

LEBANON CAMERA CLUB

Photomicrography

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11/7/2023

See last slide for Fair
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Photomicrography

Motivation

- Super blue moon in August
 - ◆ I got my astronomy gear out
 - Hadn't touched it in many years
 - Tested some equipment given to me by Tom (his father's old gear)
- Good weather in September kept me motivated
 - ◆ Tried some deep space astrophotography



Super Blue Moon Plus 2 Days



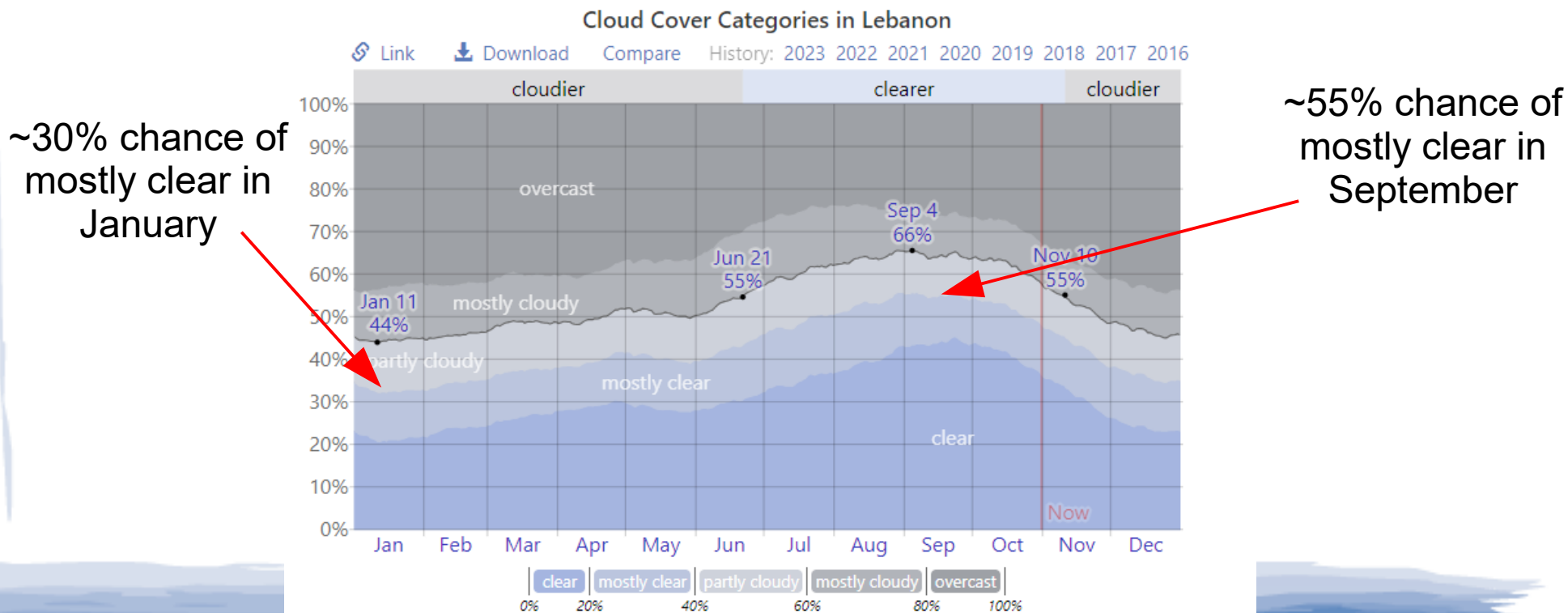
Andromeda Galaxy

Photomicrography

Motivation

Note: ~40% chance of at least mostly clear skies during the year → 146 nights. ~40% of nights the Moon does not interfere → ~58 nights. ~40% I am willing → ~23 nights.

- Started thinking about equipment upgrades → \$\$\$
- ♦ How many nights can I do it each year?
 - The weather in PA is poor → often cloudy, and cold in the winter
 - The Moon is an obstacle for nebulae and galaxies
 - I may not be motivated every time it's clear



Photomicrography

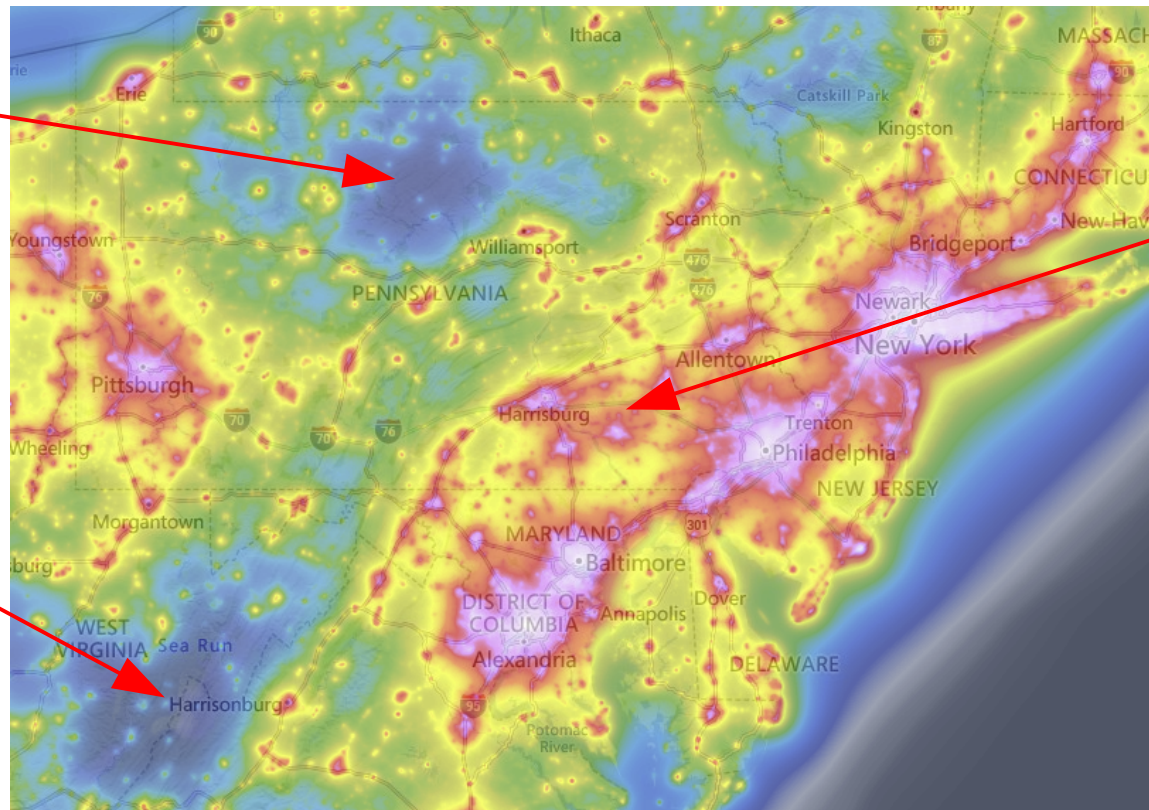
Motivation

Note: One of the least light polluted areas on the each coast is upstate → northwest of Williamsport. Cherry Springs State Park is ideal for astrophotography.

