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CARRIZO ARROYO, CENTRAL NEW MEXICO – A NEW LATE PALEOZOIC TAPHOTYPE OF ARTHROPOD FOSSILLAGERSTÄTTE

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ABSTRACT—At Carrizo Arroyo, southwest of Albuquerque, New Mexico, an approximately 100-m-thick section of the latest Pennsylvanian (latest Gzhelian) to Early Permian (early Asselian) Red Tanks Member of the Bursum Formation is exposed. This sedimentary succession is interpreted as a coastal plain on a very shallow shelf affected by repeated transgressions and regressions. Besides the marine marls and limestones, the most common lithotypes in the nonmarine fossiliferous intervals are greenish-gray and gray, variably sandy fine clastics. Lithology and facies architectures together document a low energy floodplain environment crossed by very shallow but wide flood channels. In the floodplain deposits, three basic taphotypes were observed: (1) the common plant bed type, (2) the rare conchostracan bed type, and (3) the insect bed type, which is not as rare as previously assumed. Plant beds are commonly formed by single layers of dm-long branches and leaves, as well as cm-sized plant fragments. Consequently, it is assumed that the Carrizo Arroyo plant beds were deposited by waning flood in shallow and wide floodplain channels. Conchostracan and insect beds have several features in common. Bedding planes with enrichments of conchostracans, freshwater pelecypods, insects, and, in places, eurypterids, contain tiny plant detritus of mm- to cm-size only. They form a sub-mm to mm-thick layer only, and have a restricted lateral extent of several meters to decameters. Altogether, this points to autochthonous assemblages of aquatic arthropods and molluscs preserved in short-lived freshwater puddles and ponds on the floodplain. The common but generally isolated insect wings were most likely transported by winds and trapped at the water surface of those freshwater accumulations on the floodplain. Obviously, fossiliferous deposits at Carrizo Arroyo contain an assemblage of autochthonous and allochthonous elements of the insect fauna, covering environments from the hinterland down to the seacoast. This makes the Carrizo Arroyo Fossillagerstätte exceptional.

INTRODUCTION

In contrast to the highly diverse earliest Pennsylvanian (Bashkirian) marine insect fossil-Lagerstätten of Ningxia, China, and Hagen-Vorhalle, Germany, Middle Pennsylvanian to Early Permian insect sites worldwide are dominated by fossils of cockroachoids (Bethoux et al., 2011; Ilger and Brauckmann, 2011; Zhang et al., 2013; Wei et al., 2013). Most of these sites are situated in the roof shales and interbeds of coal seams, such as Mazon Creek, Writhlington, Commentry, Wettin, Kuznetsk, etc. (Selden and Nudds, 2012; Jarzembowsky, 2004; Schneider, 1983; Ponomaryova et al., 1998). They mainly reflect the environments of wet coal forests of the Late Pennsylvanian and earliest Permian (DiMichele, 2014). The earliest Permian Carrizo Arroyo site in New Mexico (Fig. 1), investigated during the last decade, represents a new taphotype of arthropod Fossillagerstätten, which will be discussed here. The general depositional environment of this site is interpreted by Lucas and Krainer (2004) as a coastal plain on a very shallow shelf during repeated transgressions and regressions, as evidenced by the identification of six depositional sequences (DS) in the Bursum Formation section. DiMichele et al. (2004) regarded the paleoflora as representing a seasonally dry biome of the Pennsylvanian-Permian transition. Here, we evaluate the taphonomy of nonmarine Fossillagerstätte in the Bursum Formation at Carrizo Arroyo.

METHODS

Since the 1970s, the fossil content of the Red Tanks Member of the Bursum Formation at Carrizo Arroyo has become an increasing focus of publications (e.g., Kukalova-Peck and Peck, 1976; Kues and Kietzke, 1976). Kues and Kietzke (1976) discriminated and numbered 29 units in the Carrizo Arroyo section, whereas Krainer and Lucas (2004) recognized 55 units arranged in six DS (Fig. 2). A really exact, bed-by-bed sampling only became possible after Krainer and Lucas (2004) measured the
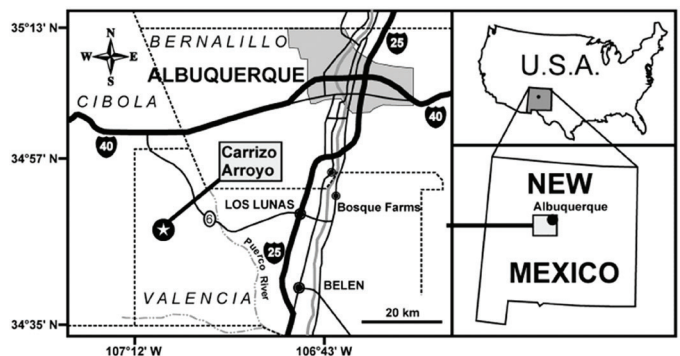

FIGURE 1. Index maps showing location of the Carrizo Arroyo section in central New Mexico.
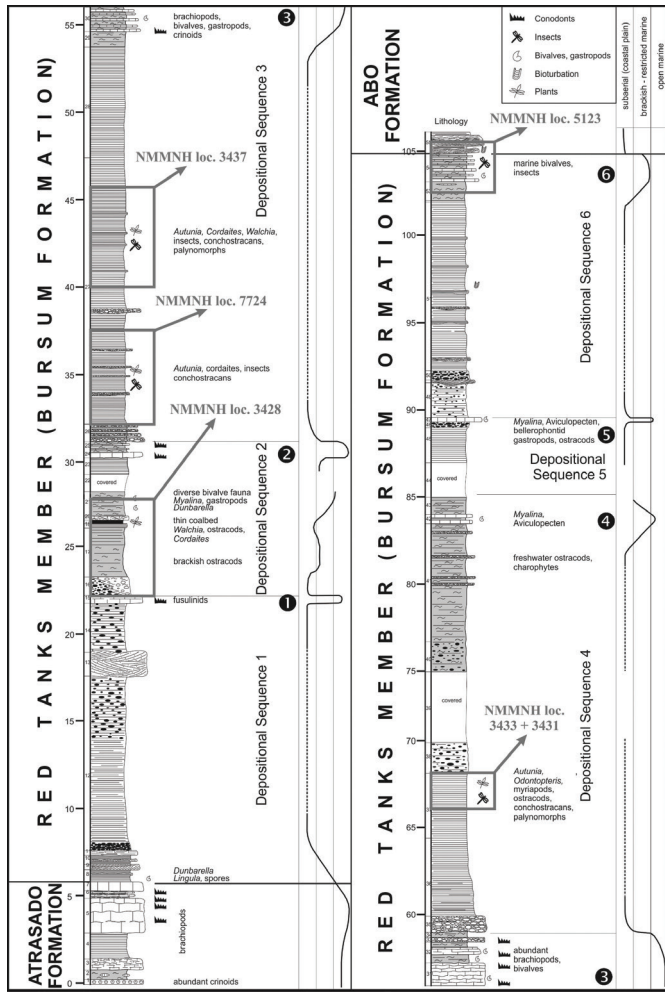
FIGURE 2. Measured stratigraphic section of the Red Tanks Member of the Bursum Formation at Carrizo Arroyo (from Krainer and Lucas, 2004). Indicated are the positions of higher resolution measured sections at the respective NMMNH locations. For detailed lithological descriptions see p. 68-69 in Krainer and Lucas (2004).

