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A MOLLUSCAN FAUNULE FROM THE PIERRE FORMATION IN EASTERN MONTANA

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The fossils listed and described in this report were collected in the fall of 1930 and presented to the Geology Department of Columbia University for study, by Mr. Theron Wasson, Chief Geologist of the Pure Oil Company. They were obtained from a horizon about 100 feet below the top of the Pierre, at a point near the northwest end of the

Fig. 1. Map of Montana, showing region from which fossils were collected (X).

Cedar Creek anticline, and near the center of that section of the anticline known as the Gas City Dome, south of Glendive, Montana (Fig. 1). This locality lies a little west of the center of Township 14 North, Range 55 East, in Dawson County, Montana (Fig. 2).

The report includes a general summary of the stratigraphy of the Pierre formation as a whole, with a more detailed lithologic description of the member in which the fossils occur, and especially of the concretions in which they are found. A study was made to determine whether

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the exceptionally good state of preservation of the fossil shell material is due to the presence of bituminous matter, or to some other cause, or both. The report also includes a list of the fossils of this faunule, which consists entirely of Mollusca, together with a description and classification of some new species. Thirty-five species in all are represented; of these, eight are Gastropoda, ten are Cephalopoda, fifteen are Pelecypoda, and two are Scaphopoda. The two new species described are ammonoid

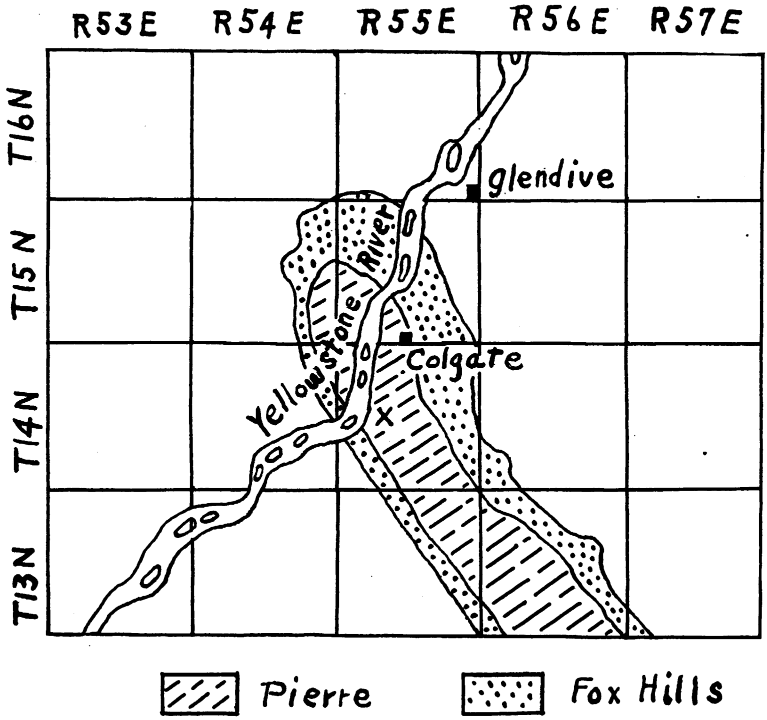

Fig. 2. Map of a part of Cedar Creek Anticline, showing locality (X) from which fossils were collected.

Cephalopoda. There is also a discussion of the classification and nomenclature of one of Meek's species of Cephalopoda. Photographs of all species described in this paper are presented in figures 5-13.

STRATIGRAPHY

The Pierre shale is one of the thickest and most widespread of the Upper Cretaceous formations of the western United States. It forms the greater part of the Montana Group, of Gulfian age (Fig. 3). Its thickness ranges from about 700 feet in the Black Hills of South Dakota, to 1100 feet in southern North Dakota, and to a minimum of 1750 feet in northeastern Wyoming and southeastern Montana. It covers many square miles of territory, outcropping widely in South Dakota, where it encircles the Black Hills in a wide band. It is the surface formation in most of the eastern part of North Dakota, and appears frequently in the southern and southwestern sections. The Pierre is also to be found outcropping extensively in eastern Wyoming and southeastern Montana. In the southwest corner of North Dakota, it comes to the surface and is exposed in a wide band all along the axis of the Cedar Creek anticline,

Series	Group	Formation and Member		Thickness
Upper Cretaceous or Gulfian	Montanan	Fox Hills Sandstone		150'-250'
		Pierre shale	Dark grey shale with concretions	150'-250'
			Monument Hill bentonitic member	150'
			Dark mudstone and shale with abundant concretions	500'-800'
			Mitten black shale member	150'-200'
			Groat ss. bed Gammon ferruginous member Pedro bentonite bed	800'-1000'
	Coloradan	Niobrara formation		375'-525'
		Carlile shale		225'-325'
		Greenhorn formation		50'-350'
		Graneros shale		650'-1575'

Fig. 3. Stratigraphic chart of Upper Cretaceous formations of southeastern Montana. After Rubey, modified.

which extends to the northwest about 70 miles into Montana, ending a few miles west of the Yellowstone River (Fig. 2).

