

# A SUMMARY OF LATE CRETACEOUS AMMONITES AND MOLLUSCAN ZONES, EASTERN SAN JUAN BASIN, RIO ARRIBA COUNTY, NEW MEXICO

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Upper Cretaceous strata exposed on the eastern side of the San Juan Basin in Rio Arriba County, New Mexico, contain ammonites and other marine molluscan fossils that date from the Turonian, Coniacian and Campanian stages. The stratigraphic units are Greenhorn Limestone, Carlile, Juana Lopez, El Vado Sandstone and Satan members of the Mancos Shale and Lewis Shale. The *Mytiloides mytiloides* inoceramid zone in the Greenhorn Limestone indicates the ammonite zone of *Mammites nodosoides* and thus a latest early Turonian age. The *Collignoniceras woollgari regulare* Subzone of the *C. woollgari* Zone and the *Prionocyclus hyatti* Zone are present in the Carlile Member. These zones represent the middle Turonian. The *Prionocyclus macombi* Zone is present just below the lower calcarenite of the Juana Lopez Member, and the *Scaphites warreni* and *S. ferronensis* zones occur in the upper calcarenite of the Juana Lopez. The *Coilopoceras colleti* Subzone of the *P. macombi* Zone and the *Inoceramus dimidius* inoceramid zone are also present in the Juana Lopez. The *P. macombi*, *S. warreni* and *S. ferronensis* zones indicate the lower part of the upper Turonian. The inoceramid *Magadiceramus complicatus* (Heine) indicates the *Scaphites depressus* Zone and thus a late Coniacian age for the top of the El Vado Sandstone in the Llaves area. Fossils representative of the Santonian stage have not been collected from the study area. The lowermost Campanian *Scaphites leei* III Zone is present in the upper Satan Tongue near Gallina. The lower Campanian *Scaphites hippocrepis* I Zone is present in the uppermost Satan Tongue near Llaves. Ammonites and inoceramids collected from the upper part of the Lewis Shale in the eastern San Juan Basin are middle to late Campanian in age. The ammonite zones include the lowermost middle Campanian *Baculites obtusus* Zone, the lower middle Campanian *B. mclerni*, *B. asperiformis* and *Baculites* sp. (smooth species) zones, the upper middle Campanian *B. perplexus* and *B. gregoryensis* zones, possibly the upper middle Campanian *B. reduncus* Zone, the uppermost middle Campanian *B. scotti* Zone, the lowermost upper Campanian *Didymoceras nebrascense* Zone, the lower upper Campanian *Exiteloceras jenneyi* and *D. cheyennense* zones and possibly the middle upper Campanian *B. compressus* Zone. Twelve ammonite zones were identified from the Lewis Shale, and a total of 21 ammonite zones are present or indicated in Upper Cretaceous strata in the eastern San Juan Basin in Rio Arriba County.

We report *Placentoceras pseudoplacenta* Hyatt from the *Prionocyclus hyatti* Zone and *Baculites yokoyamai* Tokunaga and Shimizu from the *Scaphites warreni* and *S. ferronensis* zones. *P. pseudoplacenta* and *B. yokoyamai* have not previously been reported from Rio Arriba County. From the Satan Tongue, we report the nautiloid *Eutrephoceras alicesense* Reeside and the ammonites *Menabites (Delawarella) vanuxemi* (Morton), *P. syrtales* (Morton), *P. placenta* (DeKay), *Glyptoxoceras*, *B. aquilaensis* Reeside, *Scaphites (Scaphites) hippocrepis* (DeKay) I Cobban and *Haresiceras (Haresiceras) montanaense* (Reeside). All, except the latter species, have not previously been reported from the eastern San Juan Basin in Rio Arriba County.



FIGURE 3. Outcrops east of Llaves where the *Prionocyclus hyatti* Zone occurs in the Carlile Member and the *Prionocyclus macombi* and *Scaphites warreni* zones occur in the Juana Lopez Member. Greenhorn limestone in foreground at left, Carlile near center and Juana Lopez in background at right.



FIGURE 4. Exposure of upper part of Satan Tongue overlain by Pointlookout Sandstone capping cliff north of Llaves.



FIGURE 5. Exposure of Lewis Shale overlain by the Ojo Alamo Formation north of Llaves.



FIGURE 6. *Prionocyclus hyatti* (Stanton) in a concretion in the Carlile Member. Rock hammer for scale.



