Boletín de la Sociedad Geológica Mexicana
ISSN: 1405-3322
sgm_editorial@geociencias.unam.mx
Sociedad Geológica Mexicana, A.C.
México

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Boletín de la Sociedad Geológica Mexicana, vol. 66, núm. 1, 2014, pp. 215-221
Sociedad Geológica Mexicana, A.C.
Distrito Federal, México

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**Volumen 66, núm. 1, 2014, p. 215-221**

# Exceptional preservation of a late Cenomanian (Late Cretaceous) crab from Texas, U.S.A.

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**Abstract**

One specimen of the brachyuran (Etyoidea: Feldmanniidae) *Caloxanthus americanus* from the Cenomanian Grayson Formation in Texas (U.S.A.) is here reported. The specimen includes morphological details not previously described for this species. In particular, the preservation of the eye structure is remarkable and it represents one of the few records of composite eye preservation in fossil brachyurans.

Keywords: *Caloxanthus*, Cenomanian, composite eye, Crustacea, Exceptional preservation, eye, Grayson formation, Waco, Texas.

***Resumen***

*Se reporta un ejemplar del braquiuro (Etyoidea: Feldmanniidae) Caloxanthus americanus del Cenomaniano de la Formación Grayson en Texas, E.U.A. El ejemplar incluye detalles morfológicos no descritos previamente para esta especie. En particular, la preservación de la estructura del ojo es notable y representa uno de los pocos registros de preservación de ojos compuestos en braquiuros fósiles.*

*Palabras clave: Caloxanthus*, Cenomanian, ojo compuesto, Crustacea, preservación excepcional, ojo, Formación Grayson, Waco, Texas.

## 1. Introduction

The preservation of delicate morphological elements, such as the eyes, is extremely rare in the fossil record of brachyuran crustaceans. Most of the few records come from Lagerstätten deposits, where paleoenvironmental, sedimentological, taphonomic and diagenetic conditions propitiated preservation of delicate structures. In particular, eye preservation in fossil decapods is unusual, with just a few reports (Imaizumi, 1957, 1965; Glaessner, 1969; Feldmann *et al*., 2008; Tanaka *et al*., 2009; Luque, 2012). The evolutionary significance of eye structure in decapods crustaceans has been discussed by several authors (Gaten *et al*., 1998).

The Grayson Formation, from which the specimen described here was collected, is part of the Washita Group, within the Comanchean Series. The Grayson Formation sediments and fauna represent a shallow marine (0-100 meters) depositional environment (Mancini, 1977, 1978); sediment and faunal changes in the outcrop are evidence of variations in the physical environment. The moderate diversity and the presence of stenohaline fauna suggest a normal salinity during deposition. The associated fauna consists of sponges, corals, bryozoans, bivalves, gastropods, nautiloids, ammonoids, belemnoids, crustaceans (including paguroids, a small galatheid and homolid), asteroids,

echinoids, annelids, elasmobranchs, holosteans and teleosts (see Mancini, 1978, 1982). The preservation of the specimen reported here is excellent. At the locality, the infrequent abrasion observed on shells, echinoids with articulated spines, and oysters found in a living orientation, suggest that the fossils have undergone very little transport.

## 2. Geological setting

The locality is found near the Lake Waco dam in Waco, Texas, USA. It is situated between the Central Texas Platform, Stuart City Reef Trend and North Texas - Tyler Basin (Figure 1). The Grayson Formation, at this locality, is uniform in thickness and consists of calcareous claystone interbedded with mudstone overlain by claystone interlaminated with pyritic or limonitic seams, and capped by calcareous claystone interbedded with siltstone and nodular wackestone (Figure 2). These types of sediments and the presence of microfauna are indicative of a low energy muddy substrate environment (Mancini, 1978) that combined with microreducing conditions contributed to the exceptional preservation of fossils at this locality (Mancini, 1978).

The lower boundary of the Grayson Formation correlates to the Albian/Cenomanian interval that serves as the transition from the Lower to Upper Cretaceous (Scott *et al*., 2003, 2009).