- Astrophotography is fun but challenging
 - ◆ Lots of light pollution in Lebanon
 - Have to travel fairly far to get better skies

Upstate PA dark skies

Virginia dark skies

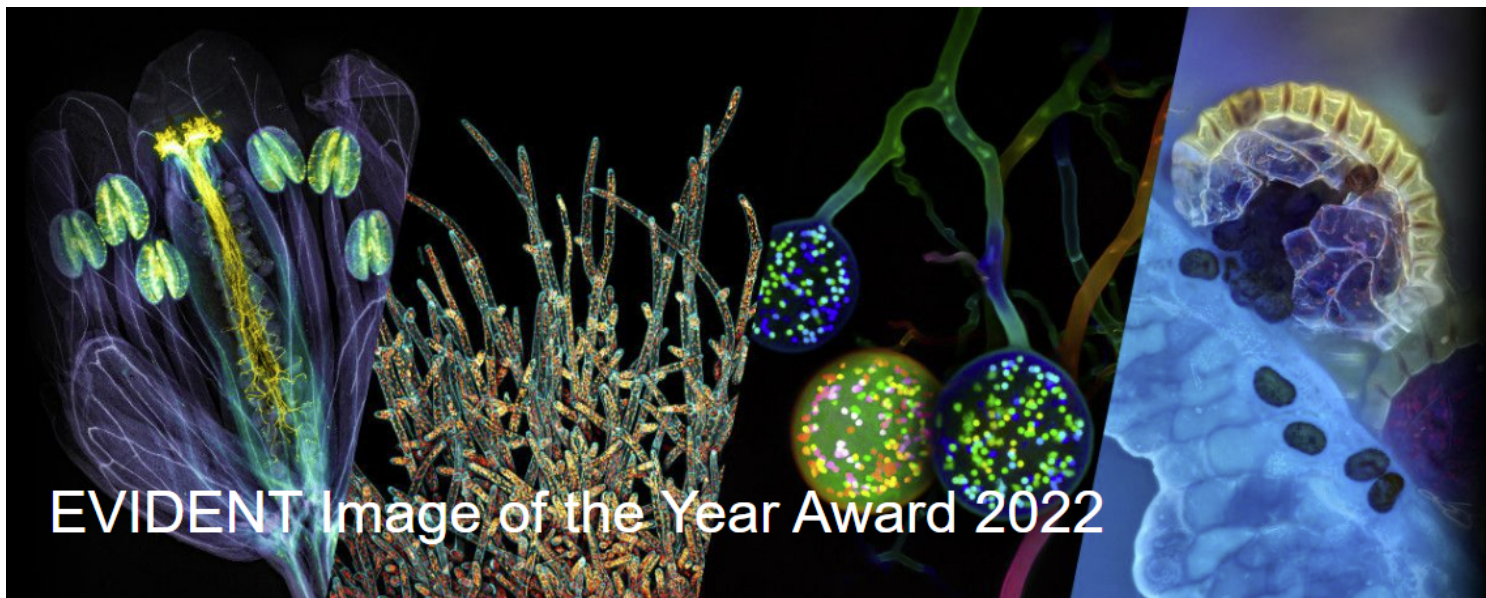


Lebanon

Photomicrography

Motivation

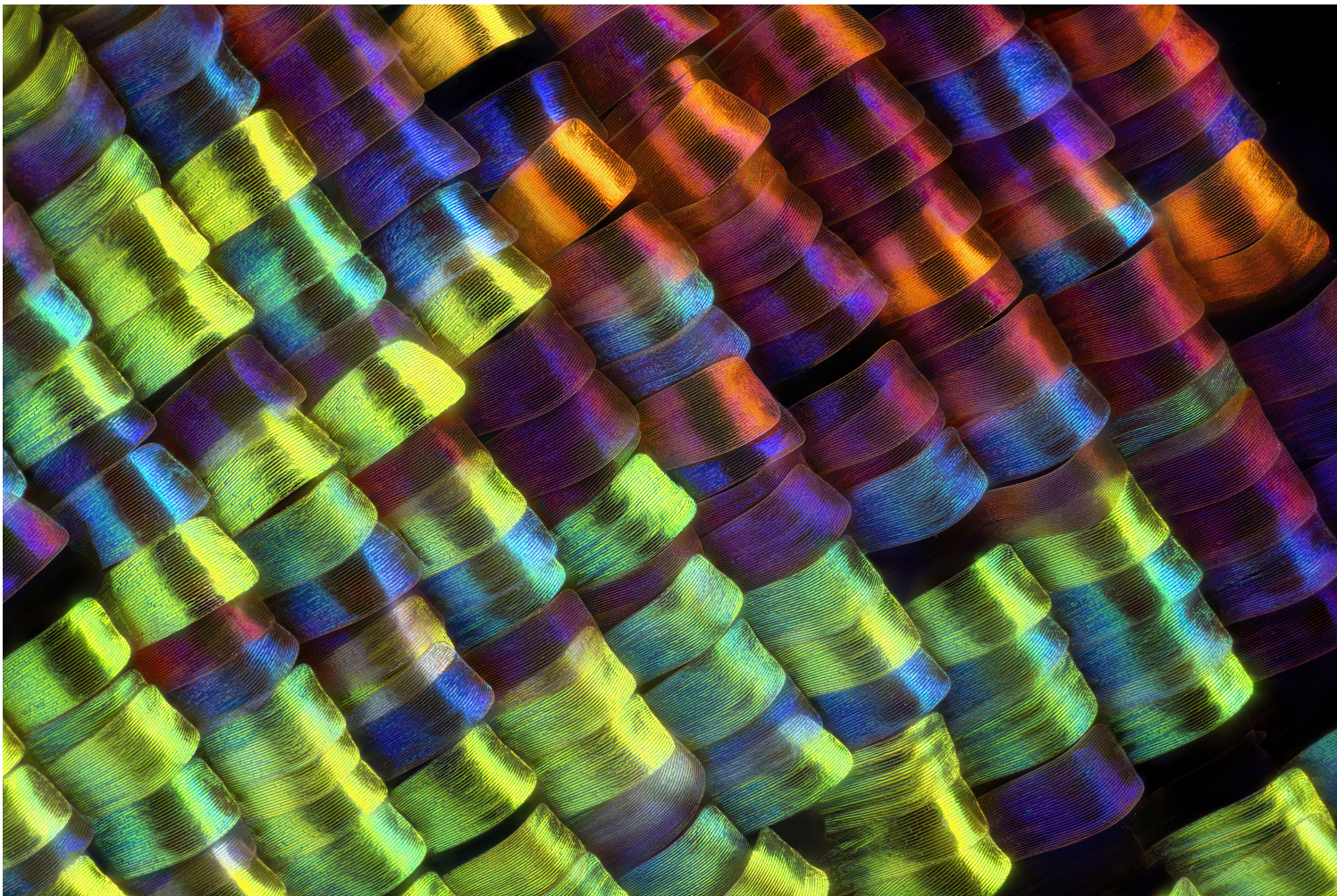
- 2022 Evident Image of the Year awards
 - ◆ Evident used to be Olympus Life Sciences
 - ◆ Annual photomicrography competition
 - I got an email because I'm on the Olympus mailing list
 - ◆ I was blown away by the images
 - Caused me to consider getting started in photomicrography



Photomicrography

Motivation

- 2022 Evident Image of the Year awards



“Scales of the wing of the *Urania rhipheus* moth, 20x” by Javier Ruperez (Spain), EMEA Winner

Photomicrography

Motivation

- 2022 Evident Image of the Year awards



“Germinating pollen grain of a morning glory” by Igor Siwanowicz (USA), Americas Winner

