

# Note

## A Bilaterally Partitioned Colour Variant of an Appalachian Brook Crayfish (*Cambarus bartonii bartonii*) from Eastern Pennsylvania

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This observation of a bilaterally partitioned colour phenotype of an Appalachian Brook Crayfish (*Cambarus bartonii bartonii*) from Fishing Creek, Columbia County, Pennsylvania, USA, appears to be the first report of such an aberrant phenotype for this species. The pattern is similar to that reported previously in Papershell Crayfish (*Orconectes immunitis*) and American Lobster (*Homarus americanus*). Although the cause of the colour pattern in the specimen of *C. b. bartonii* could not be determined, hypotheses related to previous cases in aquatic crustaceans include bilateral partition of primary and secondary sexual characteristics (bicoloured gynandromorphy) and mutation during embryogenesis.

**Key Words:** Appalachian Brook Crayfish; *Cambarus bartonii bartonii*; colour variation; bilateral partition; bicoloured gynandromorphy; Pennsylvania

Appalachian Brook Crayfish (*Cambarus bartonii bartonii*) is a small- to medium-sized crayfish occupying primarily lotic habitats from Quebec, Ontario, and New Brunswick in Canada south to Georgia, South Carolina, and Alabama in the United States (Hobbs 1989). Colouration in *C. b. bartonii* typically ranges from a single shade of olive green through amber, brown, and chestnut (Ortmann 1906; Martin 1997; Loughman 2010).

On 22 September 2016, I collected a single atypically coloured *C. b. bartonii* from among 108 crayfish captured while conducting a crayfish survey of Fishing Creek, a tributary of the North Branch Susquehanna River, near the municipality of Stillwater, Columbia County, Pennsylvania, USA (41°07'46.6"N, 76°21'37.1"W; Hartzell and Rier 2017). Here I provide a description and context for the significance of this observation.

The atypical specimen was captured by hand from under a piece of cobble at the margin of Fishing Creek, identified to species, photographed, measured, and released at the site of capture. The specimen, carapace length 2.6 cm and undetermined sex, exhibited a largely bilaterally partitioned colour pattern from the posterior portion of the cephalothorax through to the telson, with the left half of the body a dark, olive green and the right half a light amber in colour. The anterior portion of the cephalothorax was dark, olive green (Figure 1). The specimen appeared to be in excellent condition and displayed normal, unimpeded behaviour (e.g., walking, a righting response, aggressive defense with chelae during handling).

The colour pattern reported here suggests a condition referred to as “bilateral gynandromorphy”, which has been documented in various crustaceans, including lobsters, crabs, prawns, and other decapods (e.g., Chace



FIGURE 1. Appalachian Brook Crayfish (*Cambarus bartonii bartonii*) from northeastern Pennsylvania displaying a bilaterally partitioned colour phenotype. Photo: Sean M. Hartzell.

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and Moore 1959; Farmer 1972; Syslo and Hughes 1981; Taylor 1986; Micheli 1991), as well as in other invertebrates, such as ants (Taber and Francke 1986) and even vertebrates, such as birds (Peer and Motz 2014). These individuals may display a bilateral partition of colouration, termed “bicoloured bilateral gynandromorphy”. The condition is most obvious in species with sexually dimorphic colour patterns (e.g., Peer and Motz 2014). In Pennsylvania, *C. b. bartonii* appears to exhibit an ontogenetic colour shift from greener hues in younger individuals to darker brown in older specimens (Ortmann 1906), but does not appear to exhibit obvious sexual dimorphism in colouration. Although Ortmann (1906) reported two specimens of *C. b. bartonii* from Pennsylvania that displayed a mixture of male and female sexual characteristics, his lack of comment on colouration suggests that they were of normal phenotype.

Bicoloured gynandromorphy may also occur among species lacking distinct sexual dimorphism in colouration, but where some degree of colour variation is prevalent. Chace and Moore (1959) described an American Lobster (*Homarus americanus*) with a bilaterally distinct colour partition made evident by the absence of blue pigment on the left side of the body and the absence of red, yellow, and black pigments on the right side. This occurred in conjunction with bilateral partition of primary and secondary sexual characteristics. An observation of colour bilateralism similar to that reported here involves Papershell Crayfish (*Orconectes immunitis*; Dowell and Winier 1969). Dowell and Winier (1969) rejected gynandromorphy as a causative mechanism because this crayfish displayed only female external sexual characteristics, and they speculated that its bicolouration was the result of a mutation during embryogenesis. However, because neither the specimen reported by Dowell and Winier (1969) nor the *C. b. bartonii* reported here was examined internally to determine sex or intersexual status, any suggestion of the lack of a link between colour pattern and gynandromorphy in these specimens remains speculative.

Colouration in crayfish can vary and change because of environmental factors, including the hue of the background substrate (Bowman 1942; Thacker *et al.* 1993). However, it is unlikely that the colour pattern I observed may be attributed to background colour matching because of the striking bilateral partitioning. In addition, the specimen remained in a white cooler for approximately an hour with other crayfish collected at the site before being photographed, measured, and released, with no obvious shift in colour pattern.

Given that all other *C. b. bartonii* captured in Fishing Creek during the 2016 survey displayed typical colour phenotypes (i.e., a single colour varying from olive green to light amber) and that the observation reported here appears to be unique for the species, the bilaterally partitioned phenotype would appear to be

exceedingly rare in *C. b. bartonii*. Collection and dissection, or genomic analysis, of additional specimens of crayfish showing colour bilateralism may provide insight into the cause of this phenomenon.

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