## 3. Systematic paleontology

Infraorder Brachyura Latreille, 1802
Superfamily Etyoidea Guinot and Tavares, 2001
Family Feldmanniidae Schweitzer, Feldmann, Franţescu and Klompmaker, 2012
Genus *Caloxanthus* A. Milne-Edwards, 1864

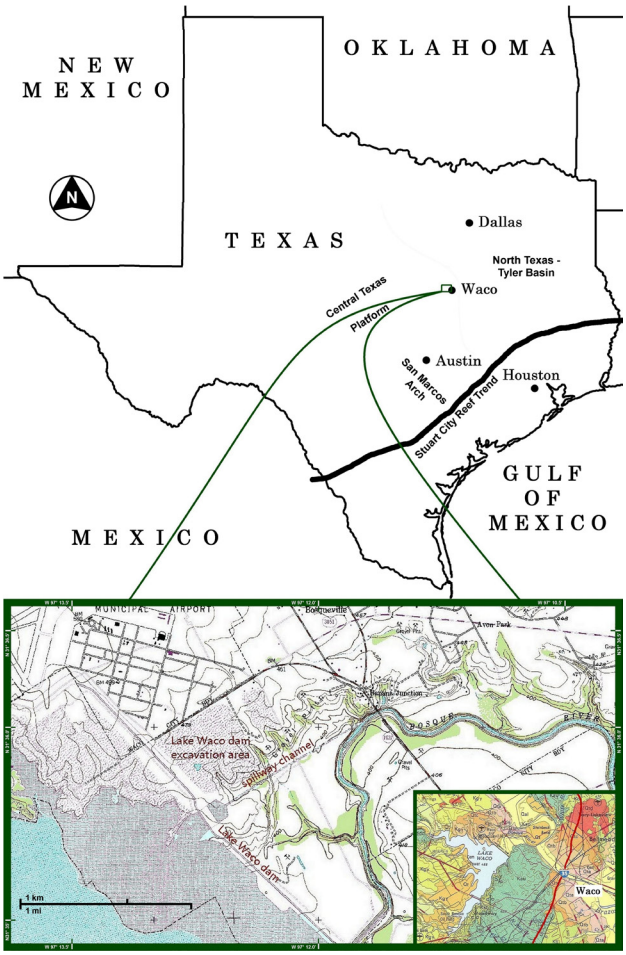


Figure 1. Location map of study area between the Central Texas Platform and Stuart City reef Trend, near Waco, Texas, USA. Compiled from the Waco West 7.5-Minute (1:24000) United States Geological Survey Topographic Map and the Geologic Atlas of Texas, Waco Sheet.

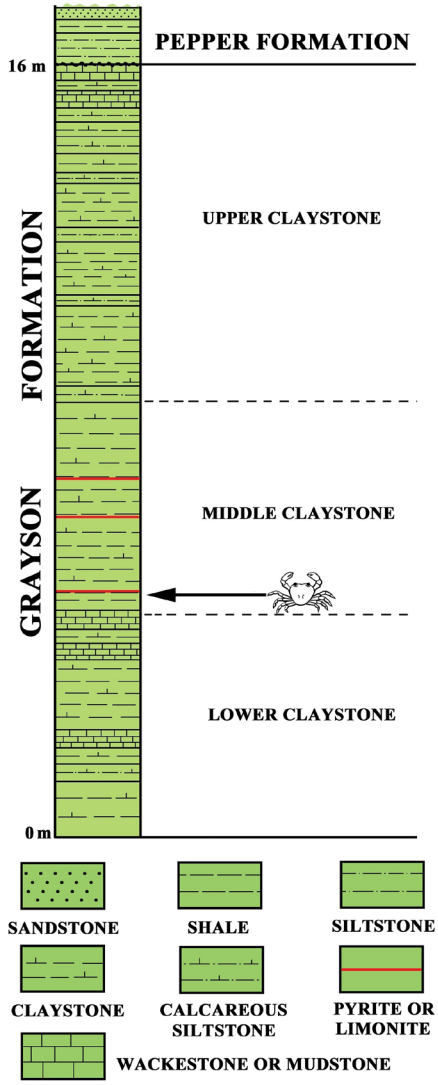


Figure 2. Stratigraphic section of the Grayson Formation at the study area. Modified from Mancini, 1978.