The Pierre has been subdivided into five members[1] (Fig. 3). The lowest of these is the Gammon ferruginous member, consisting of 800–1000 feet of light gray mudstone and shale with abundant iron-stained concretions and thin beds of siderite. The fossils, which are scarce, are marine. The member contains, near the top, the Groat Sandstone bed, of ferruginous and glauconitic sandstone and siltstone, with a thickness up to 150 feet; it also contains, near the base, the Pedro bentonite bed, of hard, white, massive clay and tuff, locally 20 feet thick but not widespread. Above the Gammon lies the Mitten black shale member, con-

[1]Rubey, W. W. 1930. U. S. G. S. Prof. Paper 165, pp. 3–5.

sisting of 150 to 200 feet of blue-black, fissile shale with a few iron-stained calcareous concretions, and containing marine fossils. This member is overlain by 500 to 800 feet of dark mudstone and shale with abundant calcareous concretions and marine fossils. The rock is light gray in the upper part and iron-stained in the lower. Above it lies the Monument Hill bentonitic member, consisting of about 150 feet of impure bentonite and siltstone, with some calcareous and barite con-

Pierre	Pierre and Fox Hills	Fox Hills
Inoceramus proximus	Nucula cancellata	Protocardia subquadrata
Dentalium gracile	Nucula subplana	Corbula crassimarginata
Alaria sublevis	Limopsis parvula	Discoscaphites nicolleti
Alaria nebrascensis	Inoceramus barabini	
Fasciolaria cheyennensis	Pteria nebrascana	
Eutrephoceras dekayi	Pteria petrosa	
Baculites compressus	Cuspidaria ventricosa	
Baculites ovatus	Cuspidaria moreauensis	
Acanthoscaphites nodosus	Lucina occidentalis	
A. nodosus brevis	Lucina subundata	
A. nodosus comprimus	Protocardia rara	
A. nodosus plenus	Dosiniopsis deweyi	
	Dentalium pauperculum	
	Margarita nebrascensis	
	Natica concinna	
	Pyrifusus newberryi	
	Pyrifusus intertextus	
	Turris minor	

Fig. 4. Table of horizons at which species of this faunule have previously been found.

cretions, and marine fossils. The top member of the formation, from which the fossils herein described were collected, consists of 150 to 200 feet of dark gray, fissile shale and mudstone, containing locally light buff sandy shales. Crystals of selenite are plentiful throughout the beds, and very fine-grained, calcareous concretions are also quite abundant, especially near the top.[1]

[1]Calvert, W. R. 1907. U. S. G. S. Bull. 471, pp.192-193.

Rubey,[1] who has made an extensive study of this and other fine-grained Upper Cretaceous formations in the Black Hills region, includes an analysis of the beds just below the Monument Hill member. He finds that the chief constituent of these beds is definitely crystalline micaceous clay, probably of the beidellite type. They also contain some fine quartz sand or silt. They are moderately calcareous, containing 6.78% of calcium carbonate, and also include 1.48% of pyrite, disseminated throughout. Organic matter in general was found to amount to 2.39%, of which 0.10% was in the form of chloroform-soluble bitumens. The beds analyzed are apparently quite similar lithologically to those under consideration here, which occur at the top of the formation.

PALAEONTOLOGY

In the locality under discussion, many fossils are found in the lime concretions, although the surrounding shales are unfossiliferous.[2] The fossils listed and described in this report are all Mollusca, and are in an excellent state of preservation. The exteriors of many of the shells, especially of the cephalopods, still retain the original pearly luster, and very few show any signs of deformation. Thin sections of the concretions cut through embedded fossils show that the interiors of the fossils are filled with quite pure crystalline calcite; the shells themselves consist of two layers, a thin inner one of platy or amorphous calcite, and an outer one of fibrous aragonite, in a practically unaltered state. Surrounding the shells is the matrix of interlocking fine-grained calcite and clay particles, with abundant flecks of pyrite.

It has been suggested that the excellent preservation of the fossils in these concretions may be due to the presence of oil or bituminous matter of some sort, which would tend to keep the groundwater out and thus prevent solution or alteration of the pearly shell material.[3] That organic matter is present in the concretions is indicated by the pyrite, since this mineral very often occurs in association with such material, and also by the dark color, which is not caused by dark detrital minerals, since none are present in the thin sections. Tests of the material of the concretions, pulverized and treated with ether, showed a very small amount of soluble bituminous matter. The extremely fine-grained character of the concretions, which show only a very slight porosity in thin section, would also tend to prevent any circulation of groundwater within the rock. Moreover, Tarr[4] has shown that these concretions are

[1]Rubey, op. cit., pp. 5–11.
[2]Communication from Mr. Theron Wasson.
[3]Communication from Mr. Theron Wasson.
[4]Tarr, W. A. 1920. G. S. A. Bull. 32, pp. 373–384.

syngenetic, that is, formed at the time of the deposition of the enclosing rock. This would mean that the fossils within the concretions were buried almost immediately after death.