approximately 100-m-thick profile of the Red Tanks Member at Carrizo Arroyo in great detail (Fig. 2). Based on this work from 2005 to 2009, one of us (JWS) documented and sampled the lithology and fossil content of five narrow stratigraphic intervals, each between 3.5 to 5 m in thickness with cm-scale resolution: (1) the coal bed profile, NMMNH (New Mexico Museum of Natural History) locality 3428, units 17 to 21 of Krainer and Lucas (2004) in the lower half of DS 2 (completed by R. Werneburg in 2009), (Fig. 3); (2) NMMNH locality 7724 in the lower third of unit 27 in DS 3; (3) NMMNH locality 3437 in the upper half of unit 27 in DS 3, (Fig. 4); (4) NMMNH locality 3433 in unit 37 of DS 4 (Fig. 5); and (5) NMMNH locality 5123, units 53 to 54 at the top of DS 6, directly below the Abo base as well as the basal part of unit 55 at the Abo base. The several hundred plant and animal fossils that are correlated to specific beds in these stratigraphic intervals are stored in the collection of the NMMNH. In the following text, the term "unit" followed by a number refers to the measured section documented by Krainer and Lucas (2004) (Fig. 2), and the term "bed" followed by a number refers to the profile documentations of JWS (Figs. 3-5).
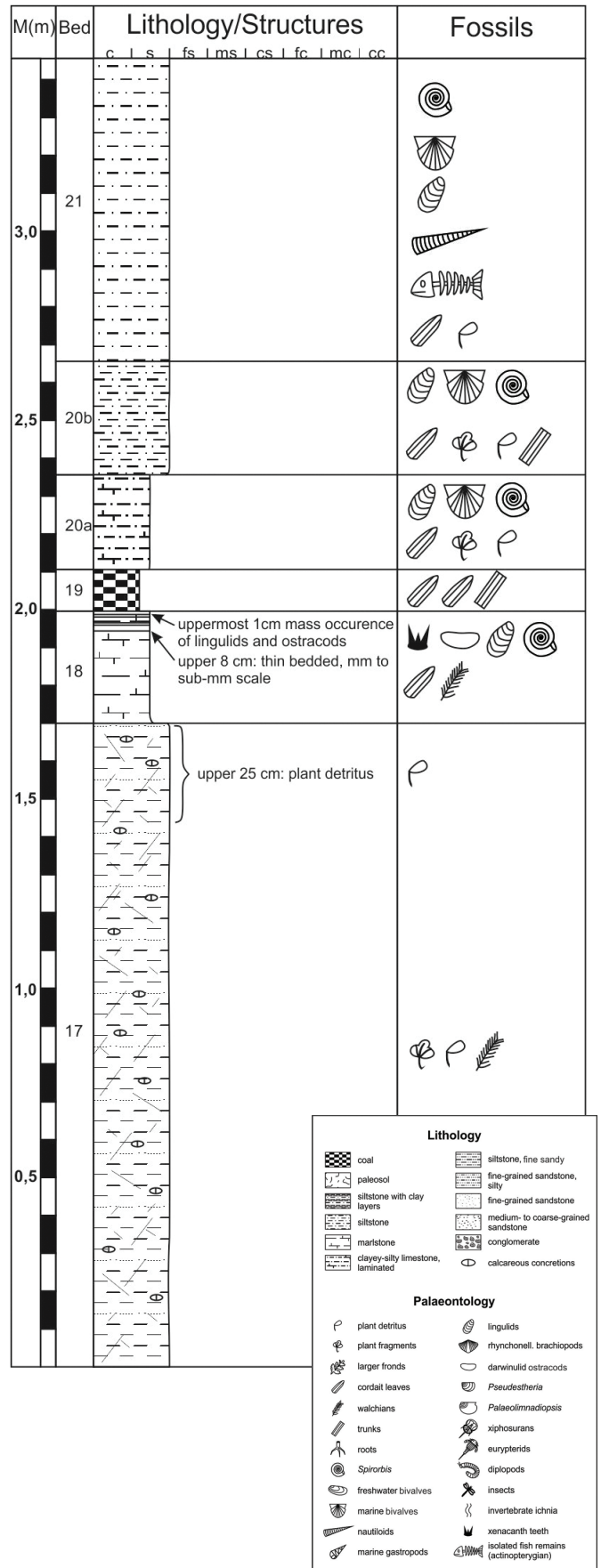
FIGURE 3. Section at NMMNH locality 3428, units 17 to 21 in DS2 of Krainer and Lucas (2004), the so-called coal bed profile, see this paper Figure 2.
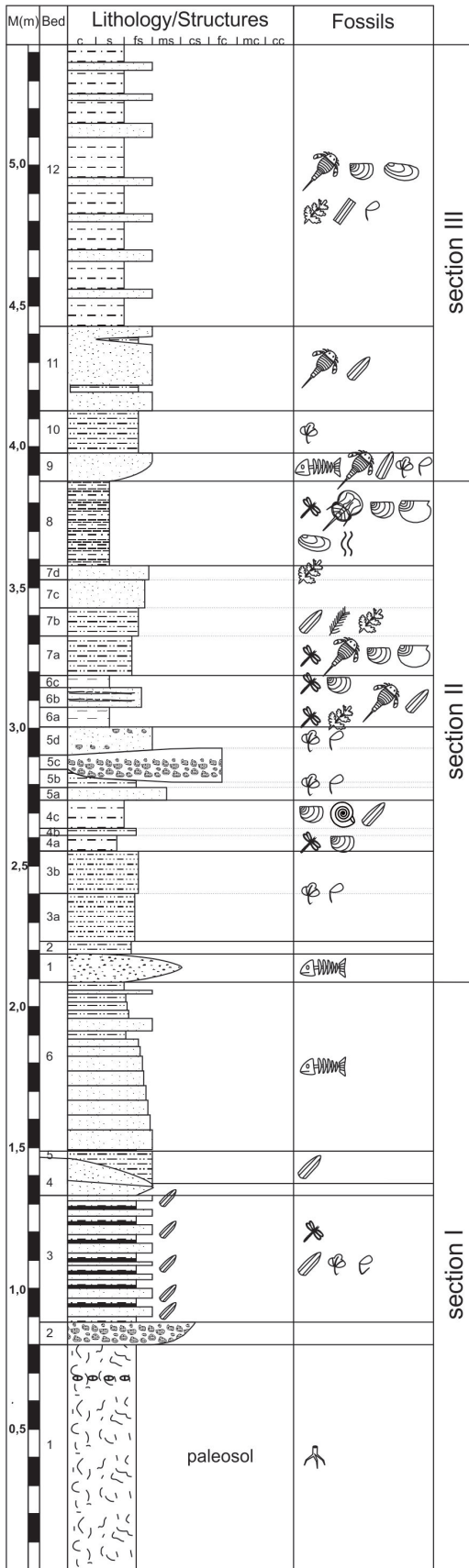
FIGURE 4. Section at NMMNH locality 3437, in the upper half of unit 27 in DS3 of Krainer and Lucas (2004), see this paper Figure 2; this section contains the "major eurypterid zone" and the "major insect zone" of Kues and Kietzke (1981).
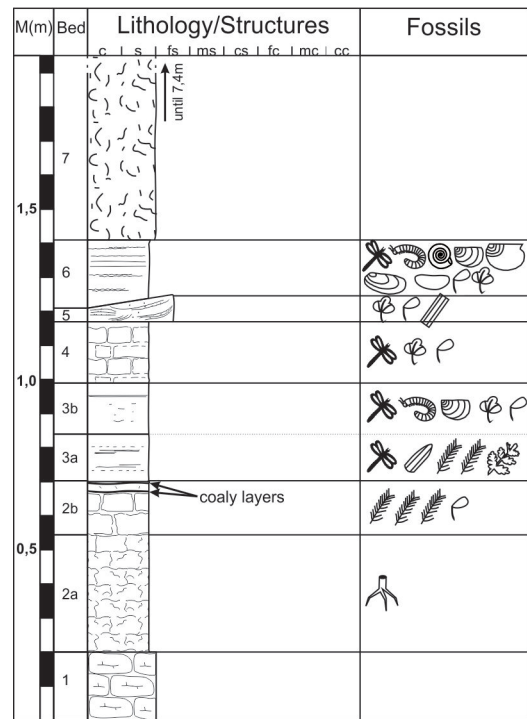