**Type species.** *Caloxanthus formosus* A. Milne-Edwards, 1864, by monotypy.

**Included species.** *Caloxanthus americanus* Rathbun, 1935; *C. kuypersi* Fraaye, 1996; *C. formosus* A. Milne-Edwards,1864; *C. ornatus* (von Fischer-Benzon, 1866); *C. paraornatus* Klompmaker, Artal, van Bakel, Fraaije and Jagt, 2011; *C. purleyensis* (Withers, 1928); *C. simplex* (Secretan, 1964); *C. wrighti* Collins and Breton, 2011.

*Caloxanthus americanus* Rathbun, 1935
Figures 3 - 5

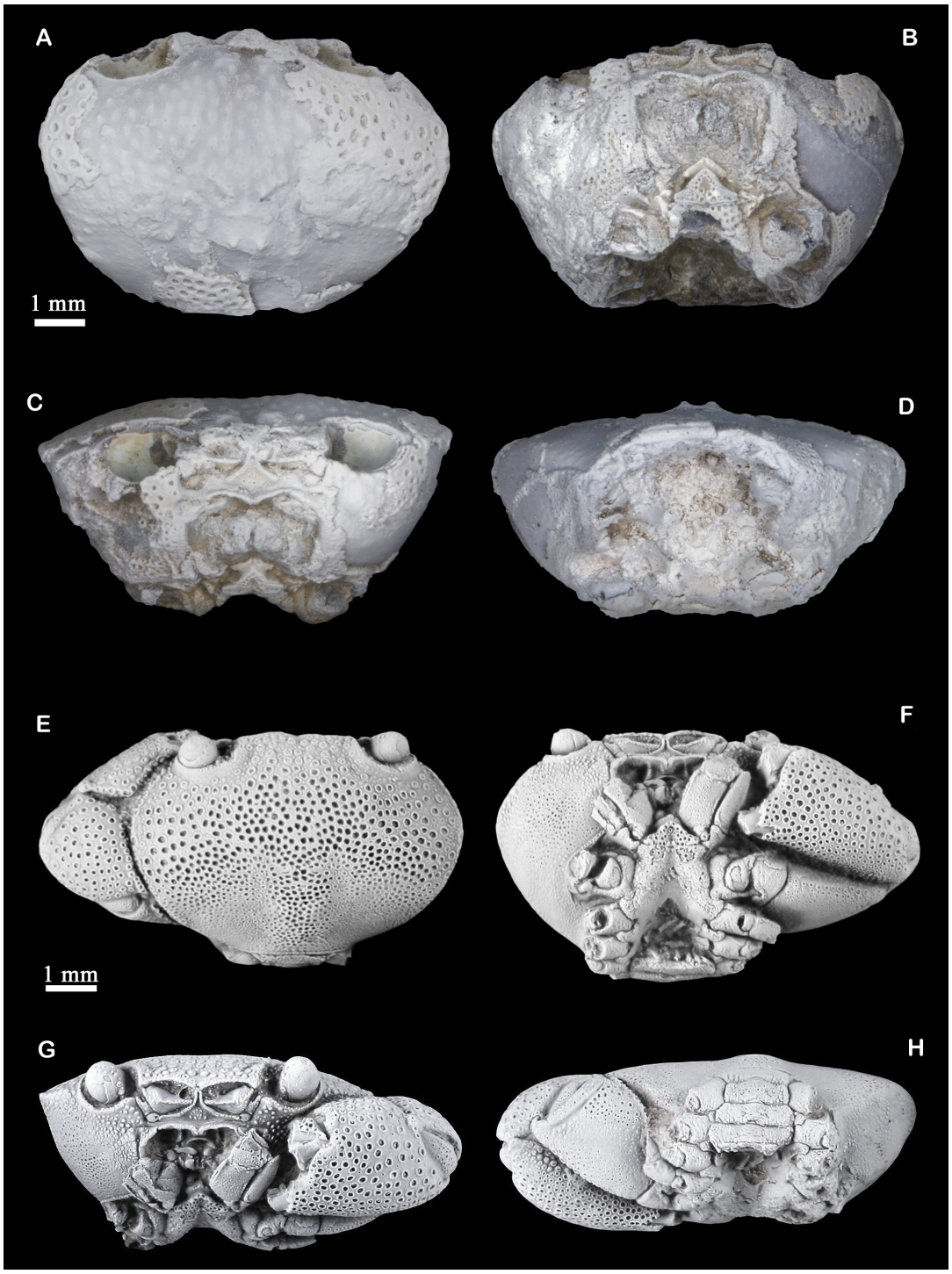


Figure 3. *Caloxanthus americanus* Rathbun, 1935. A – D, holotype BEG 21192, Pawpaw Formation, upper Albian, Tarrant County, Texas: A. Dorsal view of carapace; B. Ventral view of carapace; C. Anterior view of carapace; D. Posterior view of carapace; E – H, specimen NPL-62056, Grayson Formation, lower Cenomanian, Waco, Texas; E. Dorsal view of carapace; F. Ventral view of carapace; G. Anterior view of carapace; H. Posterior view of carapace.

*Caloxanthus americanus* Rathbun, 1935, p. 56, pl. 11, figures 12–19. Wright and Collins, 1972, p. 104, pl. 21, figure 7; pl. 22, figure 1a, 1b; Schweitzer *et al*., 2012, p. 148, fig. 11.

**Emended description.** Complete diagnoses and descriptions are found in Rathbun (1935, p. 56), Wright and Collins (1972, p. 104) and Schweitzer *et al*. (2012, p. 148). We include morphological details not previously mentioned.

Carapace transversely ovate, widest at anterior third, maximum width nearly twice the carapace length; cuticle with coarse pustules on dorsal anterior third, becoming finer at the posterior portion of carapace; anterior margin wide, straight, two-thirds