

ARE-EVALUATION OF LATE PENNSYLVANIAN BROMALITES FROM THE KINNEY BRICK QUARRY LAGERSTÄTTE, NEW MEXICO, USA

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Abstract—The Kinney Brick Quarry is a Late Pennsylvanian (middle Missourian) Konservat Lagerstätte in central New Mexico that yields a diverse paleofauna and paleoflora. The fossils derive from lagoonal shales in the Tinajas Member of the Atrasado Formation. Abundant new specimens provide for a re-assessment of the bromolite ichnofauna. A diverse bromolite assemblage preserves seven morphotypes, including *Conchobromus kinneyensis* ichnogen. et ichnosp. nov., morphotype A (large, flat ovoid with little groundmass and abundant fish debris), morphotype B (no groundmass, scattered fish debris), morphotype C (medium-sized ovoid with compact bone and some groundmass), morphotype D (elongate, thick), morphotype E (small, ovoid with macerated fish debris and groundmass), morphotype F (small, linear) and morphotype G (ovoid and within digestive tract). The bromalites probably represent sharks (morphotype A, B, D, G), palaeoniscoids (morphotype C, E?, F?) or acanthodians (morphotypes E?, F?). *Conchobromus kinneyensis* could represent an acanthodian or possibly a platysomid. A variety of bromalites (one morphotype of regurgitalite, one of an incorporeal pelletite and two of coprolites) were produced by the relatively uncommon large sharks.

INTRODUCTION

The Kinney Brick Quarry is located in the Manzanita Mountains of central New Mexico and is a world-famous locality for Late Pennsylvanian fossil plants, invertebrates and vertebrates. Kinney is a classic Konservat Lagerstätte, preserving soft tissues and other delicate structures of plants and animals (Lucas and Huber, 1991; Kues and Lucas, 1992). Fossils described from the Kinney Brick Quarry include palynomorphs, a conifer-rich megaf flora, a shelly marine invertebrate assemblage dominated by brachiopods and the pectinacean bivalve *Dunbarella*, syncarid and hoplocarid crustaceans, eurypterids, conchostracans, ostracods, terrestrial arthropods, conodonts, a diverse assemblage of fish (Table 1), amphibians, bromalites and “fish eggs” (Zidek, 1992a, b; Mamay, 1994; Hunt et al., 1996; Werneburg and Lucas, 2007; Lucas et al., 2011).

Hunt (1992) described 22 bromalites from the Kinney Brick quarry, including an intestinelite (incorporeal pelletite *sensu* Hunt and Lucas, 2012), 12 coprolites and nine possible coprolites. Since that time, SGL and collaborators from NMMNH have collected a large number (>60) of additional specimens that allows for a re-assessment of the bromalite ichnofauna at Kinney (Hunt et al., 2011). The bromalites were found during the splitting of shale. Some specimens were prepared mechanically or by the use of dilute glacial acetic and muriatic acid. The purpose of this paper is to review the large sample of bromalites from the Kinney Brick Quarry with particular regard to their morphological diversity.

GEOLOGIC SETTING

The Kinney Brick Quarry is located in the Atrasado Formation, a regionally extensive stratigraphic unit of Late Pennsylvanian (Missourian-Virgilian) age (Lucas et al., 2011). The overall depositional setting of Kinney is interpreted to be that of an estuary fed by a river delta (Feldman et al., 1992; Lorenz et al., 1992).

The stratigraphic section exposed in the vicinity of the Kinney Brick Quarry is 56 m thick and exposes the Amado and Tinajas members of the Atrasado Formation (Fig. 1). Thick-bedded cherty limestone of the Amado Member forms the base of the section and is overlain by greenish-gray shale with intercalated sandstone units and gray, bedded limestone horizons of the Tinajas Member. Most of the specimens were

collected from a 0.5-m thick sequence of calcareous shales (units 2-4 of Lucas and Huber, 1991), which overlie a micritic limestone that floors the quarry within the Tinajas Member. These shales formed in a lagoonal environment (Lucas and Huber, 1991). The bromalites occur on the same laminae as fish specimens. We recognize seven morphotypes of bromalites, principally coprolites, from Kinney, as well as one new ichnospecies.

BROMALITES

Morphotype A

Morphology: Large, flat and ovoid with little groundmass and abundant fish debris.

Referred specimens: NMMNH P-19165 (Fig. 2D-E), NMMNH P-32926 (Fig. 2C), NMMNH P-32991 (Fig. 2A), NMMNH P-36034 [counterpart of NMMNH P-32911] (Fig. 2B), NMMNH P-36035.

Description: Bromalites of this morphotype are roughly ovoid in shape but often with irregular margins. They range up to 60 mm in length and 45 mm in width. The majority are composed of palaeonisciform fish debris, but a minority contain acanthodian material (e.g., NMMNH P-19165; Fig. 2D-E). They include some dark, fine-grained phosphatic groundmass.

Discussion: This morphotype is interpreted as a large coprolite rather than a regurgitalite based on the presence of extensively disarticulated and macerated fish remains preserved within groundmass in a discrete body. The only fishes large enough to produce coprolites of this size in the Kinney ichthyofauna are chondrichthyans (Zidek, 1992b), and this indicates that Pennsylvanian sharks could produce coprolites that are not spiral in form.

Morphotype B

Morphology: No groundmass, scattered fish debris.

Referred specimen: NMMNH P-19171 (Fig. 2H).

Description: NMMNH P-19171 consists of a discrete, ovoid-shaped scattering of palaeonisciform debris that covers an area of approximately 35 by 22 mm.