In view of these facts, then, it may be concluded that the preservation of the pearly shell material of these fossils is due to the fact that they have been protected, since the deposition of the formation, by an enveloping medium of an extremely dense and non-porous character, which was also impregnated with bituminous matter.

The fossils from this horizon do not constitute a restricted Pierre fauna. The majority are species which have previously been found both in this formation and in the Fox Hills sandstone which overlies it. The next largest group comprises those which have been found hitherto only in the Pierre, and the remainder, a very small group, are those which have not been found before except in the Fox Hills (see Fig. 4). We believe this horizon must be correlated with that referred to frequently by Meek[1] as "a bed containing a blending of the fossils from the upper part of the Fort Pierre and Fox Hills groups . . . ," especially since his locality, "Yellowstone River, 150 miles from its mouth," lies only about 50 miles south of the locality of the fossils under discussion. It is not unnatural that the upper beds of the Pierre in this region should contain fossils in common with the overlying formation, since here there is no distinct stratigraphic break between the two, but a gradation from the lower into the higher.[2]

SYSTEMATIC PALAEONTOLOGY

The following is a list of the species represented in this faunule. A few references are given for each species, although the reference lists are not, in most cases, complete. The original reference is included for each species; in cases where this is a publication which is difficult to obtain, or where an illustration is not included, further references are also given. Comments upon our specimens are added wherever necessary, and some changes in classification have been made, after other authors.

PELECYPODA

Nucula cancellata Meek and Hayden, 1856

Nucula cancellata MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 85.

Nucula cancellata MEEK, F. B., 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 102, Pl. XXVIII, fig. 13, *a–e*.

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[1]Meek, F. B. 1876. 'Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country,' U. S. G. and G. S. Terr. (Hayden), IX, p. 100.

[2]Rubey, op. cit., Chart, p. 3.

One specimen of this species is included in this faunule. Its size is considerably smaller than the measurements given by Meek, but agrees with the figure, nàtural size, of the type specimen, as illustrated by Meek, Plate XXVIII, figure 13*a*. Although nearly all the outer layers of the shell are missing from our specimen, in the few patches left it is possible to see the cancellate sculpture faintly, while the crenulations along the basal margin are quite distinct.

Nucula cf. **subplana** Meek and Hayden, 1856

Nucula subplana MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 85.

Nucula subplana MEEK, F. B., 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 99, Pl. XVII, fig. 7, *a–b*.

Our specimen agrees with Meek's description and figures in size, shape, and absence of crenulations on the basal border, but some of the shell material is preserved, showing strong concentric striae and very fine radial markings, the latter being also shown on the internal mold. This ornamentation was apparently not shown on Meek's specimens. This fact, and the fact that our specimen is proportionally somewhat more convex than Meek's type, make us hesitate to identify it with his without reservations. It may be, however, that Meek's specimens did not show the radial markings on the internal mold because of poor preservation, since they are shown on ours only near the ventral border, and disappear completely near the umbo.

Limopsis parvula (Meek and Hayden), 1856

Petunculina parvula MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 86.

Limopsis parvula MEEK, F. B., 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 97, Pl. XXVIII, fig. 17, *a–c*.

This species occurred very abundantly in our collection.

Inoceramus proximus Tuomey, 1854

Inoceramus proximus TUOMEY, 1854, Proc. Acad. Nat. Sci. Phila., VIII, p. 171.

Inoceramus proximus WELLER, 1907, Pal. N. J., IV, p. 424; Pl. XL, figs. 1–6; Pl. XLI, fig. 1.

Inoceramus barabini Morton, 1834

Inoceramus barabini MORTON, 1834, Synop. Organic Rem., p. 62, Pl. XVII, fig. 3.

Inoceramus barabini WHITFIELD, 1880, 'Paleontology of the Black Hills of Dakota,' p. 398, Pl. VII, fig. 7; Pl. IX, fig. 8.

Of the three specimens in this collection, two agree very well with the description given by Meek, but the third is somewhat more difficult of identification. It is a small specimen, measuring 1⅜ inches in length; the convexity, ½ inch in the right valve alone, seems proportionally large for this species, and the ventral margin seems to be more or less parallel with the hinge line, so that this specimen has not the typical cuneate form of *Inoceramus barabini* Morton. It somewhat resembles *Inoceramus confertim-annulatus* Roemer, as described and figured by Weller (Pal. N. J., IV, p. 427, Pl. XXXIX, figs. 2–5). However, we hesitate to identify it with this form, since ours is apparently a young specimen, and might have become proportionally less convex and more cuneate as it grew longer and higher.

Pteria petrosa (Conrad), 1853

Avicula petrosa CONRAD, 1853, Jour. Acad. Nat. Sci. Phila., 2nd Ser., II, p. 274, Pl. XXIV, fig. 15.

