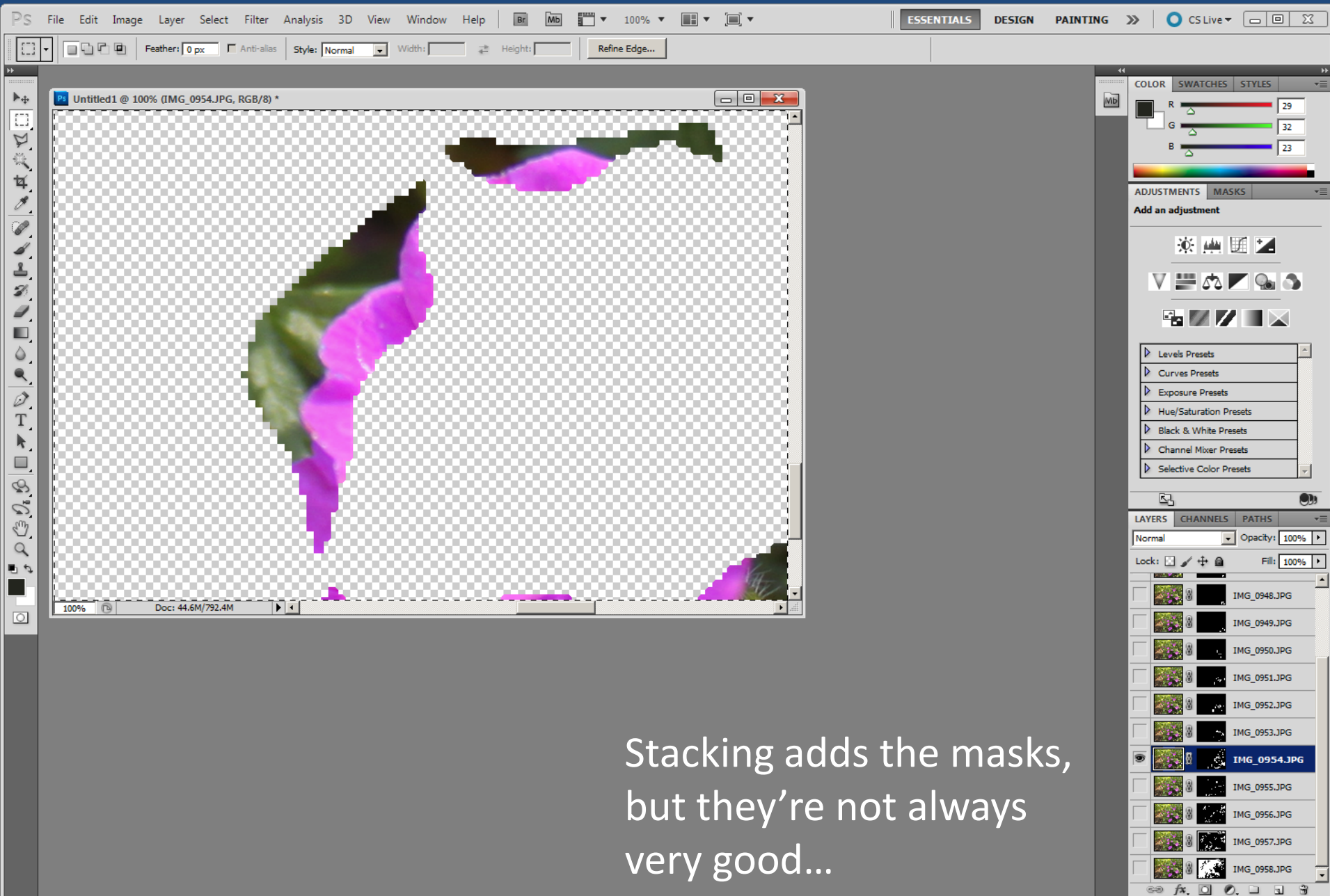
Stacking In Photoshop



Stacking In Photoshop



Stacking In Photoshop



Details by Photoshop



Details by Zerene Stacker



Anyway...

Different packages have different characteristics.

Just try them and see which you prefer.

Enough comparisons... Let's look at some more possibilities!

Feather In The Park: Kit Lens, “Magic Lantern” Firmware



Macro Landscape Using Compact Camera

Canon A710
hung upside down
under a tripod



©Rik Littlefield, 2008

Macro Lens on Geared Tripod Head



Tabletop setup: macro rail & lens



More options...a hand-driven screw table



Producing An Image Like This



John Hallmén, <http://www.johnhallmen.se/studio-stacks/3xixzx6bjwv1cichn9dyw6zxmnrwt6>

My Personal Passion Is Small Things

This is a common “bluebottle” fly.



0.001 mm resolution,
3.75 mm depth of field
“looks like SEM, but with natural colors”

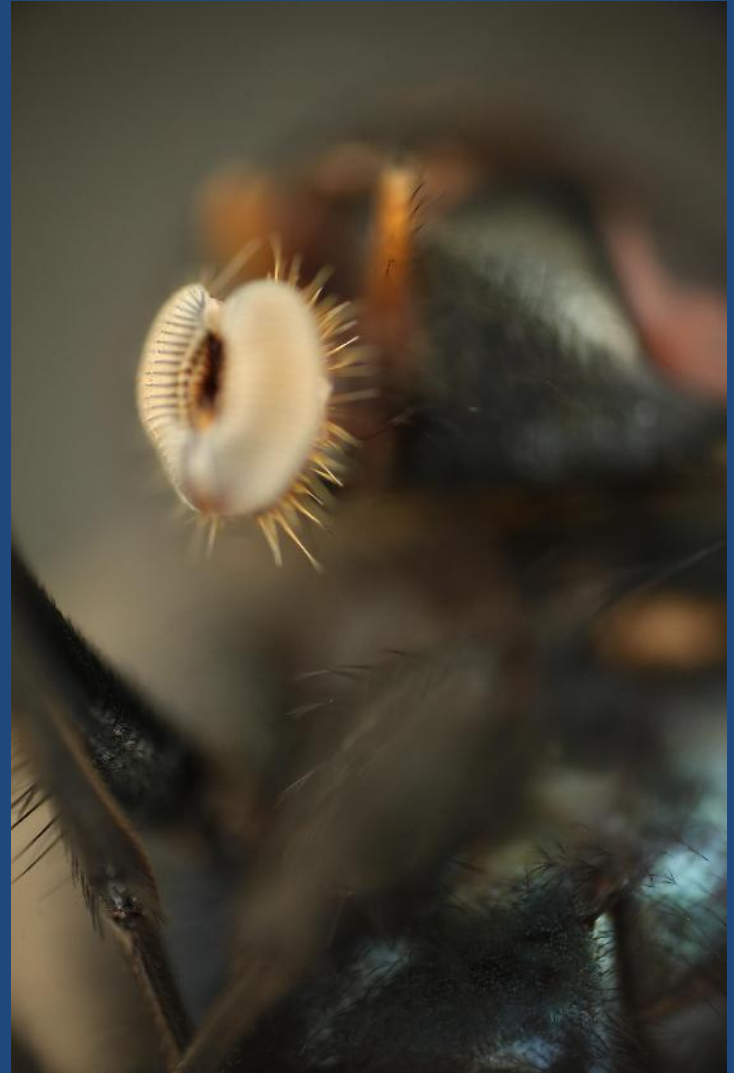


For small things, focus stacking is critical

Stacked composite



What You Can See At One Moment



Here's The Setup That Shot The Fly



Almost all this stuff can be purchased at Amazon!

