Bulletin of the Mizunami Fossil Museum, no. 40 (2014), p. 13−22, 4 figs.
© 2014, Mizunami Fossil Museum

Fossil mudshrimps (Decapoda: Axiidea) from the Pawpaw Formation (Cretaceous: Albian), northeast Texas, USA

Ovidiu D. Frantescu

Department of Geology, Kent State University, Kent, Ohio 44242 USA <ofrante1@kent.edu>

Abstract

Seven new species of mudshrimps (Decapoda: Axiidea), *Dawsonius tigris* n. sp., *Axiopsis spinifera* n. sp., *A. sampsonae* n. sp., *A. pawpawensis* n. sp., *Paraxiopsis erugatus* n. sp., *Plioaxius texensis* n. sp. and *Acanthaxius carinatus* n. sp. and one new combination *Meticonaxius rhacheochir* (Stenzel, 1945) are described from the Albian Pawpaw Formation of northeast Texas. The work extends the geologic range of six axiidean genera into the Cretaceous (Albian). Of the six generic range extensions, five represent the first fossil record for the genus, and one generic range had been extended from Late Cretaceous to Early Cretaceous. Most of the fossil specimens described herein lack preservation of the mouth parts or reproduction parts, key elements for species identification, but the carapace remains present enough morphological elements to allow for confident generic placement.

Key words: Axiidea, Ctenochelidae, Axiidae, Meticonaxiidae, Pawpaw Formation, Cretaceous, Texas

Introduction

Mr. Robert Reid and Ms. Chris Sampson, both of Fort Worth, Texas, have been amateur collectors for a long period of time, and have each amassed impressive fossil collections. This study deals with the fossil axiideans from their collections. From the thousands of specimens collected, the axiids represent but a small fraction with only 20 specimens collected. Although the axiidean specimens are rare in the fossil record of the Pawpaw shale, they present a wide range of diversity, with seven new species within five extant genera. All these new species represent the first fossil record for their genus, creating a geologic record for them starting in the Early Cretaceous. The Pawpaw Shale is part of the Washita Group, within the Comanche series and it is mostly clays and calcareous shales, deposited in a neritic environment.

Collecting localities: The fossil specimens have been collected from four different localities, which unfortunately today are unavailable because of the business and private development of the Forth Worth area. The geographic coordinates are an approximation based on the descriptions provided by Mr. Robert Reid and Ms. Chris Sampson.

Locality #1—site is now under a residential development located northwest of Browning Dr. and Wuliger Way, where Inverness Dr. is now located, approximate coordinates 32°50' 57.50"N and 97°14'53.16"W.

Locality #2—site is now under a residential development located 100 yards SW of end of East Bonds Ranch Rd, just off of Harmon Rd., approximate coordinates 32°55'29.00"N and 97°19'31.60"W.

Locality #3—located north of 820 SW and east of Oak Grove Rd. on east bank of Sycamore Creek directly west of apex of Resource Dr., approximate coordinates 32°40'16.10"N and 97°18'34.50"W.

Locality #4—site is now under "Motorola" plant, but located 200 yards west of intersection of N. Beach and Fossil Creek Blvd. approximate coordinates 32°50'59.67"N and 97°17'32. 36"W.

Institutional abbreviations: USNM—United States Natural History Museum, Smithsonian Institution, Washington, D.C.

Systematics

Infraorder Axiidea de Saint Laurent, 1979

Family Ctenochelidae Manning and Felder, 1991

Subfamily Gourretiinae Sakai, 1999

Genus *Dawsonius* Manning and Felder, 1991

Type species: *Callianassa latispina* Dawson, 1967, by monotypy.

Included fossil species: *Dawsonius tigris* n. sp. herein.

Diagnosis: See Manning and Felder (1991).

Dawsonius tigris n. sp.

(Fig. 1.A–I)

Etymology: The species name comes from the Latin word for tiger and refers to the striped pattern found on the anterior

