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Lower Cretaceous ammonites from southwestern New Mexico

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LOWER CRETACEOUS AMMONITES FROM SOUTHWESTERN NEW MEXICO

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Abstract—Lower Cretaceous ammonites are present in Aptian–Albian strata of the U-Bar and Mojado formations of the Bisbee Group in the central Peloncillo Mountains, Animas Mountains, Little Hatchet Mountains, Big Hatchet Mountains and the Cookes Range of southwestern New Mexico. The oldest ammonites are from the Carbonate Hill Member of the U-Bar Formation and include the taxa *Hypacanthoplites immunitus* (Stoyanow), *Kazanskyella spathi* (Stoyanow), *K. fosteri* (Scott), *K. arizonica* Stoyanow, *Stoliczkaia patagonica* (Stoyanow), and *Parahoplites* sp. These are ammonites of the *Kazanskyella spathi* Zone of latest Aptian age. Ammonites from the overlying Old Hachita Member of the U-Bar Formation are *Beudanticeras newtoni* Casey, *Douvilleiceras sp.* aff. *D. mammillatum* (Schlotheim), and *Hypacanthoplites* sp. These are ammonites of the early Albian *Douvilleiceras* sp. cf. *D. mammillatum* Zone. The Fryingpan Spring Member of the Mojado Formation yields ammonites of the late Albian *Mortoniceras equidistans* Zone, including *Mortoniceras equidistans* (Cragin), M. cf. *M. leonense* (Conrad) and *Eopachydiscus marcianus* (Shumard). The youngest Lower Cretaceous ammonoids from southwestern New Mexico are specimens of *Engonoceras serpentinum* (Cragin) from the upper Mojado Formation indicative of the latest Albian *Drakeoceras drakei* Zone. Lower Cretaceous ammonites thus represent four ammonite zones that well-constrain correlation of portions of the Bisbee Group in southwestern New Mexico.

INTRODUCTION

Lower Cretaceous strata exposed in southwestern New Mexico (Fig. 1) are assigned to the Bisbee Group of late Aptian–early Cenomanian age (Lucas and Estep, 1998b). Age assignments for Bisbee Group strata in this region are based largely on ammonite biostratigraphy (Lucas and Estep, 1998b). Lasky (1938, 1947) made the earliest discoveries of Bisbee Group ammonites in southwestern New Mexico in the Little Hatchet Mountains, and a diffuse but not extensive literature has been published on Lower Cretaceous ammonites from southwestern New Mexico. Here, I review this record and its biostratigraphic significance. In this article, LACMIP refers to the invertebrate paleontology collection at the Natural History Museum of Los Angeles County, Los Angeles (LACM); NMMNH to the New Mexico Museum of Natural History, Albuquerque; USGS to the U.S. Geological Survey; UCLA to the University of California, Los Angles, and USNM to the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

COLLECTING AREAS AND PREVIOUS STUDIES

In southwestern New Mexico, Lower Cretaceous ammonites are found in five distinct areas (Fig. 1). These "Collecting Areas" are described in detail in the Appendix, and area-by-area ammonite records are briefly reviewed.

Central Peloncillo Mountains

Gillerman (1958, p. 49–50) reported ammonites collected from the Carbonate Hill Member of the U-Bar Formation in the vicinity of the Carbonate Hill Mine (Collecting Area 1). Alexander Stoyanow (in Gillerman, 1958) identified the specimens as *Acanthohoplites* sp. aff. *A. aschiltaensis* Sinzow and *Parahoplites* sp. aff. *P. campichei* Sinzow, indicative of a late Aptian age. After relocating Gillerman's original collection at LACMIP, Goodspeed and Lucas (1992) reported the taxa *Acanthohoplites grandensis* Scott, *A. hesper* Stoyanow, *Hypacanthoplites immunitus* (Stoyanow), *H.* sp., *Stoliczkaia patagonica* Stoyanow and *"Sonneratia" fosteri* Scott.

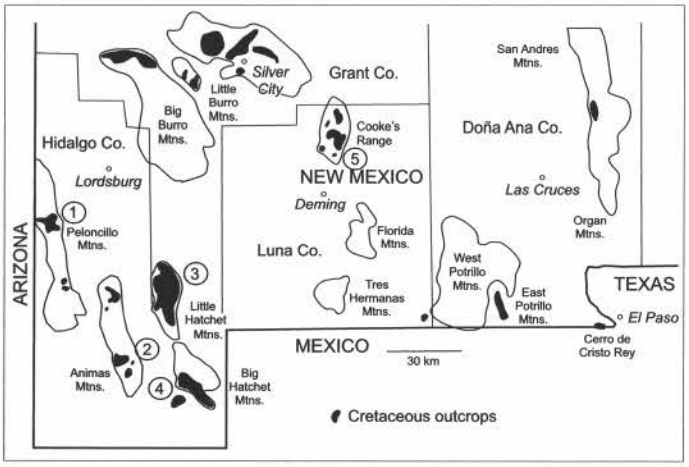


FIGURE 1. Map of southwestern New Mexico showing distribution of Lower Cretaceous strata and ammonite collecting areas (numbers in circles): **1**, Central Peloncillo Mountains; **2**, Animas Mountains; **3**, Little Hatchet Mountains; **4**, Big Hatchet Mountains; **5**, Cookes Range.

Animas Mountains

Zeller and Alper (1965, p. 19–20) reported the late Albian ammonite *Engonoceras serpentinum* (Cragin) from two localities in the upper part of the Mojado Formation, about 1341 m above its base (Collecting Area 2). W. A. Cobban identified these ammonites, which are from USGS Mesozoic localities D2096 and D2097. As Zeller and Alper (1965) suggested, these localities are in the same stratigraphic interval as the *Engonoceras* localities in the upper part of the Mojado Formation in the Big Hatchet Mountains (Lucas and Estep, 1998a).