FIGURE 7. Large concretionary bed with several *Prionocyclus macombi* Meek (black arrows) and *Inoceramus dimidius* White (red arrow) in Juana Lopez. Rock hammer for scale.



FIGURE 1. Map of study area in the eastern San Juan Basin of northern New Mexico showing some of the place names referred to in this report. Terrain map from Google Maps © with modification.

Stage	substage	Ammonite Zone	Inoceramid Zone	Formation/Member
Campanian (pars)	Upper (pars)	<i>Baculites compressus</i> **	<i>Inoceramus</i> aff. <i>dimidius</i> *	Lewis Shale
		<i>Didymoceras cheyennense</i> *	<i>Sphaeroceras personiformis</i> **	
		<i>Didymoceras nevadense</i> *		
		<i>Didymoceras nebrascense</i> *		
		<i>Baculites scotti</i> *	<i>Inoceramus</i> aff. <i>emulnatus</i> **	
		<i>Baculites robustus</i> *		
	Middle	<i>Baculites yokoyamai</i> *	<i>Catoceras subcompressus</i> **	Lewis Shale
		<i>Baculites nebrascense</i> *		
		<i>Baculites sp. (smooth species)</i> *		
		<i>Baculites asperiformis</i> *		
		<i>Baculites mclerni</i> *	<i>Inoceramus</i> aff. <i>acrobifurcatus</i> *	
		<i>Baculites obtusus</i> *		
Lower	<i>Baculites sp. (weak thick ribs)</i> *	<i>Catoceras balticus</i>		
	<i>Baculites sp. (smooth)</i> *			
	<i>Scaphites hippocrepis</i> III			
	<i>Scaphites hippocrepis</i> II			
	<i>Scaphites hippocrepis</i> I*		Satan Tongue	
	<i>Scaphites leei</i> III			
Santonian	Upper	<i>Democeras balticus</i>	<i>Sphaeroceras handbreckenensis</i>	
		<i>Democeras eridaniensis</i>	<i>Cardiceras muellei</i>	
	Middle	<i>Chioscapites chiosensis</i>	<i>Cardiceras buhlenensis</i>	
		<i>Chioscapites vermiformis</i>	<i>Cladoceras andalupicatus</i>	
	Lower	<i>Chioscapites saumumensis</i>		
Coniacian	Upper	<i>Scaphites depressus</i> **	<i>Magadiceramus cretaceus</i> ***	El Vado Member
			<i>Magadiceramus subquadratus</i>	
	Middle	<i>Scaphites venosus</i>	<i>Fabriceceramus insularis</i>	
			<i>Inoceramus gibbosus</i>	
	Lower			
		<i>Scaphites presentensis</i>	<i>Cremnoceras crassus crassus</i>	
Turonian	Upper		<i>Cremnoceras crassus inconstans</i>	
			<i>Cremnoceras deformis dohrigensis</i>	
			<i>Cremnoceras deformis erectus</i>	
			<i>Cremnoceras waltersdoerferi</i>	
			<i>Mytiloides scapiti</i>	
			<i>Mytiloides incertus</i>	
	Middle	<i>Scaphites marionensis</i>	<i>Inoceramus dimidius</i> *	Juana Lopez Member
		<i>Prionocyclus garneri</i>	<i>Inoceramus</i> aff. <i>dimidius</i> *	
		<i>Scaphites nigricollis</i>		
		<i>Scaphites whitfieldi</i>	<i>Inoceramus dolabatus</i>	Carlile Member
			<i>Inoceramus porphyreus</i>	
Lower	<i>Scaphites ferronensis</i> *			
	<i>Scaphites warreni</i> *			
	<i>Prionocyclus macombi</i> *			
	<i>Prionocyclus hyatti</i>		Carlile Member	
	<i>Collignoniceras procerus</i>	<i>Inoceramus howelli</i> *		
	<i>Collignoniceras woollgari</i> *	<i>Mytiloides heryanicus</i> **	Carlile Member	
Coniacian	Upper	<i>Mammites nodosoides</i> **	<i>Mytiloides subbrachyotus</i>	Greenhorn Limestone
		<i>Mytiloides mytiloides</i> **		
	Lower	<i>Inoceramus birchbyi</i>	<i>Mytiloides kossmati</i>	
		<i>Pseudaplicoceras fitzsimonsi</i>		
		<i>Wattoceras deventense</i>	<i>Mytiloides pueblensis</i>	
		<i>Nigeroceras scotti</i>	<i>Mytiloides huxleyi</i>	
Cenomanian	Upper	<i>Nigeroceras judithi</i>		
		<i>Burroceras cylense</i>	<i>Inoceramus pictus</i>	
		<i>Eusphaloceras septemnotatum</i>		
		<i>Inoceramus albertense</i>	<i>Inoceramus ginterensis</i>	
		<i>Duwigoceras albertense</i>		
		<i>Calycoceras cantuarum</i>	<i>Inoceramus profugus</i>	

