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A new Late Carboniferous shrimp-like crustacean from the Gwin Coal Seam, Alabama, U.S.A.

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Abstract

A fossil shrimp-like crustacean is described from the Gwin Coal Seam of Alabama, U.S.A., *Anthracophausia rheamsi* n. sp. The specimen represents the first Late Carboniferous arthropod recognized from the Black Warrier Basin and supports affinities with contemporaneous rocks in Illinois, U.S.A., and Scotland, U.K.

Key words: Multicrustacea, Malacostraca, Carboniferous, Pennsylvanian, Alabama, systematics

1. Introduction

A new species of fossil shrimp-like arthropod was found in a spoil pile adjacent to a Late Carboniferous (Pennsylvanian) coal-bearing seam, the Gwin Coal, in Alabama, U.S.A. There have been no other Paleozoic marine crustaceans found in the area to our knowledge. The specimen appears to have many characteristics of *Anthracophausia* Peach, 1908, including a carapace roughly one third of the total body length and laterally compressed.

The geographically closest shrimp-like arthropods were found in the Late Carboniferous (Pennsylvanian) Francis Creek Shale Member of the Carbondale Formation in the Mazon Creek area of Illinois (Schram, Rolfe, and Hay, 1997). Fossils there include *Anthracophausia ingelsorum* Schram, 1976, and *Peachocaris strongi* Schram, 1976. They are different enough from the Alabama specimen to warrant naming a new species of *Anthracophausia*. Thus, the purpose of this work is to describe the new species, to record the extension of the paleogeographic range of the genus, and to document some ecological similarity of the Gwin Coal in the Pottsville Formation (Culbertson, 1964) in Alabama with the Francis Creek Shale in Illinois.

2. Materials

The fossil was collected from a spoil pile derived from the Gwin Coal Seam inferred to have been collected in southern Jefferson County, Alabama (Culbertson, 1964, plate 4). It was donated to the Geology Department at Kent State University (now Department of Earth Sciences) by Larry Rheams, deceased. Subsequently the holotype and sole specimen was deposited in the Field Museum of Natural History, Chicago, Illinois.

The specimen was photographed using a Leica Z6 APO macroscope with PLANAPO 0.5xWD lens and SPOTFLEX digital camera, and a Nikon D7200 camera with an AF Nikor 28–105 mm lens. The specimen was illustrated under plain lighting, unwhitened and whitened with ammonium chloride, and immersed in 95% ethyl alcohol. Examination under long and short wave ultraviolet light did not yield fluorescence. The resulting images were toned using Adobe Photoshop.

Fig. 1. Map of Alabama, U.S.A., showing the extent of the Black Warrior Basin, marked by vertical lines, and the inferred position from which *Anthracophausia rheamsi* n. sp. was collected (X) in Jefferson County (adapted from Kidd and Hill, 1982).

3. Stratigraphy

The Gwin Coal Seam crops out in the Black Warrior Basin (also referred to as the Warrier Basin or Warrior Coal Field) (Ferm and Weisenfluh, 1989; Hatch and Pawlewicz, 2007). Precise geographic and stratigraphic data are not known. The original label states that it was collected above (taken to be a spoil pile) the Gwin Coal Seam of "New River" [sic] age. Because the primary exposure of the unit is in the southeastern part of the basin in Jefferson County, Alabama (Culbertson, 1964), that is the likely area from which the specimen was collected (Fig. 1). The Black Warrior Basin, in which the Gwin Coal Seam and many other coal-bearing units are exposed, extends across upper northwest Alabama and into Mississippi. The Gwin Coal Seam is part of a cyclothemic sequence including the Pottsville Formation of Carboniferous (early Pennsylvanian) age (Ferm and Weisenfluh, 1989; Hatch and Pawlewicz, 2007).

4. Systematic Paleontology

Class Multicrustacea Rieger, Schultz, and Zwick, 2010
Subclass Malacostraca Latreille, 1806
Order Incertae Sedis

Family Anthracophausiidae Brooks, 1962

Diagnosis: As for genus.