FIGURE 5. Section at NMMNH localities 3433 (for arthropods) and 3431 (for plants) in the first third of DS4, upper half of unit 37 of Krainer and Lucas (2004), see this paper Figure 2; NMMNH locality 3431 is the plant bed of Knaus and Lucas (2004), here the bed 3a.

Conchostracans form a paraphyletic group of Branchiopoda, now divided into the monophyletic Laevicaudata, Spinicaudata and Cladoceromorpha (Richter et al., 2007). Here, we deal with Spinicaudata and Laevicaudata, but for convenience we use the term Conchostraca.

GEOLOGY AND BIOSTRATIGRAPHY

Located on the eastern edge of the Colorado Plateau, Carrizo Arroyo (Fig. 1) is 50 km southwest of Albuquerque, New Mexico, USA (~34°45'N, 107°07'30"W). Here, an approximately 105-m-thick section of upper Paleozoic clastic and carbonate rocks yields extensive fossil assemblages of marine and nonmarine origin (Kues and Kietzke, 1976; Krainer et al., 2001; Lucas and Krainer, 2002; Lucas and Zeigler, 2004). At the base of the section, marine limestones of the upper part of the Atrasado Formation of unquestioned Late Pennsylvanian (Virgilian) age are exposed. Most of the section at Carrizo Arroyo belongs to the Red Tanks Member (~100 m thick locally) of the Bursum Formation (Lucas and Krainer, 2003, 2004; Krainer and Lucas, 2004, 2009; Lucas et al., 2013). At Carrizo Arroyo, the Red Tanks Member is mostly gray and very rarely reddish shale, mudstone and siltstone of nonmarine origin, intercalated with several beds of limestone and shale of marine origin (Fig. 2). The Red Tanks Member is overlain by nonmarine wet red beds of the Abo Formation, consisting of alluvial plain to floodplain fine clastics with intercalated fluvial channel deposits (Lucas et al., 2012a, b).

The stratigraphic architecture of the Red Tanks Member at Carrizo Arroyo has been interpreted to indicate the presence of

six DS (Krainer and Lucas 2004; Fig. 2). The base of each DS is drawn at the base of beds of conglomerates or sandstones sharply incised into underlying mudrock, and each sequence then fines upward into mudrock-dominated floodplain deposits. Marine limestone beds cap each sequence. Derived from these limestone intervals, six marine flooding events are discriminated (Fig. 2). The nonmarine, floodplain deposits are mostly composed of mudstone/siltstone beds, some of which contain abundant calcrete nodules and other evidence of immature pedogenesis. A thin cordaitalean-leaf coal bed, unit 19 at NMMNH locality 3428 (Fig. 3), in the middle of DS 2, is underlain by fossiliferous, thin-bedded to laminated marly siltstone to claystone (plants, lingulid brachiopods, "*Spirorbis*" [?microconchids], ostracods, isolated fish remains) and overlain by marly mudstone containing brackish marine bivalves (myalinids), lingulids, "*Spirorbis*" incrustations on dm-thick tree trunks, cordaitalean leaves up to 40 cm long and plant debris. Carbonate conglomerates at the bases of DS 3 and 4 probably represent upper shoreface deposits, and, thin layers in DS 3 and DS 4 are small side-channel fills of several m thick conglomeratic and sandy major channels.