the maximum carapace width; orbits broad, transversely ovate, bordered by fine pustules; podophthalmite globose with anterior row of fine pustules, facets of ommatidia hexagonal; anterolateral margin inclined, bordered by evenly-spaced small pustules, posterolateral margin rounded, bordered by fine pustules that become finer towards posterior margin; posterior margin rimmed, straight, one-fourth the maximum carapace width; carapace regions not so evident; gastric region subrhombical; cardiac region inverted subpentagonal; intestinal region depressed; cervical groove weakly impressed; branchial area swollen, with coarse pustules.

Sternum narrow, one-eighth the maximum carapace width, covered by medium-sized pustules on anterior portion, strongly deflexed posteriorly; sternite 1 triangular, very short: sternite 2 transversely subovate; sternite 3 inverted subtrapezoidal; sternite 4 subtrapezoidal, three times the length of sternite 3; episternites 4 well-developed; sternite 5 subsquare with extended episternites 5; sternites 6 and 7 similar to sternite 5, slightly narrower, deflexed posteriorly; abdominal somites 1 to 3 subrectangular, narrow; abdominal somite 3 one-third wider than somite one. Antennal cavity inclined subtriangular.

Epistome triangular, narrow. Buccal cavity subsquare; third maxillipeds relatively long, base of exognath subconical, short, exognath slender, half the width of ischium of endognath; ischium of endognath elongate, rectangular, merus subsquare, as wide but half the length of ischium; ischium of second maxillipeds narrow, palp slender; mandibles subrectangular, outer margin concave.

