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Lower Cenomanian *Forbesiceras brundrettei* zone ammonite fauna in Texas, U.S.A.

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With 6 figures in the text

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Abstract: New collections from the base of the Boquillas Formation in Trans-Pecos Texas, together with reexamination of old collections from the Pepper Shale of central Texas show the *Forbesiceras [Neopulchellia] brundrettei* zone of YOUNG (1958) and YOUNG & POWELL (1978) to be a widespread marker horizon yielding *Moremanoceras elgini* (YOUNG, 1958), *Forbesiceras brundrettei* (YOUNG, 1958), *Ostlingoceras brandi* YOUNG, 1958, *Mariella (M.) davisense* (YOUNG, 1958), *Hypoturrilites youngi* CLARK, 1965, *Inoceramus* aff. *arvanus* STEPHENSON, 1953, and *Ostrea beloiti* LOGAN, 1899.

Zusammenfassung: Neue Aufsammlungen von der Basis der Boquillas-Fam. (Trans-Pecos, Texas) und eine Revision alter Sammlungsbestände aus den Pepper Shale (Zentral-Texas) zeigen, daß die von YOUNG 1958 und YOUNG & POWELL 1978 aufgestellte Zone des *Forbesiceras [Neopulchellia] brundrettei* einen weit verbreiteten Leithorizont darstellt. In ihm finden sich *Moremanoceras elgini* (YOUNG 1958), *Forbesiceras brundrettei* (YOUNG 1958), *Ostlingoceras brandi* YOUNG 1958, *Mariellla* (M.) *davisense* YOUNG 1958, *Hypoturrilites youngi* CLARK 1965, *Inoceramus* aff. *arvanus* STEPHENSON 1953 und *Ostrea beloiti* LOGAN 1899.

Introduction

YOUNG (1958) described a small assemblage of silicified ammonites that he regarded as lower Cenomanian from the base of the Boquillas Formation in Jeff Davis County in Trans-Pecos Texas (Fig. 1). Because of the worn nature of some of the fossils and the occurrence, at the same locality of unsilicified upper Cenomanian ammonites, he concluded that the silicified fauna had been derived and redeposited during the late Cenomanian. The fauna was referred to a *Neopulchellia brundrettei* zone: subsequent work has shown that *Neopulchellia* COLLIGNON, 1929 is a synonym of *Forbesiceras* KOSSMAT, 1897. YOUNG & POWELL (1978) placed the *brundrettei* zone in the lower Cenomanian, but YOUNG (1986) has since referred it to the middle Cenomanian. Subsequent work in Texas has allowed us to place the *brundrettei* zone fauna in sequence

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(Hook & Cobban 1983; Kennedy, Cobban, Hancock & Hook 1989; Kennedy & Cobban 1989, 1990); the following zones can now be recognized across the lower-middle Cenomanian boundary in Texas:

middle Cenomanian	*Plesiacanthoceras wyomingense cobbani* zone
	Acanthoceras amphibolum zone
	Acanthoceras bellense zone
	Conlinoceras tarrantense zone
lower Cenomanian (part)	*Forbesiceras brundrettei* zone
	Acompsoceras inconstans zone
	Budaiceras hyatti zone

In western Europe the zonation developed in southern England and northern France (Wright & Kennedy, 1984) can be widely applied:

middle Cenomanian	*Acanthoceras jukesbrownei* zone
	Acanthoceras rhotomagense zone
lower Cenomanian	*Mantelliceras dixoni* zone
	Mantelliceras mantelli zone

The *Budaiceras hyatti* zone can be correlated with the *Mantelliceras dixoni* zone, through the co-occurrence of the index species of the two zones in Haute Normandie (Kennedy, Juignet & Girard 1990). The *Acompsoceras inconstans* zone (Kennedy & Cobban 1989) can be correlated with the *M. dixoni* zone because of the common occurrence of that species in the *dixoni* zone in western Europe (Kennedy & Cobban 1989). The *Conlinoceras tarrantense* zone can be correlated with the lower part of the *Acanthoceras rhotomogense* zone because of the common occurrence of *Cunningtoniceras inerme* (Pervinquière 1907) (Kennedy & Cobban 1990), *Cunningtoniceras* being unknown in the *M. dixoni* zone. There are no faunal elements in common at the species level between the fauna of the *F. brundrettei* zone and faunas from western Europe. However, *Hypoturrilites* is predominantly lower Cenomanian, and *Ostlingoceras* and *Mariella* exclusively lower Cenomanian in western Europe, and on this basis we place the *F. brundrettei* zone at the top of the lower Cenomanian.

Occurrence of the *Forbesiceras brundrettei* zone in Texas

Chispa Summit, Jeff Davis County

This occurrence is described by Kennedy, Cobban, Hancock & Hook (1989). The locality lies 37 km airline south-southwest of Van Horn (Fig. 1). Buda Limestone is overlain disconformably by the Chispa Summit Formation. The Buda Limestone yields a *Budaiceras hyatti* zone fauna. Sandstones up to 0.9 m thick, resting in a depression on the top of the Buda, yield a sparse *A. inconstans* zone fauna. Beds of limestone 2.1-3.9 m above the base of the Buda yield *Moremanoceras elgini, Acompsoceras* sp., *F. brundrettei, Borissiakoceras* sp., *Ostlingoceras brandi, Mariella (M.)* cf. *cenomanensis* (Schlüter, 1876), *M. (M.) davisense, Hypoturrilites youngi, Inoceramus* aff. *arvanus* and *Ostrea*

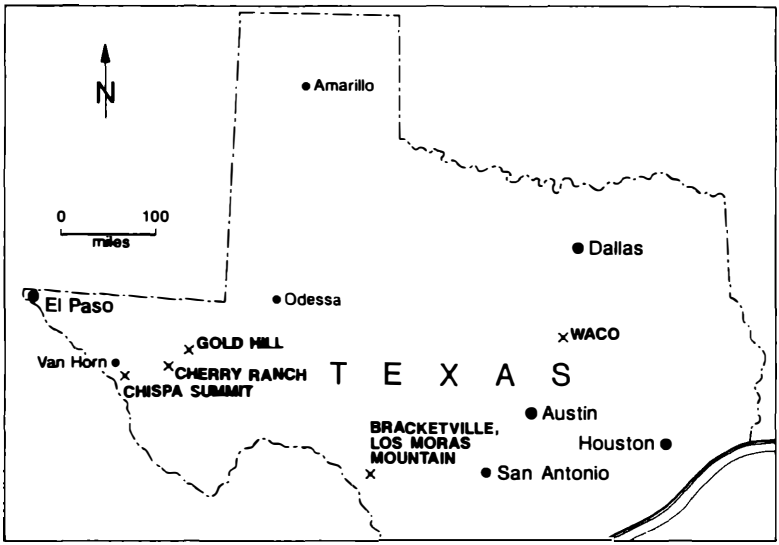

Fig. 1. Occurrences of the *Forbesiceras brundrettei* zone fauna in Trans-Pecos Texas.

beloiti. We have not recognized the *Conlinoceras tarrantense* zone at Chispa Summit, but a thin bed of limestone 4.6 m above the top of the Buda yielded an *Acanthoceras bellense* zone assemblage.