Discussion: The lack of groundmass and the distribution of the fish specimens within a rounded outline suggest that this morphotype possibly represents a regurgitalite of a large fish, probably a chondrichthyan.

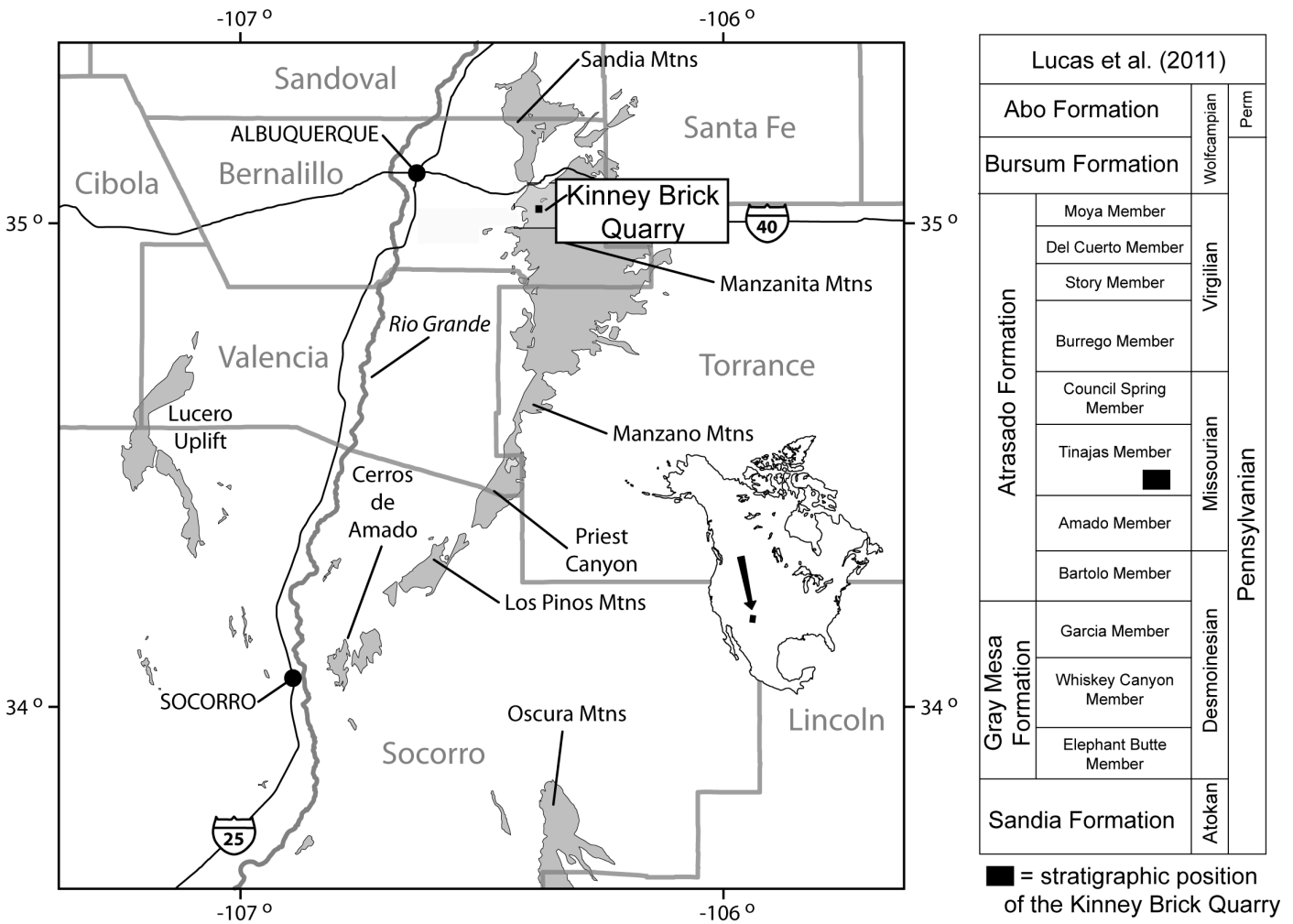


FIGURE 1. Location and stratigraphy of the Kinney Brick Quarry Lagerstätte (adapted from Lucas et al., 2011).

Morphotype C

Morphology: Medium-sized ovoid with compact bone and some groundmass.

Referred specimens: NMMNH P-19177, NMMNH P-19178, NMMNH P-19179, NMMNH P-19183, NMMNH P-19184, NMMNH P-19164 (Hunt, 1992, fig. 1C), NMMNH P-33055, NMMNH P-33056 (Fig. 2F-G), NMMNH P-33065, NMMNH P-33068, NMMNH P-33066, NMMNH P-33072 (Fig. 2J), NMMNH P-42649, NMMNH P-42669, NMMNH P-42674, NMMNH P-42673, NMMNH P-42676, NMMNH P-42677.

Description: Bromalites of this morphotype are ovoid and have dimensions that range up to 40 mm in length and up to 30 mm in width. They contain compact fish debris, principally palaeonisciform, with limited groundmass that is fine-grained and phosphatic.

Discussion: This type of bromalite is distinct from the larger ovoid morphotype (Morphotype A) in having a more subrounded shape with a smooth margin, more finely macerated fish debris and less groundmass. These specimens are considered to represent coprolites because they have the form of a rounded pellet containing finely macerated and densely packed fish debris. They typically contain only palaeonisciform debris, although some also yield some acanthodian scales (e.g., NMMNH P-19177).