Pteria linguiformis MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 32, Pl. XVI, fig. 1, *a–d*.

The specimen in our collection is very poor, consisting of only the right valve, of which the anterior wing and part of the anterior margin have been broken off. However, from the absence of any radial markings, and the general form of the posterior wing and basal portion of this valve, we feel fairly safe in assigning it to this species.

Pteria (Oxytoma) nebrascana (Evans and Shumard), 1857

Avicula nebrascana EVANS AND SHUMARD, 1857, Trans. Acad. Sci. St. Louis, I, p. 38.

Pteria (Oxytoma) nebrascana MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 34, Pl. XVI, fig. 3, *a–c;* Pl. XXVIII, fig. 11.

Cuspidaria ventricosa (Meek and Hayden), 1856

Corbula ventricosa MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 83.

Neaera ventricosa MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 238, Pl. XXX, fig. 3, *a–e*.

Cuspidaria moreauensis (Meek and Hayden), 1856

Corbula moreauensis MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 83.

Neaera moreauensis MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 239, Pl. XVII, fig. 11, *a–c*.

Lucina occidentalis (Morton), 1842

Tellina occidentalis MORTON, 1842, Jour. Acad. Nat. Sci. Phila., VIII, p. 210, Pl. XI, fig. 3.

Lucina occidentalis MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 134, Pl. XVII, fig. 4, *a–d*.

Specimens of this species were very numerous in our collection.

Lucina subundata Hall and Meek, 1854

Lucina subundata HALL AND MEEK, 1854, Mem. Am. Acad. Arts and Sci. Boston, V, new series, Pl. I, fig. 6.

Lucina subundata MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 133, Pl. XVII, fig. 2, *a–e*.

Protocardia subquadrata (Evans and Shumard), 1857

Cardium subquadratum EVANS AND SHUMARD, 1857, Trans. Acad. Sci. St. Louis, I, p. 39.

Protocardia (Leptocardia) subquadrata MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 175, Pl. XXIX, fig. 8, *a–e*.

Protocardia rara (Evans and Shumard), 1857

Cardium rarum EVANS AND SHUMARD, 1857, Trans. Acad. Sci. St. Louis, I, p. 39.

Protocardia (Leptocardia) rara MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo , p. 176, Pl. XVII, fig. 1, *a–c*.

Dosiniopsis deweyi (Meek and Hayden), 1856

Cytherea deweyi MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 83.

Callista (Dosiniopsis ?) deweyi MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 182, Pl. XVII, fig. 15, *a–e*.

Corbula crassimarginata Meek and Hayden, 1860

Corbula crassimarginata MEEK AND HAYDEN, 1860, Proc. Acad. Nat. Sci. Phila., VIII, p. 425.

Corbula crassimarginata MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 244, Pl. XVII, fig. 14, *a–c*.

SCAPHOPODA

Dentalium (Antalis) gracile (Hall and Meek), 1854

Dentalium gracile HALL AND MEEK, 1854, Mem. Am. Acad. Arts and Sci., V, New Ser., p. 303, Pl. III, fig. 11.

Dentalium gracile MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 266, Pl. XVIII, fig. 13, *a–d*.

Dentalium (Laevidentalium) pauperculum (Meek and Hayden), 1860

Dentalium pauperculum MEEK AND HAYDEN, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 178.

Entalis ? paupercula MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 269, Pl. XVIII, fig. 14.

GASTROPODA

Margarita nebrascensis (Meek and Hayden), 1856

Turbo Nebrascensis MEEK AND HAYDEN, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 64.

Margarita nebrascensis MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 298, Pl. XIX, fig. 8, *a–b;* fig. 9, *a–b*.

Natica (Lunatia) concinna (Hall and Meek), 1854

Natica concinna Hall and Meek, 1854, Mem. Am. Acad. Arts and Sci. Boston, V, p. 384, Pl. iii, fig. 2, *a–d*.

Lunatia concinna Meek, 1876, Invert. Cret. and Tert. Foss., Up Mo., p. 314, Pl. xxxii, fig. 11, *a–c*.

Alaria (Anchura) sublevis (Meek and Hayden), 1860

Aporrhais sublevis Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 178.

Anchura ? sublevis Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 327, Pl. xix, fig. 3, *a–b*.

Alaria (Anchura) nebrascensis ? (Evans and Shumard), 1854

Rostellaria Nebrascensis Evans and Shumard, 1854, Proc. Acad. Nat. Sci. Phila., VI, p. 164.

Anchura (Drepanochilus) Nebrascensis Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 326, Pl. xix, fig. 5, *a–c*.

Our specimen consists only of an internal mold, with a small remnant of shell left on the outer lip, showing the revolving striae. We cannot tell, therefore, what the surface markings of the rest of the shell may be, but the specimen agrees so well in size, form of the outer lip, and position of the carinae on the body whorl with both Meek's and Whitfield's descriptions, that we feel reasonably sure it belongs to the same species.