FIGURE 2. Western Interior biostratigraphic zonal table showing Lower Turonian to upper Campanian ammonite and inoceramid zones present on the eastern side of the San Juan Basin in Rio Arriba County, New Mexico. A single asterisk means the index taxon has been collected from the study area and a double asterisk signifies an inferred zone. A triple asterisk signifies that the index taxon has not been recovered but a concurrent taxon has been recovered. Table modified from Cobban et al. (2006, 2008), Merewether et al. (2011, fig. 2), Plint et al. (2017) and Walaszczyk et al. (2017, p. 57, figs. 2-3).

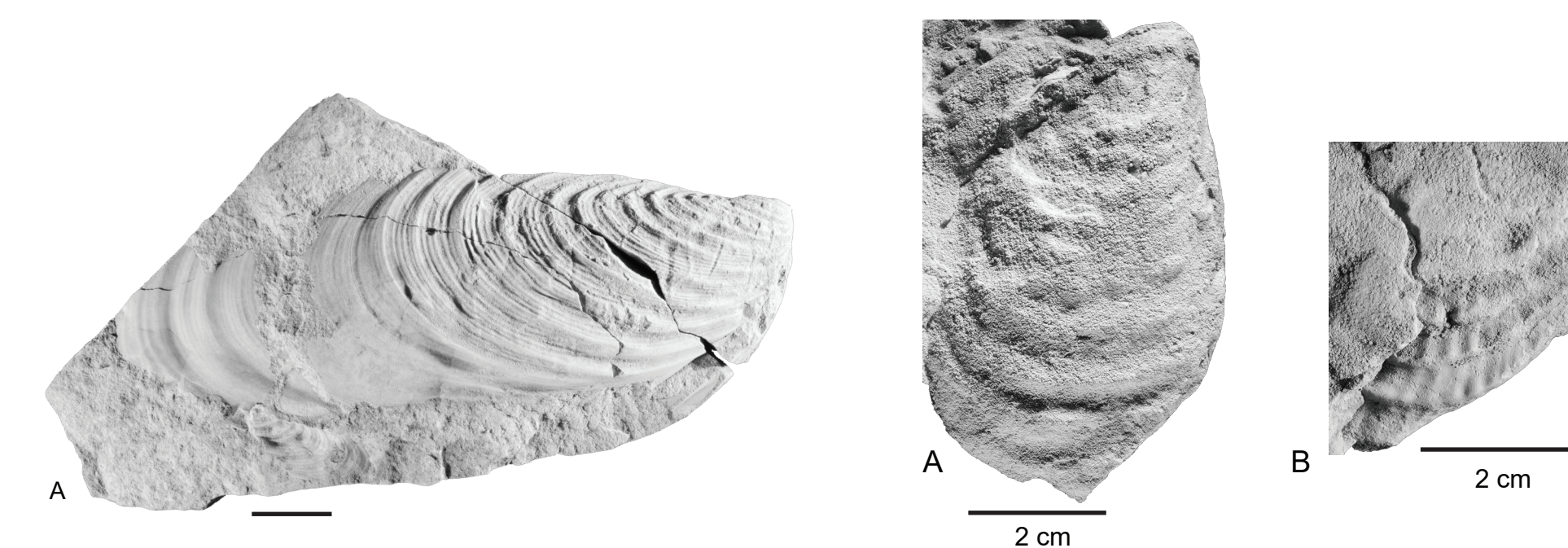


FIGURE 8. A. *Mytiloides mytiloides* (Mantell), lateral view, from the Greenhorn Limestone. Scale equals 2 cm.

Figure 9. A-B, *Magadiceramus complicatus* (Heine) from the El Vado Sandstone demonstrates the concentric, sharp-edged rugae with wide and flat-floored interspaces and radial ribs typical of this taxon.