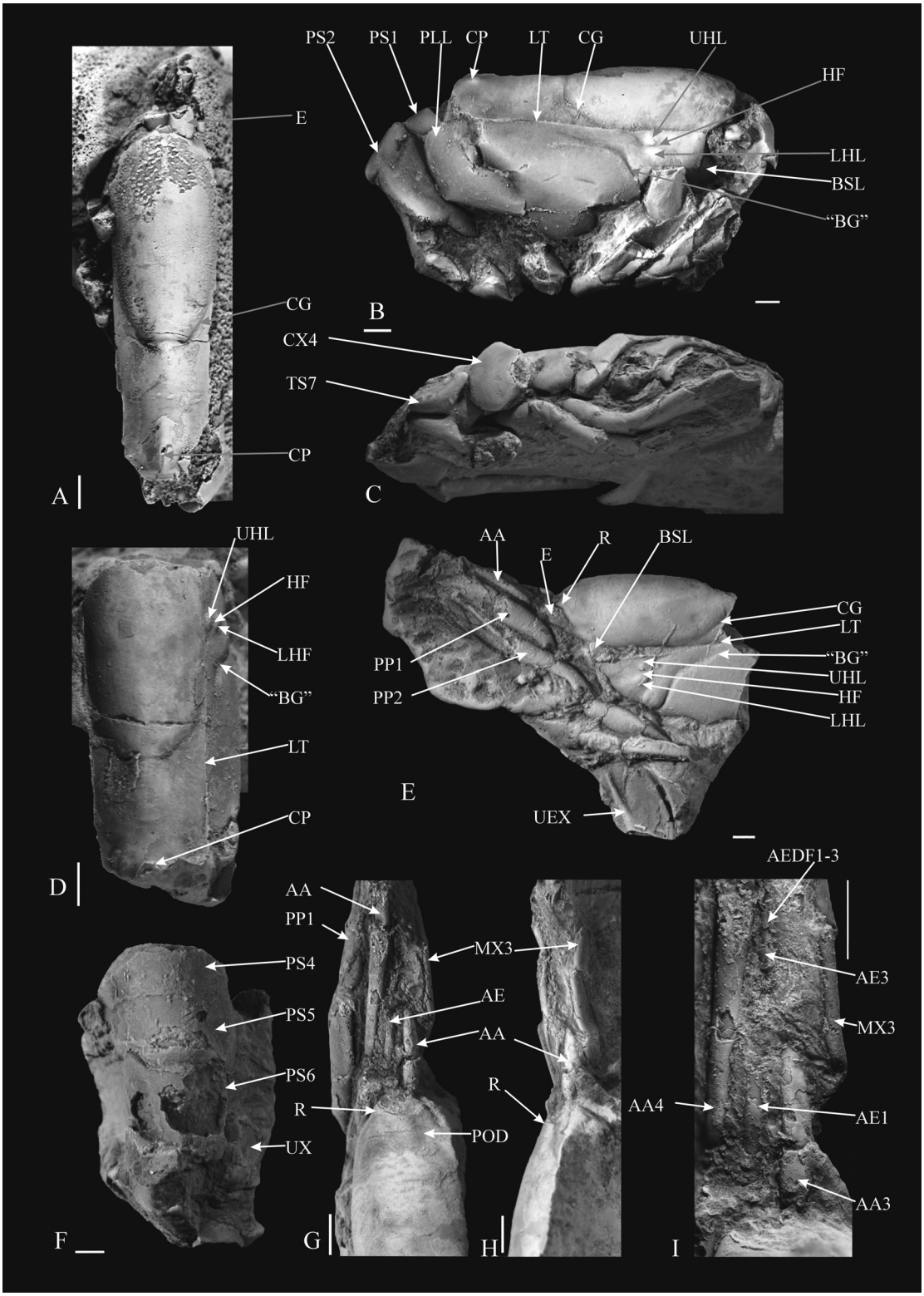


Fig. 1. *Dawsonius tigris* n. sp. A, Dorsal view of specimen USMN 558705; B, Right lateral view of specimen USMN 558704; C, Ventral view of specimen USNM 558704; D, Dorsal view of specimen USNM 558706; E, Left lateral view of specimen USNM 558707; F, Dorsal view of pleon of specimen USNM 558706; G–I, Detail view of the anterior part of specimen USNM 558707. E—Eye, CG—Cervical groove, CP—Cardiac prominence, AS—Pleonal somites, PLL—posterolateral lobe, LT—Linea thalasinica, UHL—Upper hepatic lobe, LHL—lower hepatic lobe, HF—hepatic furrow, BSL—Branchiostegal lobe, "BG"— "Branchiocardiac groove" (see text for explanations), CX—Coxae, TS—Thoracic sternite, AA—Antenna, R—rostrum, PP—Pereiopod, UEX—uropodal exopod, MX3—Third maxilliped, AE—Antennule, POD—Post orbital depression. All scale bars equal 1 mm.

part of the carapace and on part of the pereiopods.

Type: USMN 558704 Holotype; USNM 558705–558707 Paratypes, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace with *linea thalassinica* and cardiac prominence, lateral lobes on posterior margin, small well defined triangular rostrum, hepatic region with two prominent lobes, seventh thoracic sternite narrow, fourth coxae flattened.

Description: Carapace longer than wide, smooth, anterior part with striped color pattern, *linea thalassinica* complete, straight, posterior to eyes; rostrum small, triangular, smooth, shorter than eyestalks; posterior margin with well developed posterolateral lobes; dorsal oval absent; cervical groove well defined, arched posteriorly, crosses axis at about midlength; second groove present on branchiostegite, in the position of branchial groove in anomurans, well defined anteriorly, curves around hepatic region anteroventrally, disappearing posteriorly before reaching *linea thalassinica*; anterolateral region of carapace, immediately posterior of eyestalks with two subtle depressions; cardiac prominence present, with subtle depressions laterally; hepatic region divided in two gently bulbous lobes by hepatic furrows, upper lobe smaller, with sub -vertical row of at least five spinules, lower lobe larger, smooth.

Pleon partly preserved (Fig. 1F), smooth, PS1 partly exposed, short, smooth; PS2 longer than PS1, smooth, PS2 pleura long, triangular, terminates in sharp point; PS3 not preserved; PS4 with thinly rimmed posterior margin, PS5 with thicker rimmed posterior margin, PS5 pleurae small, with rounded posterolateral margin, PS6 with lateral projections (sensu Sakai, 2005). Uropods partly preserved, with thick longitudinal ridge.

Eyestalks partly preserved, flattened dorsoventrally, slightly longer than rostrum, appear to have subtriangular distal ends. Antennule poorly preserved, third article appears no longer than second article, first three articles of the dorsal flagellum preserved, equal in length, three anntenular articles shorter than first four antennal articles; antenna partly preserved, fourth article longest; third maxilliped partly exposed, pediform, each article laterally compressed, higher than wider.

Pereiopods poorly preserved, appear long and slender; coxa of fourth pereiopod large, with flattened ventral surface, rounded inner margin, sharper outer margin produced into a blunt point; third pereiopod coxa as large as fourth, with gently depressed ventral surface, rounded inner margin, outer margin poorly preserved appears to be sharper. Seventh thoracic sternite wide, diamond-shaped, with deep cleft on posterior two thirds, anterolateral margins concave with deep reentrant, posterolateral margins concave without reentrants, smooth.

Occurrence: The type series was collected from the localities 1, 2, and 4, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and Chris Sampson, and donated to USNM.

Remarks: The four specimens comprise the type series and show different degrees of lateral compression but they clearly have a number of key features, the presence of *linea thalassinica*, the presence of cardiac prominence, a triangular rostrum, and definition of the hepatic region, that have allowed for a definite placement within the genus *Dawsonius*, thus extending its range into the Early Cretaceous. *Dawsonius tigris* n. sp. differs form *D. latispina* (Dawson, 1967) by having a more clearly defined hepatic region.

Family Axiidae Huxley, 1879

Genus *Axiopsis* Borradaile, 1903

Type species: *Axius affinis* de Man, 1888, by original designation.

Included fossil species: *Axiopsis eximia* Kensley and Williams, 1990; *A. spinifera* n. sp. herein; *A. sampsonumae* n. sp. herein; *A. pawpawensis* n. sp. herein.

Diagnosis: Poore and Collins (2009).

Remarks: The specimens collected from the Pawpaw Shale, near Fort Worth, Texas, have a longer than wide, triangular rostrum, axially sulcate, median carina at the base of the rostrum, a field of small tubercles on the gastric region, and long, slender appendages. Those morphological features fit well within Kensley and Williams's (1990) diagnosis of *Axiopsis*. The three new species described herein have been differentiated based on the morphological characters of the carapace, presence or absence of carinae and length, ornamentation, and position of carinae.

***Axiopsis spinifera* n. sp.**

(Fig. 2.A–B)

Etymology: The specific name refers to the spinose anterior part of the carapace.

