Photographing specimens and composing illustrations

Matt Wedel, Western University of Health Sciences

Cervical vertebra of a turkey, by Mike Taylor
Ernst Stromer

Stromer (1915: plate 2)
*Spinosaurus* holotype on display in the museum in Munich (Smith et al. 2006)
Bombing of Munich by the RAF in April, 1944

Image from http://campmartintravels.blogspot.com/2013/05/an-american-in-germany-part-32-munich-1.html
The Palaeontological Museum
Although the holotype of *Spinosaurus* was destroyed, we actually know a lot about it thanks to Stromer’s detailed illustrations. Look at the cross-sections of the ribs and teeth, and the multi-views of vertebrae and the lower jaw. Almost a hundred years ago, Stromer was trying to escape the tyranny of two dimensions. Stromer (1915: plate 1)
Thanks to Stromer’s thorough figures, when new material was discovered in the 1990s and 2000s, it could be confidently referred to *Spinosaurus* despite the loss of the holotype. That’s the holy grail of specimen illustration. Images from Wikipedia.
Same story for *Carcharodontosaurus*. Sereno et al. (1996: fig. 2)
Taking good photographs

Taking good (i.e., useful) photographs is a process of trying to anticipate *everything* that you’re going to want to do with them later.

Basically, that means taking LOTS of photos—more than you’ll need. Fortunately with digital cameras that is dead easy.

For specific tips see [http://svpow.com/2010/02/12/tutorial-how-to-photograph-big-bones/](http://svpow.com/2010/02/12/tutorial-how-to-photograph-big-bones/)
Problems:

1. Specimen doesn’t fit in the frame
2. Not square on—vertebra in front overlaps the one behind
3. Not easy to separate specimen from background
4. Overexposed
Compare with this much better photo, also by Mike, from a few years later.
Putting a backdrop behind the specimen is often useful, but it doesn’t need to be fancy.
Quick and dirty backdrops

Blank pages in a sketchbook

Two sheets of foam core board
Lighting!

Often you will be constrained by circumstances. Tendaguru brachiosaur again, NHM basement, photo by Mike.
Always include scale bars in your photos, whether you intend to include them in the resulting figures or not.
Two lessons here:

First, think about where in the depth of field to place your scale bar. It will look bigger or smaller depending on its distance from the camera. Second, take some oblique shots to document where in the field you put the scale bar, and to help you figure out the morphology later.
Below: propping up a scale bar with a pack of cards.

Right: before and after photos to get the scale bar right on the specimen without obscuring the anatomy.

Pro tip: fold up one of the free paper tapes from IKEA and keep it in your wallet. Now you’ll never be without a tape measure again. Plus you can tear off pieces during museum visits, like I did here.

Australodocus, Museum für Naturkunde Berlin, 2011
Use color!

Like an idiot, I dropped the color from these photos *before* I cut them out from their backgrounds. Then we ended up sending the paper to a journal with free color figures. Don’t be that dumb: throw away data only as a last resort!

Wedel and Taylor (2013b: Figure 4).
Most journals now let you have free color figures for the PDF. There’s no reason not to do it; the fail mode of color is black-and-white.
Figure 3. Dahalokely tokana holotype (UA 9855), ?fifth cervical (C5) vertebra.

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0062047

Color doesn’t always help—sometimes it can obscure details.
Even if you don’t think color helps, give your readers all the options you can. For the description of *Dahalokely*, Farke and Sertich gave users color photos, still renders of 3D models, and the 3D models themselves.

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0062047
Don’t only take photographs

What’s Mike doing here in the collections room at Yale? He’s not taking photos or measurements.
Don’t only take photographs

What’s Mike doing here in the collections room at Yale? He’s not taking photos or measurements. He was busy taking notes on that *Barosaurus* vertebra in front of him. Don’t expect to be able to figure out what you were thinking at the time from your photos alone! Write down as much as you can.
From my AMNH notebook: notes on AMNH 675 on this spread...

