A STACKING MICROSCOPE

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For many years now, I've been working with Stackshot from Cognisys. It's a motorised, programmable, and computer controllable focusing rail used for very precise focus stacking. The rail is capable of moving one micron at a time, which makes it capable of stacking in the realm of photomicrography.

Not too long ago I met someone who gave me an idea for a new project. He worked for a metallurgical company and had modified a microscope with the addition of a Stackshot rail to do automated focus stacking of tiny defects in machined parts. Right then and there I made the decision to emulate his idea.

One of my acquaintances owns a company that buy and sells used microscopes. Going through his warehouse, I spotted a bare bone Olympus; it had no eyepiece, no lens, and no lighting equipment. It did have revolving turret for four lenses and a decent condenser.

The first order of business was to dismantle everything and degrease it. As usual with a microscope that had been sitting idle for a long time, the lubricant had frozen to a solid pack. WD-40 and a lot of elbow grease restored all the parts to their usual mobility.

Then the measurements started. I needed to fix the Stackshot to the lower base of the microscope and the specimen plate/condenser to the moving part of the rail. The first problem to arise right from the start was the length of my focusing rail: it was too long by at least two inches. I thought of cutting it, but lacking the proper tools decided to abandon that idea very quickly.

A few emails to Cognisys brought a response from one of its founders, John DeSweeus, who informed me that it was economically unwise to modify my existing rail. Instead, he suggested making a new custom-made unit for $300. I quickly accepted his offer as it also meant that my other rail would remain available for regular work.

The new rail came back within a week (excellent service!) and it fitted perfectly. Two holes were drilled and tapped in the "U" shaped harm of the microscope to mount the rail in position. I had to cut the bottom part of the focusing assembly of the condenser to make it fit, but it makes no difference in its operation. The stage and condenser assembly, which was previously attached to the microscope's arm, was then fixed to the moving part of the focusing rail and allowed to move up and down to play its intended role.

With the stage displaced, the microscope lenses were no longer aligned with the condenser. Fortunately, I was able to dismantle the ocular and its tube and add two inches of aluminum square tubing to realign lens and condenser. As an added benefit, I drilled and tapped two holes in that extension to mount a pair of articulated arms that can hold a macro twin-flashes (either Canon or Olympus) to light opaque subjects. In the process, I also eliminated the micro-focusing assembly, which was useless since fine adjustments would be made with the focusing rail itself.

With this microscope focusing is done by moving the tube holding ocular and lenses. Unfortunately, mounting a camera on such a tube can cause it to creep down and change the focus. Drill and tap were again brought into use: I added a new tightening screw just below the coarse focus control; once tighten, it presses against the rack and pinion that moves the tube and keeps it in place, the remaining focusing being done by the rail.

So far, most of the subjects that were shot with my new microscope were lit from above. They included butterfly wings, mouth parts and eyes of horseflies, thick forams, and various feathers. In some cases, the number of shots that had to

be stacked went well over a hundred. That's when the ability to work in tethering and control the rail by computer becomes invaluable.

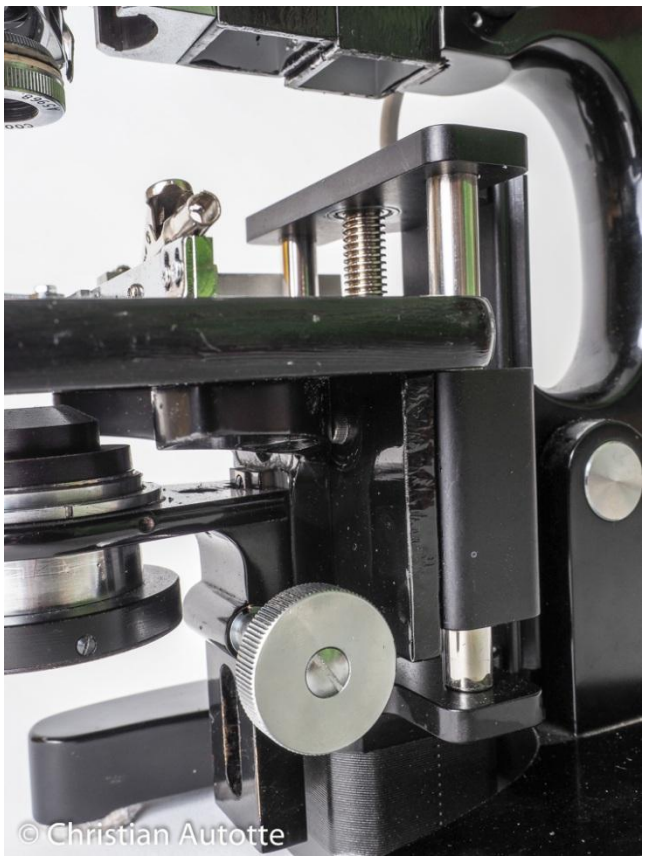
The standard working procedure is then as followed. First, take a few shots to establish composition and proper exposure. Then, using Zerene Stacker through its computer interface, determine the first and last exposure with the number of shots necessary to make a stack where everything will be in focus; as mentioned, Stackshot can move by as little as one micron between shots. When working with a flash, a delay can be set between shots to allow for the flash to recharge. When everything is set, hit "start", make sure everything works perfectly, and go have a drink: tea, coffee, or a beer, as the case may be… Zerene Stacker starts stacking pictures as soon as the first ones are made and will have completed the work in about 30 to 45 minutes.