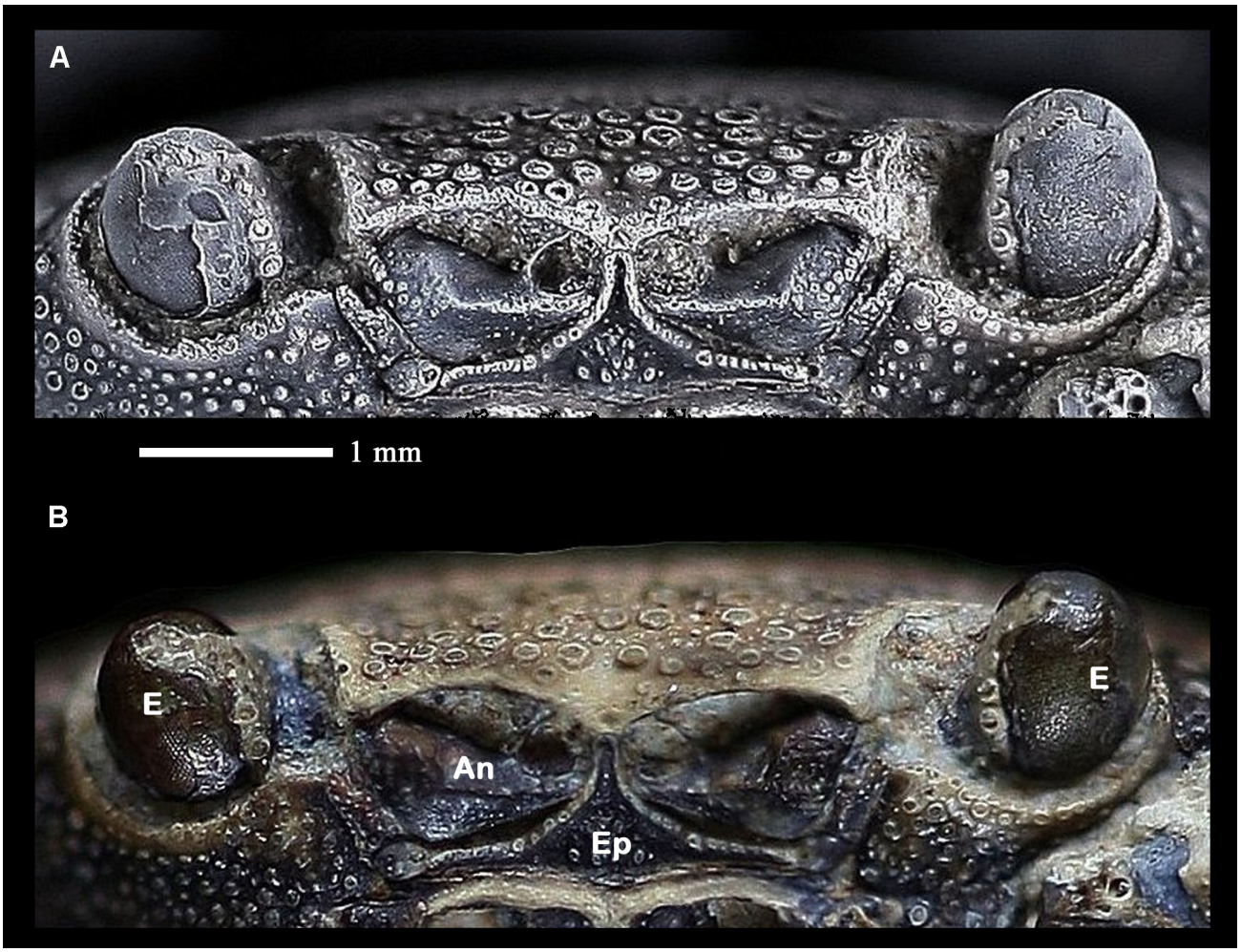


Figure 4. *Caloxanthus americanus* Rathbun, 1935, specimen NPL-62056, Grayson Formation, lower Cenomanian, Waco, Texas. A-B, anterior view of carapace: A. whitened; B. unwhitened, showing antennal cavity (An), eyes (E) and epistome (Ep).