- SI sacral rib not fused to continue at capitalum/parapophysis
  (tabuludum/diapophysis not preserved on either side)
But six sacral vertebrae fused together so don't can't be written off as merely autopsic gynecic

AMNH June 19, 2017

AMNH 675
"A." minimus

Foramen

Spools

Spools

Spools
...measurements here...

...and notes on phylogenetic codings here.
Specimen nickname—whatever helps you remember!

Vertebral measurements are pretty standardized, so here I could just make a list.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
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<td>Total length to prezyg facet</td>
<td></td>
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<tr>
<td>Centrum length</td>
<td>670 (R), 665 (L)</td>
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<td>Ant cent height</td>
<td>2100? (ant cent buried in substernum block)</td>
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<tr>
<td>Ant cent width</td>
<td>340</td>
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<tr>
<td>Post cent height</td>
<td>145</td>
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<tr>
<td>Post cent width</td>
<td>370</td>
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<tr>
<td>Width across diaphyses</td>
<td>720</td>
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<tr>
<td>Width across prezygos (as reconstructed)</td>
<td>620</td>
</tr>
<tr>
<td>Width across prezyg facets (outer edges)</td>
<td>124</td>
</tr>
<tr>
<td>Distance between prezyg facets (inner edges)</td>
<td>82</td>
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<tr>
<td>Transverse width across &quot;wings&quot; at their post. ends</td>
<td>345</td>
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<tr>
<td>Prezyg paximus width</td>
<td>190 (R)</td>
</tr>
<tr>
<td>Prezyg paximus width</td>
<td>280 (L)</td>
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But here I wasn’t sure what to measure, so I just measured everything.
Sketch informative differences while they’re fresh in your mind.
Draw *anything* that helps—like this map of which fossils are on which shelves in the OMNH collections.
Last but not least: photograph your notebook!

Do this daily. Definitely do it before you leave collections. If you have a collaborator, back up each other’s data often. When Mike and I leave a collection, each of us has all of our data (both sets) on his laptop hard drive, on a USB drive, and—if we have access—backed up online. Not to mention having all of our photos still on our cameras, and our notes in our notebooks.

Just assume all the time that there is a malign intelligence in the universe that is constantly seeking to separate you from your hard-won data, and take the appropriate defensive measures.
Manipulating photographs

GIMP is free and does most of what Photoshop does. http://www.gimp.org/

Some particularly helpful tweaks to improve your photos:

1. Unsharp mask. Don’t overdo it! Birders are all over this; there’s a nice tutorial here: http://www.digibird.com/primer2dir/primer2.htm


3. Don’t use Brightness and Contrast, Curves is much more powerful.
Cutting out backgrounds—Lasso takes longer than Magic Wand, but usually works better.
An interesting alternative is to just desaturate the background instead of deleting it (Mike’s idea).
Multi-view orthogonal figures are nice and allow easy comparisons among views. Here’s Mike’s turkey vertebra again.
You can even make multi-view figures using images from old monographs.

Modified by Mike from Osborn and Mook (1921: fig. 102).
Perspective again—here are two photos of ?C8 from *Sauroposeidon*
Perspective again—here are two photos of ?C8 from *Sauroposeidon*

Different vantage points yield different results. This is well worth pondering, especially if you want to use photos to plot morphometric landmarks.
Pet hate: I loathe scale bars in figures. They’re almost impossible to get right for anything other than 2D specimens, and they introduce pseudo-information into the figure.

For Wedel and Taylor (2013a), Mike and I used no scale bars in the figures (other than ones that were already in the photos), and listed the lengths of the vertebrae in the captions instead.

Not everyone liked this—some commenters thought that scale bars would have improved the usefulness of the figures. They might have a point. But don’t only rely on scale bars. Including actual measurements is cheap and easy and there is no good reason not to do it in every single paper you ever publish.
MYDD: Measure Your Damned Dinosaur!

It's science!
Measuring a *Camarasaurus* pelvis in the AMNH, using their fancy big-bone calipers.
Write informative captions but as much as you can, make figures that work without even without captions. It was dumb to label the lines up in A with numbers; I could have just labeled them B, C, and D.