Pyrifusus (Neptunella) newberryi (Meek and Hayden), 1856

Fusus Newberryi Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., VIII, p. 66.

Pyrifusus (Neptunella) newberryi Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 346, Pl. xxxi, fig. 6, *a–f*.

Pyrifusus (Neptunella) intertextus (Meek and Hayden), 1857

Fusus intertextus Meek and Hayden, 1857, Proc. Acad. Nat. Sci. Phila., IX, p. 139.

Pyrifusus (Neptunella) intertextus Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 348, Pl. xix, fig. 14, *a–b*.

Fasciolaria (Cryptorhytis) cheyennensis (Meek and Hayden), 1860

Rostellaria fusiformis Hall and Meek, 1854, Mem. Am. Acad. Arts and Sci. Boston, V, New Ser., p. 393, Pl. iii, fig. 10. (Not *R. fusiformis* Pictet and Roux, 1848, nor *Fasciolaria fusiformis* Valenciennes.)

Gladius ? cheyennensis Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 422.

Fasciolaria ? (Cryptorhytis) cheyennensis Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 365, Pl. xix, fig. 13, *a–b*.

Turris (Surcula) minor (Evans and Shumard), 1857

Pleurotoma minor Evans and Shumard, 1857, Trans. Acad. Sci. St. Louis, I, p. 41.

Turris minor Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 384, Pl. xxxi, fig. 9, *a–c*.

CEPHALOPODA

Eutrephoceras dekayi (Morton), 1833

Nautilus dekayi Morton, 1833, Am. Jour. Sci., 1st Ser., XXIII, p. 291, Pl. viii, fig. 4.

Nautilus dekayi Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 496, Pl. xxvii, fig. 1, *a–e*.

Baculites compressus Say, 1821

Baculites compressus Say, 1821, Am. Jour. Sci. and Arts, II, p. 41.

Baculites compressus Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 400, Pl. xx, fig. 3, *a–c*.

Baculites ovatus Say, 1821

Baculites ovata Say, 1821, Am. Jour. Sci. and Arts, 1st Ser., II, p. 41.

Baculites ovatus Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 394, Pl. xx, fig. 1, *a–b;* fig. 2, *a*, *b*, *d*.

Discoscaphites nicolleti (Morton), 1842

Ammonites Nicolletii Morton, 1842, Jour. Acad. Nat. Sci. Phila., 1st Ser., VIII, pt. 2, p. 209, Pl. x, fig. 3.

Scaphites (*Discoscaphites*) *nicoleti* Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 435, Pl. xxxiv, figs. 2, *a–b;* 4, *a–c*.

Discoscaphites nicolleti Reeside, 1927, U. S. G. S. Prof. Paper 150, p. 32, Pl. ix, figs. 5, 7.

Acanthoscaphites nodosus (Owen), 1852

Scaphites (*Ammonites ?*) *nodosus* Owen, 1852, Rept. of Geol. Surv. Wisc., Iowa and Minn., p. 581, Tab. 8, fig. 4.

Scaphites nodosus Whitfield, 1880, Pal. of B. H. of Dak., p. 441, Pl. xiii, fig. 12.

Acanthoscaphites nodosus Reeside, 1927, U. S. G. S. Prof. Paper 150, p. 32.

Acanthoscaphites nodosus brevis (Meek), 1876

Scaphites nodosus brevis Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 426, Pl. xxv, fig. 1, *a–c*.

Acanthoscaphites nodosus plenus (Meek and Hayden), 1860

Scaphites nodosus plenus Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 420.

Scaphites nodosus plenus Meek, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 429, Pl. xxvi, fig. 1, *a–c*.

DISCUSSION OF A PROBLEM OF NOMENCLATURE AND DESCRIPTIONS OF NEW SPECIES

CEPHALOPODA

Acanthoscaphites nodosus comprimus (Owen), 1852

Figures 5, 6

A. M. N. H. Cat. No. 24236.

Scaphites (*Ammonites ?*) *comprimus* OWEN, 1852, Rept. of Geol. Surv. Wisc., Iowa and Minn., p. 580, Tab. 7, fig. 4.

Scaphites nodosus quadrangularis MEEK AND HAYDEN, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 420.

Scaphites nodosus exiles MEEK AND HAYDEN, 1860, Proc. Acad. Nat. Sci. Phila., XII, p. 420.

Scaphites nodosus quadrangularis GABB, 1861, Syn. Moll. Cret. Form., p. 32.

Scaphites nodosus quadrangularis MEEK, 1876, Invert. Cret. and Tert. Foss., Up. Mo., p. 428, Pl. xxv, figs. 2, *a–c*; 3, *a–c*; 4.

Scaphites nodosus quadrangularis WHITFIELD, 1880, Pal. of B. H. of Dak., p. 443, Pl. XIII, figs. 10–11.

Scaphites nodosus quadrangularis GRABAU AND SHIMER, 1910, N. A. Index Fossils, II, p. 178, figs. 1429, 1430.

