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AN EARLY EUBRACHYURAN (MALACOSTRACA: DECAPODA) FROM THE UPPER TRIASSIC SNYDER QUARRY, PETRIFIED FOREST FORMATION, NORTH-CENTRAL NEW MEXICO

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Abstract—New Mexico Museum of Natural History and Science (NMMNH) locality L-3845 in the Petrified Forest Formation of the Chinle Group (Rio Arriba County, NM) yields nonmarine fossil vertebrates, invertebrates, and plants of Revueltian (early-mid Norian, ~218-210 Ma) age. We describe a 48 mm long by 19 mm wide decapod specimen (NMMNH P-29041) that originated in one of several fining-upward depositional sequences at the locality. The specimen is wide-bodied and short-tailed, unlike any of the known Triassic crustaceans, which are otherwise all of macrurous body plan (shrimp- or crayfish-like). This animal represents the first decapod from the Triassic of New Mexico, and is named *Rioarribia schrami*, n. gen. et. sp., and we place this specimen in the Eubrachyura *incertae sedis*. Previously, the oldest eubrachyurans were known from the Lower Jurassic, so *R. schrami* significantly extends the temporal range of the true crabs.

Keywords: Brachyura, decapod, nonmarine, Norian, Revueltian

INTRODUCTION

The first decapod, *Palaeopalaemon newberryi* (Schram, 1986) appears in the fossil record in the Upper Devonian (Famennian), in the family Palaeopalaemonidae from the northeastern and central United States (Benton, 1993). *P. newberryi* has an elongate carapace as seen in the Astacidea, but may not be astacid. The first brachyuran-like decapod is from the Upper Mississippian of Arkansas. *Imocaris tuberculata* resembles a dromiacean crab (Schram and Mapes, 1984). Permian decapods and other malacostracans are known from Antarctica (Babcock et al., 1998) and Asia (Taylor et al., 1998). Ten families of decapods are known from the Triassic. Most of these are macrurans; they possess a generally cylindrical *bauplan* with a muscular abdomen and a caudal fan, as in the extant shrimps, lobsters, and crayfish. Astacids have been described from the European Triassic (Etter, 1994; Garassino et al., 1999), Jurassic (Schweigert, 2001; Schweigert and Roper, 2000) and Cretaceous (Bravi and Garassino, 1999).

The invertebrate fauna of the Chinle Group is sparse (Breed, 1972). Two astacid families are known from the Upper Triassic Chinle Group: the Erymidae, represented by a crayfish from Arizona (Miller and Ash, 1988), and the Cambaridae, represented by undescribed (astacid-like) material from Utah (Hasiotis and Mitchel, 1989).

Previously, the brachyurans ("true crabs") first appeared in the fossil record in the Lower Jurassic of England represented by *Eocarcinus praecursor* of the family Eocarcinidae. Today, the Brachyura are the most speciose of the decapods with 635 extant genera. Although the astacid decapods have a much longer fossil record, they comprise only 25 extant genera (Glassner, 1969). We describe in this paper NMMNH P-29041, the oldest eubrachyuran. Systematics are after Martin and Davis (2001).

GEOLOGICAL CONTEXT

Near Ghost Ranch in Rio Arriba County, New Mexico, NMMNH locality 3845, also known as the Snyder quarry after its discoverer Mark Snyder of Del Mar, California, is stratigraphically high in the Petrified Forest Formation of the Chinle Group (Fig. 1). It is roughly contemporaneous with the Painted Desert Member of the Petrified Forest Formation of eastern Arizona (Petrified Forest National Park) to the west, and with the Bull Canyon Formation of east-central New Mexico and Texas to the east (Lucas, 1993). Measured sections show that the quarry lies 64 m below the Middle Jurassic Entrada Sandstone and 28.5 m below