Little Hatchet Mountains

The Lower Cretaceous ammonites known from the Little Hatchet Mountains are from the Carbonate Hill and Old Hachita members of the U-Bar Formation northeast of Howells Ridge, in parts of T27-28S, R16W (Collecting Area 3). Lasky (1938, 1947) made the earliest ammonite discoveries here, and the specimens he collected were described by Scott (1940) and revised by Lucas (2000; also see Lucas, 1989, and Lucas and Estep, 1998b). Three NMMNH localities in this area produce ammonites—one in the Carbonate Hill Member and the other two in the Old Hachita Member of the U-Bar Formation. One of these localities is the type section of the Old Hachita Member of the U-Bar Formation, which yielded numerous specimens of *Douvilleiceras* and *Hypacanthoplites* (Fig. 2).

Lucas (2000) reviewed the ammonites collected by Lasky that Scott (1940) described and assigned them to two taxa: *Beudanticeras newtoni* Casey (=*B. hatchetense* Scott) and *Douvilleiceras* sp. aff. *D. mammillatum* (=*Trinitoceras reesidei* Scott and other specimens Scott assigned to *Douvilleiceras*). These ammonites were collected from strata of the Old Hachita Member of the U-Bar Formation.

Big Hatchet Mountains

The most extensive collections of Lower Cretaceous ammonites from southwestern New Mexico are from the Big Hatchet Mountains in the U-Bar Ridge to Mojado Pass area in the central part of the range (Collecting Area 4). Zeller (1965) first reported ammonites here from the Carbonate Hill and Old Hachita members of the U-Bar Formation

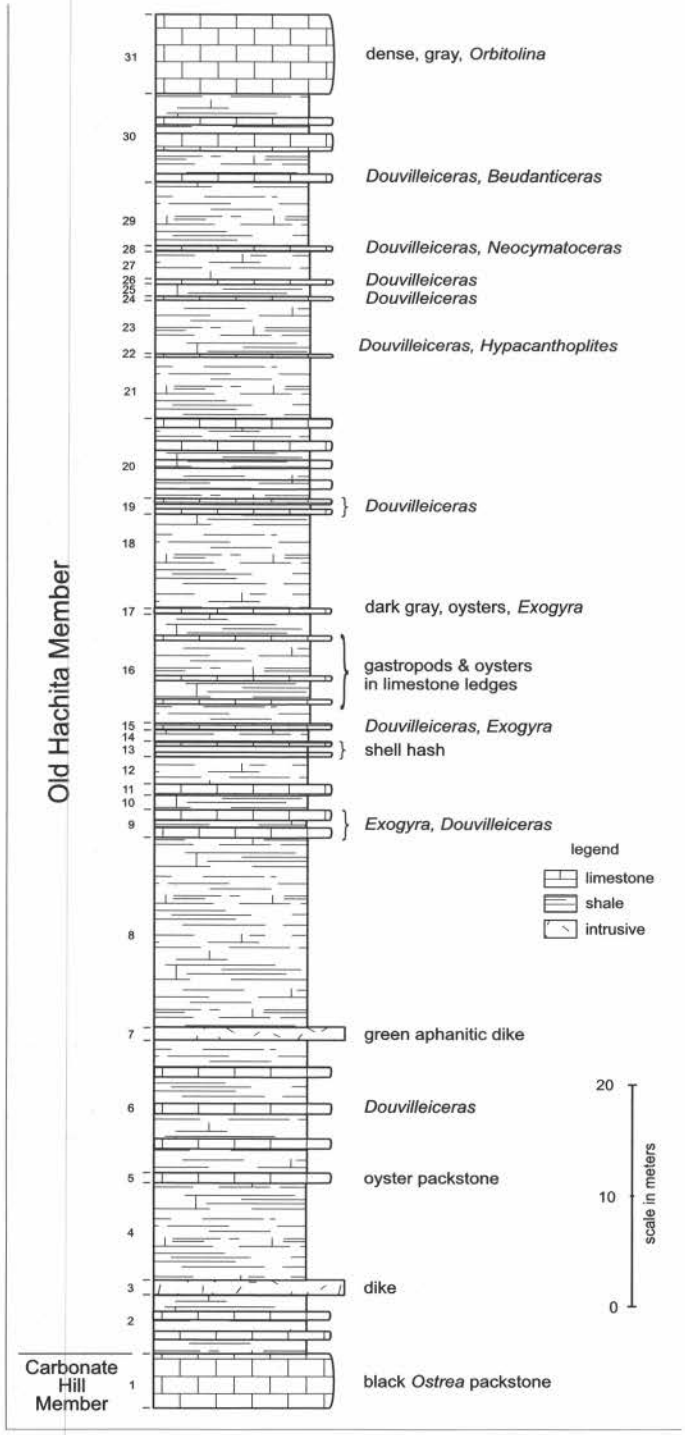


FIGURE 2. Type section of Old Hachita Member of the U-Bar Formation showing ammonite distribution (after Lucas and Estep, 1998b).

(Fig. 3) and from the upper part of the Mojado Formation. These fossils were identified by Alexander Stoyanow of UCLA (Lucas and Estep, 1998a, b). Stoyanow retained some of these ammonites in the UCLA collection, and, after his death, they were transferred to the collections of the Los Angeles County Museum (L. Saul, oral commun., 1991). From the Carbonate Hill Member, Zeller (1965, p. 64–68, pl. 5) reported identifications by A. Stoyanow of *Acanthohoplites* sp., parahoplitids and several new species of *Immunitoceras*. Also, using Stoyanow's identifications, Zeller reported *Douvilleiceras mammillatum* and *Prolyelliceras*? from the Old Hachita Member. J. B. Reeside Jr. (in Zeller, 1965, p. 70, pl. 5) identified *Engonoceras serpentinum* from the Rattlesnake Ridge Member of the Mojado Formation.