The biostratigraphic age of the Red Tanks Member at Carrizo Arroyo is determined by conodonts (Orchard et al., 2004; Lucas et al., 2013) and insects (Schneider et al., 2004; Lucas et al., 2013, 2016, herein). The presence of *Streptognathodus virgilicus* in the uppermost part of the Atrasado Formation constrains its age to the middle to upper part of the Virgilian and to a comparable position in the Gzhelian. The only biostratigraphically-significant conodont assemblage in the Red Tanks Member comes from horizon marine D, units 30-32, at the top of DS 3, and the assemblage is probably equivalent in age to the Midcontinent *Streptognathodus nevaensis* Zone, which is early to middle Asselian in age. In DS 3, nonmarine horizon A, at roughly 43 m in the upper half of unit 27, NMMNH locality 3437, fragments of the cockroachoids *Sysciophlebia ilfeldensis* and *Spiloblattina weissigensis* were discovered. Based on the insect correlation of Lucas et al. (2013a) and the precised isotopic age calibration of the insect zonation of Schneider and Werneburg (2006, 2012), in Schneider et al. (2013), the *Sysciophlebia ilfeldensis*-*Spiloblattina weissigensis*-insect zone straddles the Gzhelian/Asselian boundary. This correlation strongly supports assigning an early Asselian age to nonmarine horizon A in the upper half of unit 27, as is inferred from conodonts.

SEDIMENTOLOGY AND TAPHONOMY OF THE ARTHROPOD LAGERSTÄTTE

At Carrizo Arroyo, the Red Tanks Member yields fossils from many beds; insects as well as other nonmarine arthropods are scattered through the whole section. In the course of our prospecting for fossils, Lagerstätten of insects, conchostracans, eurypterids and other fossils were found at three levels (Fig. 2): (1) NMMNH locality 7724, situated in the basal part of DS 3, lower third of unit 27 at 32.5 to 37.5 m; (2) NMMNH locality 3437 near the middle of DS 3 in the upper half of unit 27 at 40 to 45.5 m (Fig. 4); (4) NMMNH locality 3433 in the first third of DS 4, upper half of unit 37 at 66.5 to 68.5 m (Fig.5).
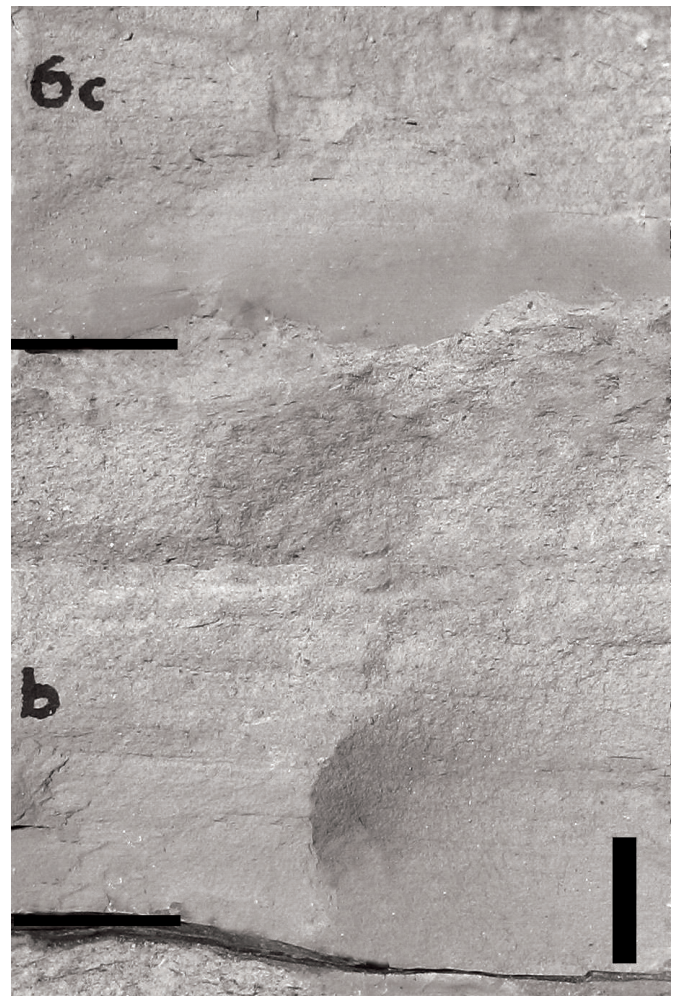

FIGURE 6. Greenish-gray and gray, variably sandy mudstones and siltstones (middle part of b), silty sandstones (upper part of b), marly claystones (lower part of b and c) and marls are the most common lithotypes in the fossiliferous intervals; bed 6b-c, section II, NMMNH locality 3437 (Fig. 4); scale bar=2 cm.

Sedimentology

The most common lithotypes in these fossiliferous intervals are greenish-gray and gray, variably sandy mudstones and siltstones, silty sandstones and marls (Fig. 6). Bedding is developed at the larger scale as dm- to several dm-thick horizontal beds (Fig. 7); rare, m-thick, trough-cross-bedded channel fills are intercalated. At the smaller scale, the widely horizontal bedsets consist of several cm- to dm-thick and some meter- to decimeter-wide shallow, stacked, and mostly internally horizontally bedded (sub-mm- to cm-scale) lenticular bodies (Fig. 8). Bedding planes often expose layers of larger plant detritus; dm-size fern leaves and cordaite leaves are common (Fig. 9); the latter can form coaly layers up to 1 or 2 cm thick. Trunks are rare, and diameters range from cm to dm. Varying pedogenic overprint caused destruction of bedding, resulting in a completely structureless and massive appearance.

In DS 3, several thin conglomerate beds (~1 dm to 1 m thick), made up of limestone clasts with thin intercalated sandstone layers, are intercalated in the greenish-gray mudstones

FIGURE 7. Typical bedding architectures are widely horizontal bedsets consisting of several cm- to dm-thick and some meter- to decameter-wide shallow, stacked, and mostly internally horizontal-bedded (sub-mm- to cm-scale) lenticular bodies; trench at NMMNH locality 3437, of section II, beds 8 (insect bed) to 12 (compare Fig. 4); scale bar=15 cm.

and siltstones (Fig. 10). At NMMNH locality 3437, one of these beds could be traced from the documentation trench laterally to a several m high cliff (base not exposed). This cliff consists of stacked limestone conglomerate channels at the bottom and of pebbly sandstone at the top. It is interpreted as a fluvial main channel that pinched out laterally in the trench. The conglom-

erate is grain supported; the subrounded clasts are poorly sorted granules and pebbles in a sandy matrix (Fig. 11). Most of the clasts are carbonates, mainly pedogenic nodules, reworked from immature calcic soils and calcretes. Red rims of some pebbles point to intermittent subaerial exposure and oxidation.