Since then, a microscope mirror was added to make it possible to use the condenser for more standard microscopic illumination.

The old Olympus with a modified Stackshot

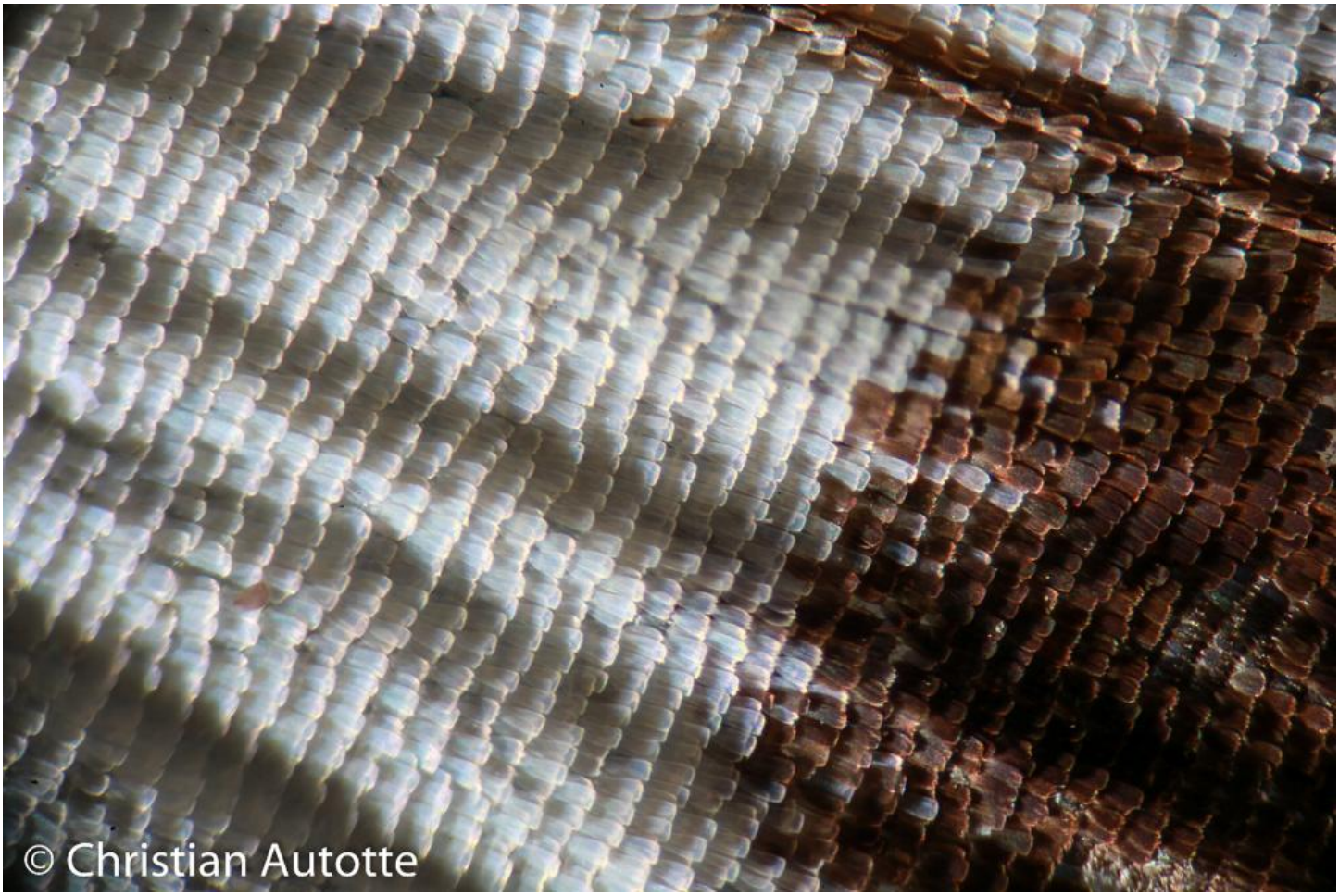
A pair of "twin flash" on articulated arms