Type: USNM 558708 Holotype, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace longer than wide, rostrum sulcate, radial pattern of nodose rows on gastric region, post-orbital margin armed with at least 9 spines, posterior margin of cervical groove armed with spines.

Description: Carapace longer than wide, widest at midpoint of branchiostegite, covered with small tubercles, in pairs posterior to cervical groove. Rostrum triangular, 2.3 times longer than wide, depressed axially, two raised, nodose keels extending posteriorly to form sub-median carinae, spinose margins; anterior margins oblique, with thin rim, bearing at least nine slender spines; posterior margin not preserved.

Cervical groove well defined, broad, with shallow anterior margin, steep, sharp posterior margin bearing anteriorly oriented, slender spines, increasing in size laterally.

Cephalic region with seven carinae and scattered tubercles. Median carina shortest, defined only in central part of cephalic region, not reaching the rostrum base and cervical groove; Sub-median carinae, an extension of rostral keels, become

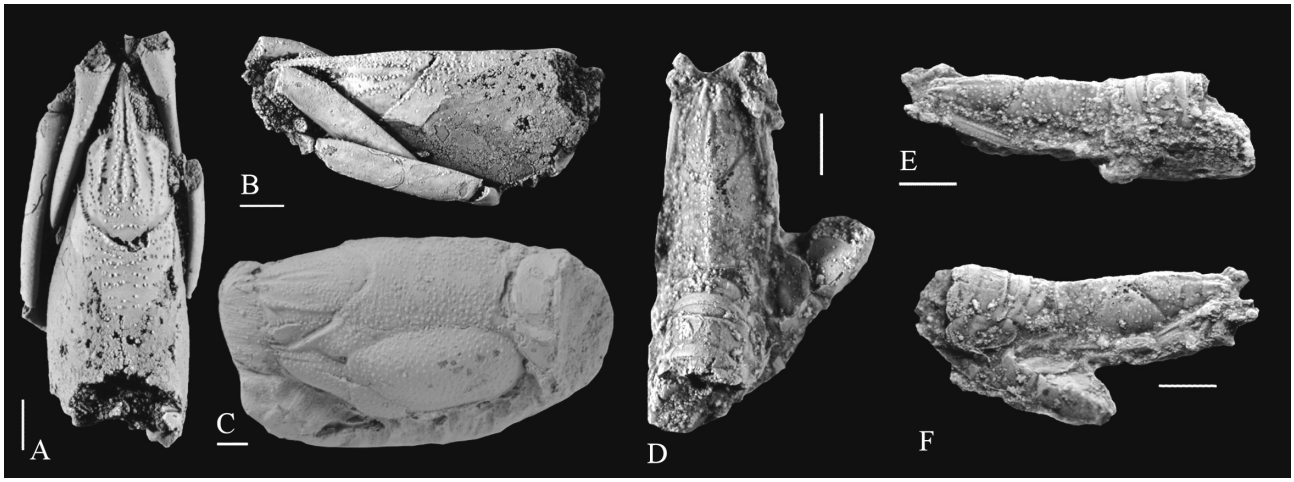


Fig. 2. A–B, *Axiopsis spinifera* n. sp. USNM 558708; C, *Axiopsis sampsonumae* n. sp. USNM 558709; D–F, *Axiopsis pawpawensis* n. sp. USNM 558710. All scale bars equal 1 mm.

broader posteriorly, defined by nodose areas, not reaching cervical groove. Supra-orbital carinae starting at inner angle of anterior margin, defined by single row of tubercles, gently arched, not reaching cervical groove. Post-orbital carinae, oblique, defined by two parallel rows of tubercles, not reaching cervical groove. On area in front of cervical groove, before posterior end of medial and sub-median carinae, a radiating feature comprised of six, short, linear features, each defined by three nodes.

Thoracic region, partly preserved, covered with scattered tubercles.

Reminder of pereiopods, long, slender, with single, short row of tubercles on upper distal margin; anteriorly directed full row of spines on antero-ventral margin; single full row of setal pits on inner-ventral margin.

Occurrence: The type specimen was collected from locality 2, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: The single specimen of *Axiopsis spinifera* n. sp. differs from *Axiopsis eximia* Kensley and Williams, 1990, by having a much narrower rostrum; also the field of tubercles on the gastric region of *Axiopsis spinifera* n. sp. is comprised of a series of radial rows of tubercles, whereas in *A. eximia* Kensley and Williams, 1990 the field of tubercles on the gastric region does not exhibit any kind of organization. The orbital margins of *A. eximia* Kensley and Williams, 1990 has only three spines, and in *Axiopsis spinifera* n. sp. the orbital margin is armed with at least nine spines. These morphological differences are sufficient to warrant erection of a new species.

Axiopsis sampsonumae n. sp.

(Fig. 2.C)

Etymology: This species is named in honor of Chris Sampson, the collector of the type specimen.

Type: USNM 558709 Holotype, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace longer than wide, granular, rostrum sulcate, scattered pattern of nodes on gastric region, post-orbital margin denticulate, posterior margin of cervical groove armed with spines.

Description: Carapace granular, well developed postero-lateral lobes; rostrum triangular, longer than wide, sulcate, proximally bifid; orbital margin denticulated.

Cervical groove well defined, anterior margin shallow, posterior margin step, armed with spines; cephalic area with scattered granules, and three longitudinal ridges as follow: short, linear, granular, axial ridge defined by the branches of rostral sulcus; two supraorbital ridges, thin, arched, granular, extending to cervical groove. Hepatic region defined by triangular depression. Thoracic region granular, void of any features, posterior margin with thin, smooth rim.

Occurrence: The type specimen was collected from locality 2, from the Pawpaw Formation, near Fort Worth, Texas, by Chris Sampson and donated to USNM.

Remarks: The specimen appears to be infected with boparid isopod on both sides. *Axiopsis sampsonumae* n. sp. differs from *A. exima* Kensley and Williams, 1990 because in *A. exima* the rostral sulcus becomes bifid and diverges strongly to encompass the gastric region, whereas in *A. sampsonumae* n. sp. the rostral sulcus becomes bifid but is gently diverging only to form the axial ridge, not encompassing the whole gastric region. *A. spinifera* n. sp. differs *A. sampsonumae* n. sp. because in *A. sampsonumae* n. sp. the granules on the gastric region are not arranged in any way, whereas in *A. spinifera* n. sp. those granules are arranged in radial rows.