Cherry Ranch, Jeff Davis County

This is the locality (Fig. 1) from which YOUNG (1958) originally described the *F. brundrettei* zone fauna; new collections from this locality form the basis of the present account. The fossils come from blocks of chert and silicified sandstone scattered over a wide area of Buda Limestone in a draw south of the Cherry Ranch road just north of an east-west fence on the Kingston Ranch, in the NW corner of section 33, block 57, township 9; we nowhere observed it *in situ*. The fauna is *M. elgini, F. brundrettei, O. davisense, O. brandi, I. aff. arvanus* and *O. beloiti*.

Gold Hill, Jeff Davis County

This occurrence (Fig. 1) is described by HOOK & COBBAN (1983). Here, pockets of silicified fossils rest on Buda Limestone and include abundant *M. elgini, F. brundrettei, O. brandi, M. (M.) davisense*, large *H. youngi, I.* aff. *arvanus* and *O. beloiti*. A middle Cenomanian fauna with *Acanthoceras* occurs 2 to 4 m above the base of the Buda here.

Los Moras Mountain, Kinney County

This record is based upon material from USGS locality 18107, collected by A. N. SAYRE in 1938. There are abundant silicified *P. elgini* in orange-buff

limestones from near the base of the Boquillas Formation 1.6 km east of Los Moras Mountain in Kinney County.

Bracketville, Kinney County

Blocks of limestone from low in the Boquillas Formation at USGS locality 184, the head of Elm Creek near Bracketville, Kinney County, collected by R. T. HILL in 1895 yielded abundant silicified *P. elgini* with rarer *F. brundrettei*, *Mariella* sp. and *Sciponoceras* sp.

Waco area, McLennan County

These occurrences are documented by KENNEDY & COBBAN (1990). An old brickpit at USGS Mesozoic locality 14592 on Cloice Branch, 1.3 km (0.8 mi) east of South Bosque, McLennan County, yielded, probably from the Pepper Shale, a fauna with *M. elgini*, *F. brundrettei*, and *O. brandi*. *F. brundrettei* and *M. (M.) davisense* occur at USGS Mesozoic locality 14598, 0.8 km (0.5 mi) east of South Bosque, near the railroad, McLennan County.

Conventions

The following abbreviations are used to indicate the repositories of specimens mentioned in the text:
TMM: Texas Memorial Museum, Austin.
OUM: University Museum, Oxford.
USNM: National Museum of Natural History, Washington, D. C.

Systematic Palaeontology

Ammonites

Order Ammonoidea ZITTEL, 1884
Suborder Ammonitina HYATT, 1889
Superfamily Desmoceratacea ZITTEL, 1895
Family Desmoceratidae ZITTEL, 1895
Genus *Moremanoceras* COBBAN, 1972

Type species: *Tragodesmoceras scotti* MOREMAN, 1942, p. 208, pl. 33, fig. 8; text-fig. 2d; by original designation.

Moremanoceras elgini (YOUNG, 1958)
Figs. 2a-x; 3c, d, h; 6k

1958 *Desmoceras (Pseudouhligella) elgini*. – YOUNG, p. 292, pl. 39, figs. 4-20, 24, 25, 30, 31; text-figs. 1a-e.
1959 *Pseudouhligella elgini* YOUNG. – YOUNG, p. 80, pl.2, figs. 1-7.
non 1963 *Desmoceras (Pseudouhligella) elgini* YOUNG. – POWELL, p. 314, pl. 31, figs. 13-16.
1978 *Pseudouhligella elgini* YOUNG. – YOUNG & POWELL, pl. 3, figs. 3-5, 7, 8, 15.
1989 *Moremanoceras elgini* (YOUNG, 1958). – KENNEDY, COBBAN, HANCOCK & HOOK, p. 52, fig. 5C, D, F.

Type: The holotype is TMM 10782A; it and numerous paratypes are from the base of the Boquillas Formation on the northeast flank of the Davis Mountains in Trans-Pecos Texas.

Description: Coiling is very involute. Umbilicus, which is small and deep, comprises around 12% of the diameter in juveniles and has a flattened, subvertical wall and narrowly rounded umbilical shoulder. Whorl section is compressed, the whorl breadth to height ratio increasing through ontogeny to around 0.6. Flanks are flattened and subparallel with broadly rounded venter and ventrolateral shoulders. Ornament consists of prorsiradiate growth lines, feebly concave on the inner flank and slightly convex at mid-flank. They slant forward and become concave on the outermost flank before crossing the venter in a linguoid peak. Distant low ribs that develop on the outer flank and venter seem to be the adapertural collars of constrictions on the mould and are faintly visible through the silicified shell. These collar-ribs strengthen markedly on adult body chambers, where the coiling becomes more evolute and the umbilicus comprises up to 18% of the diameter. The largest specimen seen has a diameter of 34 mm and an intercostal whorl breadth to height ratio of 0.71. There are an estimated 7 strong, distant ribs on the last half whorl. They arise on the outer flank and strengthen rapidly across the ventrolateral shoulder, where they are strongly concave and project forward to cross the venter in a linguoid peak. There are associated constrictions as well as intercalated riblets and striae.

Discussion: *Moremanoceras elgini* arose from *Moremanoceras bravoense* KENNEDY & COBBAN, 1989 (p. 136, fig. 2a-d) of the underlying *Acompsoceras inconstans* zone, but is much more compressed and recalls ancestral *Desmoceras*. *M. bravoense* also lacks the distinctive ventrolateral and ventral ribbing of the present species. *M. elgini* gave rise to *Moremanoceras straini* KENNEDY, COBBAN & HOOK, 1988 (p. 36, figs. 1a-g, i-t) of the *Acanthoceras amphibolum* zone. This is a much larger species essentially smooth at a diameter where *M. elgini* has developed ribs; *M. straini* has biconcave growth lines and constrictions that form acute ventral chevrons, is less compressed, and develops a siphonal keel at maturity. Other species referred to the genus are equally distinctive (COBBAN, HOOK & KENNEDY, 1989).

Occurrence: *Forbesiceras brundrettei* zone in Jeff Davis, Kinney and McLennan Counties, Texas.

Superfamily Acanthocerataceae DE GROSSOUVRE, 1894
Family Forbesiceratidae WRIGHT, 1952
Genus *Forbesiceras* KOSSMAT, 1897

Type species: *Ammonites largilliertianus* D'ORBIGNY, 1841, p. 320, pl. 95; by subsequent designation by DIENER, 1925, p. 180.

Forbesiceras brundrettei (YOUNG, 1958)
Figs. 3a, b, e-g, i-l, n; 4a-g

1958 *Neopulchellia brundrettei*. – YOUNG, p. 289, pl. 39, figs. 1-3, 26-28, 33, 35-38; pl. 40, figs. 6, 9, 11; text-figs. 1f, i, k, m.