FIGURE 8. Typical internal horizontal planar to lenticular bedding (sub-mm- to cm-scale) of fine-sandy siltstones with clayey layers and some intraclasts; thin section from bed 6, section I, of NMMNH locality 3437; scale bar=5 mm.
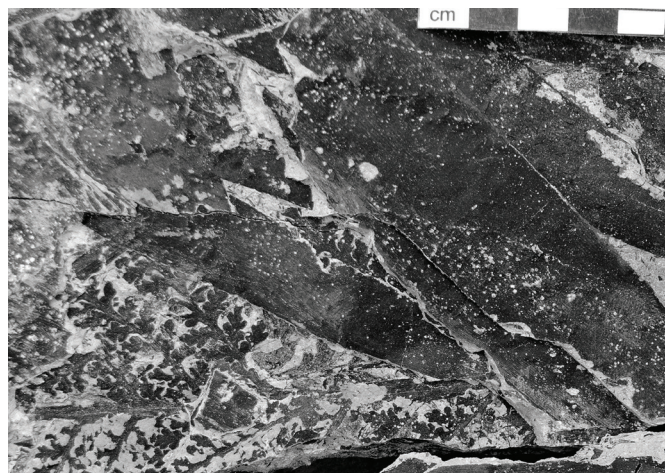

FIGURE 9. Typical plant bed with large cordaitalean leaves and fronds of pteridosperms (here *Sphenopteridium manzanitanum*) as well as plant detritus; NMMNH locality 3437, section I, bed 3; scale bar=1 cm.
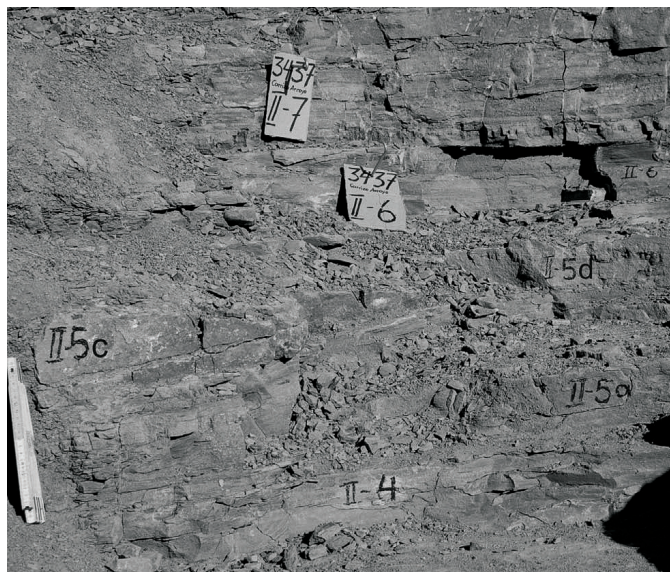
FIGURE 10. Bed 5c, section II, a laterally pinching out conglomeratic channel in floodplain fine clastics at NMMNH locality 3437; interpreted as one of the minor side channels of several meter thick main channels; scale bar=20 cm.

Taphonomy

On a large scale, three basic taphotypes were observed in Carrizo Arroyo: (1) the common plant bed type, (2) the rare conchostracan bed type, and (3) the insect bed type, which is not as rare as previously assumed.
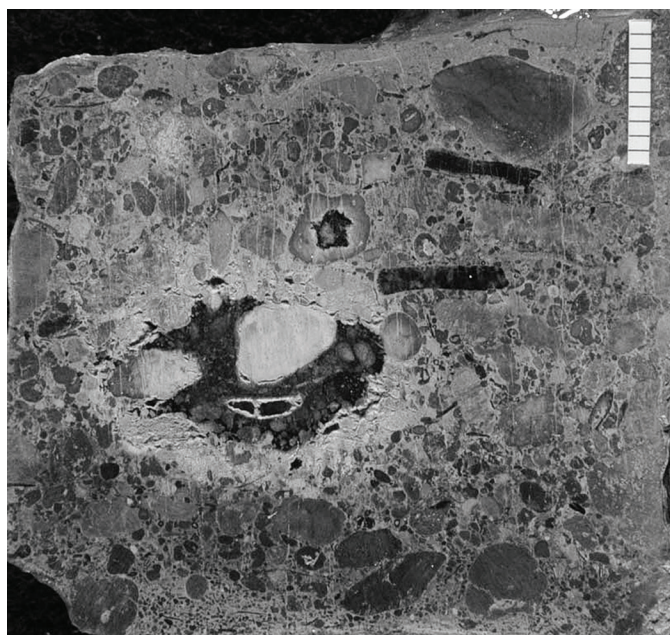

FIGURE 11. Matrix- to grain-supported conglomerate consisting mainly of reworked carbonate nodules from immature calcic soils and calcretes; red rims of some of the pebbles point to intermittent subaerial exposure and oxidation; polished section from bed 5c (see Fig. 10) of NMMNH locality 3437; scale bar=1 cm.

Plant Bed Type

Variably fragmented plant remains are scattered throughout the section. Accumulations of cm- to dm-size plant fragments, forming plant beds, occur in cm- to dm-thick, planar-bedded, fine sandy siltstones and silty fine sandstones of mainly lenticular shape. Most common are cordaitalean leaves, walchian conifer twigs and compound leaves (fronds) of pteridosperms, mainly with sphenopteridian foliage, as well as callipterid and odontopterid leaves and fronds, all preserved as carbonaceous compressions (Fig. 9). The horizons are often dominated by single plant taxa. Plant beds have been observed at different levels, with changing dominant floral elements.