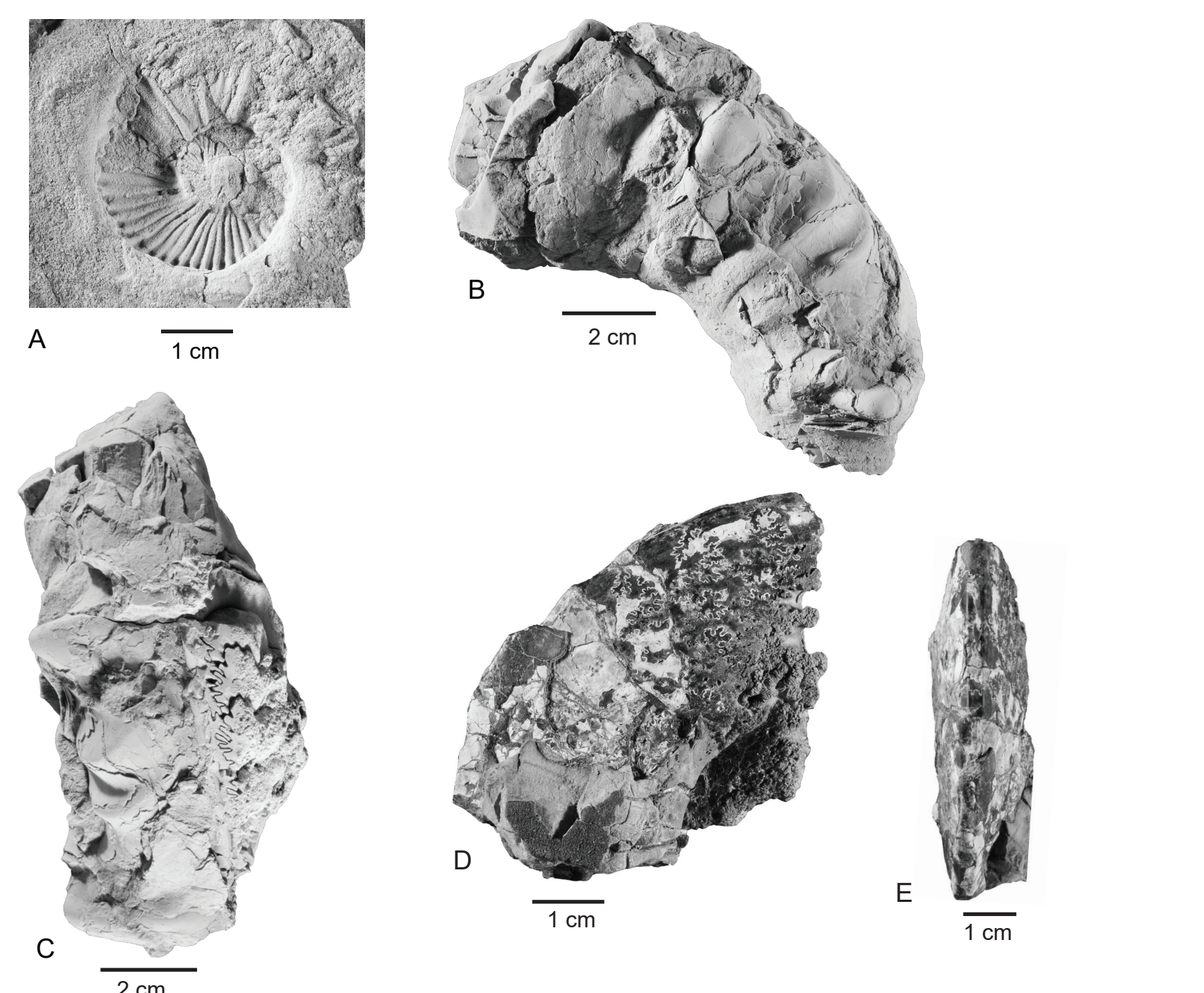


FIGURE 10. Ammonites from the Carlile Member. A, *Collignoniceras woollgari regulare*, lateral view of an impression of a juvenile; B-C, *Prionocyclus hyatti* (Stanton), B, lateral and C, ventral views; D-E, *Placentoceras pseudoplacenta* Hyatt, D, lateral and E, ventral views. Scales as indicated.