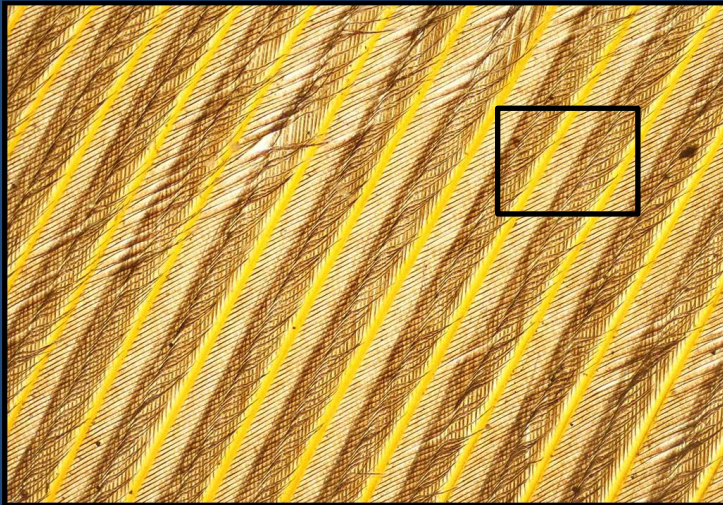
- “StackShot” automated rail
- Canon T1i camera
- Nikon microscope objective
- Vivitar telephoto (“tube lens” for objective)
- Canon 580 EX II flash
- Manfrotto 819-1 arm
- Adorama 2-axis rail
- Giottos mini ballhead
- Slik 504QF II tripod
- Cut, drilled & painted 2x4 wood

Feather On A Table

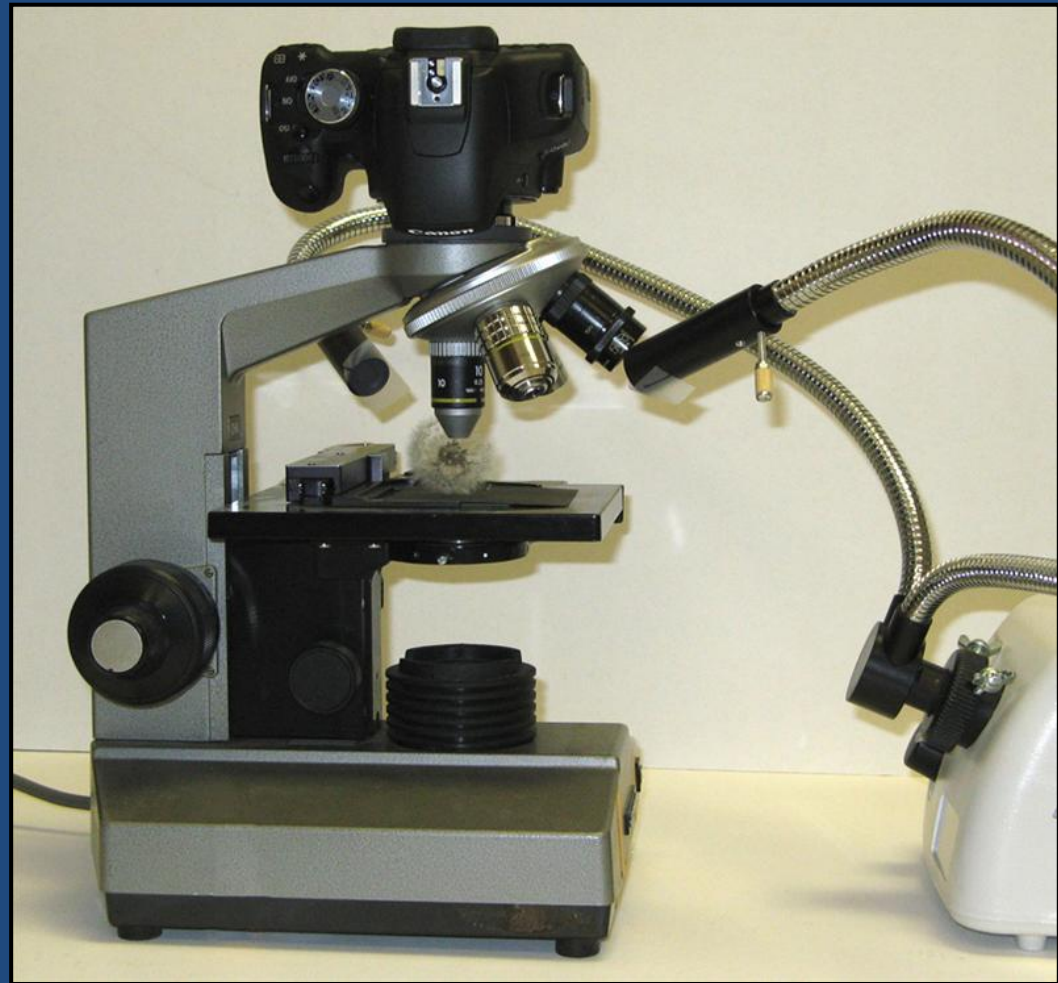


62 frames, shot at 5X on sensor
using A/F motor focusing
with microscope objective
4.4 mm total field width

This crop, $\frac{1}{2}$ mm = 1/50 inch



Shooting Through a Microscope



Manual focus step to $0.5\ \mu\text{m}$
(one wavelength of green light)