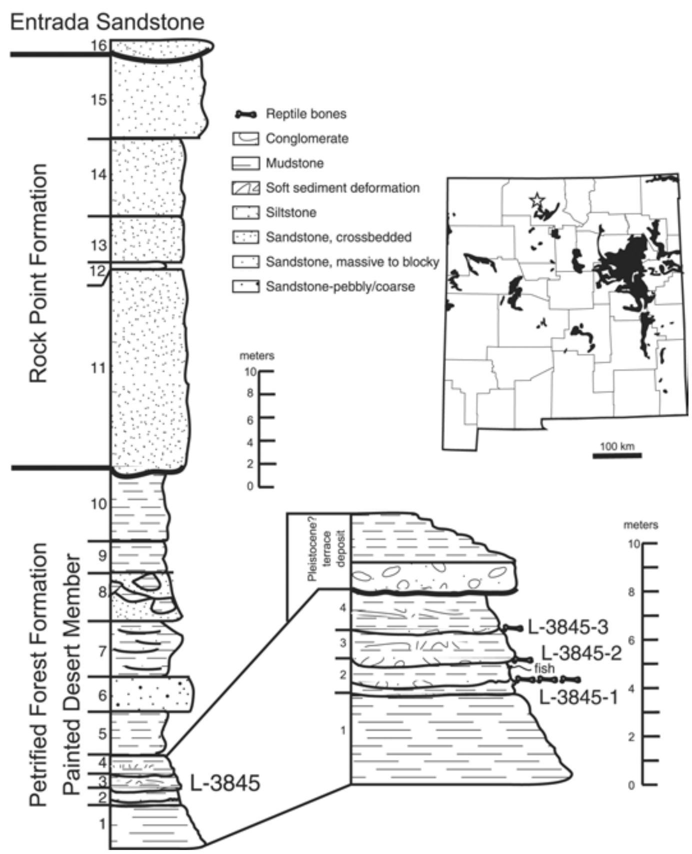

FIGURE 1. Index map showing location of the Snyder quarry site in north-central New Mexico, distribution of Triassic outcrops (from Heckert et al., 2000), and stratigraphic section at the quarry.

the contact between the Petrified Forest Formation and overlying Rock Point Formation, which locally represents the uppermost unit of the Chinle Group.

The locality comprises three fining-upward depositional sequences in which the basal sequence produces most of the vertebrate fossils. Each of the 1- to 1.5 m-thick sequences consists of a basal pebble conglomerate that fines up through muddy sandstone/sandy mudstone into laminated mudstone.

FAUNA

The Snyder quarry produces an extremely rich fauna. Invertebrates from the site include conchostracans, unionid bivalves, and the decapod described here. The osteichthyan fauna includes semionotid and colobodontid fish. Indeed, during preparation, several fish scales were noted in the matrix enclosing the decapod.

The tetrapod fauna includes the metoposaurid amphibian *Buettneria* and a variety of archosaurian reptiles. The archosaurs are represented by the aetosaurs *Desmatosuchus* and *Typothorax*, coelophysoid dinosaurs, and the phytosaur *Pseudopalatus*. Phytosaurs and aetosaurs dominate the vertebrate fauna. Other vertebrate taxa from the quarry include a cynodont, a rauisuchian, and a possible shark (Heckert et al., 2000; Zeigler et al., 2003).

SYSTEMATIC PALEONTOLOGY

Phylum Arthropoda

Superclass Crustacea Pennant, 1777

Class Malacostraca Latreille, 1806

Subclass Eumalacostraca Grobben, 1892

Order Decapoda Latreille, 1803

Suborder Pleocyemata Burkenroad, 1963

Infraorder Brachyura Latreille, 1803

***Rioarribia*, new genus**

Type species—*Rioarribia schrami*, new species.

Included species—Only the type species.

Diagnosis—Same as for the type species.

Distribution—Upper Triassic of north-central New Mexico.

Etymology—For the site of its discovery, Rio Arriba County, New Mexico.

***Rioarribia schrami*, new species**

Figs. 2-4

Holotype—NMMNH P-29041 (Figs. 2-4).

Type locality—NMMNH L-3845 in the early-mid Norian Petrified Forest Formation of the Chinle Group, Rio Arriba County, north-central New Mexico (Fig. 1).

Diagnosis—A brachyuran differing from other brachyurans by its elongate carapace in combination with its abdomen turned up over the sternum and exceptionally long antennae, fifth limb pair that is 1.5 times as long as the first through fourth limb pairs and its fifth limb pair possessing rounded, paddle-like terminations.

Etymology—The specific name is to honor Frederick R. Schram for his contributions to invertebrate paleontology.

Description

NMMNH P-29041 (Fig. 2) is in a matrix of slightly sandy, light gray mudstone that contains poorly sorted, texturally mature sand- to gravel-size clasts of very fine grained, gray mudstone. The specimen was found in the spoil pile from the quarry, however, its location upon discovery and its lithology indicate that it originated in one of three fining-upward sequences between 0.3 and 1 m above the main bone-bearing layer, L-3845-1 (Heckert et al., 1999a, b) (Fig. 1).