Morphotype A is interpreted, based on dimensions, to have derived from sharks. Morphotype C is distinct in morphology as well as size and thus probably represents a different taxonomic group. A likely

candidate would be one of the larger platysomids (Zidek, 1992b), given their abundance in these strata (Table 1), as morphotype C is the most common coprolite at Kinney. Some specimens of this morphotype could also have been produced by one of the larger paleonisciforms (e.g., type 5 of Bardack, 1992) or a sarcopterygian (Schultze, 1992), although the latter are rare at Kinney (Table 1).

Morphotype D

Morphology: Elongate, thick.

Referred specimen: NMMNH P-19163 (Hunt, 1992, fig. 1E; Fig. 2I).

Description: NMMNH P-19163 is linear with an expanded rounded tip at one end and a broken termination at the other (Fig. 2I). It is 69 mm long, with a maximum width of 28 mm and a thickness of 9 mm. Its cross section is a flattened ovoid.

Discussion: This morphotype is represented by only one specimen. It differs from all the other bromalites at Kinney in having a substantial thickness, even though it is somewhat flattened. Hunt (1992) suggested that it was spiral in structure, but this structure is poorly developed. The large size of the coprolite and its possible spiral structure suggest that it may have been produced by one of the large sharks represented at Kinney, such as *Symmorium* (Zidek, 1992b).

Morphotype E

Morphology: Small ovoid with macerated fish debris and groundmass.

TABLE 1 Relative abundance (S.C. Williams, person. commun., 2009), maximum size and diet of the fossil fish from the Kinney Brick Quarry Lagerstätte. Palaeoniscoids 1-6* were recognized by Bardack (1992).

Kinney Brick Quarry fish taxa	Total Number of specimens	% Total	Maximum length (mm)	Diet
Paleoniscoid indet.	229	48.57	220	unknown
<i>Platysomus</i> sp., <i>P. schultzei</i>	128	21.44	142	Durophage
<i>Acanthodes kinneyi</i>	110	18.42	280	Piscivore?/ ?conchostracans
<i>Schizolepis manzanitaensis</i>	29	4.85	100	Generalist
<i>Amphicentrum jurgenai</i>	22	3.68	75	Generalist
Paleoniscoid "small scale"	17	2.84	unknown	unknown
Paleoniscoid Type 6*	16	2.68	120	Generalist
Actinistia indet.	13	2.18	unknown	unknown
Paleoniscoid Type 5*	5	0.84	220	Piscivore
Rhabdodermidae Type 1	4	0.67	unknown	
<i>Cobelodus aculeatus</i>	4	0.67	41 (juvenile)	Piscivore
Paleoniscoid Type 3*	3	0.50	85	unknown
<i>Symmorium reniforme</i>	3	0.50	2500	Piscivore
Rhabdodermidae Type 2	2	0.33	unknown	unknown
Coelacanthidae indet.	1	0.17	180	unknown
<i>Sagenodus hlavini</i>	1	0.17	unknown	unknown
<i>Orthacanthus huberi</i>	1	0.17	1000	Piscivore
<i>Peripristis</i> aff. <i>P. semicircularis</i>	1	0.17	unknown	unknown
<i>Listracanthus</i> sp.	1	0.17	unknown	unknown
cf. <i>Bourbonella</i>	1	0.17	83	unknown
<i>Pyritocephalus lowneyae</i>	1	0.17	35	unknown
Paleoniscoid Type 1*	1	0.17	90	unknown
Paleoniscoid Type 2*	1	0.17	85	unknown
Paleoniscoid Type 4*	1	0.17	90	unknown
Paleoniscoid "hook scale"	1	0.17	unknown	unknown

Referred specimens: NMMNH P-19155 (Hunt, 1992, fig. 2D), NMMNH P-19158 (Fig. 3B-C), NMMNH P-19166, NMMNH P-29376 (Fig. 3D), NMMNH P-32910, NMMNH P-32925 (Fig. 3A), NMMNH P-33057, NMMNH P-33071.

Description: Bromalites of this morphotype are ovoid in shape and approximately half the size of the those of morphotype C – NMMNH P-19155 (9 by 5 mm), NMMNH P-19158 (15 by 12 mm), NMMNH P-19166 (17 by 8 mm), NMMNH P-29376 (10 by 7 mm), NMMNH P-32925 (11 by 7 mm), NMMNH P-32910 (20 by 9 mm), NMMNH P-33057 (13 by 13 mm), NMMNH P-33071 (10 by 9 mm). They contain macerated fish debris and some groundmass. Most of these bromalites are composed of palaeonisciform remains, although NMMNH P-19155 includes some small acanthodian spines.

Discussion: Bromalites of this morphotype are more similar to the medium-sized ovoid specimens of morphotype C than to the large specimens of morphotype A. They are considered to represent coprolites because they consist of finely macerated fish debris that is preserved in a rounded body with a small amount of phosphatic groundmass. Given the small size of these coprolites they could have been produced by several of the smaller fish at Kinney (or even small representatives of the larger ones), such as acanthodians and palaeonisciforms.

Morphotype F

Morphology: Small and linear.

Referred specimens: NMMNH P-19161 (Hunt, 1992, fig. 1G;

Fig. 3E-F), NMMNH P-19162 (Fig. 3I), NMMNH P-30879, NMMNH P-30883, NMMNH P-33070 (Fig. 3G-H).

Description: Coprolites of this morphotype are small (5-11 mm in length), narrow (1-2 mm in width), linear and composed of finely macerated fish debris. The majority of the specimens are straight, but one (NMMNH P-19161) is flexed at almost a right angle (Fig. 3E-F). NMMNH P-19162 displays slight decomposition around its margins (Hunt, 1992, fig. 1G). There is no groundmass within these bromalites.