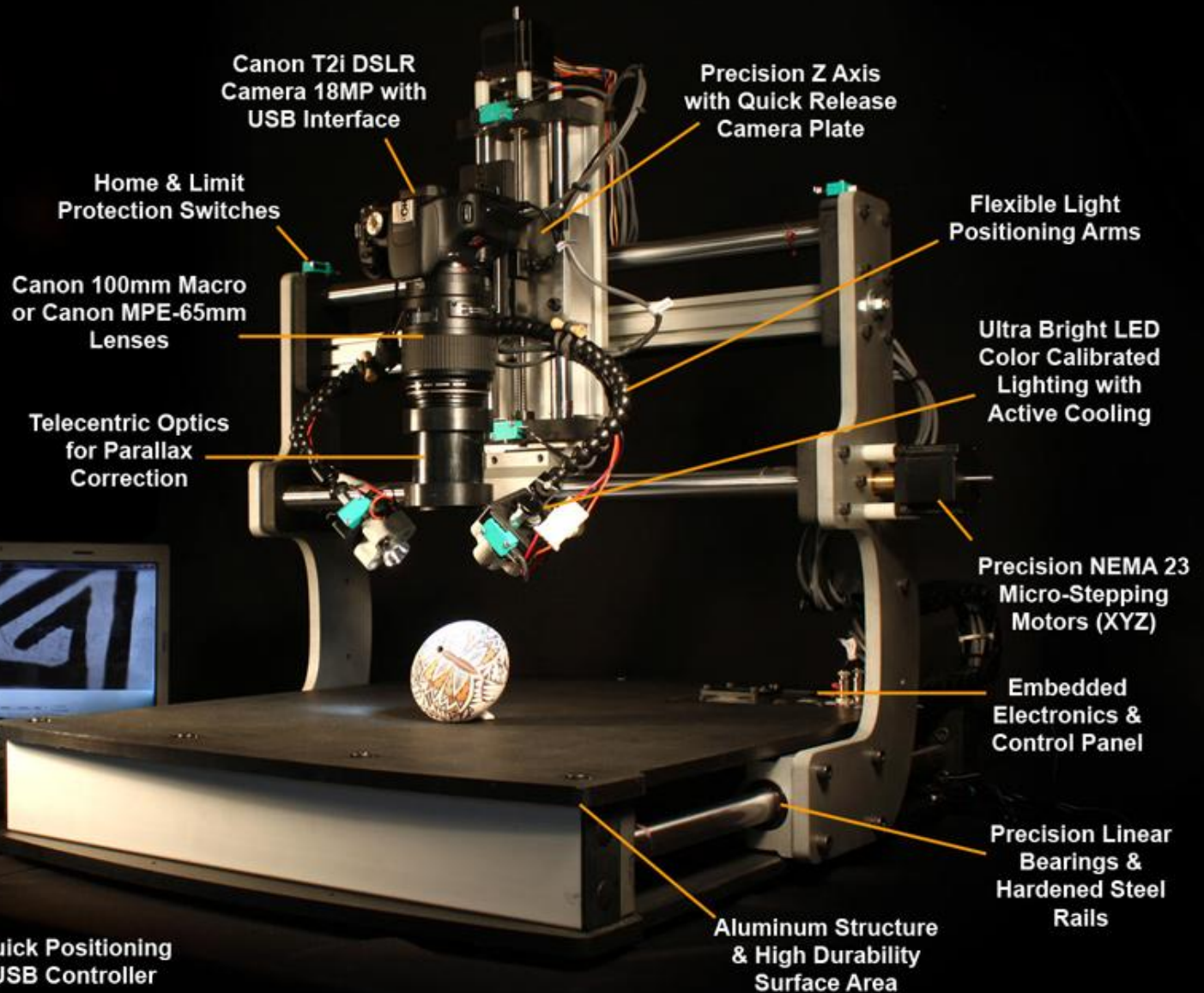
Visionary Digital's BK Plus System



GIGAmacro's package deal

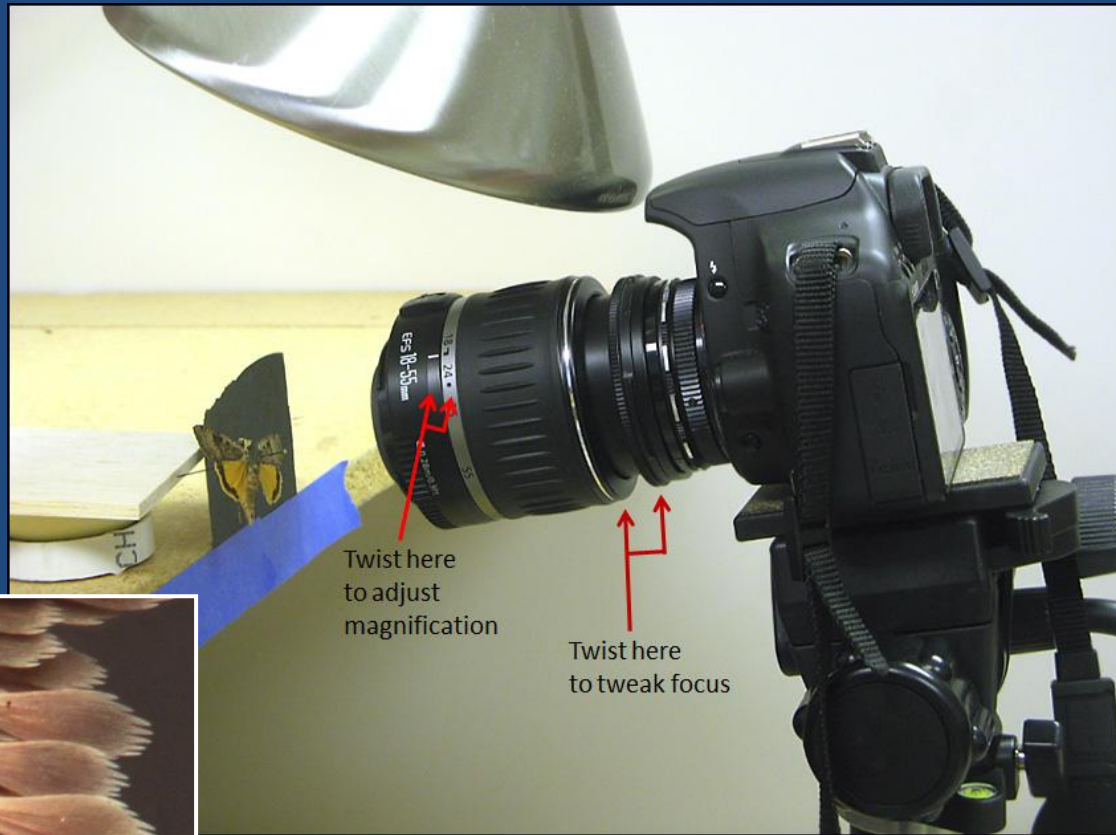
GIGAmacro Professional Imaging System

Released Nov 2011
Four Chambers Studio
GIGAmacro.com



Or Reverse a Standard Zoom Lens

This is a shockingly simple and cheap way to get high magnification with useful quality.