Axiopsis pawpawensis n. sp.

(Fig. 2.D–F)

Etymology: The specific name refers to the Pawpaw

Formation, the place of origin for this specimen.

Type: USNM 558710 Holotype, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace longer than wide, granular, rostrum sulcate, scattered pattern of nodes on gastric region, posterior margin of cervical groove smooth; complete axial ridge.

Description: Specimen poorly preserved, only carapace and first two pleonal somites preserved; carapace granular, pleon smooth. Rostrum triangular, tip broken, appears longer than wide, axially sulcate, extends onto cephalic region as two short, smooth, blunt, ridges. Cervical groove well defined, deep, narrow. Cephalic region with three longitudinal ridges as follows: two rostral ridges; and one thin, spinose, median ridge defined by the bifurcation of rostral sulcus, crosses cervical groove and extends to posterior margin. Posterior margin with thin, smooth rim.

Pleon partly preserved, first two somites, smooth, with one transverse groove; pleurae of second pleonal somite broad, overlaps first pleonal somite. Reminder of pereiopods appear slender.

Occurrence: The type specimen was collected from locality 2, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: *Axiopsis pawpawensis* n. sp. differs from *A. sampsonumae* n. sp., *A. spinifera* n. sp., and *A. exima* by the presence of a median ridge for the entire length of the carapace, which is absent in the other fossil species of *Axiopsis*. Additionally the ornamentation of *A. pawpawensis* n. sp. is coarser than that of other species of *Axiopsis*.

Genus *Paraxiopsis* de Man, 1905

Type species: *Axius* (*Paraxiopsis*) *brooki* de Man, 1888, by original designation.

Included extant species: According to Poore and Collins (2009) there are 14 extant species.

Included fossil species: *P. erugatus* n. sp. herein.

Diagnosis: See Poore and Collins (2009).

Remarks: Following Poore and Collins' (2009) generic diagnosis, and comparison of the fossil specimen against the extant species from the USNM collections, the specimen described herein is attributed to *Paraxiopsis* because it presents a smooth carapace and abdomen; no medial carinae posterior to the cervical groove; triangular rostrum; and a slightly depressed, continuous rostral carina. All carinae are smooth.

Paraxiopsis erugatus n. sp.

(Fig. 3.A–C)

Etymology: The specific name is derived from the Latin word *erugatus*, meaning free of wrinkles, smooth, referring to the smoothness of the carapace and abdomen.

Type: USNM 558711 Holotype, USNM 558712–558714 Paratypes, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace elongate, deeper than wide; rostrum triangular, broad, gently depressed; no medial carina posterior to cervical groove, submedian and rostral carinae short, smooth; pleura of second pleonal somite overlapping pleura of pleonal somites one and three; carapace and abdomen smooth.

Description: Carapace longer than wide, smooth, cephalic region longer than thoracic region. Rostrum triangular, as long as wide, depressed axially, with at least three pairs of small, triangular, forward directed spines; extends onto cephalic region to form short, narrow, raised ridges diverging posteriorly. Anterior margins with concave reentrant at base of rostrum, with thin, smooth rim. Posterior margin concave, with thin, smooth rim. Cervical groove shallow, well defined axially, fades laterally.

Cephalic region with five ridges as follows: two narrow, short, smooth rostral ridges; two, short, submedian, smooth ridges, extending posteriorly as much as rostral ridges; and one thin, smooth, median ridge, longest, not reaching cervical groove. Branchial region, smooth, broad, resulting in a tall carapace.

Pleon partly preserved, smooth, first five somites equal in length; pleura short, smooth, rounded; second somite pleurae broad, overlaps first pleonal somite.

Preserved remnants of first pereiopods long, slender, ornamented with small, forward-pointing spines on ventral margins and distal ends.

Occurrence: The type series was collected from locality 4, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: This is the first fossil occurrence of *Paraxiopsis* known to date.

Genus *Plioaxius* Fraaije, Van Bakel, Jagt, and Mollen, 2011

Type species: *Plioaxius lineadactylus* Fraaije, Van Bakel, Jagt, and Mollen, 2011, by monotypy.

Included species: *Plioaxius linneadactylus* Fraaije *et al.*, 2011; *Plioaxius texensis* n. sp. herein.

Diagnosis: See Fraaije *et al.* (2011).

Remarks: The two fossil specimens described herein were collected from Lower Cretaceous rocks of northeast Texas, and they have been attributed to *Plioaxius* based upon the morphology of the carapace; the smooth dorsal surface; a well developed cervical groove; smooth anterolateral margins; and a carinate cephalic area.

Plioaxius texensis n. sp.

(Fig. 3.D–E)

Etymology: The specific name refers to Texas, USA, the collecting location of the fossils.

Type: USNM 558715 Holotype and USNM 558716 Paratype, housed in the Smithsonian Institution, United States National