Discussion: When he named the family, Brooks (1962) included *Anthracophausia* Peach, 1908; *Crangopsis* Salter, 1863; *Belotelson* Packard, 1886; *Palaeomysis* Peach, 1908; and *Anthracomysis* Van Straelen, 1922, in it. *Anthracophausia* and *Belotelson* were the only genera Brooks discussed in the context of North American taxa. Schram (1969) recognized only *Anthracophausia*, *Crangopsis*, and *Belotelson* in the family. Subsequently, Schram (1974) erected Belotelsonidae within the stem eumalacostracans (Schram and Koenemann, 2021) to accommodate *Belotelson*. Schram (1974) also defined a new genus, *Peachocaris,* with *Anthracophausia strongi* Brooks, 1962, as its type species. Schram (1976) named *A. ingelsorum* from Sunspot Mine in Fulton County, Illinois, later recorded from the Francis Creek Formation at Mazon Creek. In a summary of the Mazon Creek fauna, Schram et al. (1997) placed *Peachocaris* within the Order Lophogastrida Sars, 1870.

In the most recent analysis of relationships of stem eumalacostracans, Schram and Koenemann (2021)

placed *Crangopsis* within the aeschronectids, shrimp-like forms with a complete carapace, achelate thoracopods, a typically enlarged pleonite 3, and a short subrectangular telson. They confirmed the placement of *Belotelson* within its own order, and assigned *Peachocaris* to the Lophogastrida. Lophogastrids exhibit a carapace covering the entire thorax, annulate thoracopods, pediform first and possibly second maxillipeds, a brood pouch, and a well-developed tail fan (Schram and Koenemann, 2021). *Palaeomysis* was placed in synonymy with *Anthracophausia* by Brooks (1969), sustained by Schram (1979) and others. Clark (1991) documented characters such as the second pleonite overlapping the first and third pleonites and a grooved, rectangular telson that differentiated *Palaeomysis* from species of *Anthracophausia* and retained *Palaeomysis* as a distinct genus. Schram (2007) assigned *Anthracomysis rostrata* Van Straelen, 1922, to *Gorgonophontes* Schram, 1984, placing it within the suborder Archaeostomatopodea Schram, 1969. The placement was based upon possession of a carapace that does not cover the entire thorax, presence of subchelate maxillipeds, and bearing pleonal pleura overlapping the preceding pleura, which defines the suborder. Thus, the remaining species of *Anthracophausia* cannot be referred to it, and it remains as the sole genus in a family with unresolved placement.

Assignment of the specimen under consideration here to Anthracophausiidae is made with some hesitation. The preservational style of these "shrimp-like" forms makes detailed comparisons difficult. Diagnostic morphological features of the various genera previously placed in Anthracophausiidae are often obscured. However, sufficient features are visible to support placement of the specimen within *Anthracophausia* and not the other genera. According to Schram and Koenemann (2021), *Crangopsis*, within Aeschronectida Schram, 1969, lacks a rostrum, bears a large second pleonite, and has a short telson. *Peachocaris*, assigned to Lophogastrida, bears a keeled rostrum of moderate length and rounded pleonal pleura. Schram (1974, p. 30) erected Belotelsonidae embracing *Belotelson* with *Acanthotelson*? *magister* Packard, 1886, as its type species. *Belotelson* is readily distinguished by possession of a long rostrum and chordate pleonal pleura, and a long, spike-like telson. Unlike *Anthracophausia* and the other genera described above, *Belotelson* is commonly preserved with the ventral surface exposed. Preservation in this configuration suggests that the carapace is not laterally compressed as are the "shrimp-like" forms. The species described here does not exhibit the character states defining *Crangosis*, *Peachocaris*, or *Belotelson*; alliance with *Anthracophausia*, as discussed below, is the most parsimonious placement.

Genus *Anthracophausia* Peach, 1908

Type species: *Anthracophausia dunsiana* Peach, 1908, by subsequent designation of Schram, 1974, p. 40.

Included species: *Anthracophausia dunsiana* Peach, 1908; *A. ingelsorum* Schram, 1976; *A. rheamsi* Vohs, Feldmann, and Schweitzer, n. sp.

Diagnosis: Elongate, laterally compressed carapace with short, carinate rostrum extending just beyond orbit; carina may be reduced to axial cephalic spine; lacking cervical groove. Pleon gently arched at pleuron 2 or 3, with pleura 1–5 of approximately equal length, smooth; epimeres rounded on pleura 1 and 2 becoming more cordate posteriorly. Pleuron 6 long. Telson spike-like, long. Pereiopods long, slender; pleopods short with feathery setal margins.