Fotodiox reverse adapter,
\$7.95 and free shipping
at [Amazon.com](https://www.amazon.com)

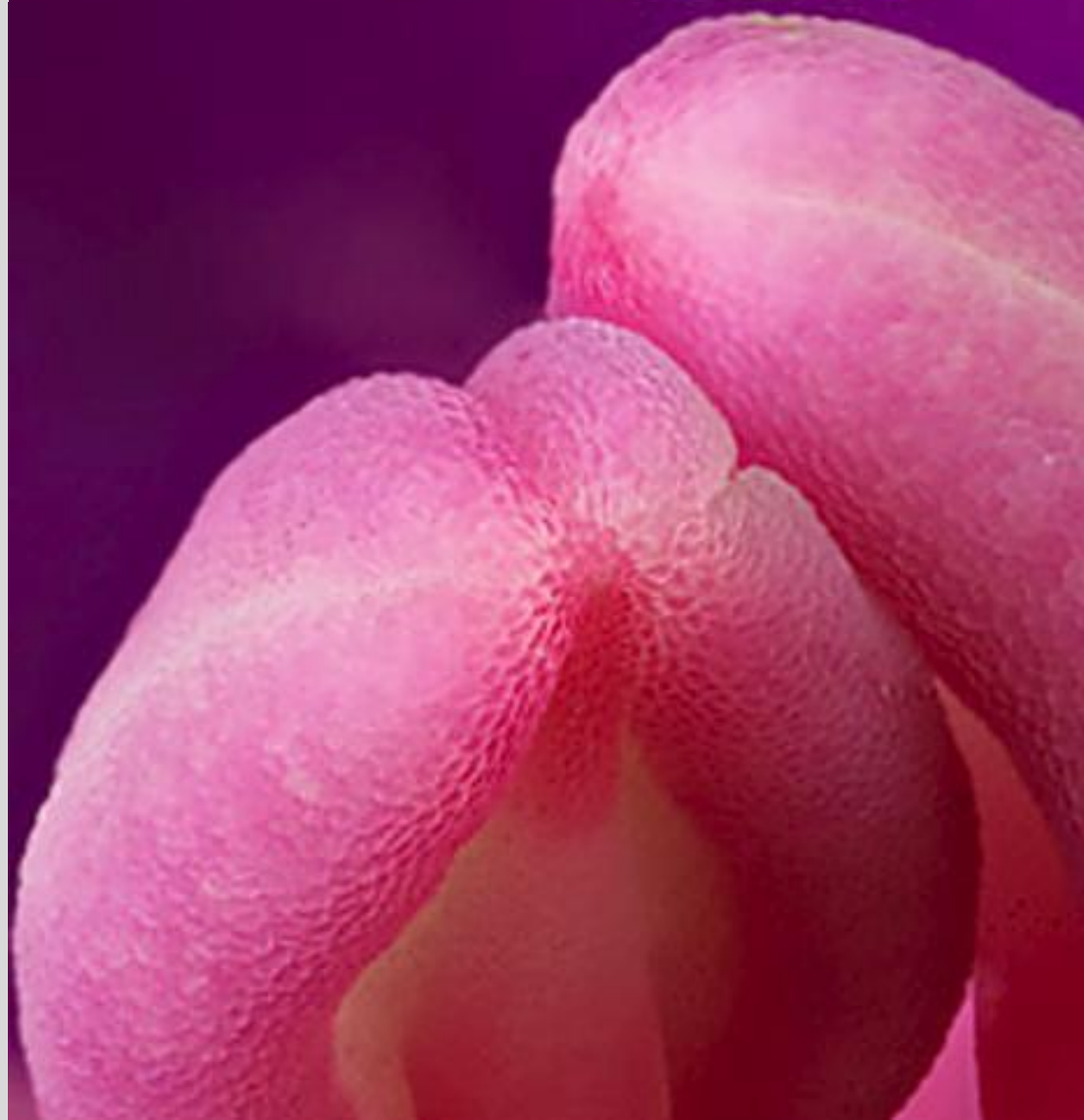
Low-tech approach



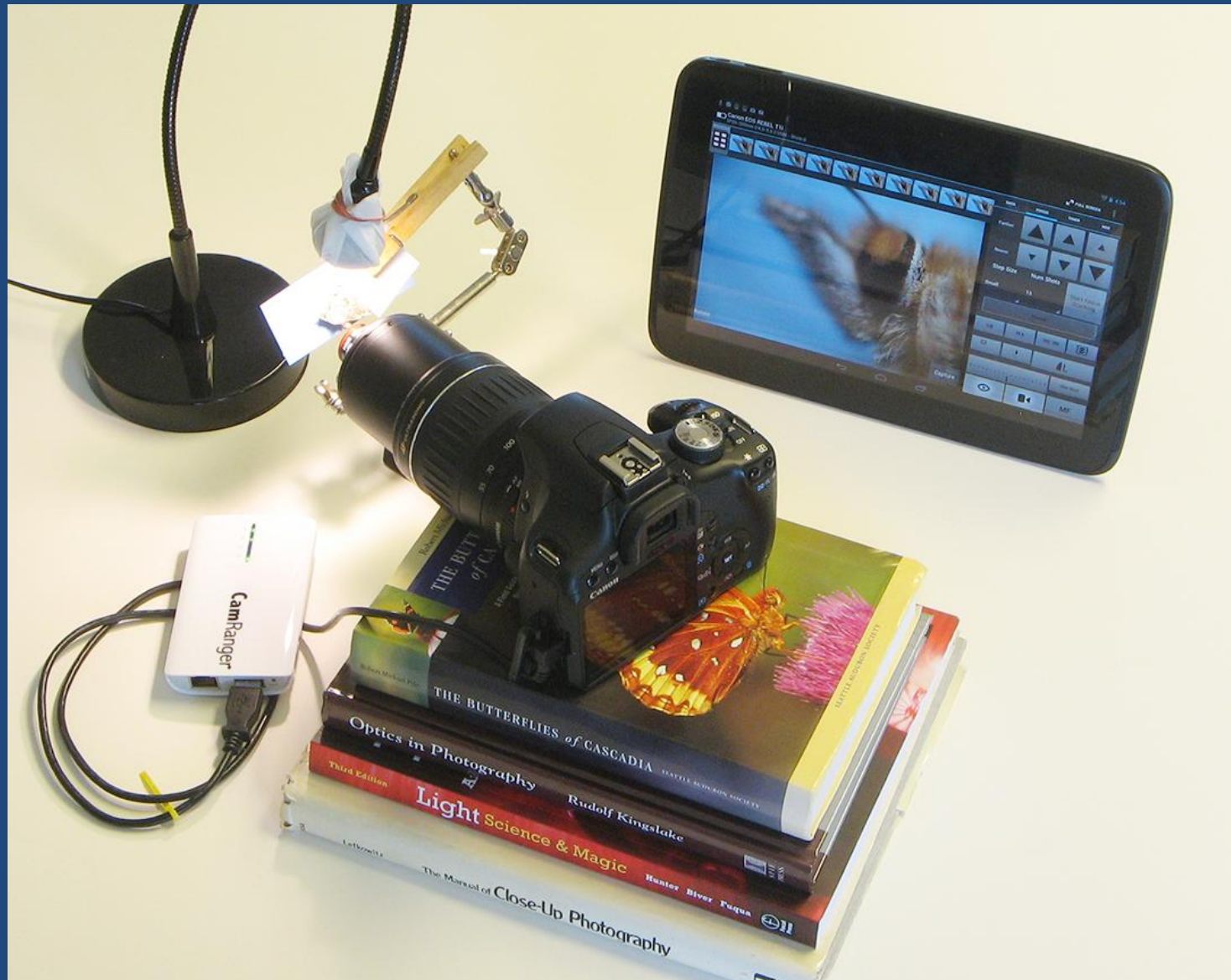
“Typical setup I use for flower bits shots”

Brian Valentine (username “LordV” on Flickr)

Brian's result: "Fuchsia Anthers"



Macro Stacking with the CamRanger



The Result (one frame)...



