



ScienceWatch – Color Them Blue

“We screened through lots of eggshells and one day had a positive result for the oviraptor eggs. It was a huge surprise. I couldn’t believe it.” – J. Wiemann

Unlike reptiles, birds are noted for their beautifully colored eggs. Their repertoire ranges from white in chicken eggs (*Gallus domesticus*), to beige with brown speckling in the Eurasian oystercatcher (*Haematopus ostralegus*), to the light blue in the American robin (*Turdus migratorius*), to the intense bluish-green of emu eggs (*Dromaius novaehollandiae*).

Abundant evidence shows that modern birds evolved from a group of bipedal, fast-running and feathered dinosaurs known as theropods (www.hras.org/sw/Sw0402.html, www.hras.org/sw/sciencedino3.html). Scientists have long believed these avian ancestors, like all reptiles, laid white eggs, and that colored eggshells only evolved once they became birds. But writing in the August 29, 2017 issue of the journal *PeerJ*, a research team headed by Jasmina Wiemann, a paleontologist at Yale University, New Haven, CT, says that at least some dinosaur eggs were colored, yielding clues to their brooding behavior and providing yet another link between dinosaurs and birds.



The study examined three different clutches of fossilized eggs laid by a beaked ostrich-like oviraptid dinosaur about five feet tall (*Heyuannia huangi*) that lived in China during the late Cretaceous period 66 million years ago. The oviraptid family is comprised of small theropods (*Tyrannosaurus rex* is a big one!) and was so named because the first one, discovered in 1924, was found in close association with an egg clutch and assumed to be eating another dinosaur’s eggs. Subsequently, scientists

realized it was incubating its own eggs.

Fossilized dinosaur eggs are usually black or brown because iron compounds in the surrounding substrate stain them as they fossilize. The fossilized *Heyuannia* eggs are unusual because they are tinted blue-green, which led the team to see if the tint was actually their original color.

Only two chemical compounds are used by birds to produce eggshell colors. Protoporphyrin (PP) is reddish-brown, while biliverdin (BV) is a bluish-green. Both are involved in hemoglobin metabolism. Using mass spectrometry to analyze the eggs, the scientists found both pigments in the eggshells of all three samples they examined. Importantly, the pigments were absent from the sediment immediately surrounding the eggs so they couldn’t have migrated from the substrate but were made in the eggshell. “Non-avian dinosaurs* and modern birds apparently use the same molecules to create eggshell



coloration,” the team writes. Based on the amounts of PP and BV found in the *Heyuannia* eggshells, they also conclude the eggs were originally an intense blue-green like that of emu eggs.

Here we should ask why eggs are colored in the first place. The **cryptic hypothesis** says coloration provides camouflage by matching the nesting materials. The **sexual selection hypothesis** says coloration is a signal to males that these eggs were laid by a healthy female and are worth protecting. These ideas are not mutually exclusive and one or another may prevail under different circumstances.

Buried eggs are always white and colored eggs are at least partially exposed which supports crypsis. For example, emus lay their eggs in soil mounds partially covered by leaf litter and vegetation, so egg color and nesting background match in tone, say the authors. Similar vegetation was abundant in the subtropical climate of late Cretaceous China. So they propose that *Heyuannia* probably made the same kind of nest.

BV is a strong antioxidant that protects the body from damaging free radicals. It also colors eggs blue, so a female that makes blue eggs is signaling her partner she has plenty of BV and is healthy. This is especially important when males do the brooding. In emus brooding of their blue eggs is done exclusively by males. The finding that *Heyuannia* eggs were also blue, means that, like emus, it was probably the *Heyuannia* father who tended the eggs, says the team.

Evidently, fatherhood for theropods was about more than just about looking macho and gnashing teeth.

Saul Scheinbach

* Most scientists studying dinosaurs consider birds to be dinosaurs. So rather than refer to dinosaurs and birds as discrete, separate groups, they refer to the traditional, extinct animals as "non-avian dinosaurs" and consider birds "avian dinosaurs."