Photomicrography

Motivation

- 2022 Evident Image of the Year awards

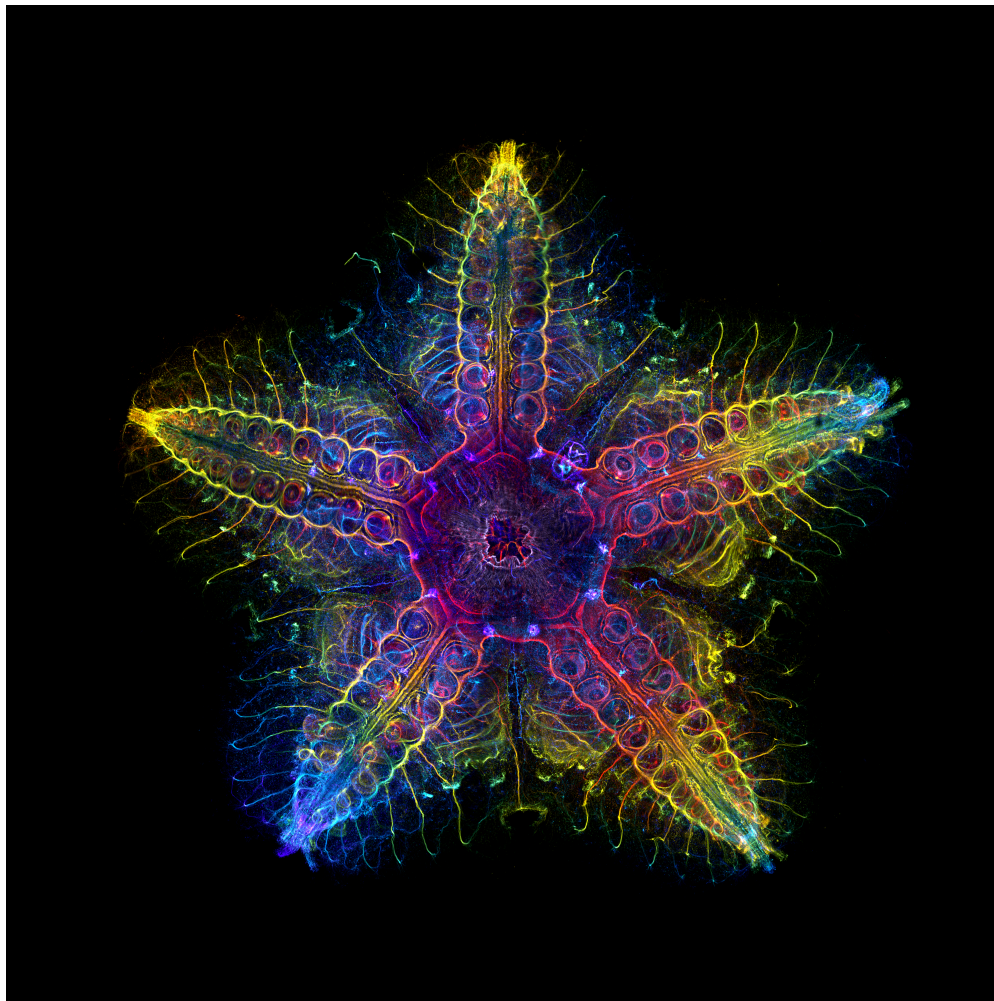


“Crystal of a topical medicine for wart treatment” by Shyam Rathod (India), Materials Science Winner

Photomicrography

Motivation

- 2022 Evident Image of the Year awards



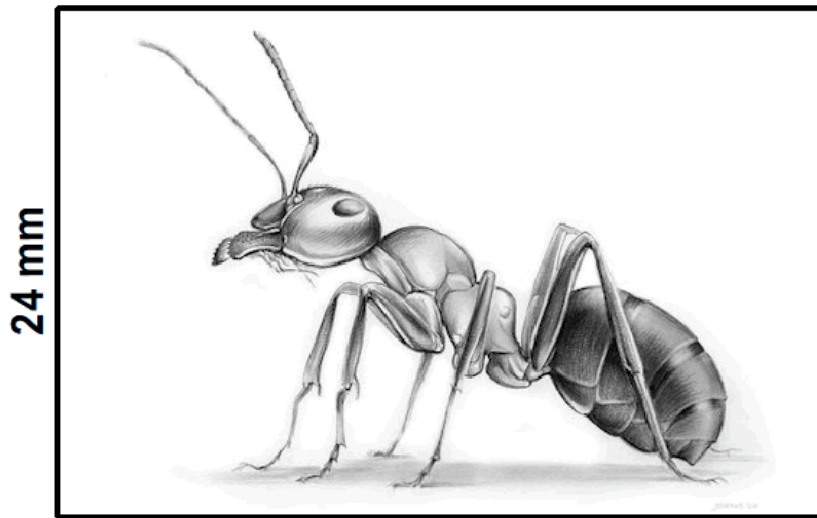
“Nervous system of a juvenile sea star, ~1 cm wide ” by Laurent Formery (USA), Global Winner

Photomicrography

Macro vs micro

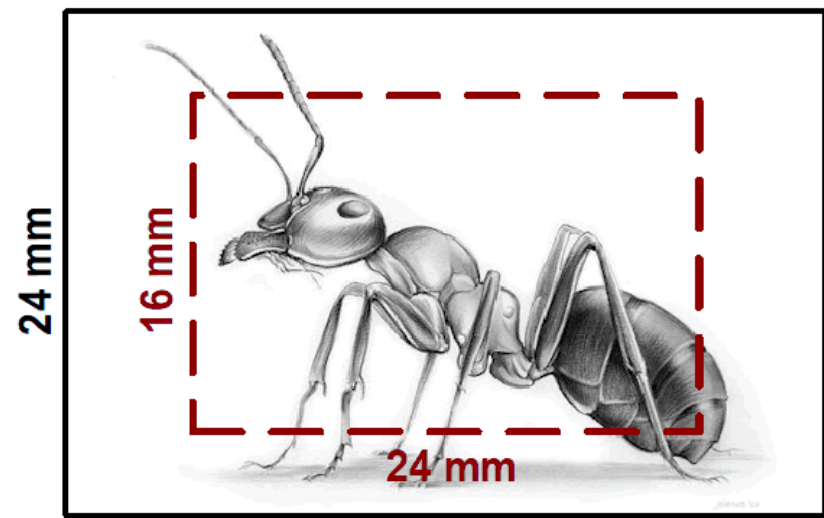
Note: Magnification = size on sensor / actual size, but the number of sensor pixels can affect amount of detail recorded and thus maximum reproduction size.

- Macro is generally 1:1 (1x) reproduction
 - ◆ Refers to the size on the sensor
 - 36x24 mm subject filling the whole 36x24 mm (FF) sensor is 1:1
 - 24x16 mm subject filling the whole 24x16 mm (APS-C) sensor is 1:1



36 mm

full frame with a very large ant → 1:1



36 mm

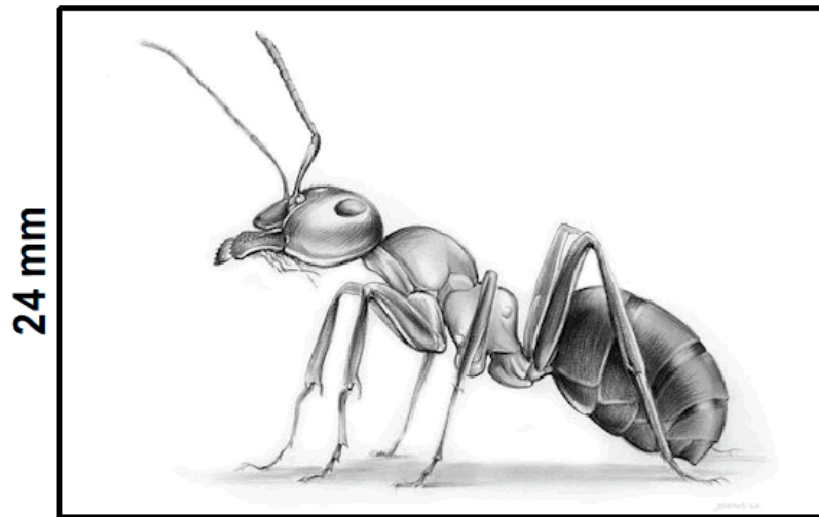
APS-C sensor, same lens, same camera location → 1:1