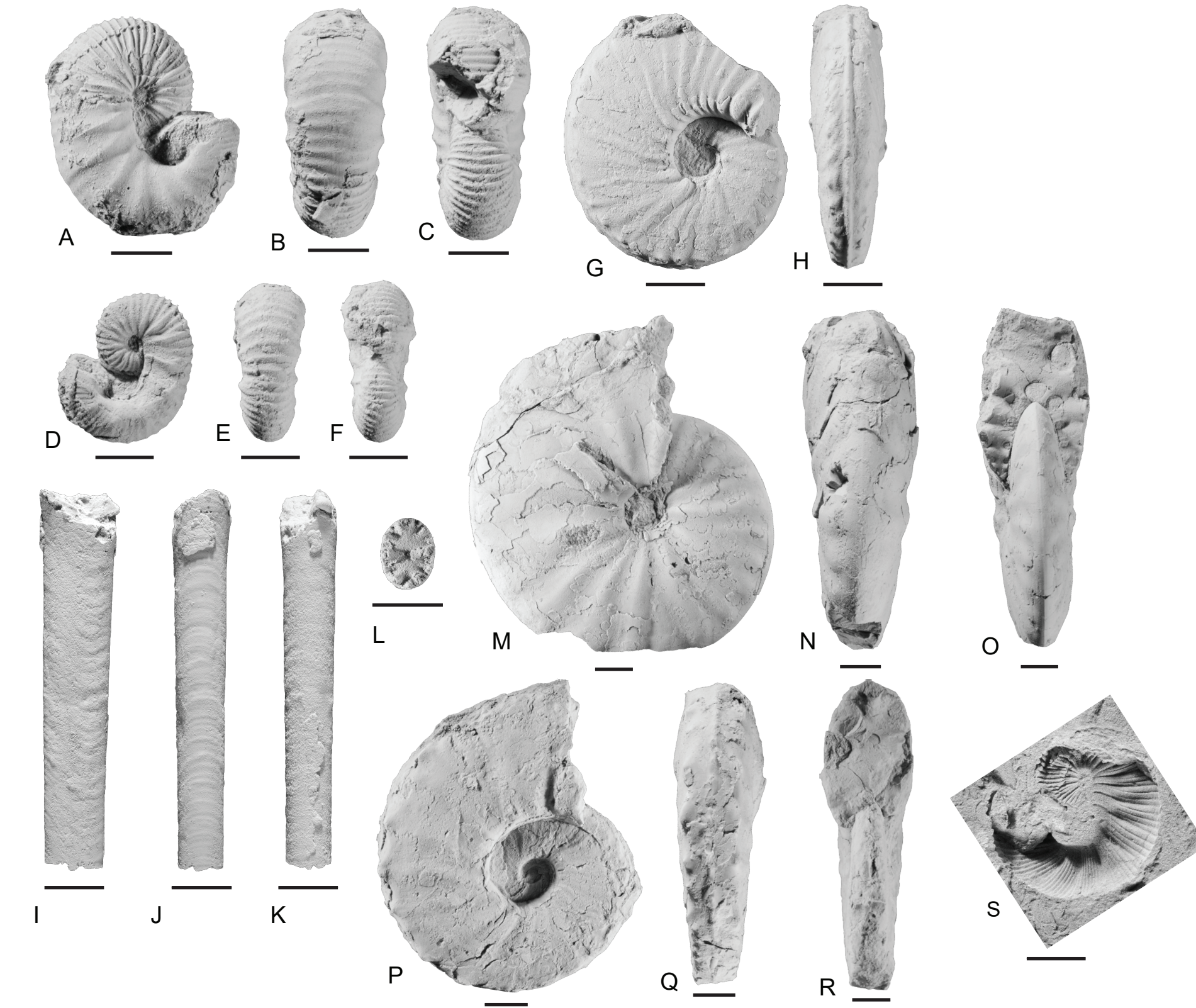


FIGURE 11. A-C, Ammonites from the Juana Lopez Member. *Scaphites warreni*, A, lateral, B, ventral and C, anterior views of a moderately preserved, complete mold of a macroconch; D-F, *Scaphites warreni*, D, lateral, E, ventral and F, anterior views of a microconch; G-H, *Prionocyclus wyomingensis*, G, lateral and H, ventral views of the gracile form; I-L, *Baculites yokoyamai*, I, lateral, J, ventral, K, dorsal and L, cross sectional views of an adult or semi-adult; M-O, *Coilopoceras colleti*, M, lateral, N, ventral and O, anterior views of a small phragmocone; P-R, *Prionocyclus macombi* Meek, P, lateral, Q, ventral and R, anterior views; S, *Scaphites ferronensis*, lateral view of microconch (compare to D-F, *S. warreni* has wider-spaced, coarser ribbing than *S. ferronensis*). Scales equal 1 cm.