The thus-far known lowermost plant bed, NMMNH locality 3428 (Fig. 3), unit 18, immediately below the coal bed (unit 19) in DS 1, contains, based on Kues and Kietzke (1976) and our own observations (JWS, 2005), mainly larger walchian twigs and rarely cordaitalean leaves. Plants occur in silty layers of a 30-cm-thick, fine-bedded ostracod marlstone (smooth shelled *Darwinula*-type); the uppermost 1 cm contains, in addition to masses of ostracods, lingulids up to 1 cm long. The 10-cm-thick dirty coal bed is mainly made up of cordaitalean leaves. Sediments above belong to the brackish A horizon of Lucas et al. (2013).

The middle of DS 3 in the upper half of unit 27 between 40 m to 45.5 m, NMMNH locality 3437 (Fig. 4), contains several plant layers and insect beds. This is the original plant locality of Kues and Kietzke (1976) in their unit 10 (Tidwell and Ash, 2004). Several leaf layers are absolutely dominated by cordaitaleans (Fig. 9), and large fronds of other plants occur at one level in the higher part of the profile only (Fig. 4, section II, boundary bed 7/8). The relatively high diversity of the flora reflects the so-called "rare elements" of DiMichele et al. (2004), which are mainly preserved as leaf fragments.

The stratigraphically highest plant bed is situated in NMMNH locality 3431, only dms below the insect bed NMMNH locality 3433, in the first third of DS 4, upper half of unit 37 at 66.5 m to 68.5 m (Fig. 5). Walchians are absolutely dominant; cordaitalean leaves are rare. Besides walchians, one bed contains common, dm-long fronds with neuropterid pinnules resembling *Odontopteris* (Knaus and Lucas, 2004, p. 119).

Conchostracan Bed Type

Accumulations of conchostracan valves on distinct bedding planes, forming mass occurrences in places, may have different causes. Monospecific accumulations could originate from the die-off of one population at the end of the ontogenetic cycle. Such accumulations are easily recognizable and characterized by adult individuals only, which show the typical crowding of growth lines at the borders of the valves (Martens et al., 1981). If a population dies because of any lethal environmental factor (e.g., sudden oxygen deficit, sudden elevated salinity, drying up), accumulations of valves are formed by one non-adult growing stage with a nearly identical number of growth lines on the valves.

Other than the coal bed profile, NMMNH locality 3428, the horizon brackish A, in DS 2, where conchostracans are seemingly absent, all of the stratigraphically higher fossiliferous

FIGURE 12. Example of conchostracan bed type; silty claystone with mass occurrence of *Lioestheria* valves (size ~2.5 mm) together with single valves of a laevicaudate conchostracan (size ~4.5 mm). NMMNH specimen 54083 from bed 6 at NMMNH locality 3433. Scale bar=1 mm.

layers contains scattered conchostracans. Most likely, they are allochthonous. But, at some levels of the section, there appear accumulations that are regarded as autochthonous populations. One of them occurs in bed 6 at NMMNH locality 3433, in the first third of DS 4, upper half of unit 37. There, single bedding planes of claystones are covered with tiny plant detritus and contain masses of *Lioestheria* valves (Fig. 14G) together with single valves of laevicaudate conchostracans (Figs. 12, 14C). Additional, smooth-shelled ostracods of the *Darwinula* type are very common, and insect wings (Fig. 14K) are not rare at some levels (see below – insect bed type). One of those bedding planes exhibited a large number of *Carbonicola*-like
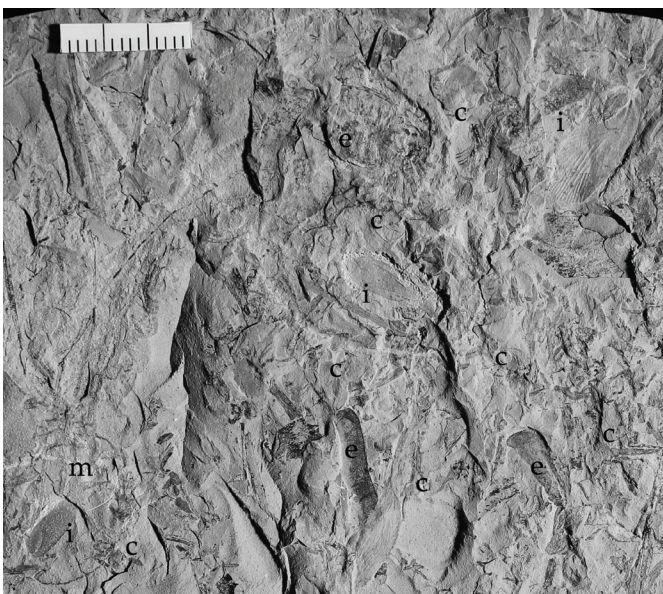

FIGURE 13. Example of arthropod bed type; siltstone covered with tiny plant detritus, numerous conchostracan valves (c; not all marked), insect wings (i), complete juvenile eurypterids and eurypterid fragments (e), and one monuran (m); NMMNH locality 3437, profile II, bed 8 (insect bed); scale bar=15 mm.

freshwater pelecypods, which are concentrated in a small area of dm diameter.

Additional mass occurrences were found in different levels of bed 8, section II, of NMMNH locality 3437. There, one bedding plane of the siltstone is covered with tiny plant detritus and *Pseudestheria* valves, and among them single insect wings and some fragments of eurypterids (Fig. 13).

Unusually large conchostracans, up to 30 mm long, identified as *Palaeolimnadiopsis* (Fig. 14I), occur as single individuals in all detailed measured sections in DS 3 and DS 4.

Insect Bed Type

The sedimentology and taphonomy of several of the insect beds in the above-mentioned localities can be exemplified by bed 8, section II, at NMMNH locality 3437 (Fig. 4) in the original "insect zone" of Kues and Kietzke (1981, fig. 2) of this locality. One bedding plane in the middle of unit 8, section II, that pinches out laterally over a strike of about 3 m, exhibited patchily arranged, very fine plant detritus in places together with common conchostracans and isolated and often fragmented insect wings (Figs. 13, 14J, L). In order of decreasing abundance follow relatively small *Carbonicola*-like bivalves and eurypterids (Fig. 14E). Single, complete eurypterids occur as early juveniles of mm-size (Fig. 14A) up to semi-adults of dm length (comp. Kues and Kietzke, 1981); the same size spectrum is covered by common eurypterid body fragments (Fig. 13). Not rare are complete specimens of the wingless aquatic monuran insect *Dasyleptus* (Fig. 14F); very rare are xiphosurids (Fig. 14B) and diplopods (Fig. 14H).