The Result (stacked from 71 frames)...



Closer...and rocking (from 1 stack)



Closer...and rocking (from 1 stack)

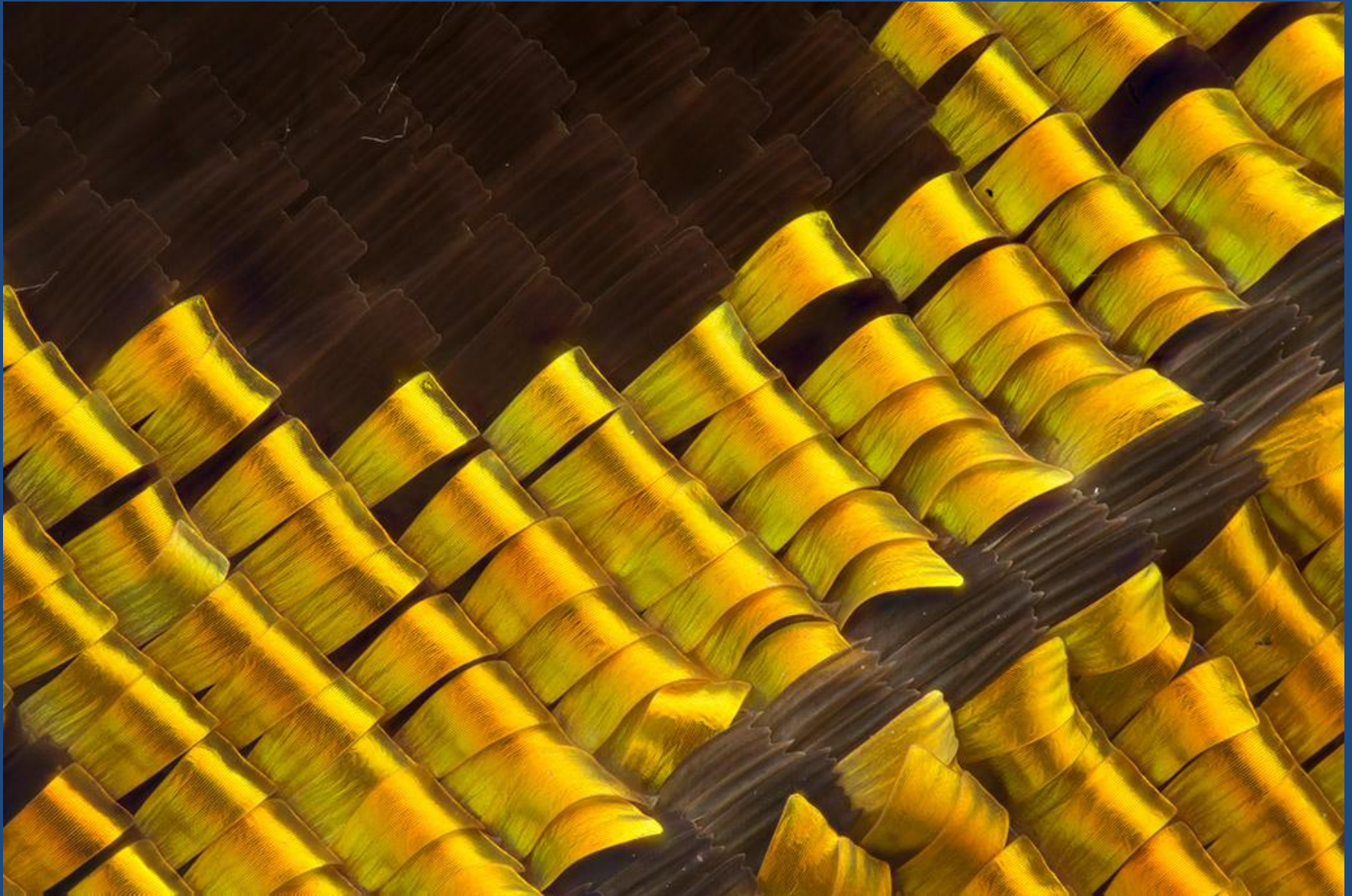


Closer...and rocking (from 1 stack)