1959 *Neopulchellia brundrettei* YOUNG. – YOUNG, pl. 1, figs. 4, 7, 8; pl. 3, fig. 4.
1978 *Forbesiceras brundrettei* (YOUNG). – YOUNG & POWELL, pp. 15-24, pl. 3, figs. 1, 2, 6.
1983 *Forbesiceras brundrettei* (YOUNG). – HOOK & COBBAN, p. 52.
1989 *Forbesiceras brundrettei* (YOUNG, 1958). – KENNEDY, COBBAN, HANCOCK & HOOK, p. 54, fig. 50, p, u, v; Fig. 7e.

Holotype: TMM 10734, the original of YOUNG, 1958, pl. 39, figs. 35-37, from the base of the Boquillas Formation on the northeast flank of the Davis Mountains in Trans-Pecos Texas.

Description: Coiling is very involute with a minute umbilicus. In middle growth the whorl breadth to height rate is as little as 0.4, the whorl sides high and very feebly convex, the greatest breadth below mid-flank and with sharp ventrolateral shoulders and a narrow, concave venter. On the phragmocone, ornament is of narrow, prorsiradiate, straight to slightly convex primary ribs that may bifurcate around mid-flank. Shorter ribs may intercalate. There may be an incipient bulla at the point of branching. Ribs may branch a second time and are feebly concave on the outer flank, broadening towards the venter, where they terminate in long, sharp ventral clavi perched on the ventrolateral shoulder. Inner flank ribs strengthen markedly on the older parts of the body chamber, and secondary ribs arise in bundles of up to 4 and may branch a second time. On the last part of the body chamber, before the adult aperture, the venter broadens and rounds, ribs crowd, and the point of branching extends to low on the flank with a biconcave course to the ribs in some specimens.

The largest individuals showing adult characters are up to 60 mm in diameter with a whorl height of 27 mm; we take them to be macroconchs. What appears to be an adult microconch is represented by a specimen with a whorl height of 24 mm.

Discussion: *Forbesiceras brundrettei* most closely resembles *Forbesiceras chevillei* (PICTET & RENEVIER, 1866) (p. 102, pl. 4, fig. 2; see revision in WRIGHT & KENNEDY 1984, p. 93, pl. 13, fig. 2; pl. 15, figs. 1, 2; text-fig. 17), but this is a much larger species that does not develop bidichotonous ribbing and has delicate multiple ventral ribs.

Occurrence: *F. brundrettei* zone in Jeff Davis, Kinney and McLennan County, Texas.

Suborder Ancyloceratina WIEDMANN, 1966
Superfamily Turrilitaceae GILL, 1871
Family Turrilitidae GILL, 1871

Genus and subgenus *Ostlingoceras* HYATT, 1900

Type species: *Turrilites puzosianus* D'ORBIGNY, 1842, p. 587, pl. 123, figs. 1, 2; by original designation.

Ostlingoceras (Ostlingoceras) brandi YOUNG, 1958

Figs. 5a, b, d, g; 6 f-i

1958 *Ostlingoceras brandi*. – YOUNG, p. 287, pl. 40, figs. 4, 5, 7; text-fig. 1n.
1959 *Ostlingoceras brandi* YOUNG. – YOUNG, pl. 1, figs. 5, 6, 9.
1965 *Ostlingoceras (Ostlingoceras) brandi* YOUNG. – CLARK, p. 37, pl. 8, figs. 2, 7.
1989 *Ostlingoceras brandi* YOUNG, 1958. – KENNEDY, COBBAN, HANCOCK & HOOK, p. 99, fig. 31r.

Type: Holotype is TMM 10281, from the base of the Boquillas Formation on the northeast flank of the Davis Mountains, Jeff Davis County, Texas.

Description: The new collections include specimens with whorl heights of up to 20 mm. The apical angle is low, producing a high-spired shell; the outer whorl face is evenly convex and has a relatively shallow impressed zone between the whorls. Ornament is of strong, narrow, straight, strongly prorsiradiate ribs that may develop an incipient bulla low on the outer exposed whorl face and a feeble bulla at the juncture of outer and lower whorl faces.

Discussion: YOUNG (1958) compared this species to *Euturrilites* (a synonym of *Turrilites*), of which the type species is *Turrilites (Turrilites) scheuchzerianus* BOSC, 1801 (see revision in ATABEKIAN 1985), but this has much less markedly prorsiradiate ribs, lacks the incipient bituberculation of the present species, and commonly shows a weakening of the ribs at mid-flank, which produces a nearly smooth spiral zone that extends over several whorls of the juvenile shell, a feature never shown by the present material. Instead, the overall shell shape and ornament recall *Ostlingoceras*, a genus which extends into the lower Cenomanian. *Ostlingoceras bechii* (SHARPE, 1857) (p. 66, pl. 26, fig. 13) has much coarser ribs, a less convex outer whorl face and three rows of tubercles low on the outer whorl face and at the juncture with the lower whorl face. *Ostlingoceras puzosiforme* SPATH, 1926 (pp. 424, 431; see revision in KENNEDY 1971, p. 26, pl. 7, fig. 6) has a very flat outer whorl face with weaker, sinuous ribs, and prominent tubercles a little below the mid-point of that face.

Occurrence: *Forbesiceras brundrettei* zone, Jeff Davis, Kinney and McLennan Counties, Texas.

Genus and subgenus *Mariella* NOWAK, 1916

Type species: *Turrilites bergeri* BRONGNIART, 1822, p. 395, pl. 71, fig. 3, by original designation.

Mariella (Mariella) davisense (YOUNG, 1958)

Figs. 5c, e, f, h, i, k; 6 c-e

1958 *Ostlingoceras davisense*. – YOUNG, p. 289, pl. 39, figs. 29, 34.

1965 *Ostlingoceras (Ostlingoceras) davisense* YOUNG. – CLARK, p. 36, pl. 8, figs. 1, 3.

1989 *Ostlingoceras davisense* YOUNG, 1958. – KENNEDY, COBBAN, HANCOCK & HOOK, p. 100, fig. 31d, v.

Type: Holotype is TMM 10286 from the base of the Boquillas Formation on the northeast flank of the Davis Mountains, Jeff Davis County, Texas.

Description: Spire is narrow and the apical angle low. Upper part of the outer whorl face is broad, the middle part flattened, so that the depression between the whorls is pronounced. Delicate prorsiradiate ribs arise at the suture of upper and outer whorl faces, and sweep forward and strengthen into bullae in the middle of the outer-whorl face. A stronger rib sweeps forward and links to a second row of tubercles, the two rows defining the upper and lower limits of the flattened part of the outer whorl face. A weakening rib sweeps forward to a pair of close-spaced, feebly clavate tubercles that extend across the juncture of

outer and lower whorl faces, and gives rise to strongly prorsiradiate ribs on the lower whorl face.