Acanthoscaphites nodosus quadrangularis REESIDE, 1927, U. S. G. S. Prof. Paper 150, p. 32.

In his description of *Scaphites* (*Discoscaphites*) *nicolletii*, Meek lists *Scaphites* (*Ammonites ?*) *comprimus* Owen as a synonym.[1] Owen's figure of *S. comprimus* (Table 7, figure 4), and his description, quoted below, do not seem to the writers to agree with the characteristics assigned originally to *Ammonites nicolletii* by Morton, and later described more fully by Meek. Owen says of his *S. comprimus:* "Shell compressed and slightly boat-shaped. One volution visible, the rest concealed in the outer chamber. Surface ornamented with slightly curved costae which, on the chambered portion of the shell, are more than twice as far apart as on the terminal, deflected, non-camerated part. Every second or third rib runs to the inner margin; the intermediate ribs are formed by bifurcation which commences one-fourth to one-half the distance toward the periphery. A row of small, pointed tubercles, on either margin of the flattened dorsum; a row of flatter and more obscure tubercles, one-fourth of the distance from the inner margin of the convolutions."[2]

Morton mentions only one row of tubercles, that on the periphery, in his original description of *Scaphites nicolletii*, and only one is shown

[1]Meek, op. cit., p. 435.
[2]Owen, op. cit., p. 580.

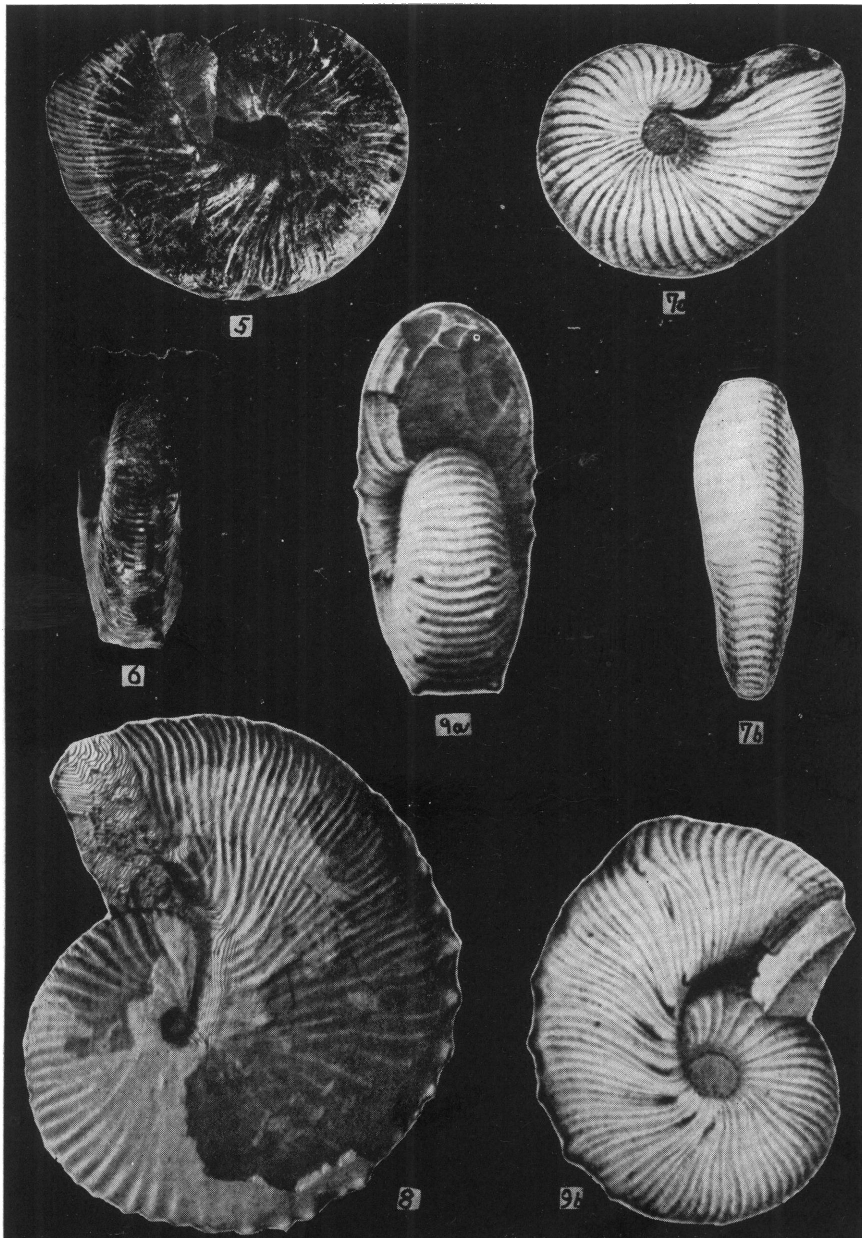

Fig. 5. *Acanthoscaphites nodosus comprimus.* Left side. ×1.

