

Hands-free: A Low-Cost Adapter for Smartphone Microscopic Photography  
Using a Cardboard Toilet-Paper Roll

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We have been following the recently published articles on microscopic photography using a smartphone with keen interest.<sup>1,2</sup> We agree that smartphone technology has the potential to revolutionize image capture for documentation, presentation, sharing, teaching, and teleconsultations, particularly in otherwise resource limited settings in which microscope-mounted cameras are prohibitively expensive, but smartphone penetration is paradoxically high.<sup>3</sup>

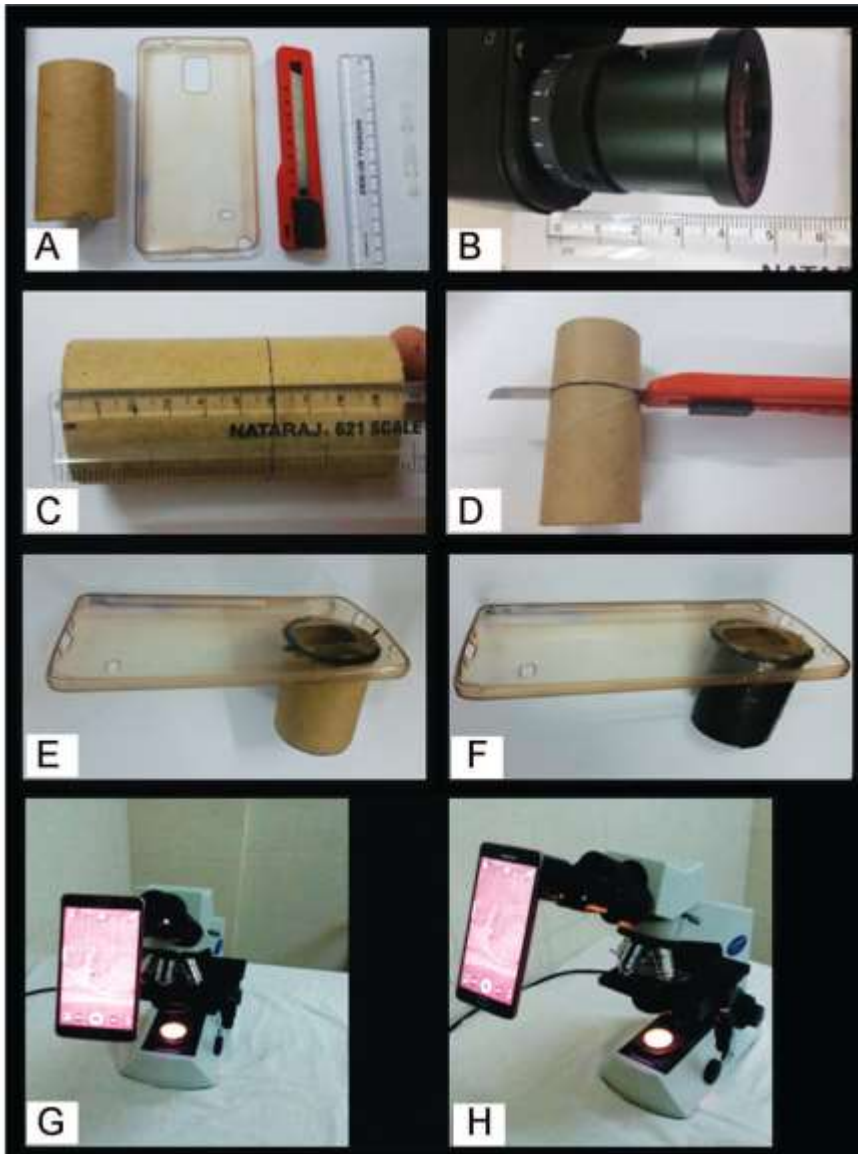


Figure 1. Low-cost adapter for smartphone microscopic photography. A, Materials used. B, Length of the eyepiece. C, Measurement of the tube according to eyepiece length. D, Cutting the tube to the desired length. E, Tube attached to the smartphone sleeve. F, Tube covered with electrical tape. G, Smartphone mounted over the eye piece. H, Side view of the assembly.

this is optional (Figure 1, F). Minor adjustments can be made by rotating the eyepiece till the image is in sharp focus (Figure 1, G and H). The microscope shown here is an Olympus CX21i, and the smartphone used was a Samsung Galaxy Note 4. Once made, the adapter is unique to the combination of microscope and smartphone used. The adapter can be modified to any microscope or smartphone by altering the length of the tube

We have used the freehand technique described in 2009 with digital cameras and camera phones<sup>3,4</sup> and more recently with smartphones.<sup>1</sup> Although this is the simplest technique that can be used, the free-hand technique has inherent limitations. The most important of these are the long learning curve, blurring of the image if the smartphone is not held steady, and the inability to change the field because both hands are used. This makes the technique time consuming and cumbersome when multiple images from different areas of the slide are to be captured. These limitations may be overcome by using an adapter.<sup>5</sup>

Although commercially developed adapters are available, the high cost precludes their use where they are needed most. We would like to describe a low-cost alternative made from readily available materials (Figure 1, A). A toilet-paper roll can be cut to the desired length, which is calculated as length of the eyepiece + 15 mm, placed over the eyepiece and used as an adapter (Figure 1, A through D). An inexpensive smartphone sleeve can be glued to the roll, which makes the device completely hands-free (Figure 1, E). The toilet paper roll is positioned around the opening for the camera in the smartphone sleeve. We used a quick-setting cyanoacrylate adhesive suitable for both plastic and cardboard. We covered the toilet paper roll with black electrical tape to make the adapter more aesthetically pleasing, but

according to eyepiece length and the size of the sleeve to accommodate any smartphone. As the adapter leaves both hands free, the field can be easily changed, minor adjustments can be made to the focus if needed, and images are easily captured. Vignetting can be overcome by using the zoom function.<sup>1</sup> Cuffs of cardboard can be placed within the adapter tube to ensure a snug fit if the tube is too loose.

The use of this low-cost adapter allows the capture of both still images and video of a quality comparable to a mounted camera (Figure 2, A and B). The myriad applications of smartphone technology in teaching and teleconsultations using this adapter are exciting.

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key. Then you can use your zoom to fill the phone's screen and sit back and enjoy the show.

I found that putting the camera setting to video kept my phone from going into power-saving mode and shutting off so fast. The auto-focus can be a little distracting, and my phone has no way to turn it off. However, it does seem to actually help focus on the specimen without my having to focus the microscope.

Above is my set up on my Premiere MSK-01L microscope. At right is a sample of pond water with a copepod.

#### We Tried This!

I ordered a cheap hard cover for my Samsung Galaxy. The one I ordered has a hard snap on retainer. I might suggest a hard back with a flexible retainer since you will be taking your phone in and out.

Meanwhile Dan looked over the instructions. He decided to make the tube for the eyepiece from PVC pipe. Instead of possibly messing up and using a permanent glue to attach it he used silicone cement. He also suggested for those who do not have scrap pieces of PVC pipe lying around to make a custom sleeve from a rectangle of cardboard cut from a cereal box. The toilet paper tube seemed like it would slop around a bit much.

It took a bit of finagling, adjusting, having the lens of the camera at a workable distance from the microscope eyepiece. This seems to be the