The lowermost insect bed yet discovered is situated in the basal part of DS 3, in the lower third of unit 27 at 32.5 m to 37.5 m, NMMNH locality 7724, in bed 7 of JWS documentation. Bedding planes in the lower part of the 18-cm-thick bed are covered by very fine plant detritus and bear common insect wings and eurypterid remains, but rarely only conchostracans.

Very similar arthropod beds are bed 7a, section II, at NMMNH locality 3437, and bed 6, at NMMNH locality 3433, described above as one of the conchostracan bed types.

CONCLUSIONS

The sedimentary successions of the Red Tanks Member exposed at Carrizo Arroyo are interpreted by Krainer and Lucas (2004) as a coastal plain on a very shallow shelf affected by repeated transgressions and regressions of decreasing intensity to the top. Besides the marine marls and limestones, the most common lithotypes in the nonmarine fossiliferous intervals are greenish-gray and gray, variably sandy mudstones and siltstones, silty sandstones and marls. Bedding is developed at a larger scale as dm- to several dm-thick horizontal beds; rarely, intercalated are m-thick, trough-cross bedded silty and sandy channel fills. At the smaller scale, the widely horizontal bedsets consist of several cm- to dm-thick and some meter- to decimeter-wide, shallow, stacked, and mostly internally horizontally bedded (sub-mm- to cm-scale) lenticular bodies. Lithology and facies architectures together document a low energy floodplain environment crossed by very shallow but wide flood channels.
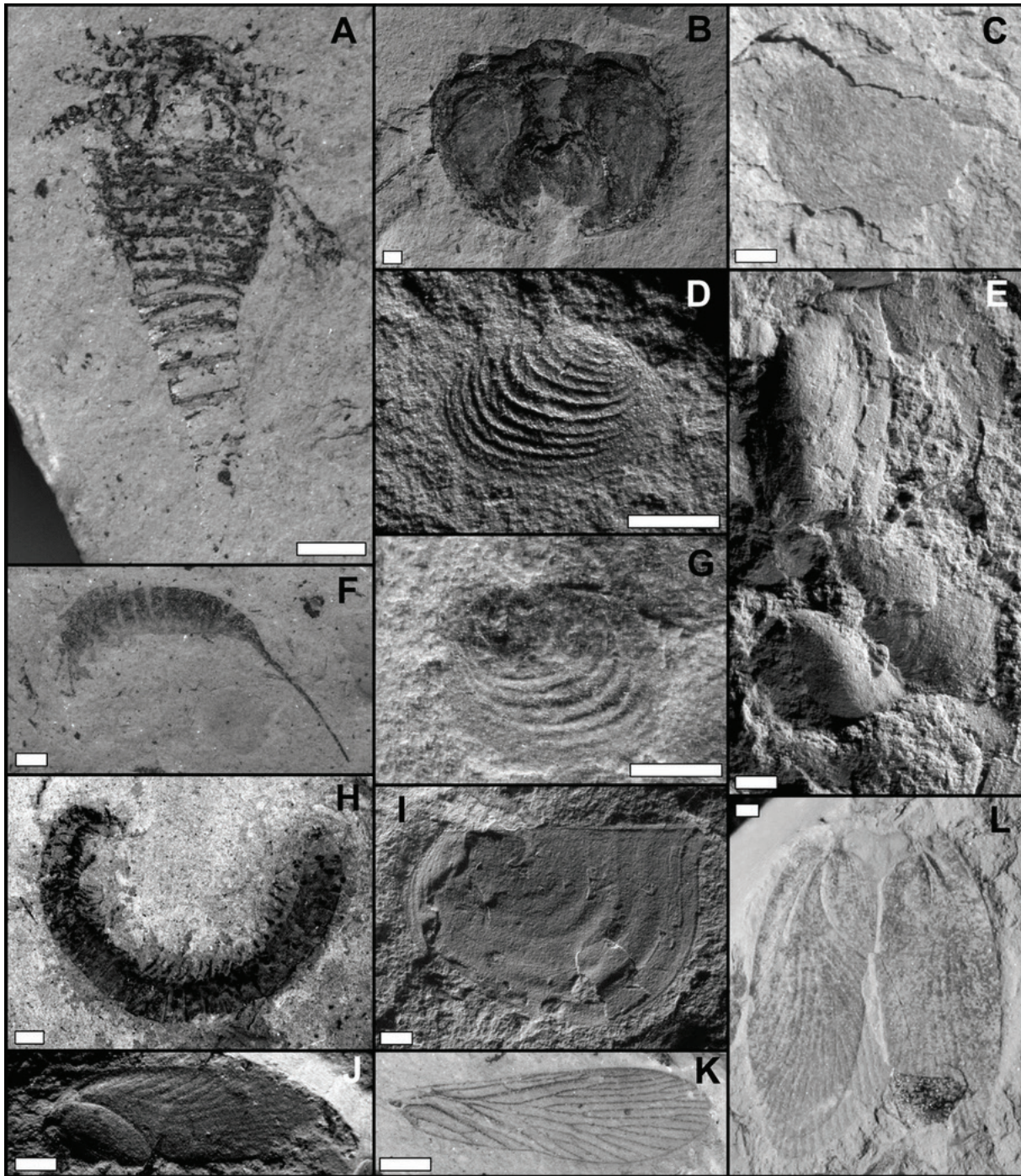
FIGURE 14. Fossils of the arthropod beds: **A)** *Adelophtalmus luceroensis*, NMMNH specimen 54052; **B)** xiphosurid ophistosoma, NMMNH specimen 54041; **C)** laevicaudate conchostracan, NMMNH specimen 54028; **D)** pseudestheriid conchostracan, NMMNH specimen 54007; **E)** *Carbonicola*-like freshwater pelecypods, NMMNH specimen 54080; **F)** monuran *Dasyleptus rowlandi*, NMMNH specimen 54015; **G)** *Lioestheria* sp., NMMNH specimen 54083; **H)** juliform diplopod, NMMNH specimen 54124; **I)** *Palaeolimnadiopsis* sp., NMMNH specimen 54039; **J)** forewing of cockroach *Poroblattina* sp., NMMNH specimen 54022; **K)** wing of a new panorbid insect, NMMNH specimen 54085; **L)** articulated forewings and left hindwing of cockroach *Phyloblatta* sp., NMMNH specimen 54023. **A**, **B**, **C**, **D**, **E**, **F**, **I**, **J**, and **L** from NMMNH locality 3437, section II, bed 8; **G** from NMMNH locality 3433, bed 3; **K** from NMMNH locality 3433, bed 6. Scale bars in all figures 1 mm.