Fig. 6. *Acanthoscaphites nodosus comprimus.* Venter, directly posterior to body whorl. ×1.

Fig. 7. *Discoscaphites nicolletii.* After Morton, Jour. Acad. Nat. Sci. Phila., 1st Ser., VIII, pt. 2, Pl. x, fig. 3. (*Ammonites nicolletii.*)

Fig. 8. *Acanthoscaphites nodosus comprimus.* After Owen, Rept. of Geol. Surv. Wisc., Iowa and Minn., Tab. 7, fig. 4. (*Scaphites* (*Ammonites?*) *comprimus.*)

Fig. 9. *Acanthoscaphites nodosus quadrangularis.* After Meek, Invert. Cret. and Tert. Foss., Up. Mo., Pl. xxv, fig. 3*a*. (*Scaphites nodosus quadrangularis.*)

in the illustration.[1] Meek specifically states the fact that there is no inner row of nodes in this species. " . . . . Costae everywhere without tubercles or nodes, excepting a single row along each side of the flattened periphery of the outer volution."[2] Owen, on the other hand, in both his verbal description, quoted above, and his figure, of *Scaphites comprimus*, distinctly indicates two rows of nodes, the inner one occurring near the umbilicus. His specimen also seems to be larger than is usual for the adult form of *S. nicolletii*, and the body chamber seems to be more deflected and to become freer at the aperture than that of *S. nicolletii* as described by Meek.

On the other hand, if Owen's description and figure of the species *S. comprimus* are compared with those of *Scaphites nodosus quadrangularis* as given by Meek,[3] a number of striking points of resemblance are found. The size of the shell as a whole, and the form and amount of deflection of the body chamber tally much more closely between the latter species and *S. comprimus* than they do between *S. comprimus* and *S. nicolletii*; the number, size and curvature of the ribs are more alike between the former two species, and the inner row of nodes on these two species seems to us to be identical in form, whereas *S. nicolletii* has none. Both *S. nodosus quadrangularis* and *S. comprimus* also have the periphery flattened in a more pronounced manner than does *S. nicolletii*, and the umbilicus of *S. comprimus*, according to Owen's figure, is larger than that of *S. nicolletii*, but the same as that of *S. nodosus quadrangularis*. Owen also has a figure of *S. nicolletii* in his report (Tab. 8, fig. 1), which resembles the original figure of Morton and the figure given by Meek, but does not resemble the figure of *S. comprimus* given by Owen in the same report.

Of course, one cannot tell certainly about the identity of Owen's species without having seen the suture, which Owen neither describes nor figures. However, as far as one can tell from external appearances, it seems to the writers that *S. comprimus* is identical with *S. nodosus quadrangularis* Meek and Hayden, rather than with *S. nicolletii* Morton. In this case, then, the name given by Owen should have precedence, having been given in 1852, while Meek and Hayden's name was not published until 1860. However, the authors feel that the form to which this name is applied should still be retained as a variety of *S. nodosus*, rather than as a separate species, which Owen originally considered it.

The figures referred to in the foregoing discussion are reproduced here as figures 7*a* and *b*, 8 and 9*a* and *b* of this paper.

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[1]Morton, 1842. Jour. Acad. Nat. Sci. Phila., 1st. ser., VIII, pt. 2, p. 209, Pl. x, fig. 3.
[2]Meek, op. cit., p. 435.
[3]Meek, op. cit. p. 428; Pl. xxv, figs. 2, a–c; 3, a–c; 4.

Acanthoscaphites nodosus crassus, new variety

Figures 10, 11

TYPE.—A. M. N. H. Cat. No. 24234.

Shell attaining a large size, very ventricose, involute, with umbilicus about one-sixth as wide as the height of the shell. Inner volutions about equal in width and height. The mature body portion is much wider than high, except just posterior to the aperture, where it is constricted. The body chamber forms about half the entire bulk, and at the aperture is moderately free from the inner volutions. The venter is rounded throughout. The inner side of deflected portion of the coil is nearly straight, except with a slight dorsad swelling, corresponding to the most ventricose portion of the body chamber, just anterior to the umbilicus of the early whorls, and a slight sulcus, corresponding to the constriction of the body chamber, just posterior to the aperture, which makes an angle of 115 to 120 degrees with the straightened portion, if measured along their respective margins. The aperture is about equal in width and height, and it is characterized by the occurrence of a shallow, flattened, impressed zone on the dorsal side, and an evenly convexed and somewhat narrower portion on the ventral side.

The surface is ornamented with numerous fine, transverse costae, which increase by bifurcation and occasional intercalation so as to form about three times as many on the venter as on the flanks. The costae cross the venter with a moderate forward curvature. Each whorl also bears two rows of rather sharp nodes on each side; the inner row is situated near the umbilical shoulder, about one-sixth the distance from there to the ventral shoulder, on the inner whorls, and about one-third of the distance from the umbilical shoulder to the ventral shoulder on the body chamber. The outer row of nodes is situated approximately on the ventral shoulder. The nodes in each row are never more than one-half inch apart, even on the straightened, ventricose portion of the body chamber, where they are largest and most widely separated. Both rows are traceable from the very edge of the aperture backward as far as the whorls can be seen.