Discussion: The original description of characters defining the genus (Peach, 1908, p. 64) was generalized. The restriction of *Anthracophausia* to only three species allows the generic diagnosis to be emended to include a short rostrum extending just beyond the orbit, strong first and second antennal articles, triangular carapace outline; carapace lacking a cervical or postcervical groove; and pleon with various marginal outlines of the pleura. These characters serve to diagnose the type species, *Anthracophausia dunsiana*, and the specimen under consideration herein as *Anthracophausia.*

***Anthracophausia rheamsi* Vohs, Feldmann, and Schweitzer, n. sp.**

(Figs. 2, 3)

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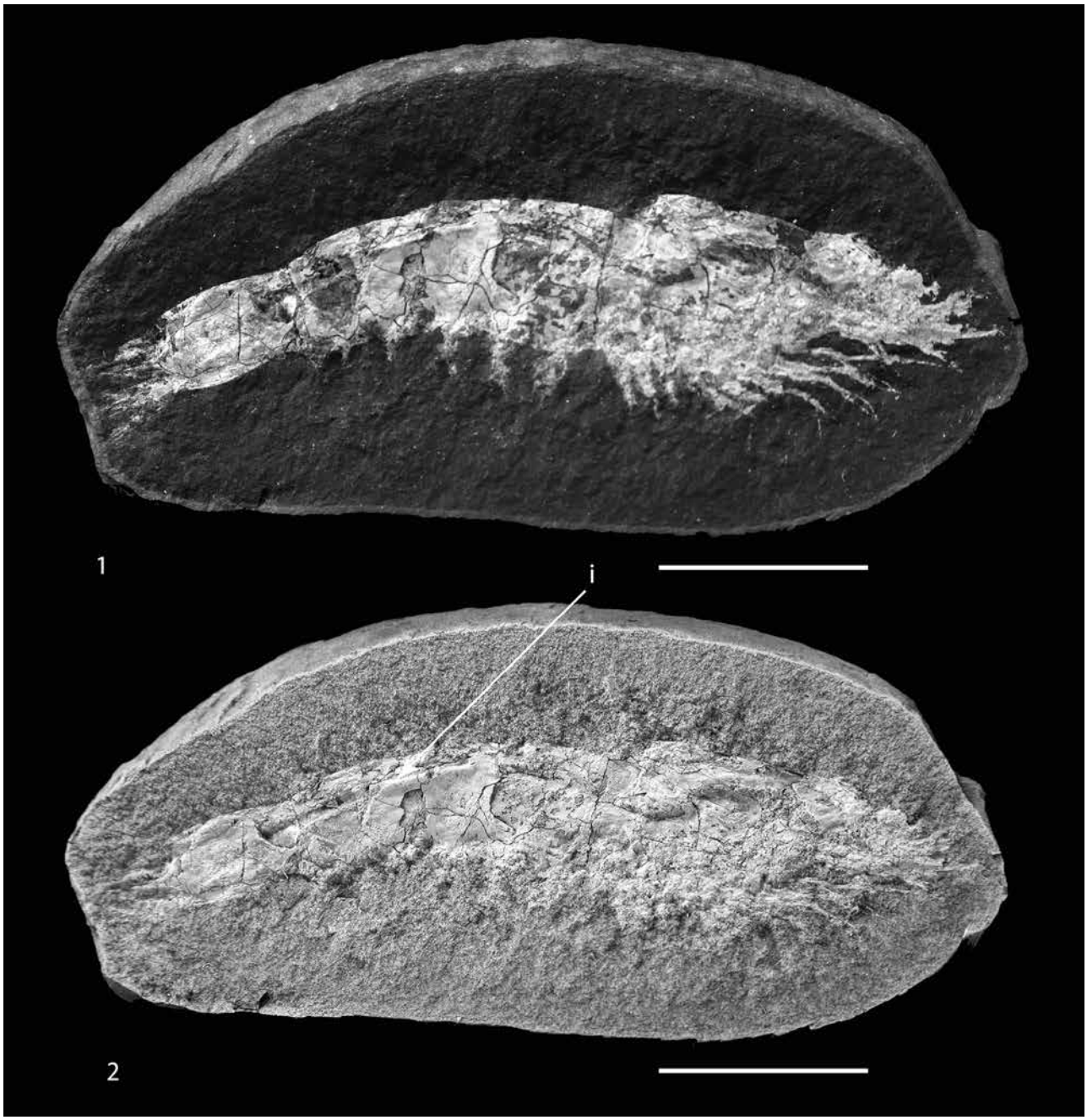