Plant beds are commonly formed by single layers of dm-long branches and leaves as well as cm-sized plant fragments. Consequently, it is assumed that the Carrizo Arroyo plant beds were deposited by waning floods in shallow and wide flood plain channels after rainstorms, during which winds had been able to snap off larger twigs of plants.

Conchostracan and insect beds have in common the following features. Bedding planes with enrichments of conchostracans, insects, and, in places, eurypterids, contain tiny plant detritus of mm- to cm-size only. They form a sub-mm to mm-thick layer only and have a restricted lateral extent of several meters to decimeters. Accumulations of conchostracans
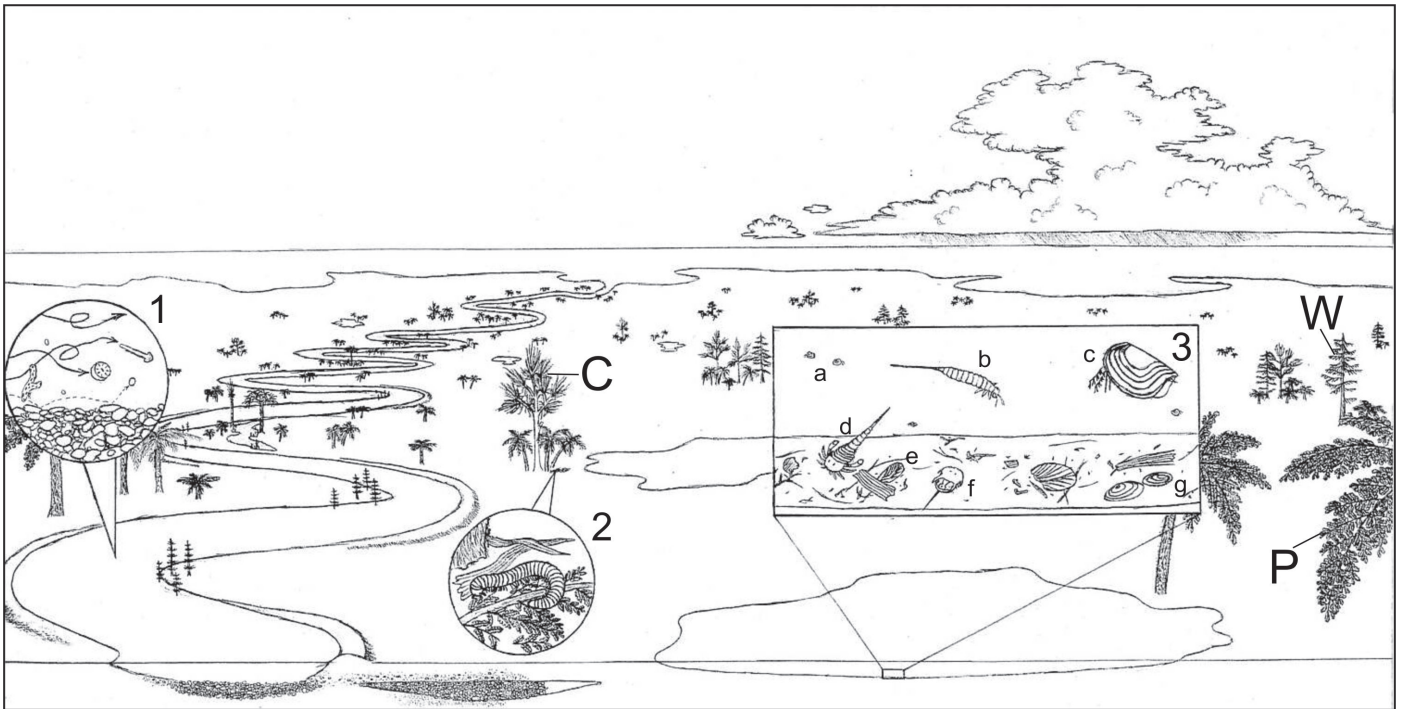
FIGURE 15. Reconstruction of the floodplain environment of the nearshore coastal plain at Carrizo Arroyo during deposition of the Red Tanks Member. (1) River channel with pebbles from eroded marine limestones and calcic soils; sand-sized grains consist mainly of corroded marine bioclasts; (2) diplopods, living in plant litter and soils in vegetated areas of the floodplain; (3) arthropod community of a floodplain freshwater pond (delivering conchostracan- and insect-bed-type assemblages): (a) small spinicaudate and laevicaudate conchostracans, (b) the aquatic wingless monuran insect *Dasyleptus*; (c) large conchostracan *Palaeolimnadiopsis*; (d) eurypterid *Adelophtalmus luceroensis*; (e) blattoid wing; (f) xiphosurid; (g) *Carbonicola*-like freshwater pelecypods. The mesophilous vegetation is dominated by cordaitaleans (C), pteridosperm foliage (P), such as odontopterids, and seed ferns, such as callipterids, growing along river courses and in the floodplain areas with high groundwater levels; xerophilous conifers such as walchians (W) grow on well drained stands of the coastal plain and in the hinterland. (Drawing St. Trümper).

represent one growth stage only (i.e., the die-off of one population). Some of these conchostracan and/or insects beds contain freshwater pelecypods of the *Carbonicola*-type, scattered on the bedding plane or, in places, forming patches. Their small sizes of up to 1 cm indicate, compared to modern unionids, juveniles of not more than one year in age. Altogether this configuration points to autochthonous assemblages preserved in short-lived freshwater puddles and ponds on the floodplain.

The question to be answered is, why is there an enrichment of isolated insect wings in these beds? It is preliminarily assumed that these isolated wings were blown by the wind across the floodplain and were finally trapped on the water surface of floodplain puddles and ponds. The unusual, very high diversity of those insect beds at Carrizo Arroyo with 30 insect genera of 17 families and 13 orders (Rasnitsyn et al., 2004) could be explained only by the following scenario: Fossiliferous deposits, such as at Carrizo Arroyo, contain an assemblage of autochthonous and allochthonous elements of the insect fauna, covering environments from the hinterland down to the seacoast. This makes the Carrizo Arroyo Fossillagerstätte exceptional.

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