Photomicrography

Macro vs micro

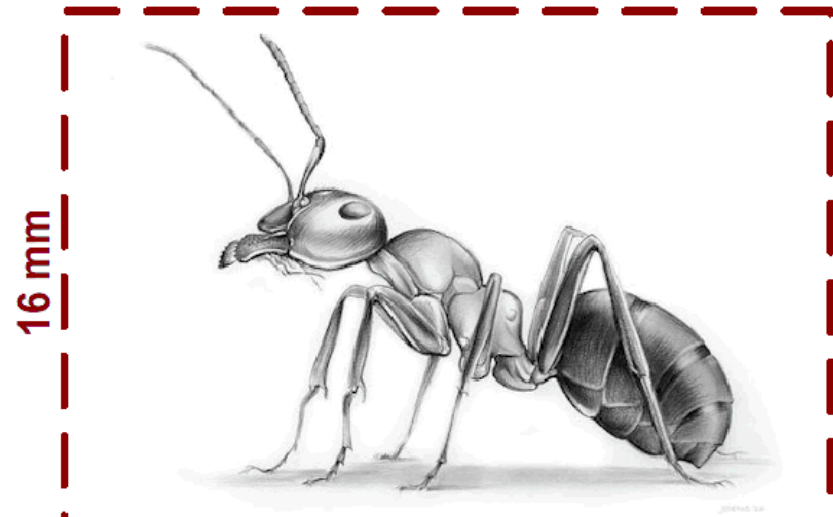
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 - Smaller sensor → don't have to get as close with the same lens...
 - ...but a subject bigger than APS-C may force less than 1x magnification



36 mm

full frame with a very large ant → 1:1



24 mm

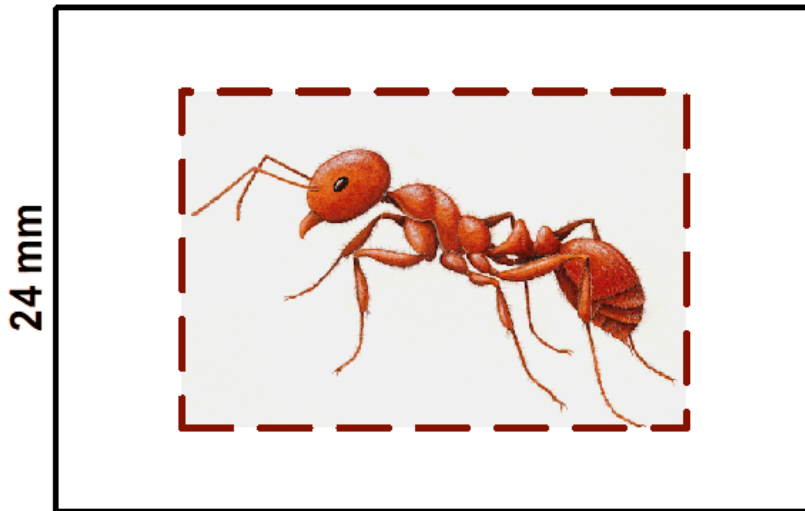
APS-C sensor, same lens, camera moved back → 2:3 = 0.67x

Photomicrography

Macro vs micro

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36 mm

full frame with a smaller ant, but cannot focus any closer → 1:1

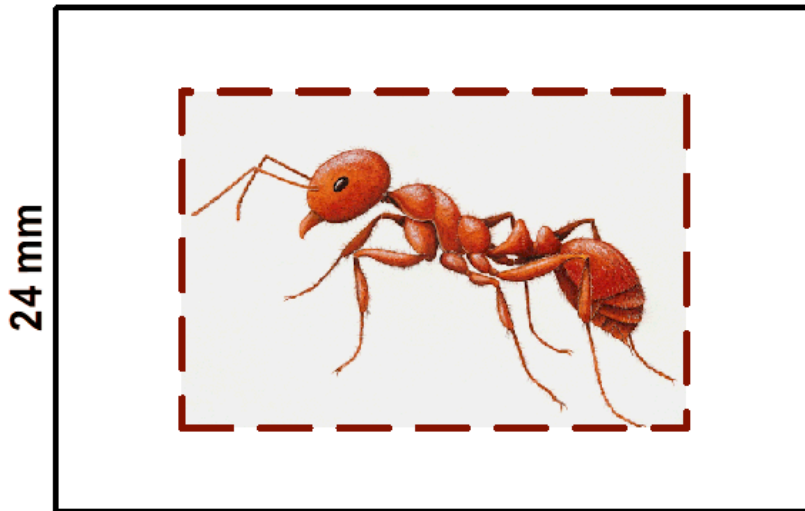
Note: If the lens could focus closer and the smaller ant filled the 36x24 mm frame then the magnification would be greater than 1x → micro photography.

Photomicrography

Macro vs micro

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36 mm

full frame with a smaller ant, but cannot focus any closer → 1:1



24 mm

APS-C sensor, same lens, same camera location → 1:1

Photomicrography

Note: The maximum focus distance of the Canon MP-E is 12.3 inches.

Macro vs micro

- Macro is generally 1:1 (1x) reproduction
 - ◆ Ways to get more than 1x magnification
 - Some newer macro lenses are capable of 2x
 - Specialized high magnification lenses → Canon MP-E = 1x-5x
 - Reversed lens + normal lens → $\text{mag} = \text{normal FL} / \text{reversed FL}$
 - Close-up lenses → attach to filter threads, lowers minimum focus dist.
 - Extension tubes → moves lens away from camera, lowers MFD
 - Bellows → moves lens away from camera, lowers MFD



Canon MP-E 65mm



close-up lens



extension tubes



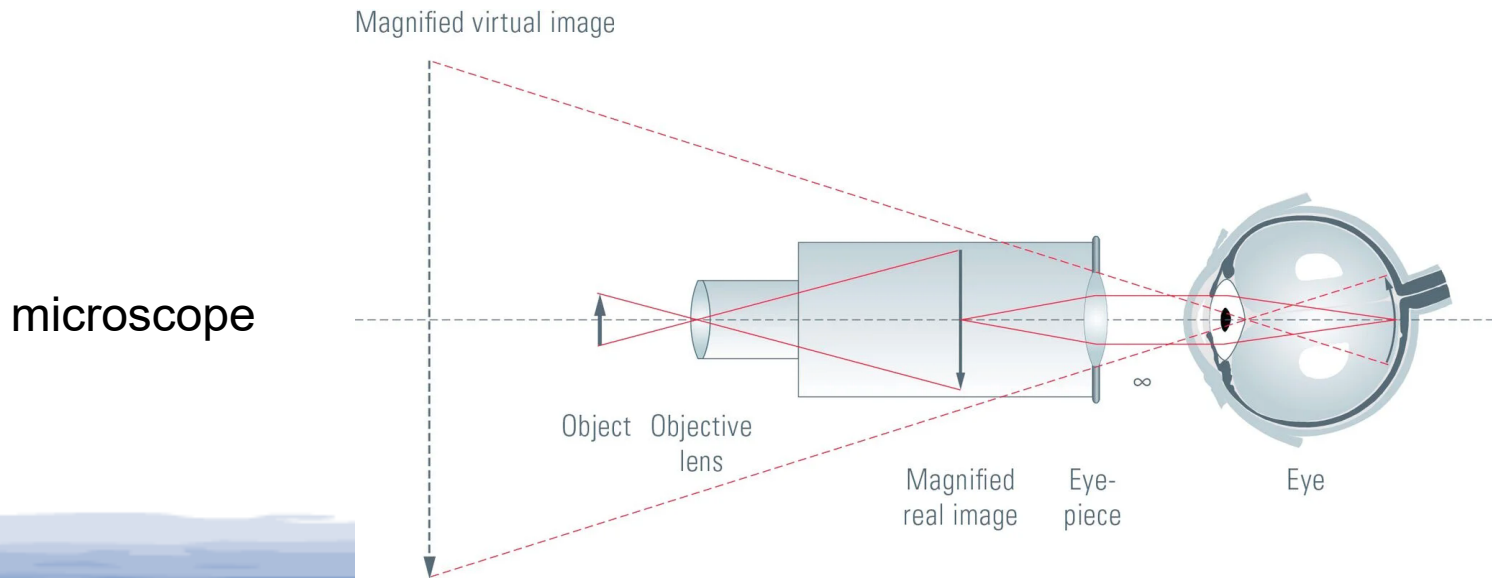
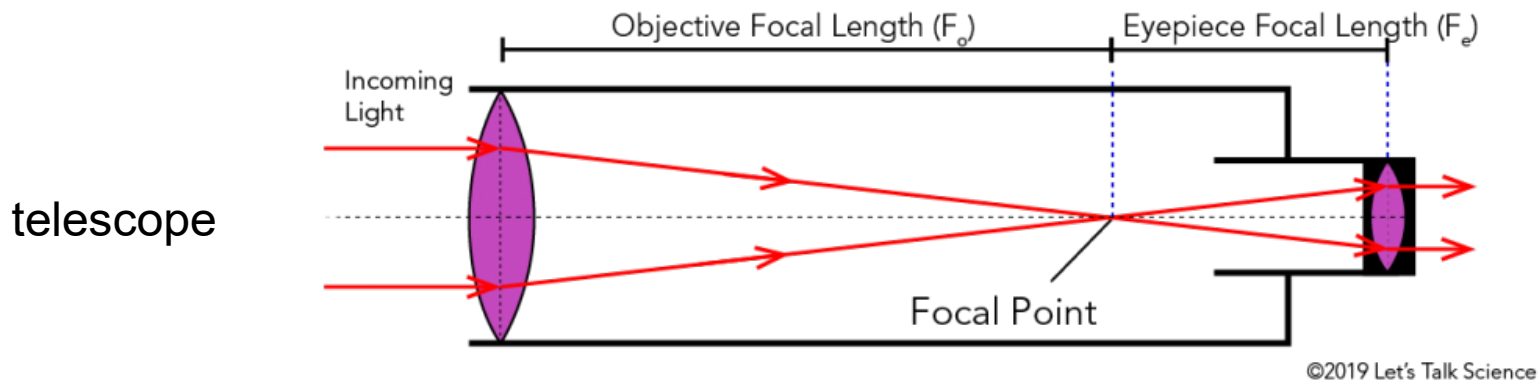
bellows