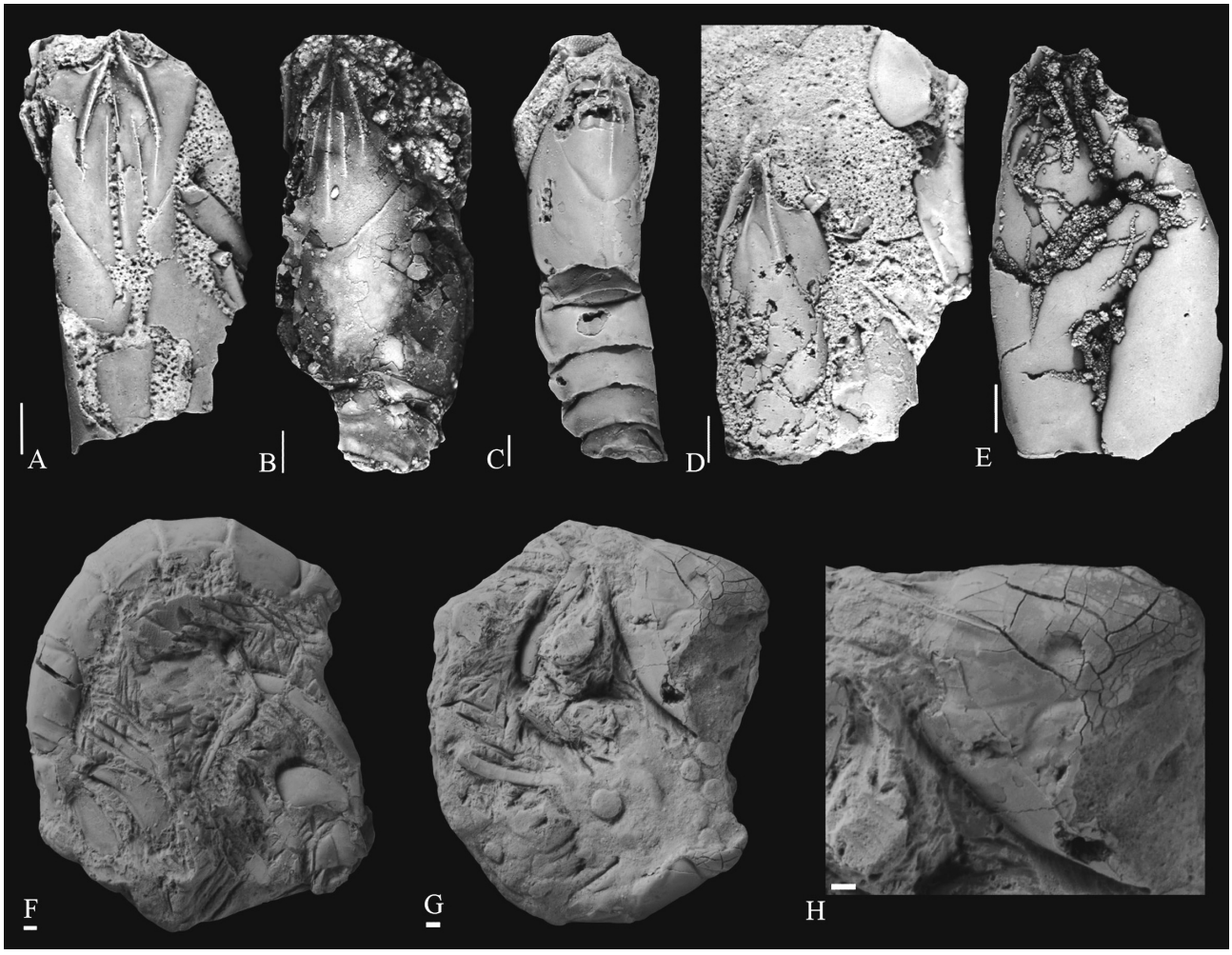


Fig. 3. A–C, *Paraxiopsis erugatus* n. sp. USNM 558713, USNM 558712, USNM 558711; D–E, *Plioaxius texensis* n. sp. USNM 558715, USNM 558716; F–G, *Meticonaxius rhacheochir* (Stenzel, 1945) n. comb. USNM 558717. All scale bars equal 1 mm.

Museum of Natural History, Washington, D.C.

Diagnosis: Carapace smooth, strongly convex transversely, well defined cervical groove, smooth anterolateral margins, carinate cephalic area, smooth carinae, outer surface of rostral carinae beaded.

Description: Specimens poorly preserved, carapace smooth, with well defined cervical groove; frontal margin partly exposed, with concave reentrant at the base of rostrum, and thin, smooth rim. Rostrum triangular, longer than wide, downturned, axially depressed, ornamentation unknown, extends onto cephalic region to form two smooth, narrow rostral carinae, outer surface of rostral carinae beaded.

Cephalic region with three ridges as follows: two rostral ridges; and one short, smooth axial ridge.

Preserved elements of pereiopods appear slender, lacking ornamentation.

Occurrence: The type series was collected from locality 4, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: *Plioaxius texensis* n. sp. differs from *P. lineadactylus* Fraaije *et al*., 2011, by the presence of the beaded outer surface of the rostral ridges. The occurence of *P. texensis* n. sp. extendes the range of *Plioaxius* to the Early Cretaceous (Albian).

Genus *Acanthaxius* Sakai and de Saint Laurent, 1989

Type species: Axiopsis (Axiopsis) pilocheira Sakai, 1987, by original designation.

Included extant species: According to Poore and Collins (2009) there are 13 extant species.

Included fossil species: *A. carinatus* n. sp. herein.

Diagnosis: See Poore and Collins (2009).

Remarks: The five fossil specimens described herein have been attributed to *Acanthaxius* based on morphological characters of the carapace and first pereiopods. These specimens have a triangular rostrum with spines on the lateral margins, a complete medial carina, spinose submedian carinae, and strongly ornamented chelae, all defining characters of *Acanthaxius*.