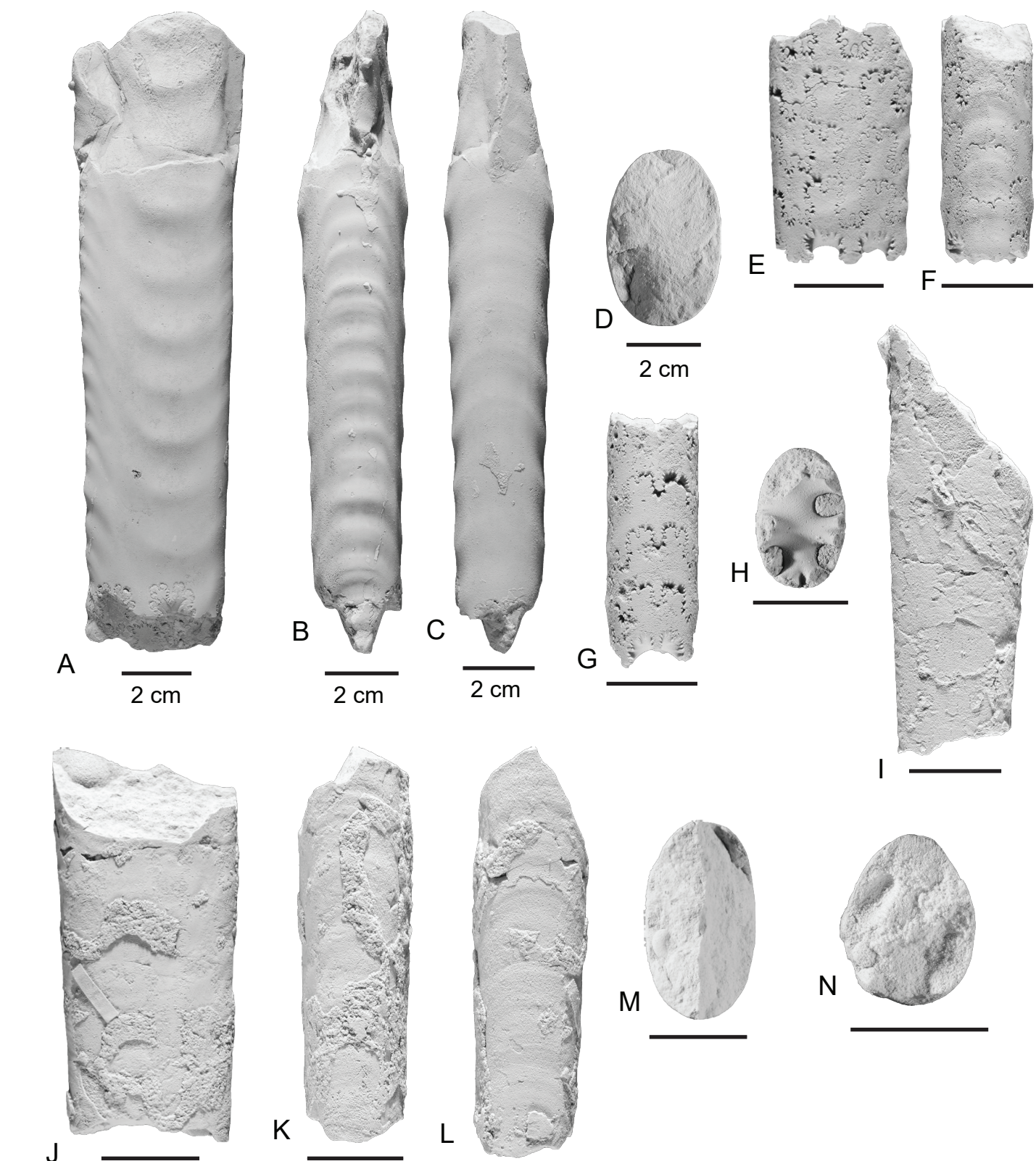


FIGURE 14. Ammonite zonal index taxa from the Lewis Shale. A-D, *Baculites perplexus* Cobban; E-I, *Baculites gregoryensis* Cobban; J-M, *Baculites* sp. (smooth species) Cobban; N, *Baculites* cf. *B. reduncus* Cobban. Scales equal 2 cm.