The stacking microscope in action, controlled by Zerene Stacker through a laptop computer



Details showing the rail with the stage and condenser

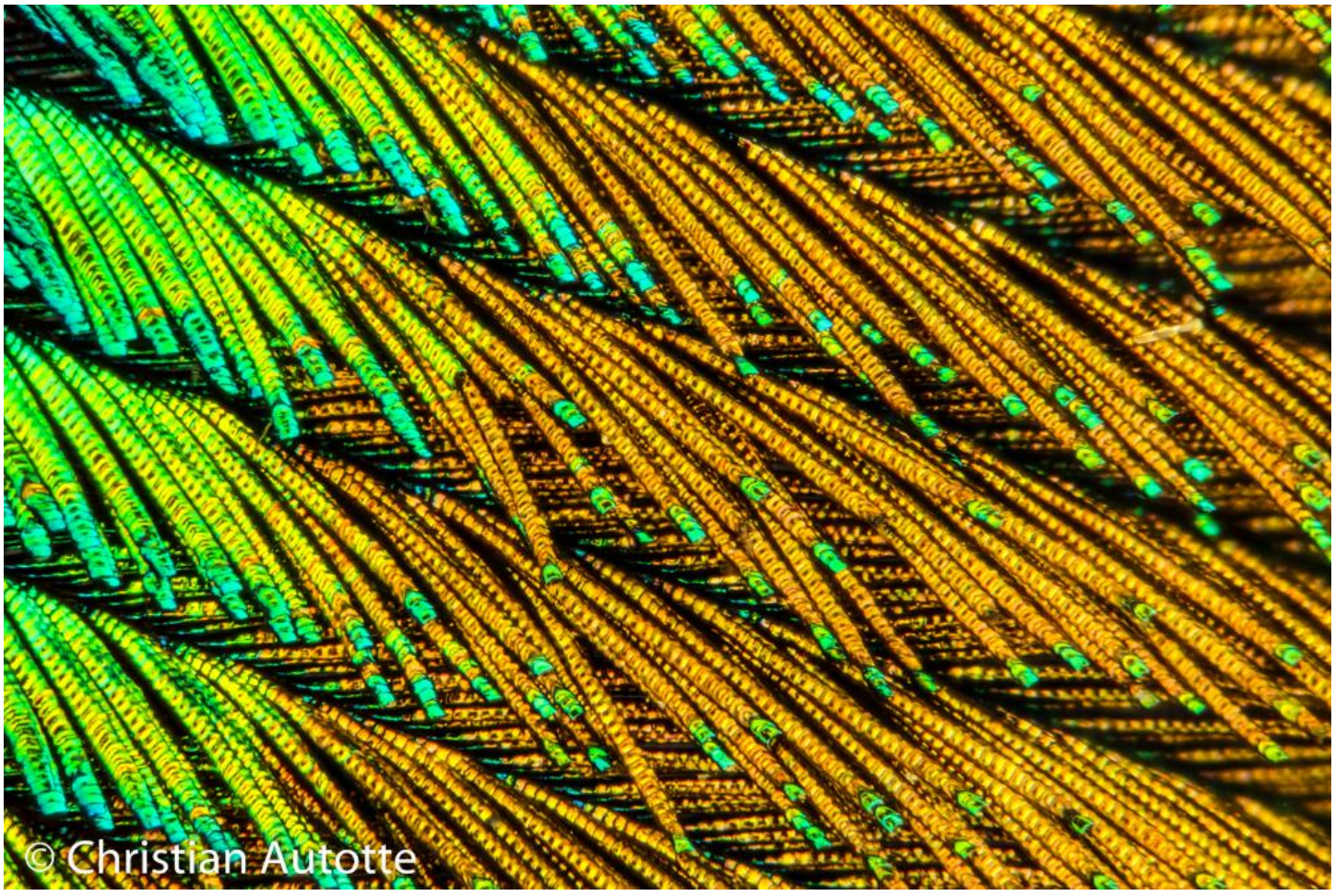
An extra screw added under the coarse focus to lock it in place



White admiral butterfly wing (stack of about 20 shots)

Forams (stack of 25 shots)

Mouthparts of Horsefly (stack of 18 pictures)



Peacock feather (stack of 150 shots)

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Published in the April 2019 issue of *Micscape* magazine.

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