Weise (1982, p. 114, pls. 28–30) illustrated specimens he identified as *Sinzowiella* cf. *S. spathi*, *Acanthohoplites* cf. *A. berkeyi* and *Immunitoceras immunitum* from the Carbonate Hill Member of the U-Bar Formation in the Big Hatchet Mountains. (The specimen he identified as *A.* cf. *A. berkeyi* (Weise, 1982, pl. 29) appears to be *Kazanskyella arizonica* Stoyanow.) Sandidge (1985) reviewed the Lower Cretaceous ammonite biostratigraphy in the Big Hatchet Mountains based on the work of Zeller and Weise, and he reported (possibly based on Weise, 1982) *Kazanskyella arizonica* from the middle part of the Carbonate Hill Member. Lucas and Estep (2000) documented specimens of *Hypacanthoplites immunitus* collected by Zeller from strata high in the Carbonate Hill Member. Lucas and Estep (1998a) documented specimens of *Engonoceras serpentinum* (Cragin) that Zeller collected from the upper part of the Mojado Formation.

Cookes Range

Only the Mojado Formation of the Bisbee Group is present in the Cookes Range, and it yields Lower Cretaceous ammonites from one stratigraphic interval low in the formation. These are specimens of *Eopachydiscus marcianus* (Shumard), *Mortoniceras equidistans* (Cragin), M. sp. aff. *M. leonense* (Conrad), *M.* sp and *M.* (*Drakeoceras*) sp. (Cobban, 1987; Lucas et al., 1988). These ammonites indicate the *Mortoniceras equidistans* Zone of late Albian age.

AMMONITE ZONES

Although ammonites are relatively uncommon and generally poorly preserved in the Lower Cretaceous strata of southwestern New Mexico, enough specimens are known to identify four Aptian–Albian ammonite zones. Here, I review the ammonites from these zones and illustrate (Figs. 4–5) some representative specimens.

Kazanskyella spathi Zone

In southwestern New Mexico, the *Kazanskyella spathi* Zone of late Aptian age is coextensive with the Carbonate Hill Member of the U-Bar Formation. In this interval, the most common ammonite is *Hypacanthoplites immunitus* (Stoyanow), a taxon that dominates the collections from the Central Peloncillo Mountains and the Big Hatchet Mountains (Lucas and Estep, 2000). Representative specimens (Fig. 4A–G) show characteristic features of *H. immunitus*: tall, flat flanks; relatively involute; falcoid primary ribs separated by single secondary ribs on inner whorls and two or more secondary ribs on outer whorls; and closely spaced ribs that cross the venter without interruption (Stoyanow, 1949; Young, 1974; Lucas and Estep, 2000).

One ammonite from the Carbonate Hill Member in the central Peloncillo Mountains (Fig. 4N–O) corresponds closely to *Stoliczkaia patagonica* Stoyanow, to which it is assigned. It has a scaphitoid chamber that is strongly compressed, with flat flanks, coarse ribs, and a convex venter that meets the flank at a right angle. The ribs are straight and strong on the venter but slightly flexed on the flanks. Strong primary ribs are separated by two secondaries (cf. Stoyanow, 1949, pl. 26, figs. 3–4).

Specimens of *Parahoplites* from the Carbonate Hill Member in the Big Hatchet Mountains (Fig. 4J–M) have a squarish cross section and relatively deep umbilicus. The flank ribs are slightly sinuous, and there are (irregularly) two secondary ribs between the primary ribs. The ribs are well separated, cross the venter without interruption, and lack tubercles. These fossils compare well to other Aptian specimens of *Parahoplites*, especially to *P. scharfi* Anderson from the Aptian of California (e.g., Anderson, 1938, pl. 73, figs. 4–5; Young, 1974, p. 206, pl. 6, figs. 1–2, 5–8, pl. 10, fig. 18), but are too incomplete or poorly preserved to be assigned a species name.

One nearly complete ammonite from the Carbonate Hill Member in the central Peloncillo Mountains (Fig. 4H–I) is moderately evolute and densely ribbed, with each primary rib thick to bullate at the umbilicus and bifurcating ventrally. One secondary rib separates each primary near the venter; the ribs are straight and cross the venter without interruption; the whorl cross section is high and ovoid; and the venter is con-