Discussion: This species was originally referred to *Ostlingoceras;* KENNEDY, COBBAN, HANCOCK & HOOK (1989) suggested it might be better referred to *Mariella (Mariella).* The present collection includes specimens that have an outer whorl face that is differentiated into a broad upper region and flattened mid-section, a feature shown by *Mariella* species, and quite distinct from the whorl shape of *Ostlingoceras*.

Occurrence: *Forbesiceras brundrettei* zone, Jeff Davis, Kinney and McLennan Counties, Texas.

Genus *Hypoturrilites* DUBOURDIEU, 1953

Type species: *Turrilites gravesianus* D'ORBIGNY, 1842, p. 596, pl. 114, figs. 3-5, by original designation.

Hypoturrilites youngi CLARK, 1965

Figs. 3m; 5j, l, m

1958 *Hypoturrilites* n. sp. – YOUNG, p. 287, pl. 39, fig. 32; text-fig. 1g.
1965 *Hypoturrilites youngi*. – CLARK, p. 52, pl. 19, fig. 6.
1989 *Hypoturrilites youngi* CLARK, 1965. – KENNEDY, COBBAN, HANCOCK & HOOK, p. 100, fig. 31s.

Type: TMM 10285, the original of Clark, 1965 pl. 19, fig. 6; holotype by monotypy. It is from the base of the Boquillas Formation on the northeast flank of the Davis Mountains, Jeff Davis County, Texas.

Description: The species reaches a large size; fragments have whorl heights of up to 70 mm. The outer whorl face is strongly convex. Strong, blunt, concave prorsiradiate ribs extend from the upper whorl suture across the upper outer whorl face and link in groups of three at massive flat-topped circular tubercles sited a little above the middle of the outer whorl face; the flat tops suggest these to be the bases of septate spines broken off at the basal septum. A low broad rib, sometimes differentiated into riblets, sweeps forward and connects these large tubercles to smaller clavate tubercles. One or two non-tuberculate ribs intercalate between the tubercles of the upper row and link to similar tubercles. Tubercles in the second row are twice as numerous as those in the upper row. A broad prorsiradiate rib or ribs sweeps forward from the tubercles of the second row across a concave spiral zone and link to a third row of slightly smaller spirally elongated tubercles, and thence to a fourth, smaller row on the lower surface of the whorl.

Discussion: *Hypoturrilites* with ribs are best known from Europe and North Africa, where *Hypoturrilites tenouklensis* PERVINQUIÈRE, 1910 (p. 57, p. 5, fig. 3) is the best-characterized. It and other species differ from *H. youngi* is having many more and finer tubercles in the lower rows.

Occurrence: *Forbesiceras brundrettei* zone, Jeff Davis County. Texas.

Bivalves

Subclass Pteriomorphia BEURLEN, 1944
Order Pterioida NEWELL, 1965
Superfamily Pteriaceae GRAY, 1847
Family Inoceramidae GIEBEL, 1852

Genus *Inoceramus* J. SOWERBY, 1814

Inoceramus aff. *arvanus* STEPHENSON, 1953
Figs. 6a, b, j

Description: The shell is moderately convex and as much as 50 mm long. It has a subquadrate outline with a posterior auricle and ornament of weak, irregular growth lines and rugae.

Discussion: These specimens resemble *I. arvanus* STEPHENSON, 1953 (p. 65, pl. 12, figs. 6-9) in many features but differ in lacking a posterior sulcus. Some of the more weakly ornamented specimens resemble *I. tenuistriatus* NAGAO & MATSUMOTO, 1939 (p. 272, pl. 24, fig. 8; pl. 26, figs. 1-4), but most seem to represent some generalized form that gave rise to *I. arvanus*.

Occurrence: Rare in the *Forbesiceras brundrettei* zone and abundant in the *Acanthoceras bellense* zone in Jeff Davis County, Texas.

Suborder Ostreina FÉRUSSAC, 1822
Superfamily Ostreacea RAFINESQUE, 1815
Family Ostreidae RAFINESQUE, 1815
Subfamily Ostreinae RAFINESQUE, 1815

Genus *Ostrea* LINNAEUS, 1758

Type species: *Ostrea edulis* LINNAEUS, 1758, p. 696 (ICZN Opinion 94, 1958).

Ostrea beloiti LOGAN, 1899

1876 *Ostrea elegantula*. – NEWBERRY, p. 33 (nomen oblitum).
1884 *Ostrea elegantula* NEWBERRY. – WHITE, p. 295, pl. 36, figs. 5-7.
1899 *Ostrea beloiti*. – LOGAN, p. 214, pl. 25, figs. 7, 8.
1965 *Ostrea beloiti* LOGAN. – HATTIN, p. 50, pl. 4, figs. A, B, G, I.
1977 *Ostrea beloiti* LOGAN. – KAUFFMAN & POWELL, p. 92, pl. 8, figs. 9, 10.
1977 *Ostrea beloiti* LOGAN. – HATTIN, fig. 4.14.
1980 *Ostrea beloiti* LOGAN. – COBBAN & HOOK, p. 169, fig. 2A, B.
1984 *Ostrea beloiti* LOGAN. – COBBAN, p. 13, pl. 5, fig. 11.
1986 *Ostrea beloiti* LOGAN. – COBBAN, fig. 5, l, b.
1988 *Ostrea beloiti* LOGAN. – KENNEDY, COBBAN & HOOK, p. 42, figs. 2f, g, m, r.
1989 *Ostrea beloiti* LOGAN. – KENNEDY, COBBAN, HANCOCK & HOOK, p. 112, fig. 34 m.

Type: Lectotype, designated by KENNEDY, COBBAN, HANCOCK & HOOK, 1989, is the original of Logan, 1899, pl. 25, figs. 7, 8, from the Cenomanian of north-central Kansas.

Discussion: Numerous whole and fragmentary specimens of this species, described recently by KAUFFMAN & POWELL (1977) and COBBAN & HOOK (1980), occur in the *F. brundrettei* zone in Trans-Pecos Texas. The species ranges up to the *Dunveganoceras pondi* zone, but is chiefly known from the *Acanthoceras amphibolum* zone, where it may occur in rock forming proportions. It ranges geographically from Trans-Pecos, north and central Texas as far north as Manitoba, Canada.

Fig. 2. a-x: *Moremanoceras elgini* (YOUNG, 1958). a, b – OUM KT 2104; c-e – OUM KT 2101; f-h – OUM KT 2105; i-k – OUM KT 2107; l-n – OUM KT 2106; o, t – OUM KT 2111; p – OUM KT 2121; q-s – OUM KT 2111; u – OUM KT 2117; v-x – TMM collections. All specimens are from the *Forbesiceras brundrettei* zone on the Cherry Ranch, Jeff Davis County, Texas. All figures are x 1.