Photomicrography

Microscopes

- Optical
 - ◆ Objectives and eyepieces, just like refractor telescopes

Note: Objective lenses for telescopes are large, to gather as much light as possible for dim objects. Microscope lighting can be very bright, so objective lenses do not have to be large → less glass = less expensive.



Photomicrography

Microscopes

Note: Plan objectives are more expensive, but very beneficial for photomicrography. Prices range from \$40 to \$2,000 depending on manufacturer, magnification, and whether it is an apochromat (APO).

- **Optical**

- ◆ Objectives and eyepieces, just like refractor telescopes
- ◆ Objective image quality issues
 - Flat field → entire field of view can be in focus at the same time
 - Distortion → straight lines not straight
 - Vignetting → light loss toward the edges of the field of view
 - Chromatic aberration (CA) → colors do not come into focus together
- ◆ Plan objectives → ~95% flat field (semi-plan = ~85% flat field)
- ◆ Achromatic → lower CA (APO = no CA)



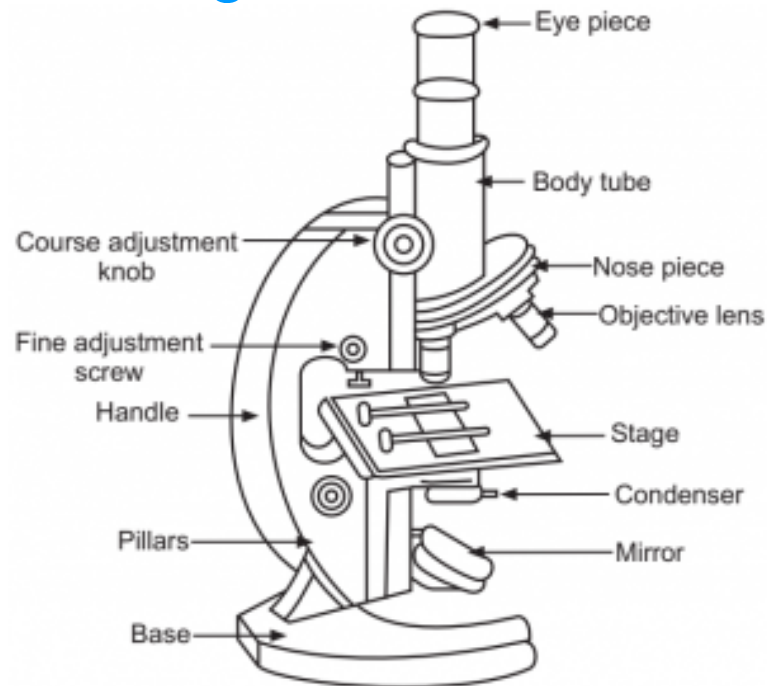
Photomicrography

Microscopes

- Types

- ◆ Compound

- Optical head + stage + light (or mirror) integrated into a single unit
- Rotating turret with several objectives for different magnifications
- Usually bottom lighting for viewing slides



Photomicrography

Microscopes

- Types

- ◆ Compound

- Monocular → one optical path (one eyepiece)
- Binocular → two optical paths (usually two eyepieces for both eyes)
- Trinocular → three optical paths (two eyepieces + a camera port)

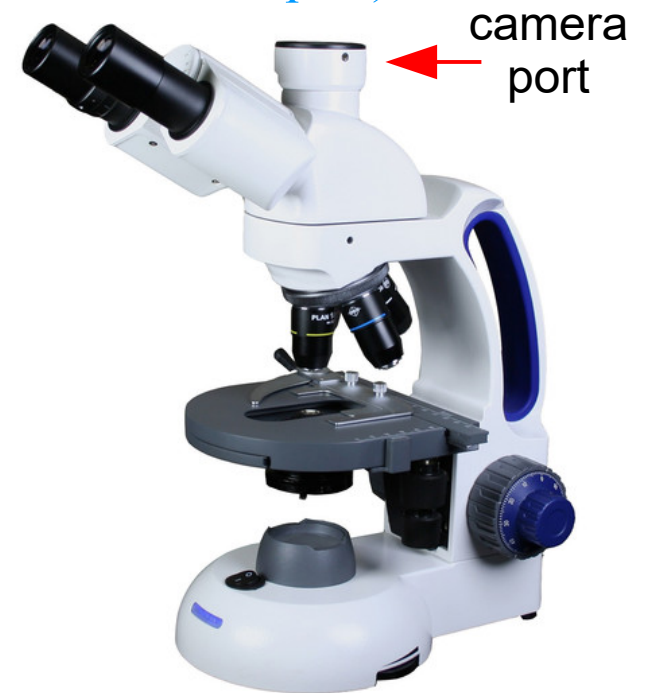
Note: The trinocular camera port usually uses a C-mount → threaded mount 1" in diameter with 32 threads per inch (the same mount is used on 16mm movie cameras).



monocular



binocular



trinocular

Photomicrography

Microscopes

Note: Stereo microscopes usually have less magnification than compound microscopes.