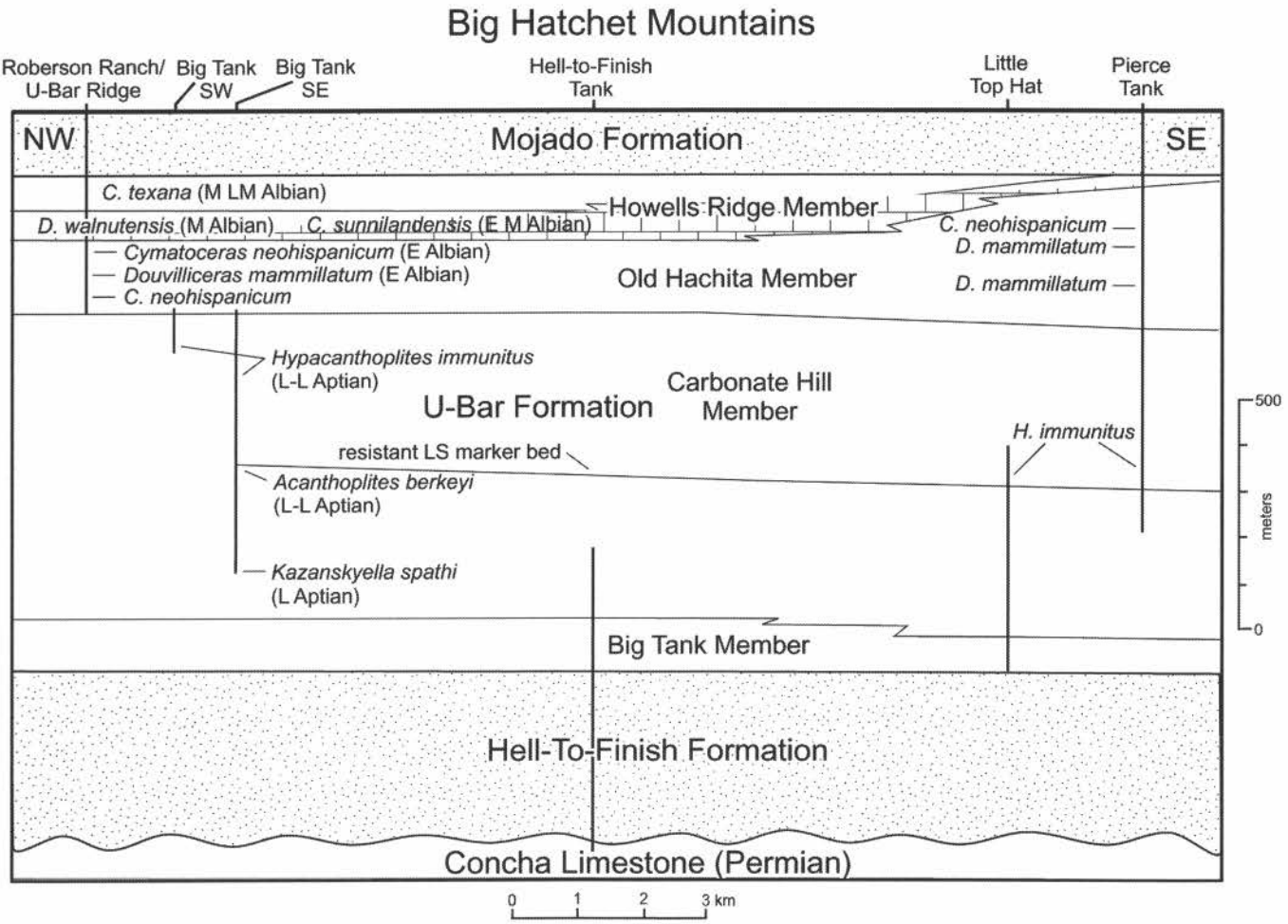


FIGURE 3. Synopsis of ammonite distribution in the U-Bar Formation in the Big Hatchet Mountains (after Warzeski, 1987).

vex. Closest resemblance is to *Kazanskyella fosteri* (Scott) (Scott, 1940, pl. 67, figs. 1–2; Young, 1974, pl. 13, figs. 16, 19), to which it is tentatively referred.

Other ammonite taxa known from the Carbonate Hill Member have been reported by Zeller (1965), Weise (1982), Sandidge (1985) and Goodspeed and Lucas (1992). They are: *Acanthohoplites grandensis* Scott, *A. hesper* Stoyanow, *Kazanskyella spathi* (Stoyanow) and *K. arizonica* Stoyanow, all characteristic late Aptian taxa.

Douvilleiceras sp. cf. *D. mammillatum* Zone

In southwestern New Mexico, the *Douvilleiceras* sp. cf. *D. mammillatum* Zone of Young (1974) is coextensive with the Old Hachita Member of the U-Bar Formation. Only two ammonites are common in this zone, *Douvilleiceras* (=*Trinitoceras* Scott) and *Hypacanthoplites*. Specimens of *Douvilleiceras* are either relatively small specimens (e.g., Fig. 5A–B) that have the characteristic rounded whorls, ventral sulcus, and numerous prominent ribs with multiple tubercles seen in *D. mammillatum* (Schlotheim) (cf. Spath, 1925, pl. 5, figs. 1–3; Casey, 1962, pl. 40, fig. 4) or they are large specimens (e.g., Fig. 5C–D; Lucas, 2000) that lack tubercles, except at the umbilical base of the ribs, and are covered by nearly straight, relatively closely spaced ribs that surround rectangular to broadly rounded whorls. Only occasionally are secondary ribs present. For reasons discussed by Young (1974) and Lucas (2000), these ammonites are not assigned with certainty to *D. mammillatum*, but instead I identify them as *D.* sp. aff. *D. mammillatum*.

In the Old Hachita Member, specimens of *Hypacanthoplites* are common but fragmentary (e.g., Fig. 5E–F). Characteristic features are: high and thin whorls (H/W = 1.6), flat flanks, rounded venter, nearly straight primary ribs, single secondary ribs that sometime anastomose with primaries, and all ribs crossing the venter without interruption. The Old Hachita Member specimens are most similar to the Lower Albian species *H. mayfieldensis* Scott (Scott, 1940, pl. 63, figs. 3–6; Young, 1974, pl. 14, figs. 1, 2, 6) but are too incomplete to be assigned to a species. In Texas, *H. mayfieldensis* co-occurs with *Douvilleiceras* in the Cuchillo Formation (Young, 1974).