FIGURE 12. Ammonites from the Satan Member. A-C, *Placentoceras syrtales*, A, lateral, B, ventral and C, anterior views of a phragmocone; D-G, *Baculites* aff. *B. aquilaensis*, D, lateral, E, ventral, F, dorsal and G, cross sectional views; H, *Glyptoxoceras* sp., lateral view of a partial impression; I-K, *Scaphites hippocrepis* I, I, lateral, J, ventral and K, lateral views. Scales equal 1 cm.

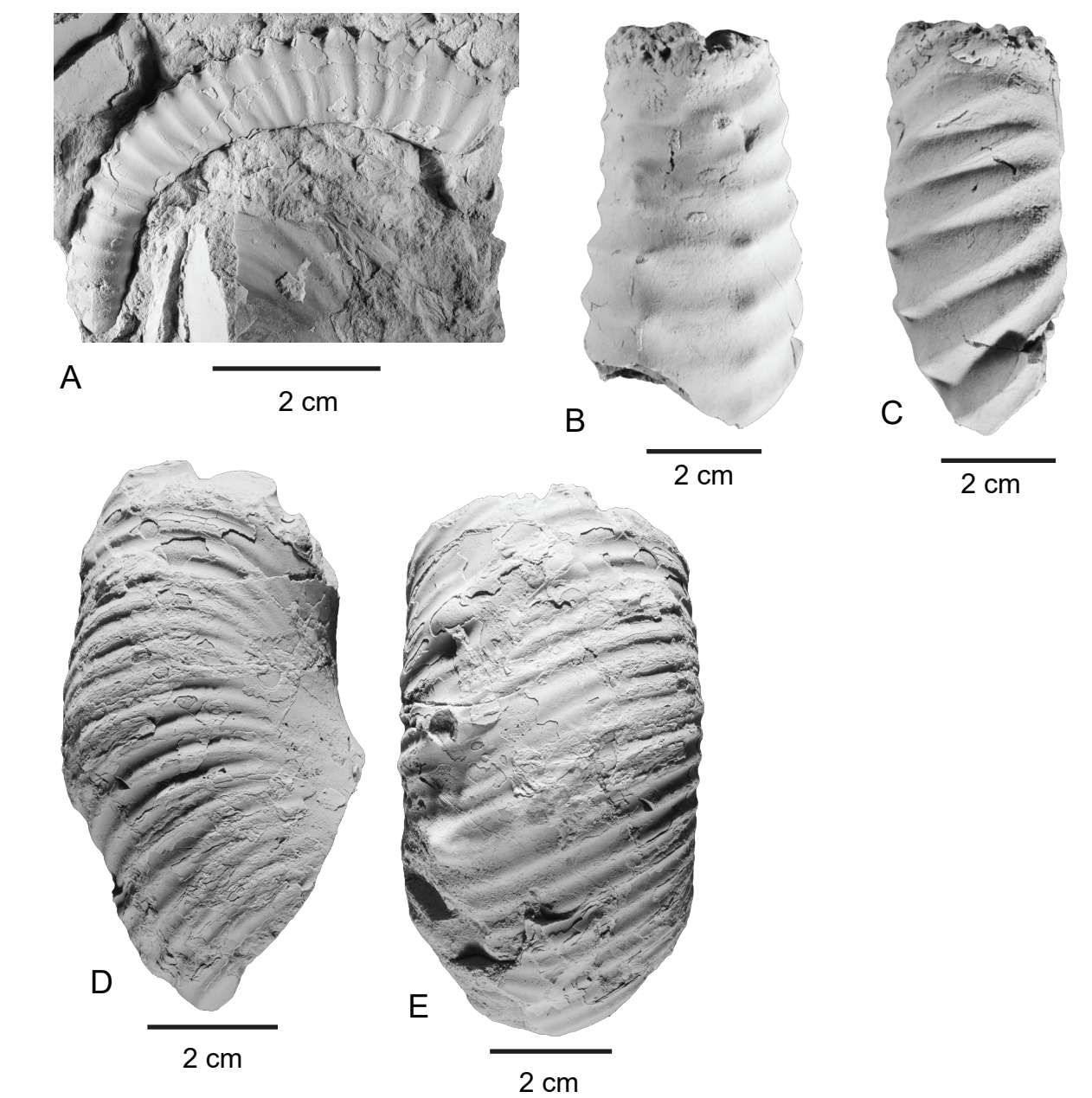


FIGURE 15. Ammonite zonal index taxa from the Lewis Shale. A, *Exiteloceras jenneyi jenneyi* (Whitfield); B-C, *Didymoceras cheyennense* (Meek and Hayden); D-E, *Didymoceras nebrascense* (Meek and Hayden). Scales equal 2 cm.