The decapod specimen comprises a part and counterpart, split along a mid-lateral plane and preserved in ventral aspect on facing halves of its matrix. It is dorsoventrally compressed, preservation is fair to poor, and it is extremely fragile. The specimen measures 48 mm long by 19 mm wide, exclusive of legs and antennae (Fig. 2). The halves of the fossil are mounted in epoxy jackets to maintain their integrity, as the mudstone matrix is extremely friable. The exoskeleton is fragmented, but the fragments are closely associated and not displaced to any significant extent.

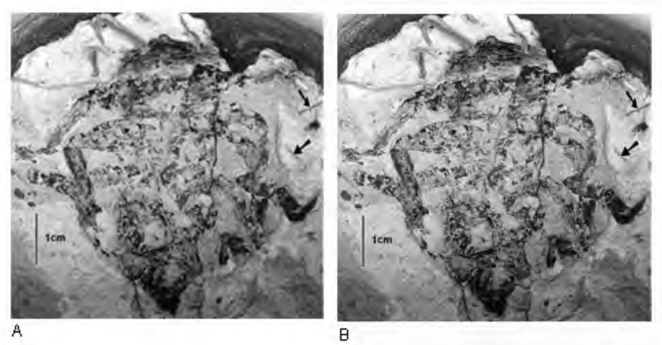

FIGURE 2. Part and counterpart of NMMNH P-29041, holotype of *Rioarribia schrami* new genus and species. Anterior end is at the top. Two short, straight antenna fragments are exposed near the right edge of 2A (arrows).

The carapace, which is particularly diagnostic within the class Malacostrica, is either missing or preserved in the matrix underneath the exposed material. It is possible that the material represents only the posterior and ventral aspect of a shed exoskeleton, and that the carapace is therefore missing. The small, blunt anterior terminus (Figs. 2, 3) may represent the rostrum and would indicate the presence of the carapace. No clear indication of stalked eyes is seen, but the eyes of some brachyurans are small and may be retracted. Two pairs of antennae are present; one pair is apparently at least a few cm long because they emerge from the head, then bend and disappear under the specimen at 1.5 cm length without apparent decrease in diameter. The long antennae show a 1 mm-long barb-like projection, ~1 cm from the head. Antenna fragments are exposed in the matrix 2 to 3 cm from the head (Fig. 2). The bases of the antennae form a rectangle ~ 1 cm wide transversely and ~ 0.2 cm long anterioposteriorly and are centered on the head.

Camera lucida sketches were made of the part and counterpart of the fossil, and overlaid to produce a complete composite outline (Fig. 3). The specimen shows five pairs of limbs; the first pair are 18 mm long, slender, and bear chelae. The distal end of the left forelimb is off the edge of the matrix, but the right is preserved. The chelae are very small and probably were used in food manipulation rather than some more rigorous pursuit. The dactyl (movable finger of the claw) structure is a 2-mm long, sharply curved, fattened cone. Part of the dactyl is now missing from the specimen, but a photograph taken during preparation exists (Fig. 4). The propodus (fixed finger) is much larger and is crushed. Limb pairs two, three, and four are robust, uniramous pereiopods (walking legs). They measure 21 mm, 22 mm, and 19 mm long, respectively. The dactyls of these limbs are long (up to 6 mm) and show two-stage diameter and taper; a gentle taper over the proximal half of the dactyl, then a decrease in diameter and a more severe taper to the tip. The limbs of pair five are 31 mm long and terminate in small, paddle-like structures (swimming legs). The limb posture is a sprawling type, where the limbs extend out from the body in opposite directions as opposed to the more upright posture of the astacids, which have limbs that extend more downward from the body in parallel rows.

Sternites are present, although their defining sutures are poorly preserved; only short suture fragments are visible under microscopic examination. The sternites are best observed macroscopically as ~0.5 cm long (anterioposteriorly) bands of larger, darker fragments transversely oriented between their corresponding limb coxae (Fig. 2A).

There are no uropods (caudal fan) on the distal abdomen; instead, the abdomen is reduced and turned up over the sternum. The pointed (as opposed to rounded) tip of the abdomen probably indicates that the specimen is male (best seen in Fig. 2B).