Mortoniceras equidistans Zone

The lower part of the Mojado Formation (Fryingpan Spring Member of Lucas and Estep, 1998b) yields ammonites of the late Albian *Mortoniceras equidistans* Zone. These were documented by Cobban (1987) and include the taxa *Eopachydiscus marcianus* (Shumard), *Mortoniceras equidistans* (Cragin), *M.* sp. aff. *M. leonense* (Conrad), *M.* sp and *M.* (*Drakeoceras*) sp.

Drakeoceras drakei Zone

The upper part of the Mojado Formation (Rattlesnake Ridge Member of Lucas and Estep, 1998b) yields the ammonite *Engonoceras serpentinum* (Cragin) (Fig. 5G–H) indicative of the *Drakeoceras drakei* Zone of latest Albian age (Lucas and Estep, 1998a). The youngest Mojado strata in the Cookes Range, include lowermost Cenomanian (Upper Cretaceous) ammonites (Cobban, 1987), indicating that the uppermost Mojado Formation locally encompasses the Early-Late Cretaceous boundary.

CORRELATION

Hypacanthoplites and the other ammonites from the Carbonate Hill Member of the U-Bar Formation clearly identify the *Kazanskyella*

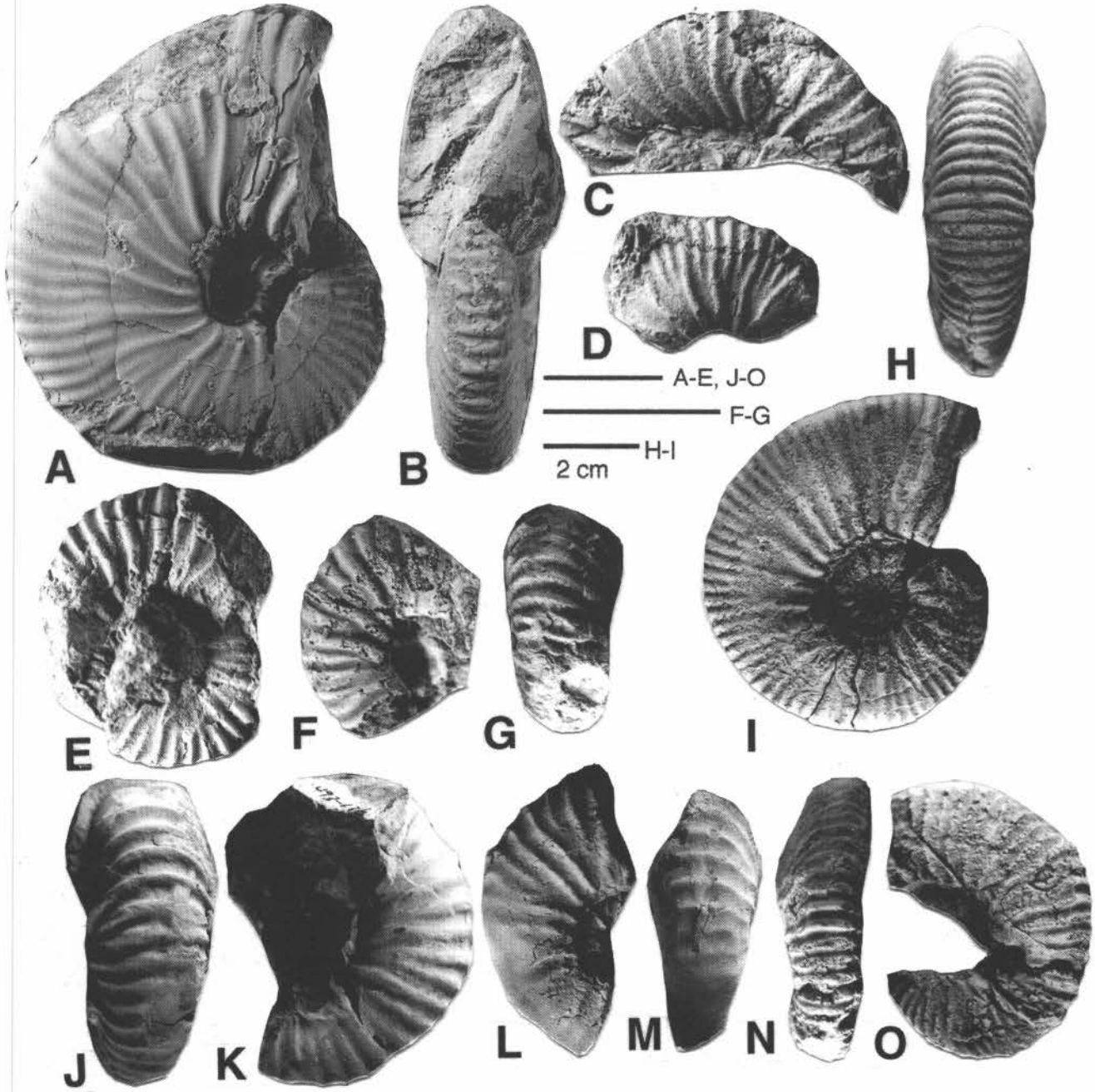


FIGURE 4. Selected Aptian ammonites from southwestern New Mexico. **A–B**, *Hypacanthoplites immunitus* (Stoyanow), LACMIP-12195 from LACM locality 17136 in the Big Hatchet Mountains, lateral view (A) and whorl cross section (B). **C**, *H. immunitus*, NMMNH P-31418 from NMMNH locality 1341 in the central Peloncillo Mountains, lateral view. **D**, *H. immunitus*, LACMIP-12877, from LACM locality 17135 in the central Peloncillo Mountains, lateral view. **E**, *H. immunitus*, LACMIP-12187 from LACM locality 17135 in the central Peloncillo Mountains. **F–G**, *H. immunitus*, NMMNH P-31420 from NMMNH locality 1341 in the central Peloncillo Mountains, lateral (**F**) and venter (**G**) views. **H–I**, *Kazanskyella fosteri* (Scott), LACMIP-12189 from LACM locality 1735 in the central Peloncillo Mountains, venter (**H**) and lateral (**I**) views. **J–K**, *Parahoplites* sp., LACMIP-12185 from Pierce Tank in the Big Hatchet Mountains, venter (**J**) and lateral (**K**) views. **L–M**, *Parahoplites* sp., LACMIP-12876 from Pierce Tank in the Big Hatchet Mountains, lateral (**L**) and venter (**M**) views. **N–O**, *Stoliczkaia patagonica* Stoyanow, LACMIP-12188 from LACM locality 17135 in the central Peloncillo Mountains, venter (**N**) and lateral (**O**) views.