Chelipeds robust, swollen, covered by coarse pustules on distal portion; coxae short, concave, inner condylus rounded; basis short, subconical; ischium of left cheliped, inverted, subtriangular, robust; merus robust, covered on dorsal surface by coarse pustules that become finer to ventral side; carpus relatively short, as high as merus and palm, covered by coarse tubercles; palm robust, three times longer than high, covered by coarse pustules; proximal portion of fixed finger with fine teeth; coxae of P4 and P5 subdorsal, subrectangular; coxae of P3 a P2 slightly longer.

**Material examined.** Holotype BEG 21192 and specimen NPL-62056, deposited at the Nonvertebrate Paleontology Lab (University of Texas at Austin, Texas).

**Measurements (in mm).** NPL-62056: carapace length = 5.7; width = 8.0; height = 4.5.

**Discussion.** The specimen shows a unique preservation, not only among representatives of the Feldmaniidae, but also among many fossil crustaceans. Preservation of

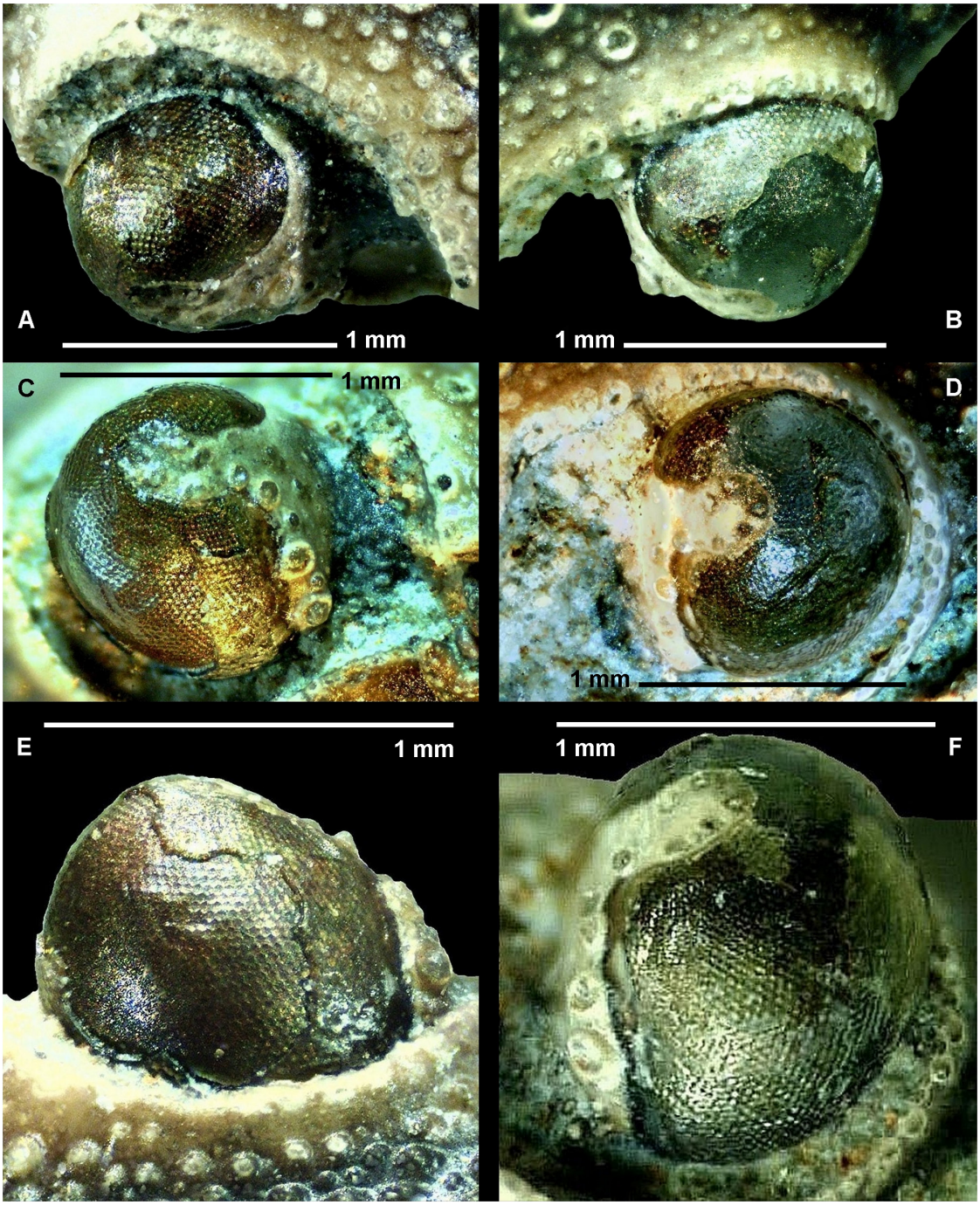


Figure 5. *Caloxanthus americanus* Rathbun, 1935, specimen NPL-62056, Grayson Formation, lower Cenomanian, Waco, Texas. A-F, left and right eye close-ups: A. right eye dorsal view; B. left eye dorsal view; C. right eye front view; D. left eye front view; E. right eye ventral view; F. left eye ventral view.

delicate parts, such as the eyes, is exceptional and allows the documentation of the eye structure in this extinct group. This is probably the first evidence of three-dimensional preservation of brachyuran eyes in the fossil record. Haug *et al*. (2013) reported the presence of bi-dimensional eyes in fossils of Jurassic polychelid fossils with preserved ommatidia. Bi-dimensional eyes with ommatidia are also preserved on an Upper Cretaceous raninoid from Colombia (Luque, 2012). The ommatidia of the studied specimen show hexagonal facets, which indicates apposition optics (E. Gaten, pers. com), one of the various types that may be present in eyes of decapods, as the different types of superposition optics, which are evidenced by square facets of ommatidia (Gaten, 1998).

Whereas apposition optics is present in all decapod larvae, they are only retained by few adults, mainly Eubrachyura. Most of the decapod groups use superposition optics in the adult state, which are more suitable for a dark habitats or deep waters. The presence of apposition optics in the reported specimen would confirm the interpretation of the Grayson Formation as a shallow water paleoenvironment, since this kind of optics is adapted to brighter habitats. The presence of apposition optics in adult decapods is usually interpreted as paedomorphic (see Gaten, 1998; Porter and Cronin, 2009).