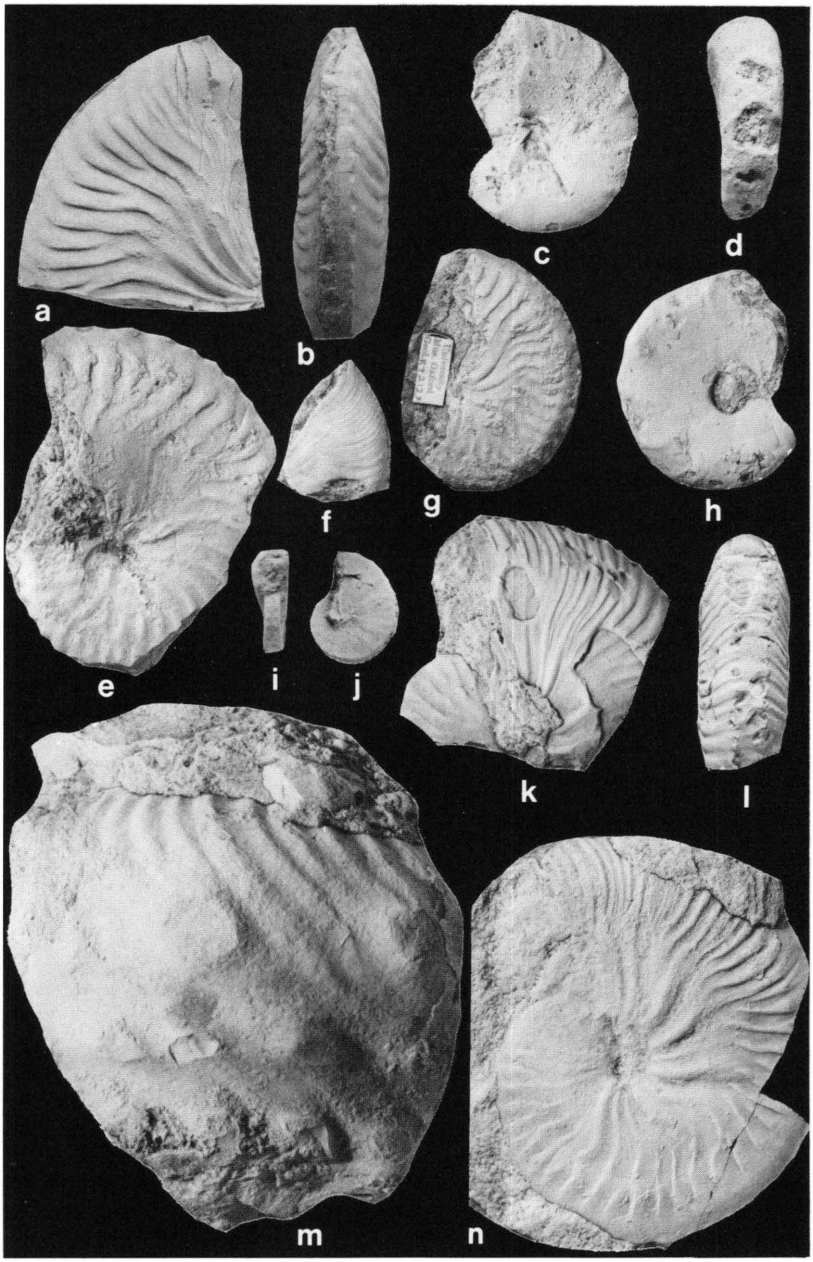

Fig. 3. a, b, e-g, i-l, n: *Forbesiceras brundrettei* (YOUNG, 1958). a, b – TMM 10735; e – OUM KT 2132; f – OUM KT 2133; g – OUM KT 2129; i, j – TMM10739; k, l – OUM KT 2135; n – OUM KT 2126. c, d, h – *Moremanoceras elgini* (YOUNG, 1958), TMM collections. m – *Hypoturrilites youngi* CLARK 1965, TMM collections. All specimens are from the *Forbesiceras brundrettei* zone on the Cherry Ranch, Jeff Davis County, Texas. All figures are x 1.

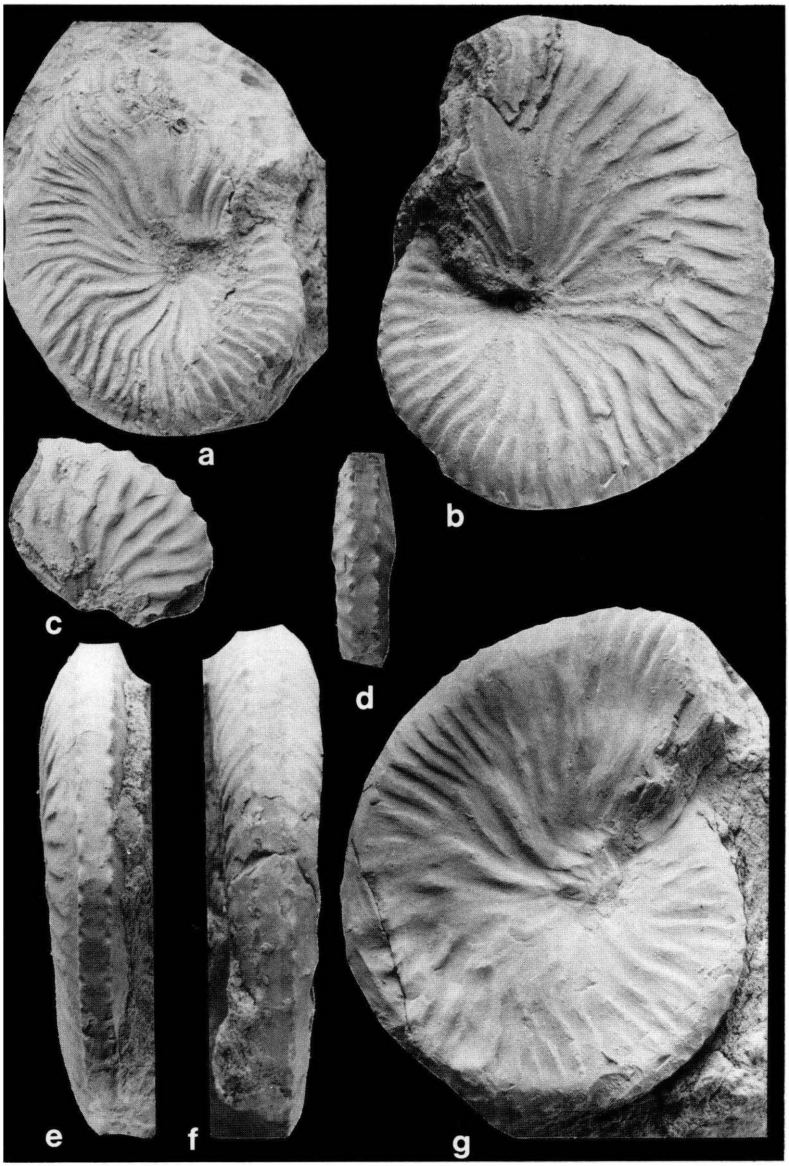

Fig. 4. a-g: *Forbesiceras brundrettei* (YOUNG, 1958). a – TMM 10744; b, e – the holotype, TMM 10734; c, d – TMM 10282; f, g – TMM 10737. All specimens are from the *Forbesiceras brundrettei* zone on the Cherry Ranch, Jeff Davis County, Texas. All figures are x 1.