spathi Zone of late Aptian age (Sandidge, 1985; Scott, 1987; Lucas and Estep, 2000) (Fig. 6). The most common ammonite from the Carbonate Hill Member, *Hypacanthoplites*, is a characteristic upper Aptian ammonoid known from Soviet Middle Asia, Western Europe and southwestern North America (e.g., Scott, 1940; Stoyanow, 1949; Casey, 1961, 1965; Young, 1974; Drushchits and Mikhaylova, 1981).

Beudanticeras and *Douvilleiceras*, which occur in the Old Hachita Member of the U-Bar Formation, are characteristic Albian-age ammonites that have a nearly global distribution (Owen, 1988a, b; Kotetichvili, 1988). More precisely, *B. newtoni* and *D. mammillatum*, the taxa closest to, if not identical to, the ammonites from the Old Hachita Member, are index fossils of what Owen (1988a) terms the *Douvilleiceras mammillatum* Superzone of early Albian age. In western Europe, Owen (1988a, table 6) divided this Superzone into seven subzones (numbered in ascending order), and *B. newtoni* occurs in subzones 2–6, whereas *D. mammillatum* is in subzones 3–6. The New Mexican material probably provides an inadequate basis for correlation to these subzones, but it seems certain they correlate the Old Hachita Member of the U-Bar Formation to part of the early Albian *D. mammillatum* Superzone (Fig. 6). In central Texas, Young (1974) defined an

