# In Animal Kingdom, Blood Comes in a Rainbow of Colors

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Photograph by Tomas Lundälv

Blood isn't always red—evolution has given rise to a variety of hues.

The Antarctic octopus, pictured, has a copper-rich protein in its blood that turns the vital fluid blue. Society elites aren't the only blue bloods. Several species of octopus have blue, rather than red, fluid running through their veins.

The blue comes from a copper-rich protein called hemocyanin, which carries oxygen from the lungs to the bloodstream and then to the cells of the octopus's body. Hemoglobin, an iron-containing protein found in the blood of other animals—including humans—serves the same oxygen-transporting function but turns blood red.

Both hemoglobin and hemocyanin release their bound oxygen when they reach tissues that need it.

But for the Antarctic octopus Pareledone charcoti, transporting oxygen via hemocyanin poses problems at subzero temperatures.

That's because in polar waters oxygen binds so tightly to hemocyanin that it doesn't let go very easily. If these tissues can't get oxygen, the octopus will die.

A new study, published March 11 in the journal Frontiers in Zoology, shows that this cold-water critter overcomes the obstacles by producing an overabundance of hemocyanin.

To solve this frigid mystery, study leader Michael Oellermann, an ecophysiologist at the Alfred Wegener Polar Institute in Germany, compared P. charcoti with two other hemocyanin-carrying octopus species that live in warmer waters: Octopus pallidus and Eledone moschata.

He found that on average, P. charcoti had 40 percent more hemocyanin in its blood than either O. pallidus or E. moschata.

"We really weren't expecting to find this," Oellermann said.

**In the Clear**

Here's another surprise: A variety of animals bleed colors other than red.

The ocellated icefish, for instance, may brush fins with the Antarctic octopus in the same chilly habitat, but its blood is quite different. It runs completely clear.

The polar dweller lacks both hemoglobin and hemocyanin, leaving its blood without any color at all.

"Cold water can hold a lot more oxygen than warmer water. There's enough dissolved oxygen at these depths that the fish doesn't need an active oxygen carrier like hemoglobin," Oellermann said.

The icefish is strange in other ways too. Unlike most other fish, it completely lacks scales.

Scientists believe that the absence of scales helps oxygen diffuse through the icefish's skin, where it's pumped around the body by an unusually large heart.

**Going Green**

Why Do Mysterious Lizards Have Green Blood?

The country of Papua New Guinea is home to the green-blooded skink, which biologist Christopher Austin at Louisiana State University has spent his career studying.

The skink uses hemoglobin to carry oxygen, and as in many animals, the liver breaks down the used hemoglobin into by-products such as bilirubin and biliverdin. Humans normally excrete these by-products into the intestines, since a buildup of them in the blood can cause jaundice or a yellowing of the skin and whites of the eyes.

The skink, however, seems to thrive with high levels of biliverdin in its blood, which gives the blood a green color.

"If humans had this amount of biliverdin in their blood, they would be dead," Austin said.

Austin is currently working to determine what factors may have forced the skink to adapt to such high biliverdin levels. His current hypothesis is that the chemical provides protection against parasites like those that cause malaria.

With so many species remaining to be studied, one thing's for sure: There will be blood (research for many years to come).