Discussion: These specimens are considered to represent coprolites rather than regurgitalites, even though they contain little or no groundmass, because they are discrete bodies of finely macerated fish material. These coprolites are in a much smaller size class than other morphotypes from Kinney. They presumably derive from a small fish, possibly a haplolepid such as *Pyritocephalus* (Huber, 1992b), a small palaeonisciform (Bardack, 1992) or an acanthodian (Zidek, 1992b).

Morphotype G

Morphology: Ovoid and within digestive tract.

Referred specimen: NMMNH P-19182, skeleton of the symmoriid chondrichthyan *Cobelodus aculeatus* with a intestinelite in the posterior digestive tract (Hunt, 1992, fig. 2; Zidek, 1992b, fig. 3A; Hunt and Lucas, 2010, fig. 1a; Fig. 4).

Description: The intestinelite, an incorporeal pelletite *sensu* Hunt and Lucas (2012), is 28 mm long and broadly oval in lateral view but with a more rounded posterior termination anterior and a more acute anterior

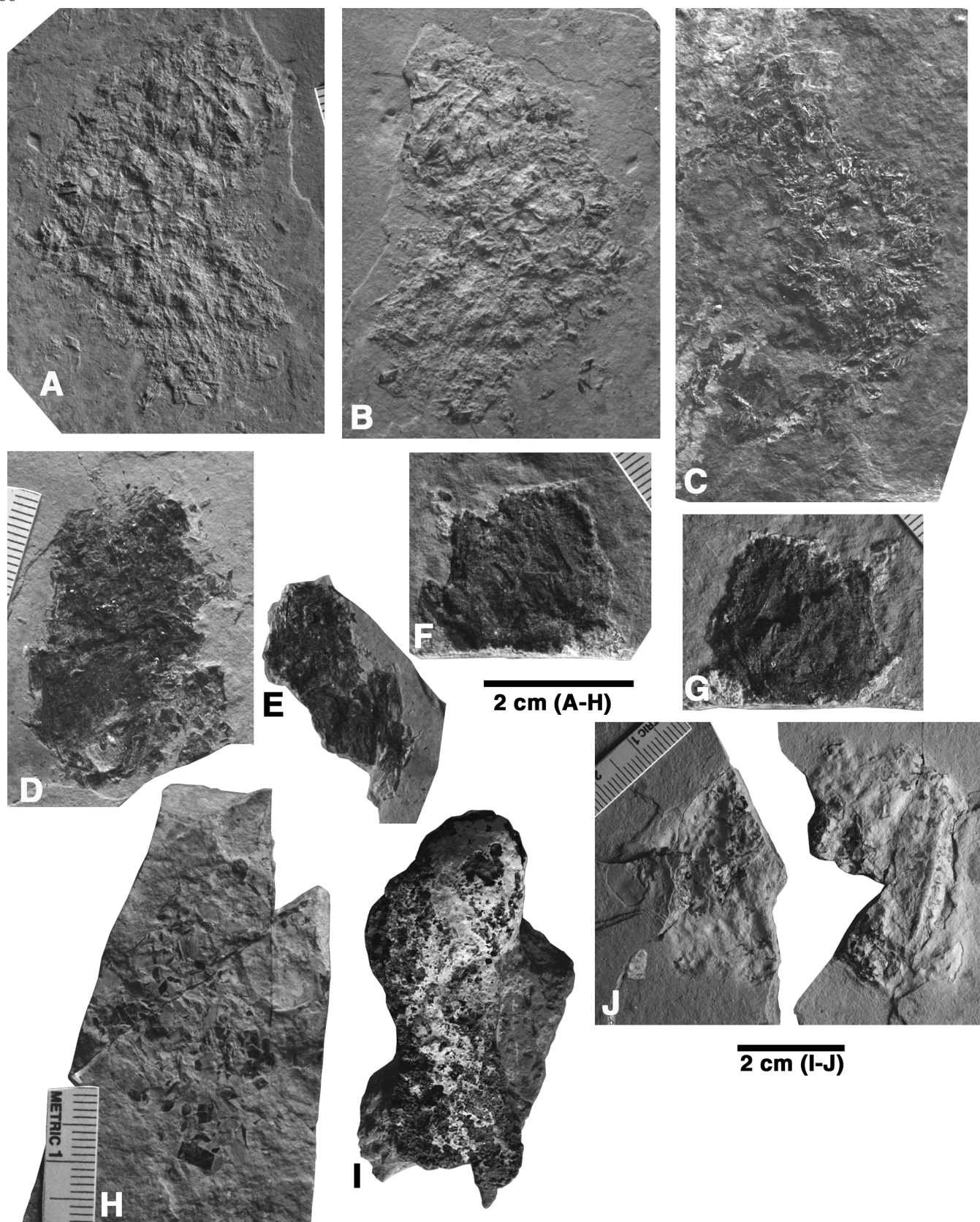


FIGURE 2. Kinney Brick quarry bromalite morphotypes. **A-E**, Morphotype A, large, flat ovoid with little groundmass and abundant fish debris: **A**, NMMNH P-32911 and **B**, NMMNH P-36034, counterpart of NMMNH P-32911; **C**, NMMNH P-32926; **D-E**, NMMNH P-19165, **D**, part and **E**, counterpart. **F-G, J**, Morphotype C, medium-size ovoid with compact bone and some groundmass; **F-G**, NMMNH P-33056, **F**, part and **G**, counterpart; **J**, NMMNH P-33072. **H**, Morphotype B, no groundmass, with scattered fish debris, NMMNH P-19171. **I**, Morphotype D, elongate, thick coprolite, NMMNH P-19163.