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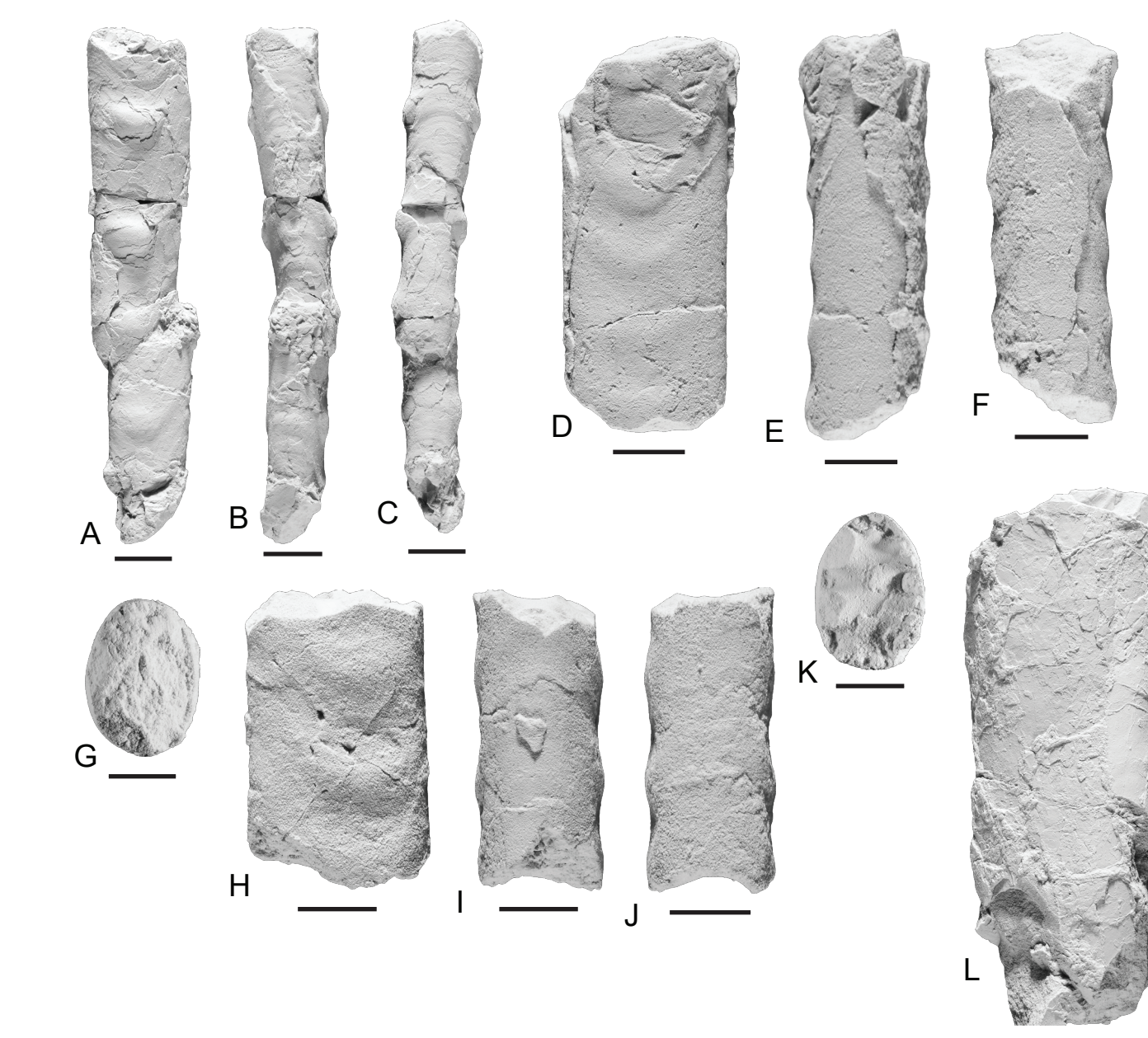


FIGURE 13. Ammonite zonal index taxa from the Lewis Shale. A-C, *Baculites* cf. *B. asperiformis* Meek; D-G, *Baculites obtusus* Meek; H-K, *Baculites mclerni* Landes; L, *Baculites scotti* Cobban. Scales equal 1 cm.