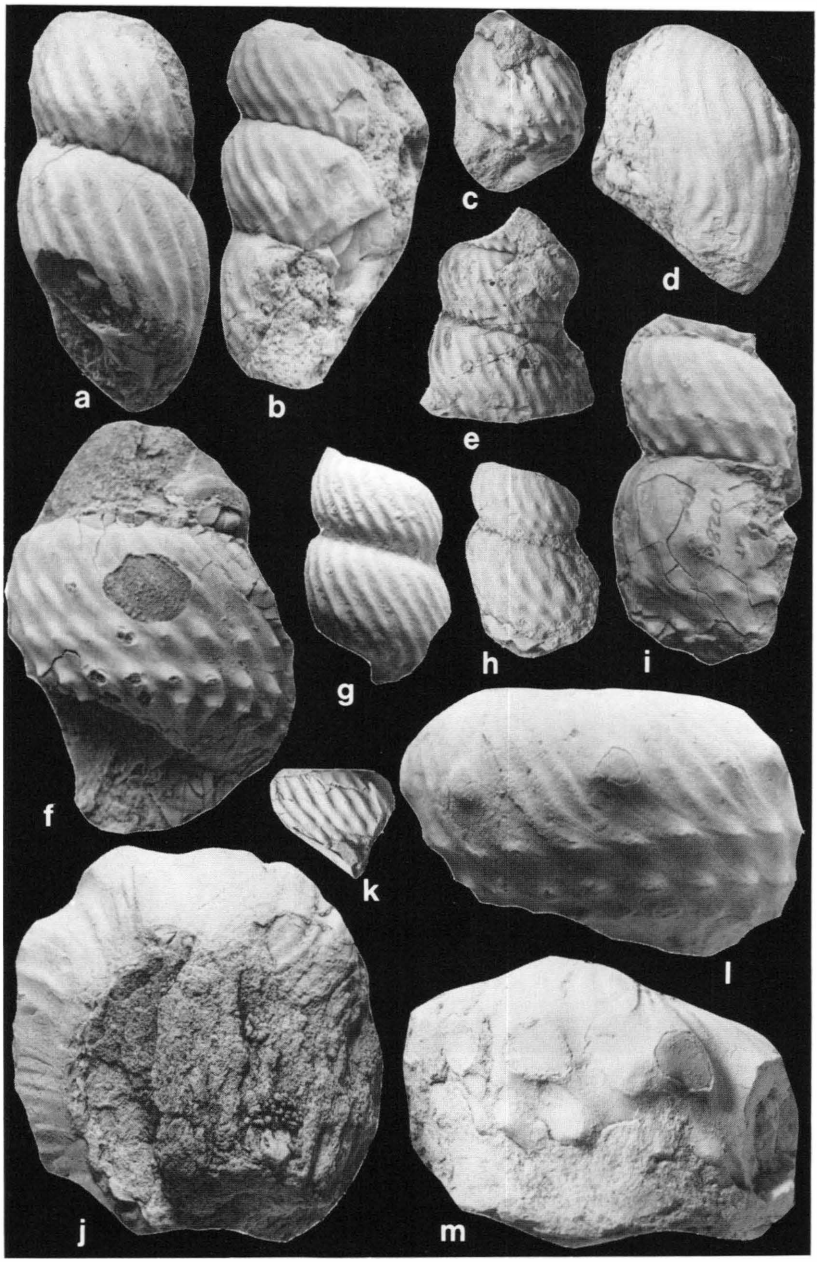

Fig. 5. a, b, d, g: *Ostlingoceras brandi* YOUNG, 1958. a – TMM 10284; b – the holotype, TMM 10281; d – OUM KT 2094; g – TMM 10288. c, e, f, h, i, k – *Mariella (Mariella) davisense* (YOUNG, 1958). c – OUM KT 2092; e – OUM KT 2090; f – TMM 10782; h – OUM KT 2087; i – the holotype, TMM 10286; k – OUM KT 2084. j, l, m – *Hypoturrilites youngi* CLARKE, 1965. j, m – OUM KT 2140; l – the holotype, TMM 10285. All specimens are from the *Forbesiceras brundrettei* zone on the Cherry Ranch, Jeff Davis County, Texas. All figures are x 1.

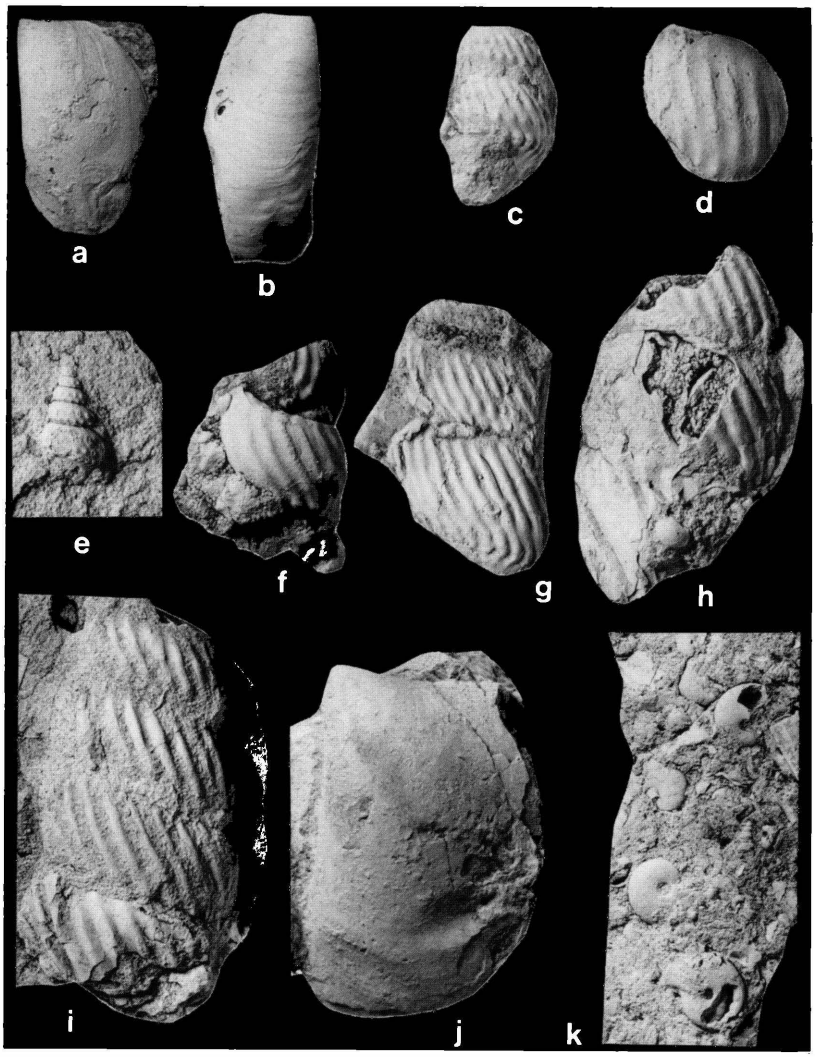

Fig. 6. a, b, j: *Inoceramus* aff. *arvanus* STEPHENSON, 1953. a – OUM KT 2150; b – OUM KT 2149; j – TMM collections. c-e – *Mariella (Mariella) davisense* (YOUNG, 1958) c – OUM KT 2089; d OUM KT 2019; e – OUM KT 2114. f-i – *Ostlingoceras brandi* YOUNG, 1958. f – OUM KT 2096; g – OUM KT 2095; h – OUM KT 2100; i – OUM KT 2141. k – *Moremanoceras elgini* (YOUNG, 1958), OUM KT 2181. All specimens are from the *Forbesiceras brundrettei* zone on the Cherry Ranch, Jeff Davis County, Texas. All figures are x 1.