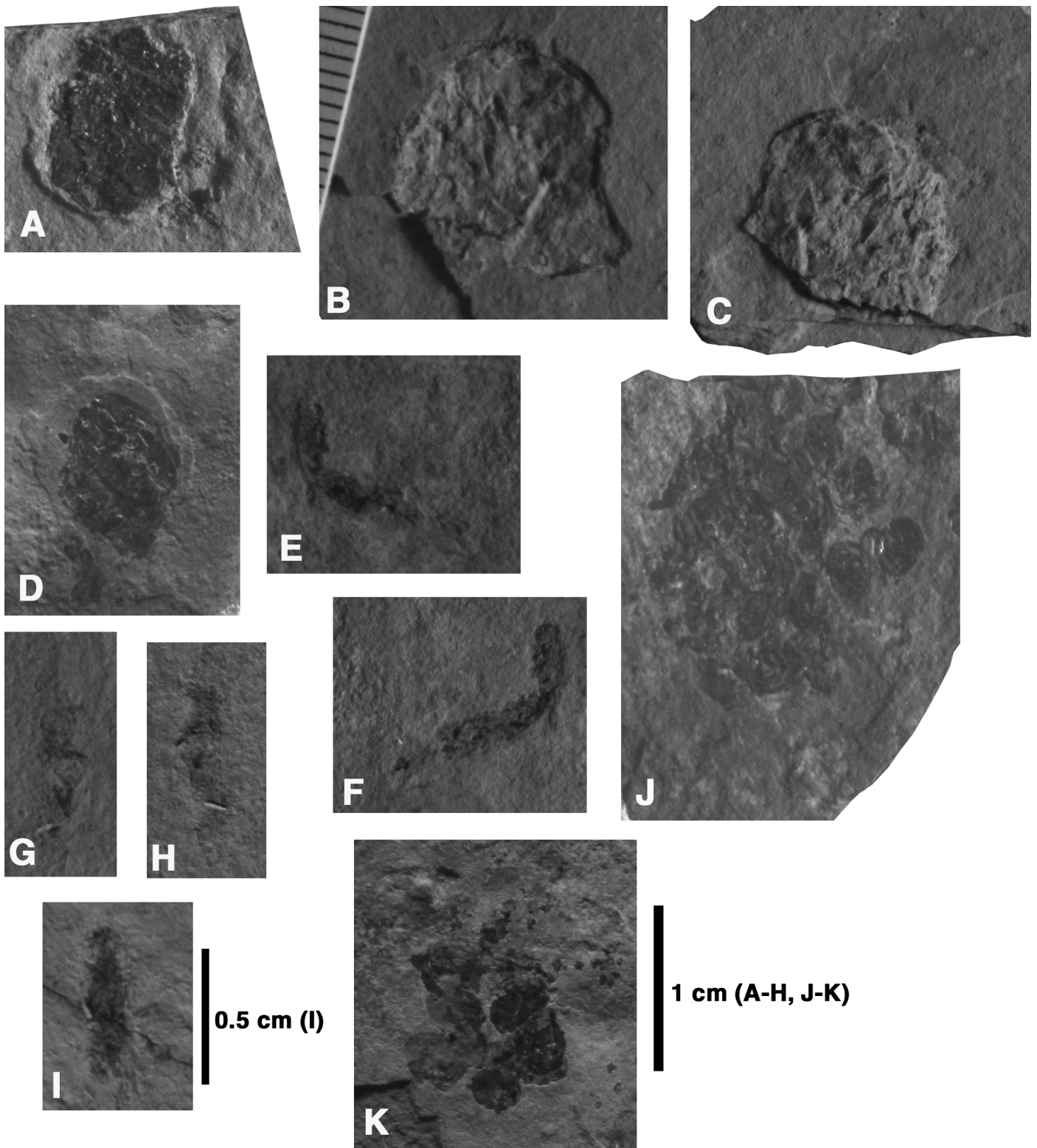


FIGURE 3. Kinney Brick quarry bromalite morphotypes. **A-D**, Morphotype E, small ovoid with macerated fish debris and groundmass: **A**, NMMNH P-32925; **B-C**, NMMNH P-19158, **B**, part and **C**, counterpart; **D**, NMMNH P-29376. **E-I**, Morphotype F, small linear coprolite, **E-F**, NMMNH P-19161, **E**, part and **F**, counterpart; **G-H**, NMMNH P-33070, **G**, part and **H**, counterpart; **I**, NMMNH P-19162. **J-K**, *Conchobromus kinneyensis*, **J**, NMMNH P-19157; **K**, NMMNH P-19156.