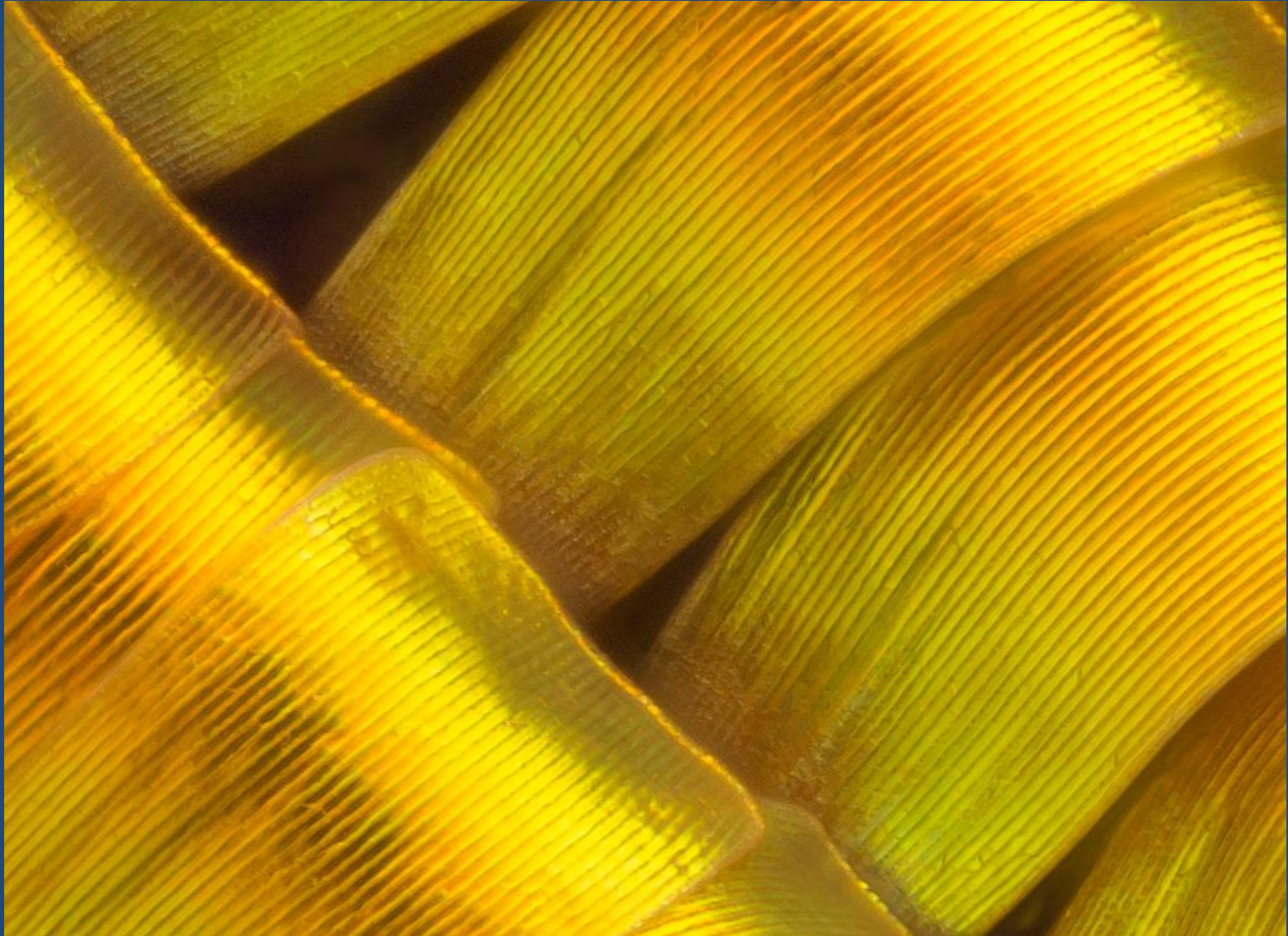
Wing Scales of Sunset Moth

(*Chrysiridia rhipheus*, 20X objective, 128 frames @ 0.002 mm)



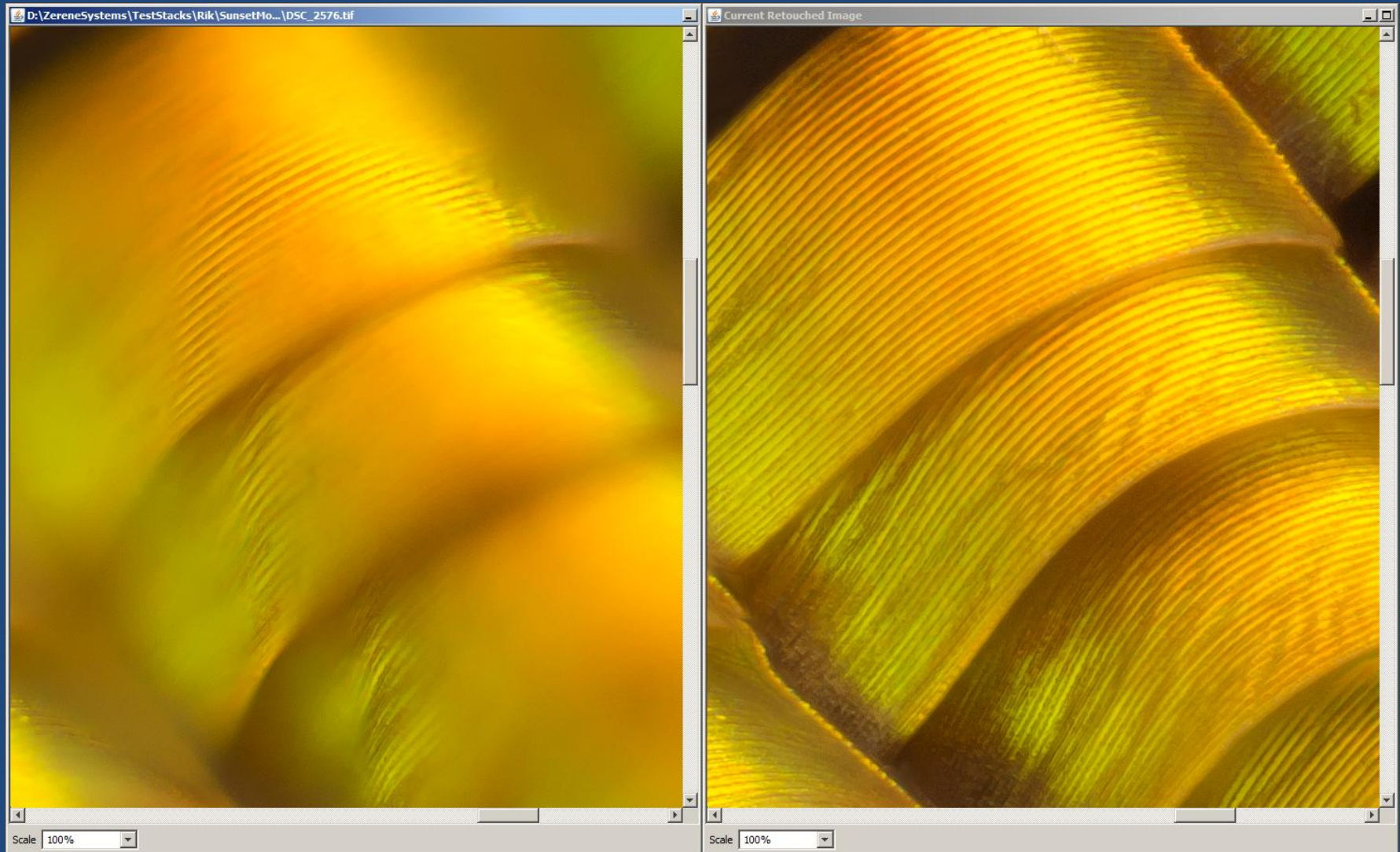
A Closer View of Those Scales

(about "500X")



Single Frame versus Stacked

(Sunset Moth: *Chrysiridia rhipheus*, 20X objective, 128 frames @ 0.002 mm)





rjlittlefield
Site Admin
Joined: 01 Aug 2006
Posts: 11876
Location: Richland,
Washington State, USA

Posted: Sun Feb 07, 2010 10:49 pm Post subject: List of links in FAQ: What's the best way to focus?

quote edit IP

Additional links to setups and discussions for high magnification work:

Charles Krebs: [Tabletop "macro" setup](#).

Many contributors, covering [Nikon](#), [Olympus](#), [Meiji](#), [Swift Focus Blocks & Setups](#).

Chris S: ["Bratcam" \(focus blocks and goniometers\)](#)

Chris S: [A field rig \(a bit of the Bratcam\)](#)

LordV: [sliding by hand on glass table mat](#) (more [HERE](#))

liuto: [Proxxon table and linear stages](#)

rjlittlefield: ["afocal" setup through microscope](#)

rjlittlefield: [bellows on microscope base](#)

RogelioMoreno: [infinity objective on telephoto lens](#)

seta666: [linear stage with micrometer drive, mounted on mini tripod](#). For part numbers, visit the Flickr link and hover over parts of the image.