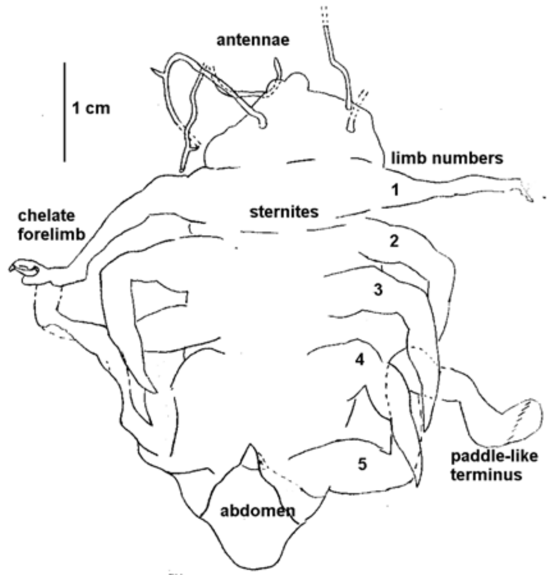

FIGURE 3. Outline drawing of NMMNH P-29041, holotype of *Rioarribia schrami* new genus and species, in ventral view; a composite of camera lucida drawings of the fossil part and counterpart. The specimen is 48 mm long. Anterior end is at the top.

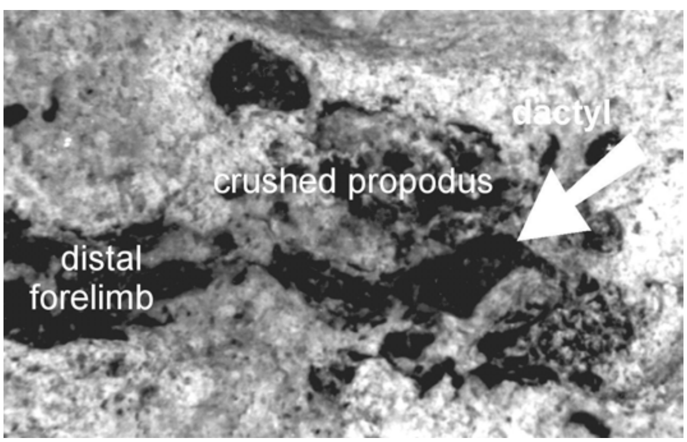

FIGURE 4. Photomicrograph of the distal end of the right forelimb of NMMNH P-29041, holotype of *Rioarribia schrami* new genus and species.

DISCUSSION

The Decapoda consists of two suborders, the Dendrobranchiata, which contains some shrimps, and the Pleocyemata, which contains several shrimps, plus the crabs, lobsters, and crayfish. Historically, the Pleocyemata (sometimes all decapods) were divided into the Nantantia, or swimming decapods, and the Reptantia, or walking decapods (Brusca and Brusca, 1990). Nantania has been discontinued as formal taxon, but remains in use as a descriptive term. The vast majority of crabs are marine, but freshwater and even semiterrestrial species occur. Although the oldest Brachyura, the "true crabs," were previously known from the Lower Jurassic (Manton, 1969), *Rioarribia schrami* shows all of the defining characters of the Brachyura (Brusca and Brusca, 1990):

1. Carapace shortened and widened. Because the specimen is exposed in ventral view, this is a judgment based on the short, wide body style with legs extending in the lateral plane away from the body.
2. First pereiopods chelate.

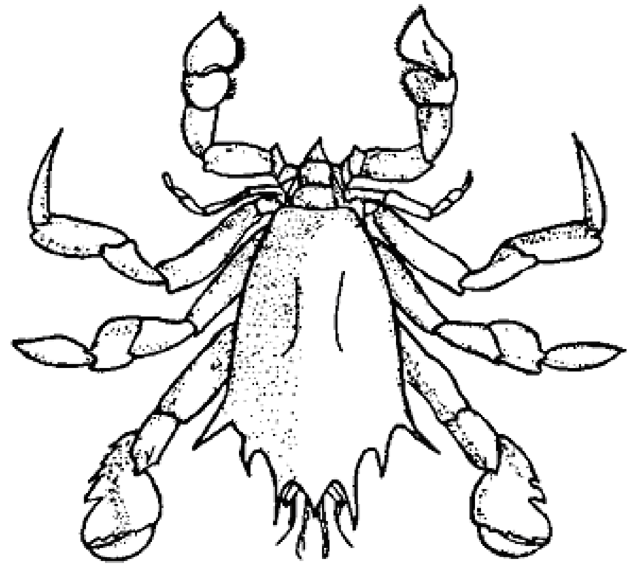

FIGURE 5. *Lyreidus channeri*, a raninid crab; from Schram (1986). Note cetae on the distal posterior thoracipods.