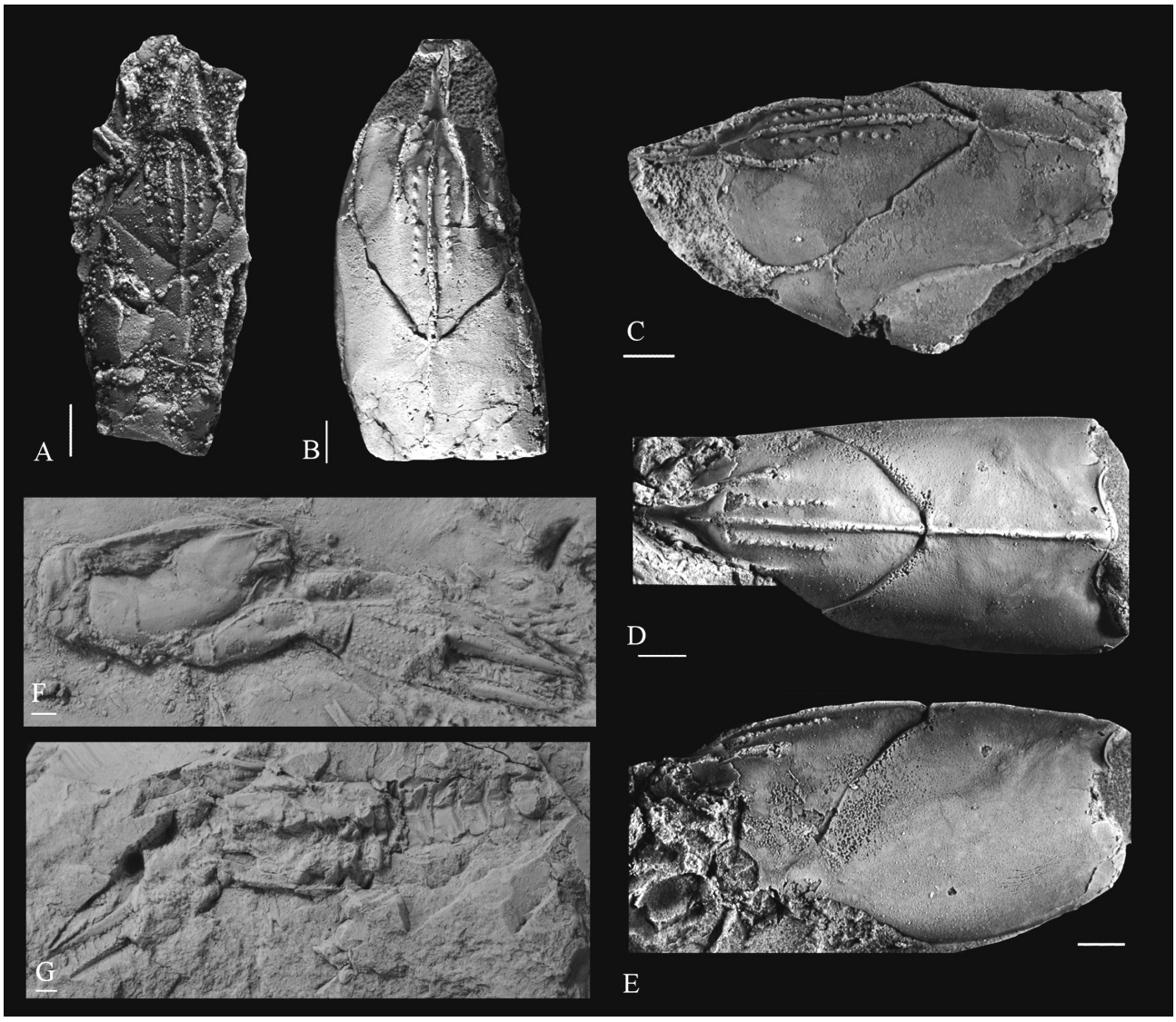


Fig. 4. A, *Acanthaxius carinatus* n. sp. dorsal view of specimen USNM 558720; B–C, *Acanthaxius carinatus* n. sp. dorsal and lateral views of the specimen USNM 558721; D–E *Acanthaxius carinatus* n. sp. dorsal and lateral views of specimen USNM 558722; F, *Acanthaxius carinatus* n. sp. lateral view of carapace and first pereiopod of specimen 558719; G, *Acanthaxius carinatus* n. sp. ventral view of carapace and first pereiopod and steinkern of pleon of specimen USNM 558718. All scale bars equal 1 mm.

***Acanthaxius carinatus* n. sp.**

(Fig. 4.A–F)

Etymology: The trivial name refers to the medial carina present on the pleon of this species.

Type: USNM 558718 Holotype, USNM 558719–558722 Paratypes, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace longer than wide, smooth; complete, smooth, medial carina; rostrum with two pairs of spines; pleon with thick, smooth medial carina.

Description: Carapace smooth, longer than wide, with very fine tubercles only on ventral border. Rostrum triangular, pointing downward, narrow, axially depressed, with two triangular pairs of spines, directed forward, extending onto anterior half of cephalic region as narrow, thin diverging rostral ridges. Anterior margin with concavity at the base of the rostrum, and thin, smooth, narrow rim; sinuous posterior margin, with thin, smooth rim. Cervical groove well defined, deep, narrow, extends to hepatic region, crosses the axis at midlength of carapace.

Cephalic region of equal length to thoracic region, with five ridges as follows: two rostral ridges, two submedian ridges, and one median ridge. Submedian ridges, straight, parallel, ornamented by at least 12 pairs of triangular, forward pointing spines; median ridge thin, narrow, extending from base of rostrum to posterior margin, smooth.

Pleon only as steinkern, smooth, with thick, smooth, complete medial carina; pleura terminating with blunt posterolateral corner.

Occurrence: The type series was collected from localities 3,

and 4, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: The specimens described herein represent the first known fossil occurrence of *Acanthaxius*. The present species differs from the extant species by the presence of the medial carina on the pleon.

Family Micheleidae Sakai, 1992

Genus *Meticonaxius* de Man, 1905

Type species: *Meticonaxius monodon* de Man, 1905, by monotypy.

Included extant species: 9 extant species, see Lin (2006).

Included fossil species: *M. rhacheochir* (Stenzel, 1945) new combination as *Upogebia*, and *M. gamma* (Rathbun, 1935) new combination as *Callianassa* herein.

Diagnosis: See Poore (1997).

Remarks: The fossil specimen described herein was assigned to *Meticonaxius* because it presents some of the key characters described by Poore (2006): a triangular rostrum which is gently depressed with a smooth rim and setal pits on rostral margins: an unarmed medial carina; the absence of submedial carinae; and the presence of postorbital row of setal pits.

Karasawa and Hayakawa (2000) advised that *Upogebia rhacheochir* Stenzel, 1945 should be assigned to *Meticonaxius* or *Marcusiaxius* but did not reassigned Stenzel's specimens based on the lack of a well preserved carapace. The specimen described herein fortunately preserves the anterior part of the carapace and offers essential elements to allow a confident generic placement. The fossil has been assigned to *Meticonaxius* because of the rostral morphology, the only element preserved that could separate *Marcusiaxius* from *Meticonaxius.* The rostrum in *Marcusaxius* has a broad, triangular, elevated area axially, whereas the fossil specimen described herein and *Meticonaxius* have a gently depressed rostrum with short axial carina.

Meticonaxius rhacheochir (Stenzel, 1945) new combination

(Fig. 3.F–H)

Studied specimen: USNM 558717, housed in the Smithsonian Institution, United States National Museum of Natural History, Washington, D.C.

Diagnosis: Carapace longer than wide; rostrum triangular, with smooth rim, and setal pits; postorbital margin smooth, with distal row of setal pits; medial carina short, smooth; submedial carinae absent; telson nearly as long as wide, 60% of uropod length; uropods with longitudinal ridges, endopod obliquely truncated.