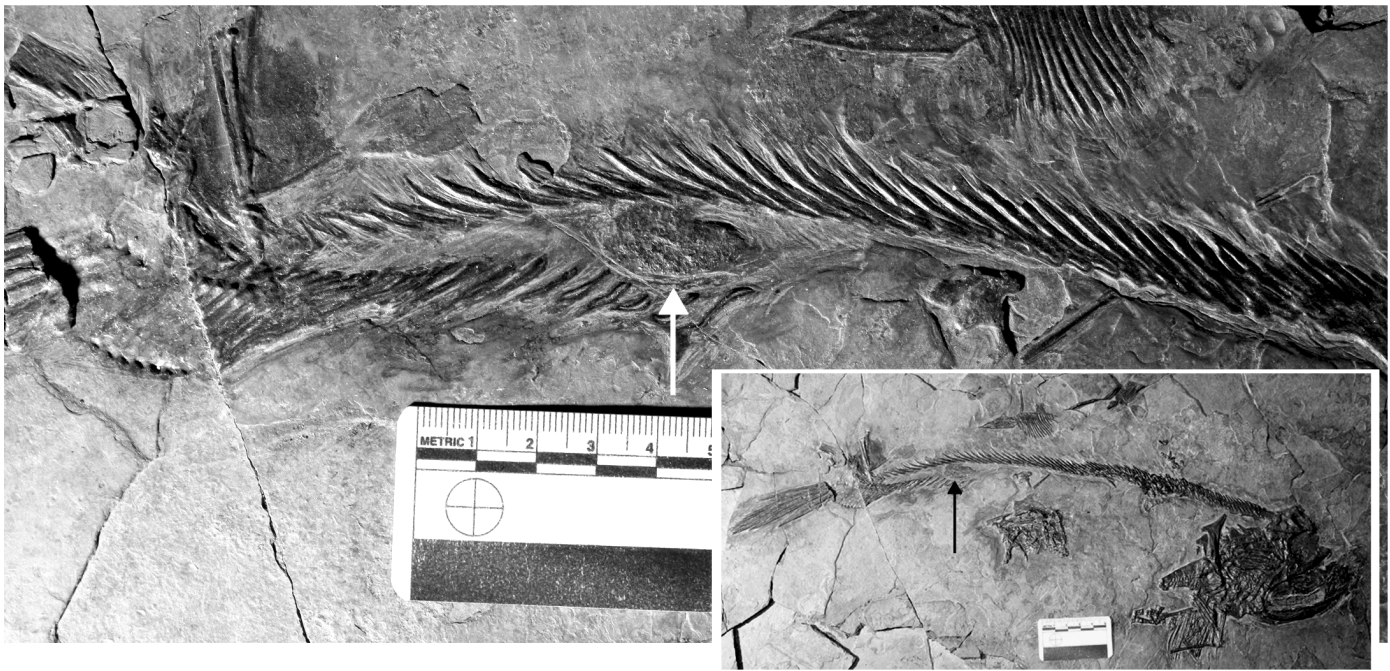


FIGURE 4. Kinney Brick intestinelite. NMMNH P-19182, skeleton of the symmoriid *Cobelodus aculeatus* with incorporal pelletite in the posterior digestive tract.

one (Fig. 4). It contains macerated fish debris that appears to be acanthodian.

Discussion: The intestinelite represents a formed pellet and therefore it is presumably located within the colon or cloaca, posterior to the spiral valve.

Unassigned morphotype

Referred specimens: NMMNH P-19153 (Hunt, 1992, fig. 1J), NMMNH P-19154, NMMNH P-23976 (11 specimens), NMMNH P-32943, NMMNH P-33071, NMMNH P-33082, NMMNH P-33083, NMMNH P-31091, NMMNH P-42675, NMMNH P-33077, NMMNH P-33081, NMMNH P-33082, NMMNH P-42672.

Discussion: There are 23 coprolites that are not assigned to a morphotype, most of which are partial specimens or are covered by thin laminae of shale.

Conchobromus, ichnogen. nov.

Type species: *Conchobromus kinneyensis* Hunt et al., 2012.

Included species: Known only from the type species.

Etymology: From the Greek *konche* (shell), in allusion to the characteristic valves of conchostracans, and *broma* (food).

Distribution: Late Pennsylvanian of New Mexico.

Diagnosis: Bromalite that differs from other named ichnogenera in being flattened and ovoid in shape and composed predominantly of conchostracan valves with little groundmass.

Discussion: Huber (1992a, p. 9, fig. 2) considered that the specimen, here described as the holotype, represented a “current-deposited grouping of disarticulated carapaces.” Conchostracans are common at the Kinney Brick Quarry, but there is little evidence of significant currents in the lagoon and it is most parsimonious to consider that the repetitive occurrence of these small ovoid concentrations of conchostracans has a biological origin. The relative lack of groundmass in the specimens from Kinney may indicate that *Conchobromus* represents a regurgitalite (cf. McAllister, 1988; Myhrvold, 2011; Hunt and Lucas, 2012). This would be consistent with the concentration of probably indigestible conchostracan valves. However, it is clear that multiple conchostracan valves were ingested by some acanthodians (Fig. 5) and that they are

present throughout the digestive tract, and thus coprolites rich in such valves would be the logical result. Another possible source of conchostracan-bearing bromalites would be the duraphagous platysomids that are abundant at Kinney (Zidek, 1992; Table 1).

Conchobromus kinneyensis, ichnosp. nov.

Holotype: NMMNH P-19157, bromalite (Hunt, 1992, fig. 1H; Fig. 3J).

Etymology: For the Kinney Brick Quarry, which yielded the holotype.

Type locality: Kinney Brick Quarry, Bernalillo County, New Mexico.

Type horizon: Tinajas Member of the Altrasado Formation (Late Pennsylvanian: middle Missourian).

Distribution: As for genus.

Referred specimens: Kinney Brick Quarry, Bernalillo County, New Mexico (NNMNH L-345): NMMNH P-12994, NMMNH P-19156 (Fig. 3K), NMMNH P-19166; Tinajas Lagerstätte, Socorro County, New Mexico (NNMNH L-4667): NMMNH P-37668, NMMNH P-37673, NMMNH P-37667, NMMNH P-37675.

Diagnosis: As for genus.