Fig. 2. ***Anthracophausia rheamsi*** **n. sp. 1,** Right lateral view of the holotype unwhitened. **2,** Same view whitened, showing intestine (i). Scale bars = 1 cm. Photo by RMF.

Diagnosis: As for genus with rostral crest reduced to axial cephalic spine; pleon arched at pleonite 3.

Description: The specimen is approximately 3 cm long. Carapace triangular, 8 mm long and 6 mm high at its highest point in the branchial region. A small anteriorly curved spine is situated on the midline of the cephalic region. The shape of the rostrum cannot be observed in this specimen. Region ventral to the rostrum appears to expose two antennal bases. Orbit set in a re-entrant on the carapace.

Smooth pleon gently arched with subtle arch at pleonite 3; pleonite 1 shortest, pleonites 2–5 similarly long. Pleonite 6 longest, approximately double the length of pleonite 5. Surface of terga interrupted by trace of intestinal structure impressed upon surface. Pleura poorly preserved but appear to be rounded anteriorly and becoming cordate posteriorly.

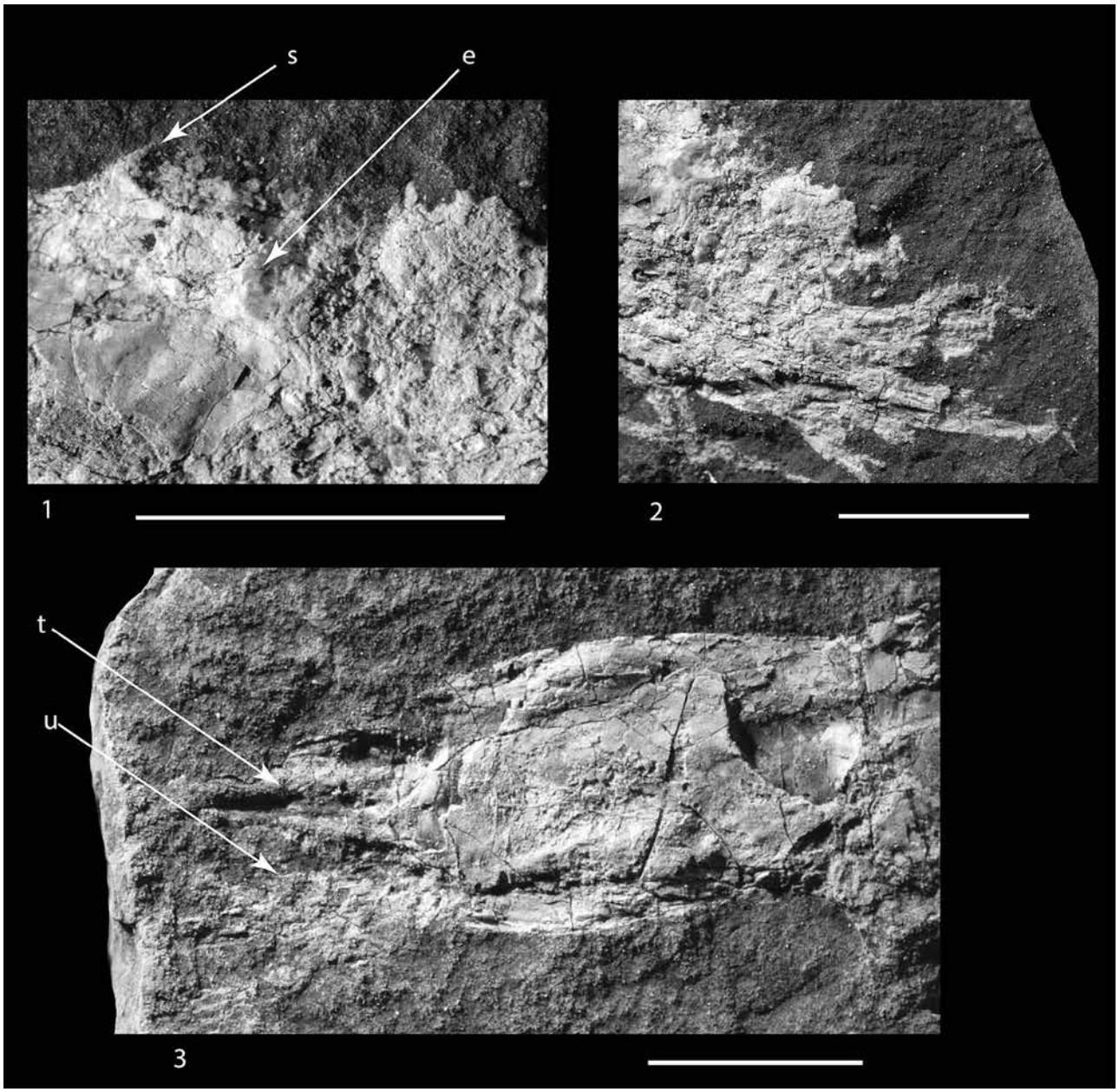

Fig. 3. ***Anthracophausia rheamsi*** **n. sp.**, enlargements. **1,** Dorsal margin of cephalic region showing cephalic spine (s) and eye (e). **2,** Anterior part of the specimen showing basal antennal articles and maxillipeds undifferentiated. **3,** Pleuron 6, spike-like telson (t), and uropod (u). Scale bars = 5 mm. Photo by RMF.

Telson poorly preserved, axially keeled, spike-like. Uropods appear subtly ribbed, long.

Seven or eight pairs of pereiopods. As preserved, pereiopods become longer anteriorly. Pleopods short, stout, with feathery setal margins.

Type: The holotype and sole specimen FMNH PE 93430, is deposited in the Field Museum of Natural History, Chicago, Illinois, U.S.A.

Age and type locality: The Gwin Coal Seam is part of the Carboniferous (lower Pennsylvanian) Period; the type locality is inferred to be in Jefferson County, Alabama.

Discussion: Though this specimen has been assigned to *Anthracophausia, A. rheamsi* n. sp. exhibits some characters distinguishing it from *A. dunsiana*. Peach (1908) described the type species as having a falciform shape, bent in the abdomen