Description: Original description "Carapace too poorly preserved for description. First abdominal somite is the smallest of all seven; its anterior margin is one-half the width of its posterior margin; the center is occupied by a large, elongate boss behind the groove which delimits the carapace abdomen joint; a pair of hair-pits is just behind that groove spaced far apart; a line of four hair-pits is on the posterior slope of the central boss; a line of about 8 crowded hair-pits is on a low ridge, which separates the tergum from the pleura; the pleura are simple and narrow. The second abdominal tergum is large and squarish in outline; its smooth, shiny surface is interrupted by 4 pairs of widely separated hair-pits; the anterior pair is near the middle, the 2 posterior pairs are at the posterior edge, the 4 pits on either side are not in line; the low, smooth ridge separating the tergum from the pleura is sigmoid; the pleura are triangular with their greatest width at the posterior, the point is narrowly rounded; an oblique line of crowded hair-pits begins at the posterior edge and separates the rounded point from the remainder of the pleurum. The third abdominal tergum is rectangular, broader than long, and smaller than the second; a curved, well-defined ridge with a shallow, adjoining groove above separates the tergum from the pleura; tergum with 8 pairs of hair-pits, some of which are on either side parallel to and just above the groove; two pairs of slanting hair-pits are at the posterior margin of the tergum; an oblique line of crowded hair-pits runs forward and outward from the middle of the ridge which separates tergum from pleurum; behind this line there are on the pleurum a few scattered pits near this ridge; a hair-pit is near the anterior end of this ridge. The fourth tergum is smaller than but similar to the third; there are 4 evenly spaced rows of hairpits; the outer rows each with 4 pits are near the lateral groove of the tergum; the inner rows each with 5 pits are slightly convergent; the lateral groove and ridge of the tergum are well defined; the pleura are similar to those of the third somite, but the line of crowded hair-pits is more anterior in position and runs outward and backward; scattered hair-pits are on the pleurum behind this line. The fifth tergum is almost the same size as the fourth; it has a line of 6 hair-pits in the lateral groove; this groove and its accompanying ridge are less distinct; the pleura are evenly rounded at the margin and are almost semicircular; the oblique line of crowded hair-pits is far to the anterior and runs outward and backward; scattered hair-pits occupy the middle of the pleurum behind that line. The sixth abdominal tergum is larger and elongate rectangular; 3 curved lines of crowded hair-pits are on each side running up on the tergum from its posterior corner; the last pair of lines almost meets in the middle; there are 5 pairs of hair-pits on the tergum; the first 4 pits are near the anterior margin of the tergum; the two inner ones of these and 2 additional pairs form a pair of lines of unevenly spaced pits; another widely spaced pair is near the posterior margin; the lateral margins of this somite are curled down forming rudimentary pleura; the lateral edges have narrow rims. The tail is well developed; the telson has parallel sides and is ovally rounded at the end; a small, median boss with several hair-pits at its top is near the anterior edge; a pair of slightly divergent

rows of hair-pits is on the posterior half of the telson; a curved, transverse row of widely spaced pits is at the anterior edge of the telson and extends through the boss; the outer uropod fin has 2 radiating ridges, of which only one extends to the margin; on one specimen there is a row of setae along the inner margin of this fin; the inner uropod fin has one ridge running near its inner margin and accompanied by a row of widely spaced hair-pits.

The chelae of the first legs are equal in size and elongate. Carpus short, less than one-half the length of the manus; greatest thickness about 3/4 of its height; height equal to the length; surface polished; upper margin narrowly rounded; lower margin broadly rounded and with a shallow transverse constriction near the carpus joint; upper margin ends distally in an inconspicuous, well-rounded point; spines are absent. Manus elongate; its length twice its height; height slightly increasing distally; its greatest thickness 3/5 of its height; upper margin narrowly rounded and with 3 unevenly spaced hairpits in a row on its crest; toward the outer surface the upper margin is delimited by a narrow rim; the upper margin and this rim are straight except at the proximal end, where they curve rapidly down to the manus-carpus joint; a similar rim delimits the outer surface below and extends to the tip of the pollux; the lower margin of the manus is so nearly flat that it forms something of a narrow lower surface; this lower surface curves narrowly into the inner surface forming a rounded longitudinal edge, which extends to the tip of the pollux, but flattens there; along this rounded edge on the lower surface there is a line of about 7 hair-pits, which are wider spaced at the proximal end; the outer surface is at its lower distal part twisted inward to the pollux, which is curving forward and inward; aside from this twist the outer surface is gently convex, but at its upper third there is a very slight longitudinal dell, which is more conspicuous distally and flattens out near the middle; the inner surface is slightly more tumid than the outer; near its upper margin are two pits in a row, one near the middle, the other at the anterior quarter; the lower surface is very slightly convex in transverse direction and twisted in longitudinal direction, its slant being downward and outward at the distal end. The point of the pollux is bruised in the best specimen (see Pl. 42, figs. 7–10) but can not have added much to its length, which is 1/5 of that of the manus; the pollux is twisted inward so that it points inward and forward; its outline is short triangular; its outer surface is slightly concave; its inner surface is tumid; its lower surface is gently convex; the occludent margin may have had a low proximal tooth.

The manus of a smaller specimen (female?, Pl. 42, figs. 11–14) differs in the following features: the outer surface is more tumid, the dell is not developed, and the twist toward the pollux is slighter; the inner surface is also more tumid; the lower surface is slightly more convex and the distal twist is absent; the rims delimiting the outer surface above and below are less sharp; there is only one hair-pit on the upper margin; it is in the middle; the pollux is only slightly curved inward, slenderer, and longer; its length is about 1/3 of that of the manus." (Stenzel, 1945, p. 432–434).

Emendation to original description: Carapace smooth, *linea thalassinica* absent, rostrum triangular, broad, smooth rim with longitudinal row of setal pits, gently depressed; orbital margin smooth; medial carina short, smooth; rostral carinae short, smooth; vertical row of setal pits well back from anterolateral margin present; hepatic region with oblique row of at least eight setal pits; posterior part of carapace not preserved.

Occurrence: The specimen was collected from locality 1, from the Pawpaw Formation, near Fort Worth, Texas, by Robert Reid and donated to USNM.

Remarks: The specimen described herein presents all the characters of the specimen described by Stenzel (1945) which allow for a confident identification. Stenzel (1945) assigned his specimens to *Upogebia*, and not *Callianassa*, which was typical at that time, based on the characters of the first pereiopods. The specimen described herein preserves a part of the carapace and provides clear evidence for its reassignment from *Upogebia* to *Meticonaxius*, by the absence of *linea thalassinica*, and a well defined, triangular, unarmed rostrum, with rows of setal pits on the margins.