Description: NMMNH P-19157 is a partial bromalite with an ovoid outline preserved on a sheet of matrix (Fig. 3J). The preserved dimensions are 26 mm by 21 mm. The bromalite consists primarily of densely packed and disarticulated valves of the conchostracan *Pseudestheria* sp. (Kozur et al., 1992), which are slightly more segregated towards the broken margin of the specimen. There is little or no groundmass between the conchostracans.

Discussion: All the referred specimens preserve the same ovoid morphology and contain concentrated valves of conchostracans. Some bromalites are smaller, and NMMNH P-19156 preserves a whole specimen that is only 14 mm long and 10 mm wide.

CONCLUSIONS

The Kinney Brick Quarry Lagerstätte has produced an abundant ichthyofauna that consists primarily of palaeoniscoids, acanthodians with actinopterygians, chondrichthyans, and sarcopterygians (Zidek,

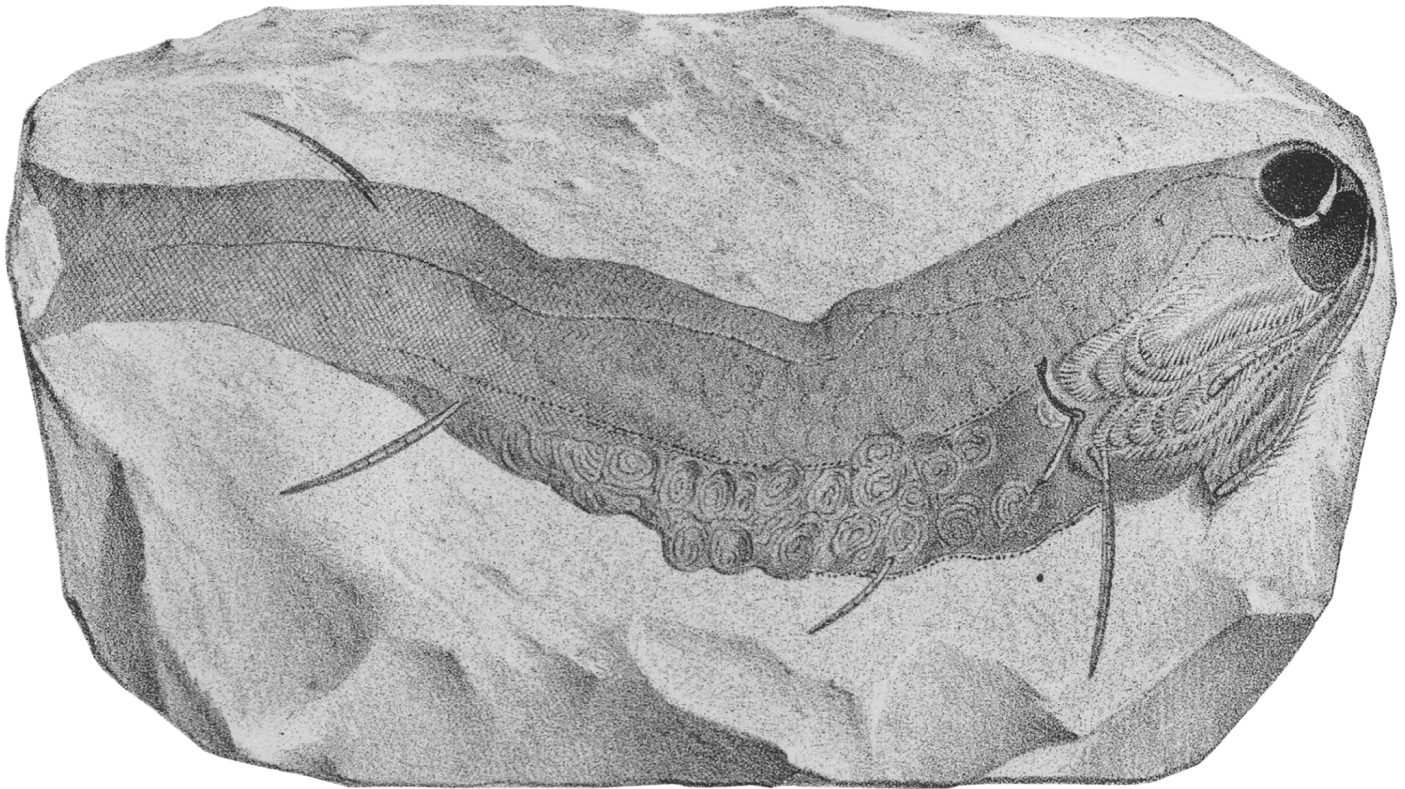


FIGURE 5. Lower Permian acanthodian from the Lebach Beds of Germany preserving a consumolite (*sensu* Hunt and Lucas, 2012) comprised of valves of conchostracans (from Kner, 1868, pl. 5).

1975, 1992b; Gottfried, 1987a, b, 1992; Bardack, 1992; Huber, 1992b; Schultze, 1992; Lucas et al., 2011; Table 1). The most common specimens (48.57% of total) represent indeterminate palaeoniscoids (Table 1). The identifiable fish are dominated by *Platysomus* spp. (21.44% of total) and *Acanthodes kinneyi* (18.42%). Several other taxa represent between 2% and 5% of the fauna – *Schizolepis manzanitaensis*, *Amphicentrum jurgenai*, “small scale” palaeoniscoid and palaeoniscoid type 6 (of Bardack, 1992). The majority of bromalites described herein contain palaeonisciform remains, with only a few containing acanthodian specimens or conchostracans, and only two yielding shark material (Hunt, 1992). The bromalites were probably produced by sharks (morphotype A, B, D, G), palaeoniscoids (morphotype C, E?, F?) or acanthodians (morphotypes E?, F?). *Conchobromus kinneyensis* could represent the remains of an acanthodian or possibly a platysomid. It is interesting that

the Kinney ichnofauna sample includes a variety of bromalites (one morphotype of regurgitalite, one of an incorporeal pelletite and two of coprolites) apparently produced by large sharks, which are relatively uncommon at the locality.