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Literature

Atabekian, A. A. (1985): [Turrilitids of the late Albian and Cenomanian of the southern part of the USSR]. 112 p., 34 pls. NAUK, Leningrad. [in Russian]

Beurlen, K. (1944): Beiträge zur Stammesgeschichte der Muscheln. – Sber. bayer. Akad. Wiss., **1944** (1, 2): 133-145.

Bosc, L. A. G. (1801): (An. 13) In Roissy, F. Histoire Naturelle générale et particulière, des Mollusques, Animaux sans vertébres et à sang blanc. Ouvrage faisant suit aux Oeuvres de Leclerc de Buffon, et partie du Cours complet d'Histoire naturelle, rédigé par C. S. Sonnini, membre de plusiers Sociétés savants. Continué par. F. de Roissy. viii + 448 + 3 pp., pls.; Paris.

Brongniart, A. (1822): Sur quelques terrains de Craie hors du Bassin de Paris 80-101 in Cuvier, G. & Brongniart, A. Description géologique des environs de Paris. 3 edition, 428 pp., 11 pls.; Paris.

Clark, D. L. (1965): Heteromorph ammonoids from the Albian and Cenomanian of Texas and adjacent areas. – Mem. geol. Soc. Am., **95:** 99 pp., 24 pls.

Cobban, W. A. (1972): New and little-known ammonites from the Upper Cretaceous (Cenomanian and Turonian) of the Western Interior of the United States. – Prof. Pap. U.S. geol. Surv., **699:** 24 pp., 18 pls. (1971 imprint).

–,– (1984): Molluscan record from a mid-Cretaceous borehole in Weston County, Wyoming. – Prof. Pap. U.S. geol. Surv., **1271:** 24 p., 5 pls.

–,– (1986): Upper Cretaceous molluscan record from Lincoln County, New Mexico. – Southwest Section of the American Association of Petroleum Geologists, Transactions and Guidebook of 1986 Convention, Ruidoso, New Mexico, 77-89.

Cobban, W. A. & Hook, S. C. (1980): Occurrence of *Ostrea beloiti* Logan in Cenomanian rocks of Trans-Pecos Texas. New Mexico Geological Society Guidebook, 31st Field Conference, Trans-Pecos Region, 1980: 169-172; Socorro.

Cobban, W. A., Hook, S. C. & Kennedy, W. J. (1989): Upper Cretaceous rocks and ammonite faunas of southwestern New Mexico. – Mem. New Mex. Bur. Mines Min. Res., **45:** 137 p.

Collignon, M. (1928-1929): Paléontologie de Madagascar, XV. Les céphalopodes du Cénomanien pyriteux de Diégo-Suarez. – Annls. Paléont., **17** (1928): 139-160 (1-24), pls. 15-19 (1-5); **18** (1929): 1-56 (25-80), pls. 1-2 (6-7).

Diener, C. (1925): Ammonoidea neocretacea. – Fossilium Catalogus (1: Animalia), **29:** 244 pp.

Dubourdieu, G. (1953): Ammonites nouvelles des Monts du Mellègue. – Bull. Serv. Carte géol. Algér. (1), Paléontologie, **16:** 76 pp., 4 pls.

Férussac, A. E. de. (1822): Tableaux systèmatique des animaux mollusques. 111 pp.; Paris & London.

Giebel, C. G. (1852): Deutschlands Petrefacten. Ein systematisches Verzeichnis aller in Deutschland und der angrenzenden Ländern vorkommenden Petrefacten nebst Angabe der Synonyme und Fundorte, 329-441; Leipzig.

GILL, T. (1871): Arrangement of the families of Mollusks. – Smithson. Misc. Coll., **227:** xvi + 49 pp.

GRAY, J. E. (1847): A list of the genera of recent mollusca, their synonyms and types. – Proc. Zool. Soc. Lond., **15:** 129-219.

GROSSOUVRE, A. DE (1894): Recherches sur la craie supérieure, 2, Paléontologie. Les ammonites de la craie supérieure. – Mém. Serv. Carte géol. dét. France 264 pp., 39 pls. (misdated 1893).

HATTIN, D. E. (1965): Stratigraphy of the Graneros Shale (Upper Cretaceous) in central Kansas. – Bull. Kansas Univ. geol. Surv., **178:** 83 pp.

–,– (1977): Upper Cretaceous stratigraphy, paleontology and paleoecology of western Kansas. – Mount. Geologist, **14:** 175-218.

HOOK, S. C. & COBBAN, W. A. (1983): Mid-Cretaceous molluscan sequence at Gold Hill, Jeff Davis County, Texas, with comparison to New Mexico. – Circ. New Mex. Bur. Min. Miner. Res., **185:** 48-54.

HYATT, A. (1889): Genesis of the Arietidae. – Smithson. Contrib. Knowl., 673, xi + 239 pp., 14 pls.

–,– (1900): Cephalopoda, pp. 502-604 in ZITTEL, K. A. VON 1896-1900, Textbook of Palaeontology, transl. EASTMAN, C. R.; London and New York; (Macmillan)

KAUFFMAN, E. G. & POWELL, J. D. (1977): Paleontology. Pp. 47-114. – In: KAUFFMAN, E. G., HATTIN, D. E. & POWELL, J. D.: Stratigraphic, paleontologic and paleoenvironmental analysis of the Upper Cretaceous rocks of Cimarron County, northwestern Oklahoma. – Mem. geol. Soc. Am., **149:** X + 150 pp., 12 pls.

KENNEDY, W. J. (1971): Cenomanian ammonites from southern England. – Spec. Pap. Palaeont., **8:** V + 133 pp., 64 pls.

KENNEDY, W. J. & COBBAN, W. A. (1989): *Acompsoceras inconstans* zone, a lower Cenomanian marker horizon in Trans-Pecos Texas, U.S.A. – Neues Jb. Geol. Paläont., Abh., **178:** 133-145.

–,– (1990): Cenomanian ammonite faunas from the Woodbine Formation and lower part of the Eagle Ford Group, Texas. – Palaeontology, **33:** 75-154, 17 pls.