- Types

- ◆ Stereo

- Often a base + column + optical head, but may have a stage
- No rotating turret, but may be able to select different magnifications
- Binocular or trinocular
- May have top lighting, bottom lighting, or both



magnification selector,
no separate objectives

top light

bottom light



Photomicrography

Microscopes

- Types

- ◆ Digital

- Can be any type, but often a base + column + optical head
- Cheap ones are monocular, no eyepieces
- Usually top lighting
- Normally use USB to connect to a computer (may save to an SD card)

Note: Digital microscopes may have an attached LCD screen. Magnification may be based on size of the image on the LCD screen, not the size of the sensor (often 1000x is reported, which is misleading).



built-in LCD display

focus adjust

8 LED ring light

dual LED lights



Photomicrography

Microscopes

- **Advanced features**
 - ◆ **Siedentopf head for microscopes with two eyepieces**
 - Can change the interpupillary distance without affecting focus
 - ◆ **Mechanical stage**
 - Stage can be moved by turning knobs
 - Allows precise positioning of subject



Siedentopf head



mechanical stage
X-Y position adjust knobs

Photomicrography

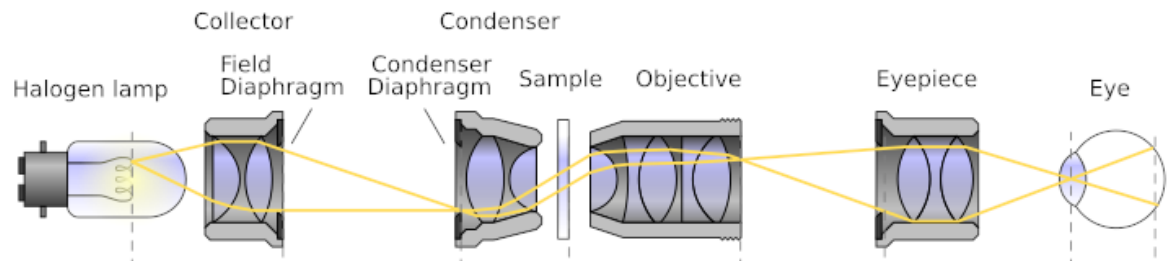
Note: LED lighting has become more common because it generates less heat, which can dry out liquids on slides.

Microscopes

- Lighting

- ◆ From below

- Mirror to reflect light from an external source (reduces heat)
- May have an integral light source → bulb (older) or LED (newer)
- Better microscopes have a condenser → lenses provide even light



Photomicrography

Microscopes

- Lighting
 - ◆ From above
 - Types: one fixed light, dual gooseneck, or LED ring
 - More common for stereo & USB (more space between objective & subject)



one fixed light



dual gooseneck



LED ring light

Photomicrography

Microscopes

- Camera attachment

- ◆ Afocal

- Photograph through eyepiece
- Often done with cell phones → small sensors may work better
- Requires good alignment and no light leaks (or a dark room)

Note: Known as 'eyepiece projection' for astrophotography. Can achieve higher magnifications. Special adapters can hold cell phones in place.



Photomicrography

Microscopes

- Camera attachment

- ◆ Direct projection

- No eyepiece used → objective projects image directly on sensor
- Can remove an eyepiece, but easier to use a trinocular microscope
- Larger sensors may not be fully illuminated → vignetting

Note: Known as 'prime focus' for astrophotography.

Magnification usually is lower than eyepiece projection, but field illumination may be larger than afocal.

no lenses
in C-mount
adapter



Note: The C-mount adapter may require a T-mount adapter (also used for telescopes) which attaches to the camera mount.

Photomicrography

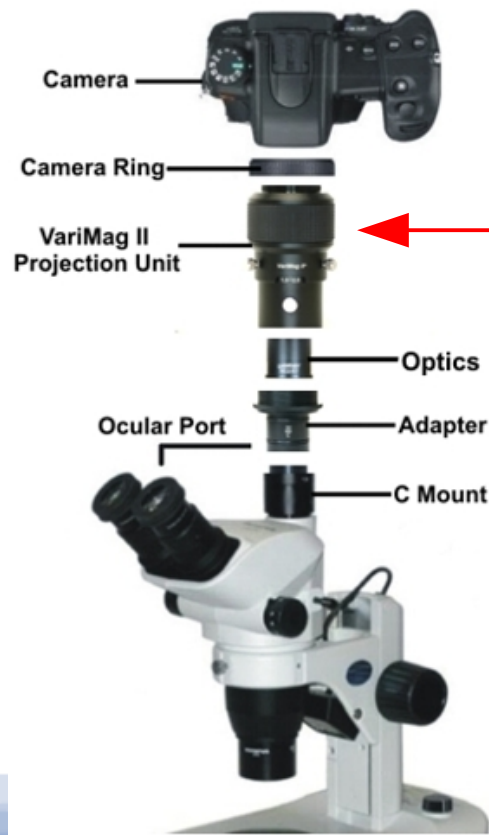
Microscopes

- Camera attachment

- ♦ Dedicated intermediate optics

- Adapter with lenses used to connect camera to microscope
- Can remove an eyepiece, but easier to use a trinocular microscope

Note: Similar to a Barlow lens used on a telescope. Barlows usually provide 2x-4x magnification, but on a microscope the optics may reduce magnification to provide even illumination over a larger area.



VariMag is a specific product for achieving variable magnification → many setups omit this and use the magnification provided by the objective + intermediate optics



Motic camera with 0.5x intermediate optics

Photomicrography

Microscopes

- Cameras

- ◆ Cell phone

- Should use an adapter for proper alignment
- Can do video in addition to still images
- Adapters range from \$30 to \$150
- Can also get devices that attach to a phone to make it a 'microscope'

Note: Some afocal adapters may also be used on telescopes. There are lots of different adapters available, and even CAD files to make one on a 3D printer



Bresser afocal adapter
(\$30)



Bresser afocal adapter on
telescope eyepiece



converts a cell phone
into a microscope (\$90)

Photomicrography

Microscopes

- Cameras

- ◆ USB microscope camera

- Designed to attach to a microscope → eyepiece tube or trinocular port
- Low resolution models can be cheap (1-2 megapixels)
- 5 megapixels is considered a moderate resolution
- High resolution models can be over \$1,000 (8-16 megapixels)

Note: For general photography CMOS sensors have become the standard. For scientific use CCD sensors may be preferred and cost more.



Bresser 5MP eyepiece camera
(\$59)



Motic 5MP C-mount camera
(\$450)