Pau: [vertical macro setup](#), using salvaged microscope for fine focus.

januszj: [horizontal setup](#), using microscope base including the stage for focus and specimen holding.

Tomatito: horizontal setup using Lego blocks for structure (see [HERE](#), images 5-6) and Proxxon precision vise ([HERE](#), image 2) for subject movement.

Keks: an "all directions" setup using the StackShot, [HERE](#).

Marc Iwaniec, Thorlabs stages and goniometers, [HERE](#).

Wil Milne: extending the stage of a microscope base, [HERE](#).

John Hallmén: simple off-the-shelf stacking setup using Proxxon screw table, [HERE](#).

naturephoto1: studio macro rig with goniometers, focus block, and screw rail, [HERE](#)

Hokan: a Velmex rig, [HERE](#).

daemonoropsis, StackShot mounted on Arca/Swiss rails & breadboard, [HERE](#).

ecooper, Laboval 4 microscope body lying on its back, [HERE](#).

noah212, microscope turret on bellows, [HERE](#)

--Rik

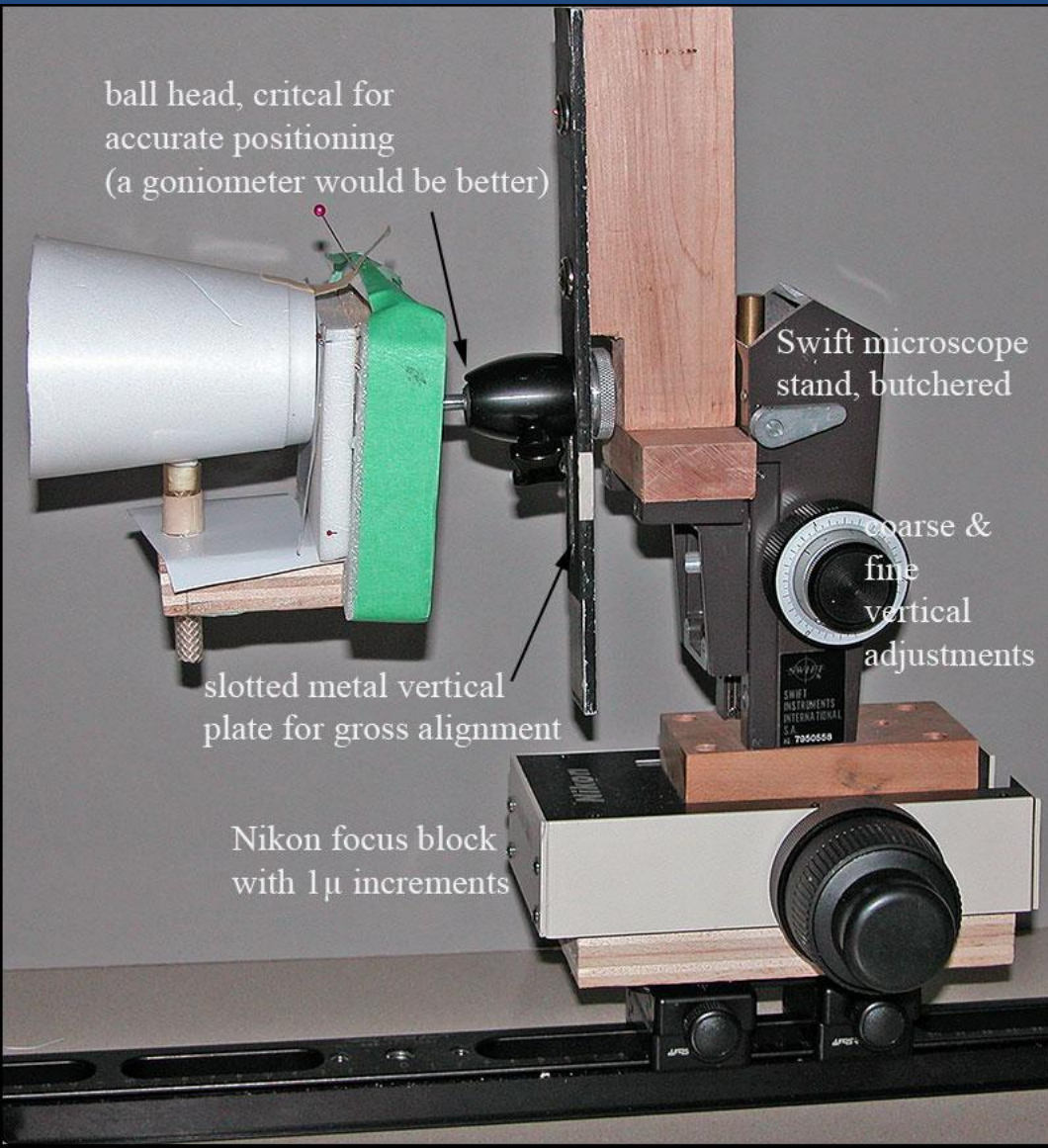
Edited May 2, 2010, to add some more links.

Edited July 7, 2010, to add some more links.

photomacrography.net has lots of descriptions of setups for macro/micro work

“The solutions are frighteningly simple when you see what can be cannibalised and bolted together”

Chris Raper (new stacker)



Built and photographed by Dr. Tony Thomas

As discussed at

<http://www.photomacrography.net/forum/viewtopic.php?p=94421#94421>

The Bottom Line:

Just do whatever it takes
to get numerous images
from the same viewpoint
but in different focus planes

Remember These Examples...



Macro and Close-up Photography
Text and Photos by Michael Erlewine



Or This New One...