In his comparison, Stenzel (1945) placed *Callianassa gamma* Rathbun, 1935 into *Upogebia* based on the close similarities of the two species, *C. gamma* and *U. rhacheoir*. *Upogebia gamma* (Rathbun, 1935) should be moved into *Meticonaxius* because of the close resemblance of *U. gamma* (Rathbun, 1935) and *M. rhacheochir* (Stenzel, 1945). The other two species that were compared by Stenzel (1945) with *M. rhacheochir* (Stenzel, 1945), *Upogebia midwayensis* Rathbun, 1935, and *U. eocenica* Rathbun, 1926 should remain in *Upogebia* because of a series of marked differences of the pleonal somites and pleurae with the species placed in *Meticonaxius* herein.

This represents the first record of the genus *Meticonaxius* as a fossil, and extends the range of the genus to Albian (Early Cretaceous).

Conclusions

The record of extant mudshrimps is really vast and abundant with over 12 families know (Dworschak *et al.*, 2012) whereas the fossil record is sparse, and primarily based on cheliped remnants. This paper represents an important contribution to the knowledge of the fossil axiideans. With the description of seven new species of mudshrimps, a fossil record has been established for three extant genera, dating back to Albian. *Plioaxius* has been reported for the first time from the fossil record of North America, and its record has been extended from Neogene to Cretaceous.

The paleoenvironmental conditions of the Pawpaw Shale represents a favorable environment for the occupation by mudshrimps, among other decapods, based on the presence of at least eight different species.

Acknowledgements

First and foremost I would like to express my gratitude to Chris Sampson and Robert Reid for allowing me to study the specimens from their private collections and for donating them to the U.S. National Museum of Natural History. I am deeply in debt to R. Feldmann and C. Schweitzer for their invaluable guidance and assistance in the process of this research. My gratitude to K. Reed from Smithsonian Institution for her assistance in researching specimens from the Invertebrate Zoological collections of the institution. Also I would like to thank H. Karasawa for this input and guidance, and for revising the manuscript. Supported by NSF grant EF-0531670 to Feldmann and Schweitzer.

References

Borradaile, L. A. 1903. On the classification of the Thalassinidea. Annals and Magazine of Natural History, (7) 12: 534–551.

Dawson, C. E. 1967. *Callianassa latispina* (Decapoda, Thalassinidea), a new mud shrimp from the Northern Gulf of Mexico. Crustaceana 13: 190–196.

Dworschak, P. C., D. L. Felder, and C. C. Tudge. 2012. Infraorders Axiidea de Saint Laurent, 1979 and Gebiidea de Saint Laurent, 1979 (Formerly known collectively as Thalassinidea). In Schram, F. R., and J. C. von Vaupel Klein (eds.) The Crustacea, Treatise on zoology—Anatomy, Taxonomy, Biology 9(B): 109–220.

Fraaije, R. H. B., B. W. M. van Bakel, J. W. M. Jagt, and F. H. Mollen. 2011. A new axiid (Crustacea: Decapoda: Axiidea) from the Neogene of Belgium and the Netherlands. Neues Jahrbuch für Geologie und Paläontologie—Abhandlungen 260: 157–163.

Huxley, T. H. 1879. On the classification and distribution of the crayfishes. Proceedings of the Scientific Meetings of the Zoological Society of London 1878: 752–788.

Kensley, B. 1996. New species of Calocarididae from the Caribbean Sea and Gulf of Mexico (Crustacea: Decapoda: Thalassinidea). Bulletin of Marine Science 59: 158–168.

Kensley, B., and A. B. Williams. 1990. *Axiopsis eximia*, a new thalassinidean shrimp (Crustacea, Decapoda, Axiidae) from the Middle Eocene of South Carolina. Journal of Paleontology 64: 798–802.

Lin, F. J. 2006. Two new axioids (Decapoda: Thalassinidea) from New Caledonia. Journal of Crustacean Biology 26(2): 234–241.

De Man, J. G. 1905. Diagnoses of new species of macrurous decapod Crustacea from the "Siboga-Expedition". Tijdschrift der Nederlansche Dierkundige Vereeniging 9: 587–614.

Manning, R. B., and D. L. Felder. 1991. Revision of the American Callianassidae (Crustacea: Decapoda: Thalassinidea). Proceedings of the Biological Society of Washington 104: 764–792.

Poore, G. C. B. 1997. A review of the thalassinidean families Callianideidae Kossmann, Micheleidae Sakai, and Thomassiniidae de Saint Laurent (Crustacea, Decapoda) with description of fifteen new species. Zoosystema 19(2–3): 345–420.

Poore, G. C. B., and D. J. Collins. 2009. Australian Axiidae (Crustacea: Decapoda: Axiidea). Memoires of Museum Victoria 66: 221–287.

Rathbun, M. J. 1926. The fossil stalked-eyed Crustacea of the Pacific slope of North America. United States National Museum Bulletin 138: 1–155.

Rathbun, M. J. 1935. Fossil Crustacea of the Atlantic and Gulf Coastal Plain. Geological Society of America, (special paper) 2: 1–160.

Saint Laurent, M. de. 1979. Vers une nouvelle classification des Crustacés Décapodes Reptantia. Bulletin Office National Pêche, Tunisie 3: 15–31.

Sakai, K. 1987. Two new Thalassinidea (Crustacea: Decapoda) from Japan, with the biogeographical distribution of the Japanese Thalassinidea. Bulletin of Marine Science 41: 296–308.

Sakai, K. 1992. The families Callianideidae and Thalassinidae, with the description of two new subfamilies, one new genus and two new species (Decapoda, Thalassinidea). Naturalists 4: 1–33.

Sakai, K. 1999. Synopsis of the family Callianassidae, with keys to subfamilies, genera and species, and the description of new taxa (Crustacea: Decapoda: Thalassinidea). Zoologische Verhandelingen, Leiden 326: 1–152.

Sakai, K. 2005. Callianassoidea of the world (Decapoda: Thalassinidea). Crustaceana Monographs 4: 1–285.

Sakai, K., and M. de Saint Laurent. 1989. A check list of Axiidae (Decapoda, Crustacea, Thalassinidea, Anomura), with remarks and in addition descriptions of one new subfamily, eleven new genera and two new species. Naturalists, Publications of Tokushima Biological Laboratory, Shikoku University 3: 1–104.

Stenzel, H. B. 1945. Decapod crustaceans from the Cretaceous of Texas. The University of Texas Publication 4401: 401–477.

Manuscript accepted on February 10, 2013