(pleon). The flexure of the pleon in *A. rheamsi* arises on the third pleonite and is more subtle than that of the type specimen. The holotype of the new species is also a few millimeters larger than the holotype of *A. dunsiana* (as described by Schram, 1979), although this may be explained as within the predictable range of variation. A second species of *Anthracophausia, A. ingelsorum*, known from the Sunspot Mine in Fulton County, Illinois, was described based upon relatively few, poorly preserved specimens (Schram et al., 1997).

Anthracophausia rheamsi n. sp. was found in Alabama, *A. ingelsorum* is known from Illinois, while the type species was found in Scotland. Although Europe and North America are quite far apart today, they were much closer in the Carboniferous and geographic separation did not form a significant barrier. All of the species inhabited marginal marine environments near a delta plain or embayment (Schram and Koenemann, 2021).

5. Paleoenvironment

Within the coal beds of the Black Warrior Basin, many transitional sequences can be seen. Seams are finely interbedded with lithic arenites in what appears to be a coarsening-upwards sequence. This is suggestive of several small sea level transgressions, in which sand washed farther inland. This is common in upper delta plains and alluvial plains, in which fresh and sea water can mix in a marginal marine setting (Ferm and Weisenfluh, 1989). The depositional framework is similar to that of the Mazon Creek deposits in the Francis Creek Member of the Carbondale Formation (Baird, 1997). The holotype of *Anthracophausia dunsiana* was found in the Cementstone Group in Scotland. Its stratigraphy and paleoenvironment are quite similar to that of the Black Warrior Basin. The Cementstone Group contains siliceous silt and claystone that are interbedded with sandstone. The beds are fairly thin and, in some cycles, ripple marks were observed (Belt et al., 1967). This suggests that the area was a marginal marine environment; sometimes the sea level was higher and allowed for more marine organisms to thrive while other times, salinity levels were low and the rocks did not yield fossils (Cater et al., 1989).

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