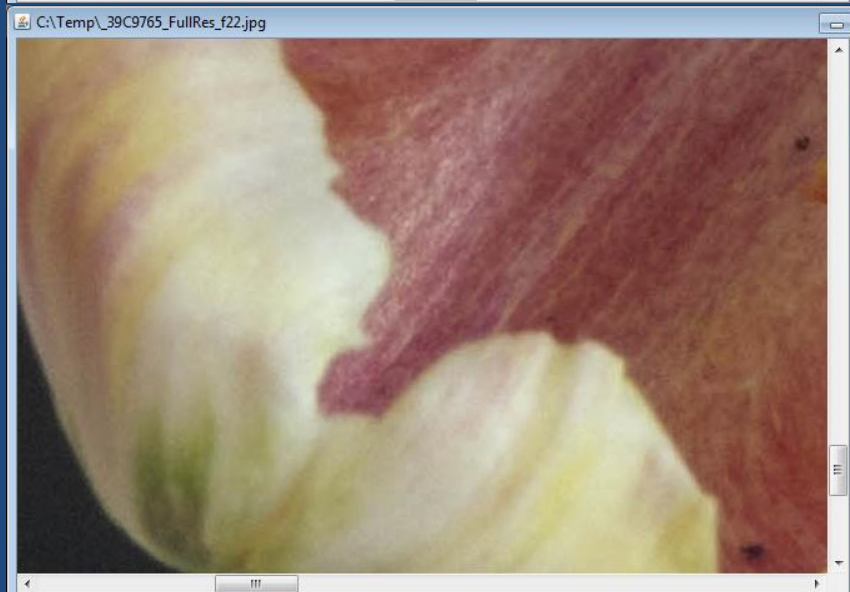
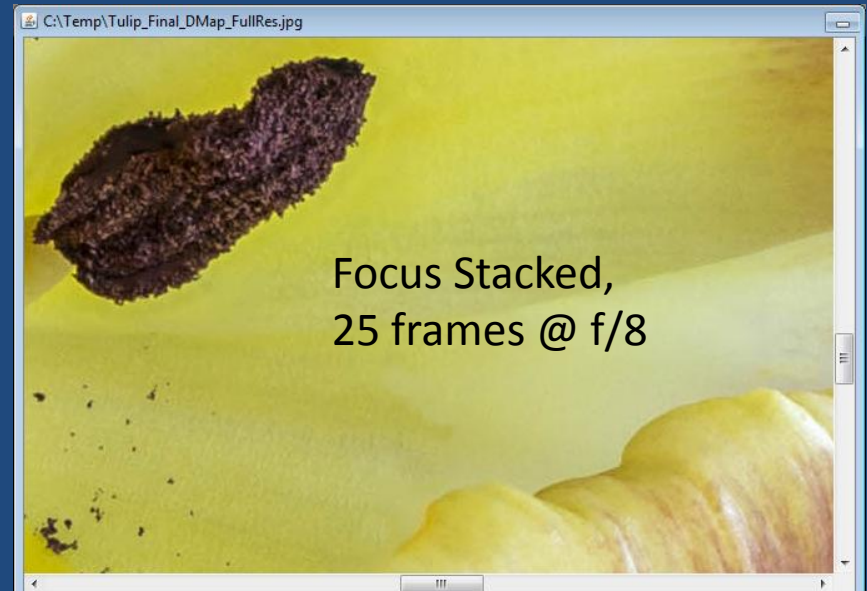
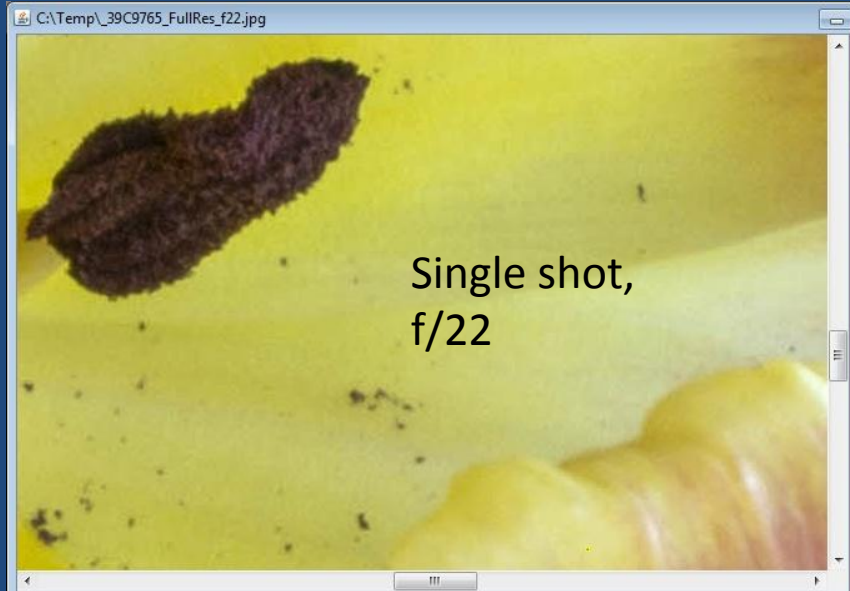
John Hallmén, field stack

Or This One...



© George D. Lepp 2013

Which Would You Rather Have?



One Last Time...



So, What Do You Want To Do?

Recap & References

- Focus stacking gives sharp images and large depth of field
- Recommended software:

Zerene Stacker, <http://ZereneSystems.com/stacker>

- Web forum dedicated to photography of small things

<http://www.photomacrography.net>

- For more information

email: support@ZereneSystems.com

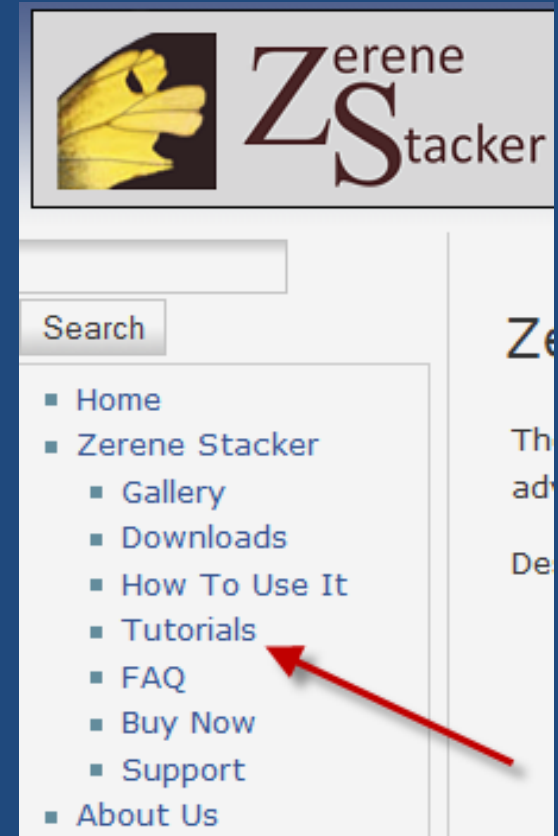
Zerene Stacker License Editions

- **Computers:** Windows, Macintosh, Linux, 32- and 64-bit, every license works on all platforms, mix & match is OK.
- **Upgrades:** just the difference in license price.
- **Updates:** free.
- **30-day Free Trial:** fully functional, all features, no restrictions, no registration needed.
- **Professional:** \$289, allows unlimited sale of images, includes all advanced functions such as Lightroom plug-in, faster processing, built-in controls for StackShot.
- **Prosumer:** \$189, hobbyists only, same features as Professional.
- **Personal:** \$89, hobbyists only. Provides all key functions including retouching and 64-bit mode.
- **Student:** \$39, same features as Personal.

To See The Slides Again...

This slide set can be found at
<http://zerenesystems.com>

It's in the "Tutorials" section,
linked at the bottom of page.



Presentation Slide Set

- A slide set providing an introduction to focus stacking, presented at the Northwest Outdoor Writers Association on 5/2/2015, can be viewed as PDF at http://zerenesystems.com/presentations/NOWA_Conference20150502/NOWA_Conference20150502.pdf (13 MB download).