Photomicrography

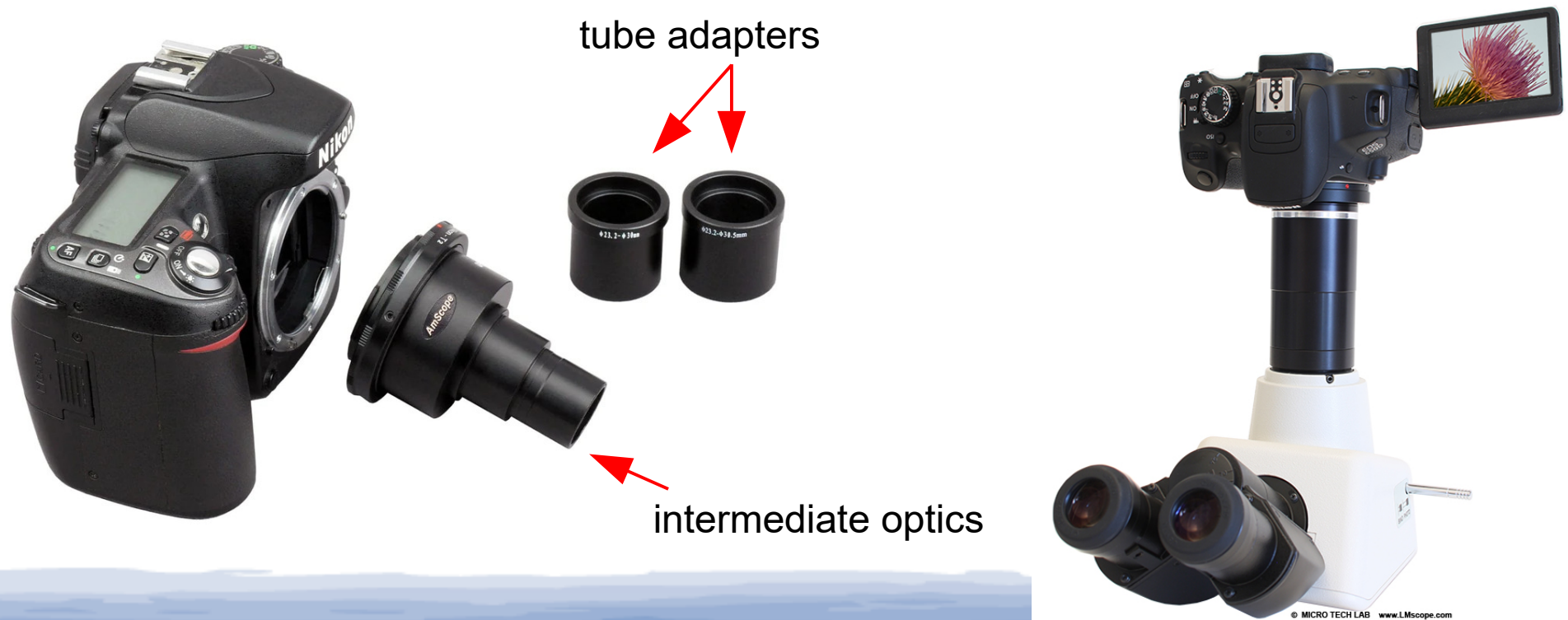
Microscopes

- Cameras

- ◆ DSLR or mirrorless camera

- Mirrorless can work better for direct projection (adapter = \$10-\$100)
- Both may benefit from dedicated intermediate optics (\$50-\$2300)
- Trinocular port for vertical orientation (avoids weight on eyepiece tube)

Note: The flange focal distance (FFD) of C-mount is 17.526 millimeters. This is close to the FFD of mirrorless cameras, while the FFD of DSLRs is much larger.



Photomicrography

Microscopes

Note: Although I'm showing Amazon and B&H prices I'd probably purchase from Carolina Biological Supply or directly from Swift or Amscope if I was buying a quality microscope.

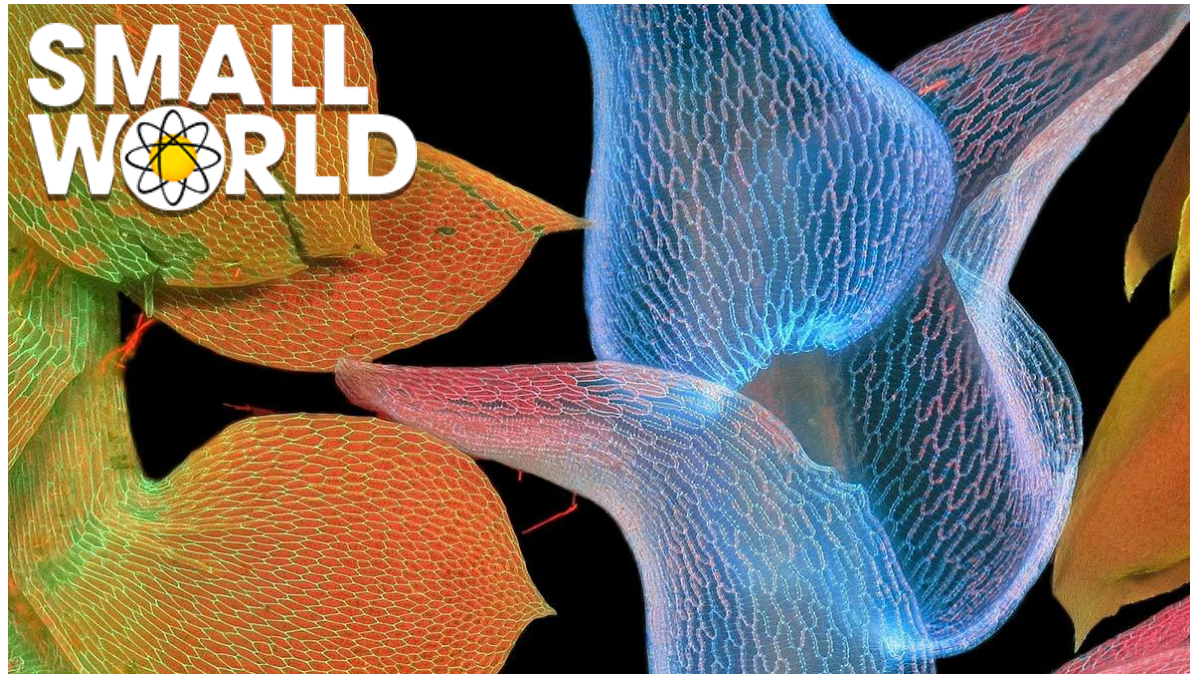
- **Cost**

- ◆ **Digital** → \$10 (Amazon) to \$560 (B&H)
 - A decent model can be had for \$100 to \$250
- ◆ **Stereo** → \$49 (B&H) to \$1176 (B&H)
 - Trinocular models are usually at least \$300
 - Prices do not include a camera (some scopes are bundled with cameras)
- ◆ **Compound** → \$25 (B&H) to \$2670 (B&H)
 - Trinocular models are usually at least \$250
 - Models with plan objectives are usually at least \$600

Photomicrography

Motivation

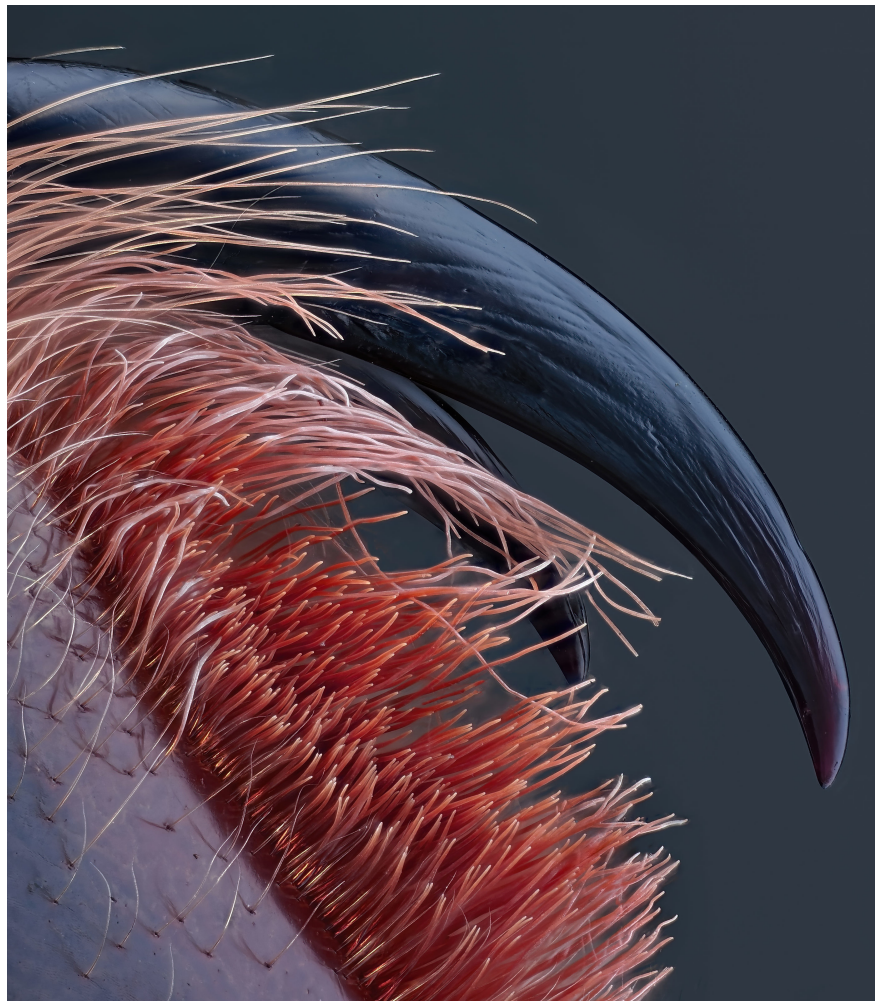
- ◆ 2023 Nikon Small World awards
 - ◆ Annual photomicrography competition
 - I got an email because I'm on a Nikon forum mailing list
 - ◆ More fantastic images
 - Increased my interest in buying a microscope