3. Third pereiopods not chelate.
4. Abdomen short, flattened, symmetrical, and turned under sternum.
5. No uropods present.

Two possible familial affiliations are offered:

1) Assignment to the Raninidae de Haan (1841) would be suggested by the anteroposteriorly elongate carapace, the morphology of the sternum, which is broad anteriorly (19 mm) and narrower posteriorly (13 mm), and the significantly larger hind limbs (Glassner, 1969). The posterior pereiopods are particularly interesting in their wide, rounded, flat paddle shape, which apparently was used in sculling locomotion. Although the Brachyura are generally regarded as reptantian, some are swimmers (Portunidae), and some non-portunid crabs are equipped with paddle-like limbs. A typical raninid crab, *Lyreidus channeri*, is illustrated for comparison (Fig. 5). The characteristic flattened chelae, elongate carapace, width narrowing posteriorly, and in this species, paddle-like but somewhat leaf-shaped posterior pereiopods with setae, are shown. In small aquatic organisms, the setae produce a thick boundary layer, which is an important swimming adaptation (Brusca and Brusca, 1990). The most significant problem with assignment to the Raninidae is the necessity of an ~100 Ma temporal extension.

2) Temporally, the Eocarcinidae Withers (1932) offer a more parsimonious affiliation. *Eocarcinus praecursor*, the only species in the Eocarcinidae, is known from the Lower Jurassic Pliensbachian (~185 Ma) Imo Formation of Arkansas and thus requires an ~ 30 Ma temporal extension of the family to the Revueltian (~215 Ma). *Eocarcinus* shows an elongate carapace with a short, blunt rostrum. The chelae are proportionately larger than in *Rioarribia* and the abdomen is short and bears no uropods; but it is not turned under the sternum. The 4th and 5th limb pairs are not well preserved and may originate dorsally (Glassner, 1969). A reconstruction of *Eocarcinus* is presented for comparison (Fig. 6).

Moving the origin of the Brachyura from Early Jurassic to at least the Late Triassic represents a significant extension of the temporal span of the taxon. The plausibility of a Triassic eubrachyuran origin is addressed in Figure 7, in which the number of genera versus time before present is plotted. Extrapolation of the trendline shows a likely origin in the Triassic or Permian. A simple extrapolation should not be taken too seriously as a predictor of time of origin, but it is clear from the plot that

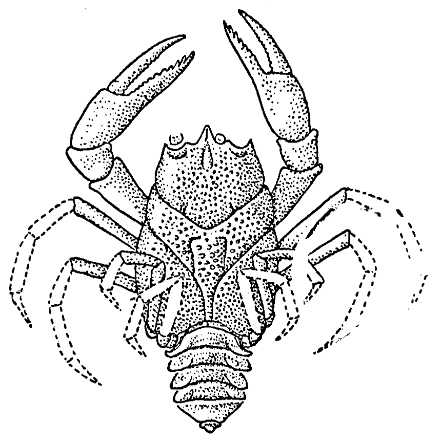

FIGURE 6. *Eocarcinus praecursor*, the eocarcinid crab; from Glassner (1969).

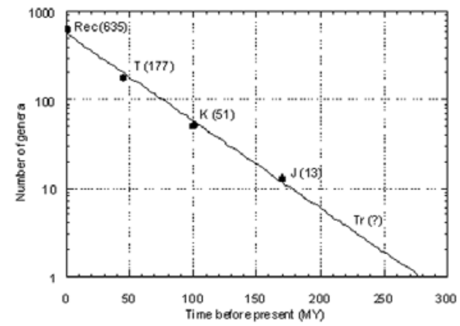

FIGURE 7. Number of brachyuran genera versus time before present. Rec.= Recent, T = Tertiary, K = Cretaceous, J = Jurassic, Tr = Triassic. Data from Benton (1993) and Glassner (1969).

a Triassic or earlier origin is plausible.

CONCLUSIONS

Rioarribia schrami is an unusual decapod recovered from freshwater deposits of the Revueltian Chinle Group. The proportionately wide-bodied, short-tailed body plan is unlike any other Chinle decapod, or even known Triassic decapods generally. Because the specimen preserves an apparently elongate carapace narrowing posteriorly, chelate first pereiopods, non-chelate third pereiopods, and a short, flattened, and symmetrical abdomen turned under the sternum and lacks uropods, we place it in the Brachyura (Malacostraca, Decapoda). This is a significant, yet plausible, temporal range extension for the group, and brings forward the role of freshwater habitats in the early evolution and radiation of the crabs.

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