KENNEDY, W. J., COBBAN, W. A. & HOOK, S. C. (1988): Middle Cenomanian (Late Cretaceous) molluscan fauna from the base of the Boquillas Formation, Cerro de Muleros, Doña Ana County, New Mexico. – Bull. New Mex. Bur. Min. Miner. Res., **114:** 35-44.

KENNEDY, W. J., COBBAN, W. A., HANCOCK, J. M. & HOOK, S. C. (1989): Biostratigraphy of the Chispa Summit Formation at its type locality: a Cenomanian through Turonian reference section for Trans-Pecos Texas. – Bull. geol. Instns Univ. Uppsala, N. S. **15:** 39-119.

KENNEDY, W. J., JUIGNET, P. & GIRARD, J. (1990): *Budaicers hyatti* (SHATTUCK, 1903), a North American index ammonite from the Lower Cenomanian of Haute Normandie, France. – Neues Jb. Geol. Paläont., Mh., **1990:** 525-535.

KOSSMAT, F. (1895-1898): Untersuchungen über die Südindische Kreideformation. – Beitr. Paläont. Geol. Öst. Ungarn, **9** (1895): 97-203 (1-107); **11** (1897): 1-46 (108-193); **11** (1898): 89-152 (154-217).

LINNAEUS, C. (1758): Systema Naturae, **1:** 10th Edn. 823 + 1 p.; Stockholm.

LOGAN, W. N. (1899): Some additions to Cretaceous invertebrates of Kansas. – Kansas Univ. Q., **8,** (A): 87-98.

MOREMAN, W. L. (1942) Paleontology of the Eagle Ford group of north and central Texas. – J. Paleont., **16:** 192-220, pls. 31-34.

NAGAO, T. & MATSUMOTO, T. (1939): A monograph of the Cretaceous *Inoceramus* of Japan. – J. Fac. Sci. Hokkaido Imp. Univ., (4) **4** (3-4): 241-299, pls. 23-34.

NEWBERRY, J. S. (1876): Geological report. – In: MACOMB, J. N.: Report of the exploring expedition from Santa Fe, New Mexico, to the junction of the Grand and Green Rivers of the Great Colorado of the West in 1859. – U.S. Army, Engineering Department, 9-118.

NEWELL, N. D. (1965): Classification of the Bivalvia. – Am. Mus. Novit, **2206:** 25 p.

NOWAK, J. (1916): Über die bifiden Loben der oberkretazischen Ammoniten und ihre Bedeutung für die Systematik. – Bull. int. Acad. Sci. Lett. Cracovie, C1. Sci. math. nat. B., (195): 1-13.

ORBIGNY, A. D. (1840-1842): Paléontologie française: Terrains crétacés. **1:** Céphalopodes. 1-120 (1840); 121-430 (1841); 431-662 (1842).

PERVINQUIÈRE, L. (1907): Études de paléontologie tunisienne. 1: Céphalopodes des terrains secondaires. – Carte géol. Tunisie, v +438 pp., 27 pls.

–,– (1910): Sur quelques ammonites du Crétacé algérien. – Mém. Soc. géol. Fr., Paléont., **17,** (2-3): 86, pp., pls. 10-16 (1-7).

PICTET, F. J. & RENEVIER, E. (1866): Notices géologiques et paléontologiques sur les Alpes Vaudoises et les régions environnantes. IV. Céphalopodes de Cheville. – Bull. Soc. vaudoise, Sci. natur., **9:** 93-114.

POWELL, J. D. (1963): Cenomanian-Turonian (Cretaceous) ammonites from Trans-Pecos Texas and north-eastern Chihuahua, Mexico. – J. Paleont., **37:** 309-322, pls 31-34.

RAFINESQUE, C. S. (1815): Analyse de la nature ou tableau de l'Univers et des Corps organisés etc. 224 pp.; Palermo.

SCHLÜTER, C. (1871-1876): Cephalopoden der oberen deutschen Kreide. – Palaeontographica, **21:** 1-24, pls. 1-8 (1871): **21:** 25-120, pls. 9-35 (1872): **24:** 121-264, pls. 36-55 (1876).

SHARPE, D. (1853-57): Description of the fossil remains of Mollusca found in the Chalk of England. I, Cephalopoda. – Monogr. palaeontogr. Soc., 1-26, pls. 1-10 (1853); 27-36, pls. 11-16 (1855); 37-68, pls. 17-27 (1857).

SOWERBY, J. (1812-1822): The mineral conchology of Great Britain. **1,** pls. 1-9 (1812), pls. 10-44 (1813), pls. 45-78 (1814), pls. 79-102 (1815); **2,** pls. 103-114 (1815), pls. 115-150 (1816), pls. 151-186 (1917), pls. 187-203 (1818): **3,** pls. 204-221 (1818), pls. 222-253 (1819), pls. 254-271 (1820), pls. 272-306 (1821); **4,** pls. 307-318 (1821), pls. 319-383 (1822); London.

SPATH, L. F. (1926): On the zones of the Cenomanian and the uppermost Albian. – Proc. Geol. Ass., **37:** 420-432.

STEPHENSON, L. W. (1953): Larger invertebrate fossils of the Woodbine Formation (Cenomanian) of Texas. – Prof. pap. U.S. geol. Surv., **242:** iv + 226 pp., 59 pls. (1952 imprint).

WHITE, C. A. (1884): A review of the fossil Ostreidae of North America; and a comparison of the fossil with the living forms. – U.S. 48th Congress, 1st Session, Report of the Secretary of Interior 3, 273-308 (1883 imprint).

WIEDMANN, J. (1966): Stammesgeschichte und System der posttriadischen Ammonoideen; ein Überblick. – Neues Jb. Geol. Paläont., Abh., **125:** 49-79.

WRIGHT, C. W. (1952): A classification of the Cretaceous ammonites. – J. Paleont., **26:** 213-222.

WRIGHT, C. W. & KENNEDY, W. J. (1984): The Ammonoidea of the Lower Chalk. Part 1. – Monogr. palaeontogr. Soc., 1-126, pls. 1-40.

YOUNG, K. (1958): Cenomanian (Cretaceous) ammonites from Trans-Pecos Texas. – J. Paleont., **32:** 286-294, pls. 39-40.

–,– (1959): Index fossils of the Trans-Pecos area. – West Texas Geological Society Guidebook: Geology of the Val Verde Basin, 79-84, 3 pls.

YOUNG, K. (1986): The Albian-Cenomanian (Lower Cretaceous-Upper Cretaceous) boundary in Texas and northern Mexico. – J. Paleont., **60**: 1212-1219.

YOUNG, K. & POWELL, J. D. (1978): Late Albian-Turonian correlations in Texas and Mexico. – Ann. Mus. Hist. Nat. Nice, **4**: xxv.1-xxv.36, 9 pls. (1976 imprint).

ZITTEL, K. A. VON (1884): Handbuch der Palaeontologie **1**: Abt. 2; Lief 3, Cephalopoda, pp. 329-522; München & Leipzig.

–,– (1895): Grundzüge der Palaeontologie (Palaeozoologie). – vii + 972 pp.; München & Leipzig.

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