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REFERENCES

- Bardack, D., 1992, Late Pennsylvanian palaeonisciform fish from the Kinney Quarry, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 197-203.
- Feldman, H.R., Archer, A.W., West, R.R. and Maples, C.G., 1992, The Kinney Brick Company Quarry: Preliminary analysis using an estuarine depositional model: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 21-26.
- Gottfried, M.D., 1987a, A Pennsylvanian aedeulliform (Osteichthyes, Actinopterygii) from North America with comments on aedeulliform relationships: *Paläontologische Zeitschrift*, v. 61, p. 141-148.
- Gottfried, M.D., 1987b, A new long-snouted actinopterygian fish from the Pennsylvanian of north-central New Mexico: *New Mexico Journal of Science*, v. 27, p. 7-19.
- Gottfried, M.D., 1992, A new deep scaled “palaeoniscoid” from the Kinney Quarry, Late Pennsylvanian of New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 189-196.
- Huber, P., 1992a, Faunal distribution, seasonal deposition, and taphonomy at the Upper Pennsylvanian (Missourian) Kinney Brick Company quarry, central New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 37-48.
- Huber, P., 1992b, *Pyritocephalus lowneyae* n. sp., the youngest Haplolepidiformes (Pisces: Actinopterygii) from the Pennsylvanian of central New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 183-187.
- Hunt, A.P., 1992, Late Pennsylvanian coprolites from the Kinney Brick Quarry, central New Mexico, with notes on the classification and the

- utility of coprolites: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 221-229.
- Hunt, A.P. and Lucas, S.G., 2012, Classification of vertebrate coprolites and related trace fossils: New Mexico Museum of Natural History, Bulletin 57, this volume.
- Hunt, A.P., Lucas, S.G. and Berman, D.S., 1996, A new amphibamid (Amphibia: Temnospondyli) from the Late Pennsylvanian (Middle Stephanian) of central New Mexico, USA: *Paläontologische Zeitschrift*, v. 7, p. 555-565.
- Hunt, A.P., Lucas, S.G. and Spielmann, J.A., 2011, A re-evaluation of the coprocoenosis from the Upper Pennsylvanian Kinney Brick Quarry, central New Mexico: *New Mexico Geology*, v. 33, p. 54-55.
- Kner, R., 1868, Über *Conchopoma gadiforme* nov. gen. et spec. und *Acanthodes* aus dem Rothliegenden (der untern Dyas) von Lebach bei Saarbriicken in Rheinpreussen: *Wiener Akademie Wissenschaften Sitzungberichte*, v. 57, p. 278-305.
- Kozur, H., Lucas, S.G. and Hunt, A.P., 1992, Preliminary report on Late Pennsylvanian Conchostraca from the Kinney Brick Quarry, Manzanita Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 123-126.
- Kues, B.S. and Lucas, S.G., 1992, Overview of Upper Pennsylvanian stratigraphy and paleontology of the Kinney Brick Quarry, Manzanita Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 1-11.
- Lorenz, J.C., Smith, G.S. and Lucas, S.G., 1992, Sedimentation patterns in Pennsylvanian Strata at the Kinney Brick Quarry, Bernallilo County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 3-19.
- Lucas, S.G. and Huber, P., 1991, Late Pennsylvanian stratigraphy and paleontology of the Kinney Brick Quarry, Manzanita Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 137, p. 79-86.
- Lucas, S.G., Allen, B.D., Krainer, K., Barrick, J., Vachard, D., Schneider, J.W., DiMichele, W.A. and Bashforth, A.R., 2011, Precise age and biostratigraphic significance of the Kinney Brick Quarry Lagerstätte, Pennsylvanian of New Mexico, USA: *Stratigraphy*, v. 8, p. 7-27.
- Mamay, S.H., 1994, Fossil eggs of probable piscine origin preserved on Pennsylvanian *Sphenopteridium* foliage from the Kinney Quarry, central New Mexico: *Journal of Vertebrate Paleontology*, v. 14, p. 320-326.
- McAllister, J.A., 1988, Preliminary description of the coprolitic remains from Hamilton quarry, Kansas: Kansas Geological Survey, Guidebook 6, p. 195-202.
- Myhrvold, N.P., 2011, A call to search for fossilized gastric pellets: *Historical Biology*, v. 24, p. 505-517.
- Schultze, H.P., 1992, Coelacanth fish (Actinista, Sarcopterygii) From the Late Pennsylvanian of the Kinney Brick Company Quarry, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 205-209.
- Werneburg, R. and Lucas, S.G., 2007, "*Milnerpeton*" from the Late Pennsylvanian of New Mexico is the first truly "European branchiosaurid" from North America: *Journal of Vertebrate Paleontology*, v. 27 (supplement to no. 3), p. 164A.
- Zidek, J., 1975, Some fishes of the Wild Cow Formation (Pennsylvanian) Manzanita Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 135, p. 1-22.
- Zidek, J., 1992a, editor, *Geology and paleontology of the Kinney Brick Quarry, Late Pennsylvanian, central New Mexico*: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, 242 p.
- Zidek, J., 1992b, Late Pennsylvanian Chondrichthyes, Acanthodii, and deep bodied Actinopterygii from the Kinney Quarry, Manzanita Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 138, p. 145-182.