*Caloxanthus americanus* was erected by Rathbun (1935) based on a nearly complete carapace and several chelae collected from two localities of the upper Albian Pawpaw Formation near Fort Worth, Texas. Wright and Collins (1972) illustrated and described two carapaces that resemble *Caloxanthus americanus* from lower Cenomanian beds near Devon, England and France. A closer examination of these specimens is required to confirm if they belong to this species.

Schweitzer *et al*. (2012) revised 19 incomplete specimens from four localities of the late Albian Weno and Pawpaw formations near Fort Worth, Texas, and based on these specimens, Schweitzer *et al*. (2012) included details of the cuticle. Occurrence of the specimen described here as *C. americanus* from the Grayson Formation, represents an extension of the stratigraphic range of the species, from the upper Albian to the lower Cenomanian in Texas. The specimen (NPL-62056) described here as *C. americanus* was collected by the second author from the Grayson Formation. A detailed review of the English specimens could reveal if the species had a wide distribution during late Albian/early Cenomanian times.

## Acknowledgements

Thanks to Ann Molineaux (The University of Texas, Texas Natural Science Center Austin, Nonvertebrate Paleontological Laboratory) for facilitating the photography and access to the specimens at the NPL. We also thank James Sprinkle and Angella Thompson (The University of Texas, Texas Natural Science Center Austin, Nonvertebrate Paleontological Laboratory) for their kind assistance in preparation and photography of the specimens illustrated here. We are grateful to Günter Schweigert (Staatliches Museum für Naturkunde, Stuttgart, Germany) for providing literature and translation from German to English, and to Edward Gaten (University of Leicester, UK) for opinions on the eyes structure. Detailed review and suggestions of D. Guinot and A. Klompmaker helped to improve the original manuscript.

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Manuscript received: October 7, 2013.
Corrected manuscript received: December, 8, 2013.
Manuscript accepted: December 12, 2013.