Photomicrography

Motivation

- 2023 Nikon Small World awards

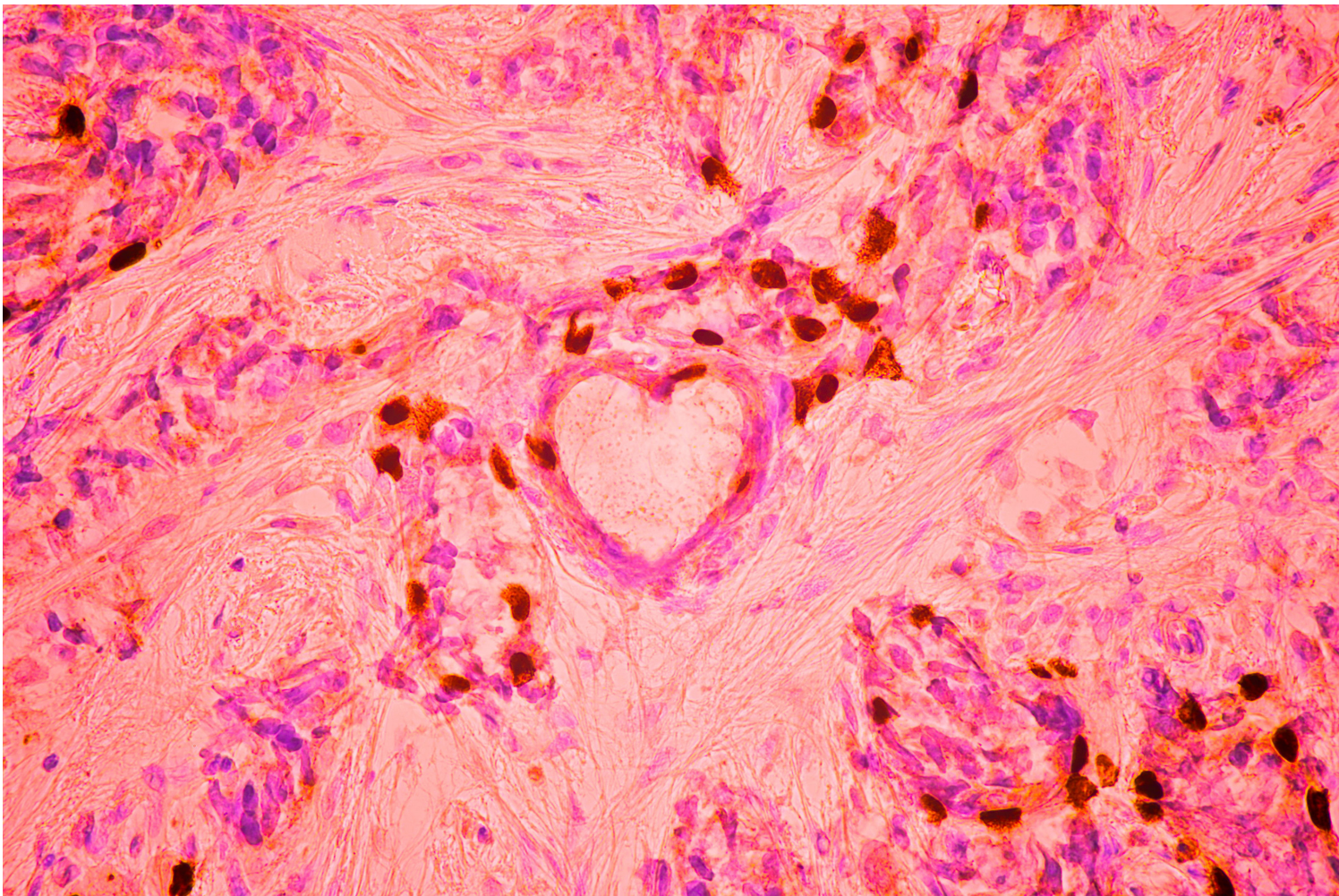


“Venomous fangs of a small tarantula, 10x” by John-Oliver Dum (Bendorf, Germany), 4th place

Photomicrography

Motivation

- 2023 Nikon Small World awards



“Breast cancer cells, 40x” by Malgorzata Lisowska (Warsaw, Poland), 3rd place

Photomicrography

Motivation

- 2023 Nikon Small World awards

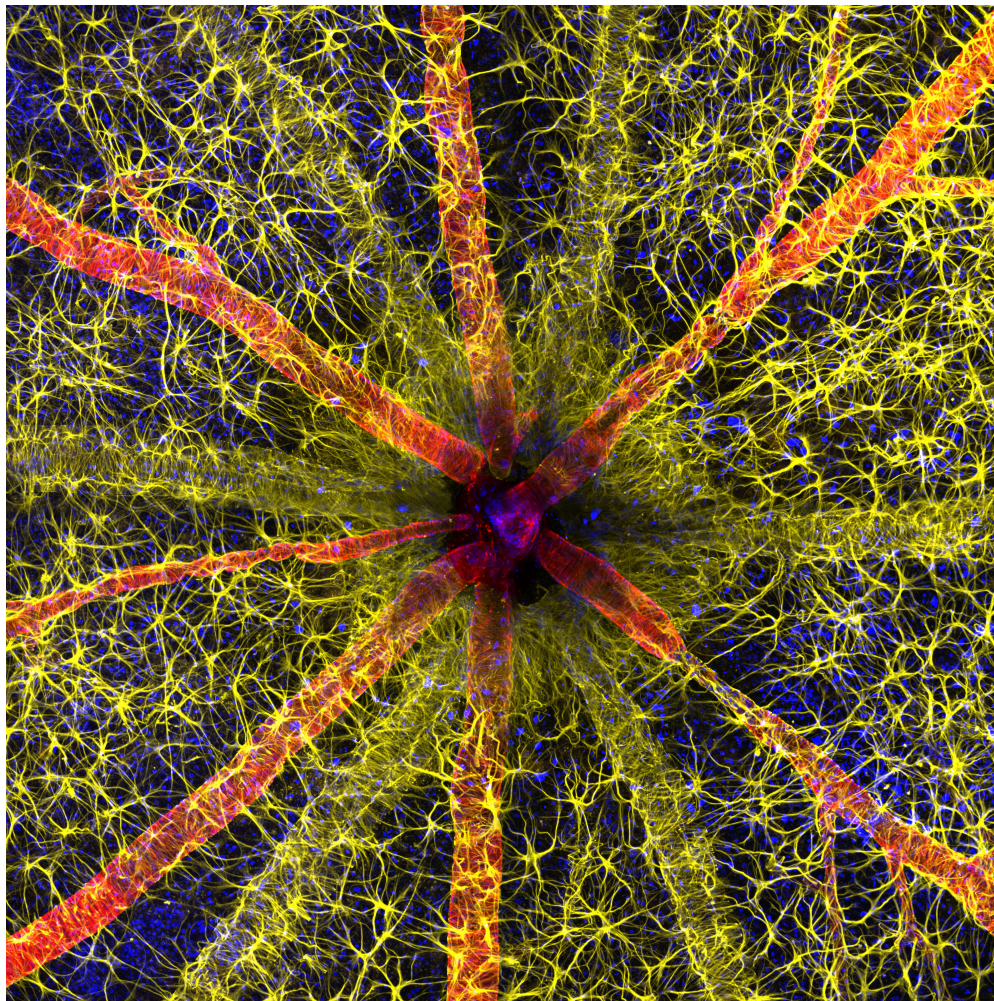


“Matchstick igniting by the friction surface of the box, 2.5x” by Ole Bielfeldt (Cologne, Germany), 2nd place

Photomicrography

Motivation

- 2023 Nikon Small World awards



“Rodent optic nerve head, 20x” by Hassanain Qambari (Lions Eye Institute, Perth, Australia), 1st place

Photomicrography

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