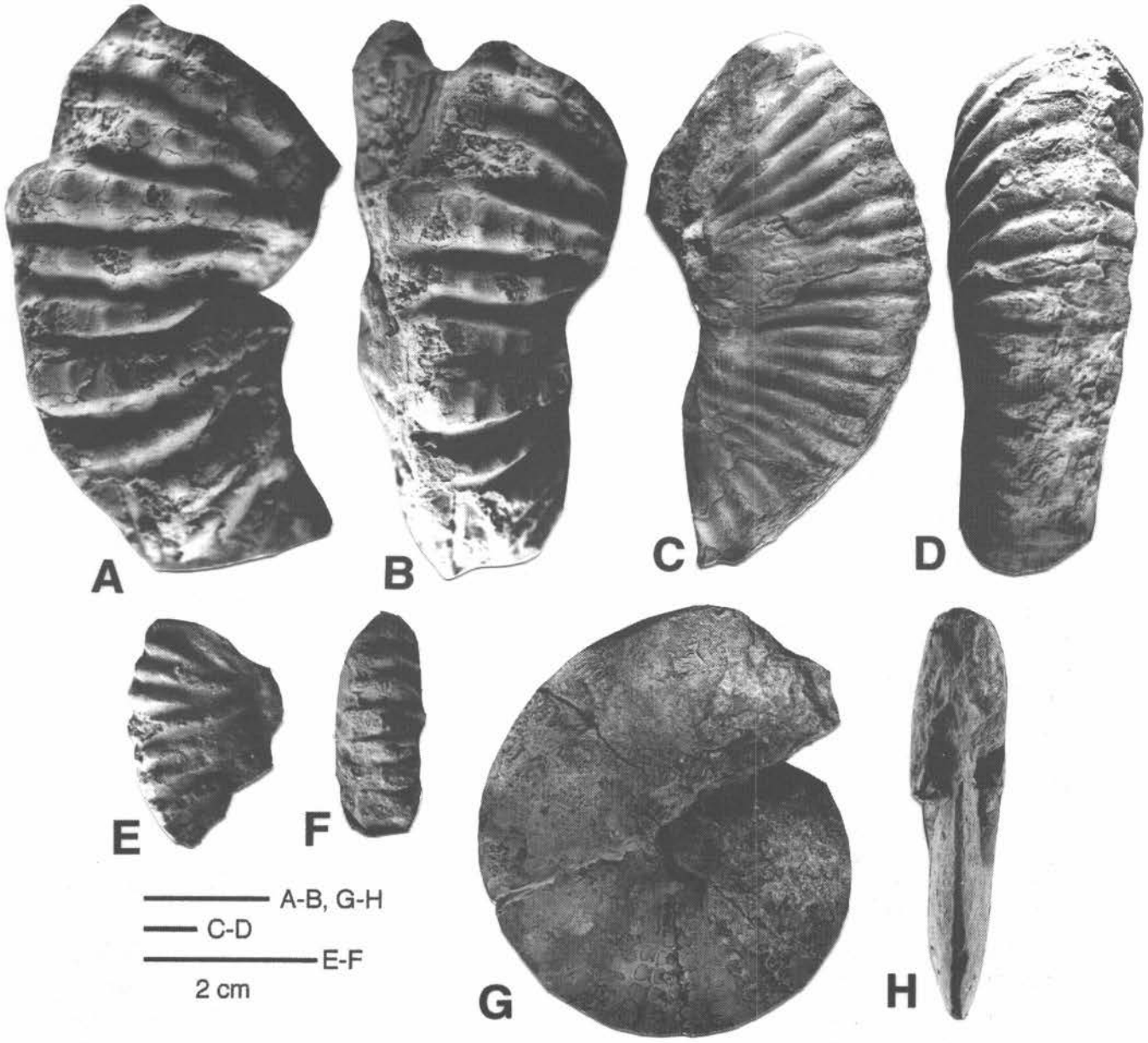


FIGURE 5. Selected Albian ammonites from southwestern New Mexico. **A–B**, *Douvilleiceras* sp. aff. *D. mammillatum*, NMMNH P-31421 from NMMNH locality 1365 in the Little Hatchet Mountains, lateral (**A**) and venter (**B**) views. **C–D**, *Douvilleiceras* sp. aff. *D. mammillatum*, NMMNH P-31422 from NMMNH locality 1365 in the Little Hatchet Mountains, lateral (**C**) and venter (**D**) views; note that specimen is crushed laterally. **E–F**, *Hypacanthoplites* sp., NMMNH P-31420 from NMMNH locality 1365 in the Little Hatchet Mountains, lateral (**E**) and venter (**F**) views. **G–H**, *Engonoceras serpentinum* (Cragin), LACMIP-7294 from the upper Mojado Formation in the Big Hatchet Mountains, lateral view (**G**) and whorl cross section (**H**).

approximately equivalent *Douvilleiceras* sp. cfr. *D. mammillatum* Zone of early Albian age that correlates to the Little Hatchet Mountain records of *Douvilleiceras*.

In western Europe, the *D. mammillatum* Superzone is not the base of the Albian Stage; the *Leymeriella regalis* Zone is the lowest Albian interval in the section. Similarly, in central Texas the *Hypacanthoplites cragini* Zone is the lowest Albian interval, beneath the *D.* sp. cfr. *D. mammillatum* Zone. This indicates that the Old Hachita Member of the U-Bar Formation is not of earliest Albian age. The underlying Carbonate Hill Member is of latest Aptian age, yielding ammonites of the *Kazanskyella spathi* Zone (Zeller, 1965; Sandidge, 1985; Lucas and Estep, 1998a, b, 2000). Thus, in southwestern New Mexico there is an unconformity at the Aptian-Albian boundary equivalent to about one earliest Albian ammonite zone (Lucas, 1995).

Ammonite zones of the Mojado Formation place close constraints on its age range. At the base, the Mojado Formation is in the upper Albian *Mortoniceras equidistans* Zone. The top of the formation crosses the Albian-Cenomanian boundary, with ammonites from the *Drakeoceras drakei* Zone (latest Albian) to the *Plesioturrilites brazoensis* Zone (earliest Cenomanian) and possibly slightly younger (Cobban, 1987; Lucas et al., 1988).

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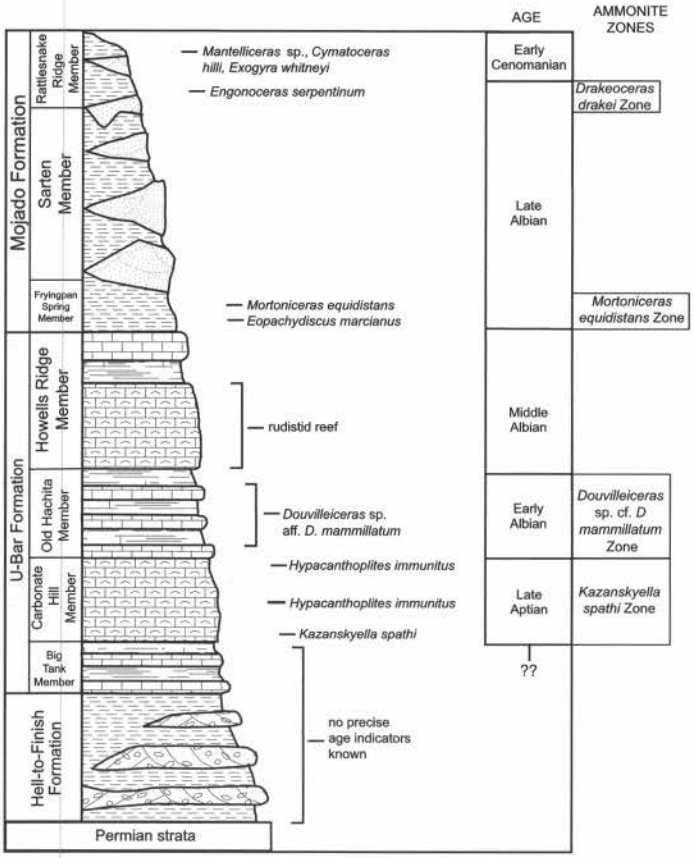


FIGURE 6. Generalized stratigraphic section of Lower Cretaceous rocks in southwestern New Mexico showing ammonite zones (after Lucas and Estep, 1998b).

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APPENDIX—LOWER CRETACEOUS AMMONITE LOCALITIES

Collecting Area 1 – Central Peloncillo Mountains

This collecting area is the vicinity of the Carbonate Hill Mine (Gillerman, 1958, p. 49), which is in the SE¼ SE¼ sec. 34, T24S, R21W, Hidalgo County. Gillerman's exact location cannot be more precisely determined, but NMMNH locality 1341 just SE of the Carbonate Hill Mine produced fragmentary ammonites at UTM Zone 12, 3560790N, 689360E, in the lower part of the Carbonate Hill Member, which is only about 60–70 m thick at this location (Gillerman, 1958).