Wedel et al. (2000b: fig. 9)
Oddly enough, I had gotten this right in the previous figure in the same paper!

Wedel et al. (2000b: fig. 8)
Figures on the page

This may not matter much if you publish in a born-online journal like PLOS ONE or PeerJ.

Pages from Wedel 2003b (left and center) and Wedel and Sanders 2002 (right)
Explanations and comparisons

Here I used a hand-drawn legend.

Wedel et al. (2000b: fig. 20)
For this figure, I copied the photos and made them partially opaque, and drew on the copies. Today I would use color and do stereophotos or anaglyphs.

Wedel (2007: text-fig. 10)
Insofar as possible, draw on the legend, not on the data. Taylor and Wedel (2013c: fig. 12)
I broke that rule on the very next figure! What a doofus. Taylor and Wedel (2013c: fig. 13)
Getting fancy: stereo and 3D

Peter Falkingham’s 3D digital model of a chicken skeleton, made with a Microsoft Kinect. He did this two years ago—ancient history by now!

Image (and a bunch of cool abstracts) from here:
http://www.naturkundemuseum-berlin.de/forschung/tagungen/digitalfossil-berlin-2012/home/abstracts-of-presentations/
Stereopairs rely on overlapping two images to produce the illusion of depth, like a “magic eye” poster. Some people can merge the images without any gear, others require a stereo viewer. *Saltasaurus* caudal from Powell (2003: plate 53, part 3).
Red-cyan anaglyphs require the use of glasses—but so do stereopairs for people who can’t merge them without help. And the glasses are dead cheap. Anaglyphs can also be much larger than stereopairs, and thus give more detail.

These were assembled by Mike—for details see:  
http://svpow.com/2010/12/14/but-red-cyan-anaglyphs-are-cooler/
I think 3D photogrammetry is the wave of the future. I made this model of a dinosaur claw in about 20 minutes using Autodesk 123D Catch, which runs in a web browser. The first render wasn’t so hot...
...but the computer was still thinking. The final product was pretty darned good.
Especially since I only used 20-odd photos instead of the recommended 70.
Some photogrammetry links

• Peter Falkingham’s 2012 paper about using free, open-source software in Palaeontologica Electronica: http://palaeo-electronica.org/content/issue1-2012technical-articles/92-3d-photogrammetry

• Heinrich Mallison has a series of how-to posts going on his blog:
  – http://dinosaurpalaeo.wordpress.com/2013/10/31/photogrammetry-tutorial-1-equipment/
  – http://dinosaurpalaeo.wordpress.com/2013/12/20/photogrammetry-tutorial-3-turntables/
  – http://dinosaurpalaeo.wordpress.com/2014/01/27/photogrammetry-tutorial-4-bulky-stuff/
Figures are like tracks; a paper is like an album

Up until now I’ve been focusing on illustrating specimens. But your paper will need other figures to serve other needs.
It never hurts to remind readers of the relevant anatomy with an intro figure. This one was inspired by one of the early figures in Janensch (1950).

Wedel et al. (2000b: fig. 1)
That goes double if you’re comparing across disparate lineages or addressing homologies.

Wedel and Sanders (2002: fig. 1)
Figures that summarize a lot of information and facilitate comparisons are also helpful. We wanted this one to work like a heat map. Wedel and Taylor (2013a: fig. 9).

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BUT it still works if the reader is colorblind or working with a grayscale print.
What we should have done: add a tree! Very silly not to have, in retrospect.
Can you make a figure do more than one job?

I got the idea for this one from Kevin Padian—he has similar figures showing bird’s-eye views of evolutionary transformations in several of his papers.

Wedel (2007: text-fig. 8)
Can you make a figure summarize the entire paper?

Pat O’Connor asked for a figure showing our phylogenetic framework for Wedel and Taylor (2013b). And rightly so—hence fig. 2 here. The tail-block diagrams were our idea. If you only had this figure, you’d still have the major points of the paper.
Bottom Line

If you present information in a format that is
(1) easy to understand, and
(2) easy to reproduce,
people will use your work—and cite you!