Collecting Area 2 – Animas Mountains

Zeller and Alper's (1965) locality for *Engonoceras serpentinum* is near the center of sec. 13, T31S, R18W, Hidalgo County, about 1341 m above the base of the Mojado Formation.

Collecting Area 3 – Little Hatchet Mountains

Lasky (1947, p. 14, pl. 12) listed four ammonite taxa from four localities in the Little Hatchet Mountains in his "Broken Jug Limestone," strata that now are assigned to the U-Bar Formation (Zeller, 1970). Lasky's localities are:

1. USGS locality 17432 in the "Broken Jug Limestone" yielded *Douvilleiceras*

sp. This locality is in the NW¼ NW¼ sec. 36, T27S, R16W, but no specimens in the USNM collection document the report. USGS locality 17432, and the other two sites nearby (localities 17364 and 16692), are in heavily faulted outcrops of the Old Hachita Member of the U-Bar Formation (Lucas, 2000).

2. USGS locality 17364 in the "Broken Jug Limestone" yielded the lectotype and a paralectotype of *Trinitoceras reesidei* Scott (USNM 103256a–b). USGS records list the locality as "NW¼ sec. 36, T27S, R16W outcrop just west of shaft on King-400 claim."

3. USGS locality 16692 yielded "*Douvilleiceras* n. sp." (USNM 103261) from the "Broken Jug Limestone" in "sec. 36, T27S, R16W on the edge of the arroyo just north of the Eight of March shaft."

4. USGS locality 17349 yielded the holotype of *Beudanticeras hatchetense* Scott (USNM 103258) and a paralectotype of *Trinitoceras reesidei* (USNM 103257) from the "Broken Jug Limestone." USGS records list this locality as center of east line of sec. 12, T28S, R16W. This site is in the type section of the Old Hachita Member of the U-Bar Formation (Lucas and Estep, 1998b).

In addition, there are three NMMNH ammonite localities in the U-Bar Formation in the Little Hatchet Mountains:

1. NMMNH locality 3415 (same locality as USGS locality 17349) at UTM Zone 12, 743890N, 3530180E and vicinity, the type section of the Old Hachita Member of the U-Bar Formation, produced numerous incomplete specimens of *Douvilleiceras* and *Hypacanthoplites* (Fig. 2).

2. NMMNH locality 4404 at UTM Zone 12, 742480N, 3534220E in highly faulted strata of the Old Hachita Member, yielded a single unidentified ammonite.

3. NMMNH locality 4405 at UTM Zone 12, 743313E, 3529080N about 10 m below the top of the Carbonate Hill Member, yielded a single unidentified ammonite.

Collecting Area 4 – Big Hatchet Mountains

Zeller (1965) collected Lower Cretaceous ammonites from seven localities in the U-Bar and Mojado formations in the Big Hatchet Mountains:

1. Zeller (1965, pl. 5) reported *Douvilleiceras mammillatum*? and *Prolyelliceras*? from the limestone-shale member (= Old Hachita Member) of the U-Bar Formation in his Lower U-Bar Ridge section (SE¼ SE¼ sec. 1, T32S, R15W).

2. Zeller (1965, pl. 5) listed "*Immunitoceras*, several new species" from the oyster-limestone member (= Carbonate Hill Member) in his Big Tank Southwest section. Zeller (1965, p. 65, 113) referred to these ammonites as "collection 73a from near the base of the Big Tank Southwest section." He stated that "several new species of *Immunitoceras* (identification by Stoyanow)" (p. 113) were present and indicated a very late Aptian age. Lucas and Estep (2000) described these specimens as *Hypacanthoplites immunitus*. The locality (LACMIP 17136) is in the NW¼ NE¼ sec. 31, T31S, R15W (UTM 746635E, 3495600N, Zone 12, datum NAD27).

3. In his Big Tank Southeast section, Zeller (1965, pl. 5) listed *Acanthohoplites* sp? from approximately the middle of the Carbonate Hill Member. This locality is in the S½ NW¼ sec. 32, T31S, R15W. The specimen of *Kazanskyella* ("*Sinzowiella*") sp. cf. *K. spathi* illustrated by Weise (1982, pl. 28) apparently came from this locality.

4. From his Little Hat Top section, Zeller (1965, pl. 5) reported "parahoplitids, new genera and species" from approximately the middle of the Carbonate Hill Member. This locality is in the SW¼ SE¼ sec. 19, T32S, R14W. The specimen of *Hypacanthoplites immunitus* illustrated by Weise (1982, pl. 30) is apparently from this locality.

5. In the Pierce Tank section, Zeller (1965, pl. 5) listed "parahoplitids, same as in collection 75g of Little Hat Top section" from approximately the middle of the Carbonate Hill Member. This locality is in the SW¼ sec. 29, T32S, R14W. Weise (1982, pl. 29) illustrated a specimen of *Kazanskyella arizonica*, apparently from this locality.

6. Higher in the Pierce Tank section, Zeller (1965, pl. 5) indicated two stratigraphic levels in the Old Hachita Member of the U-Bar Formation that yielded specimens of "*Douvilleiceras mammillatum*." These localities are either in the SE¼ SE¼ sec. 30 or the SW¼ SW¼ sec. 29, T32S, R14W.

7. Zeller (1965, pl. 5) listed specimens of *Engonoceras serpentinum* collected 1286 m above the base of the Mojado Formation in his Upper Part of U-Bar Ridge section. This locality is in the NW¼ SE¼ sec. 20, T32S, R15W (Lucas and Estep, 1998a).

Collecting Area 5 – Cookes Range

Localities in the Fryingpan Spring Member of the Mojado Formation in the southern Cookes Range of Luna County are listed in detail by Cobban (1987, table 1) and Lucas et al. (1988, appendix 1).