Greatest diameter of an apparently full-grown specimen is about 4.5 inches; the length, from the edge of the aperture backward along the venter as far as the volution can be followed, 13.25 inches. Greatest width (body chamber): 2.75 inches.

The sutures are deeply incised, with many slender branches and branchlets. The siphonal lobe is long and narrow, terminating in two main parallel branches, and bearing, about halfway to the base, on each

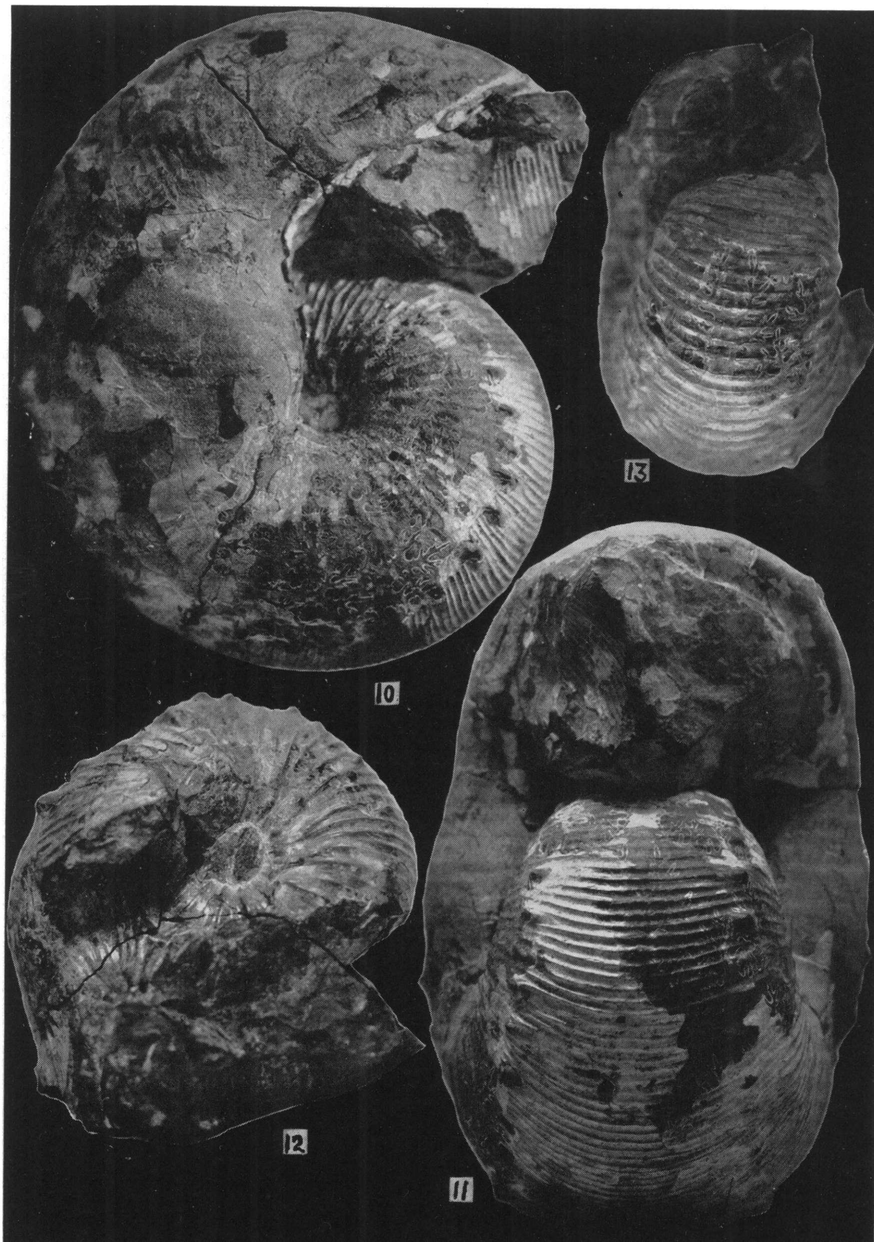

Fig. 10. *Acanthoscaphites nodosus crassus*. (n. var.). Left side. $\times \frac{4}{5}$.
Fig. 11. *Acanthoscaphites nodosus crassus*. (n. var.). Apertural view. $\times \frac{4}{5}$.
Fig. 12. *Acanthoscaphites duplico-nodosus*. (n. sp.). Right side (incomplete). $\times 1$.
Fig. 13. *Acanthoscaphites duplico-nodosus*. (n. sp.). Venter. $\times 1$.

side, a large, unequally bifid branch and several smaller trifid branches. The first lateral lobe is as wide, but not nearly so long, as the siphonal lobe; it ends in two unequally bifid branches, between which there are two small, simple projections. The second lateral lobe is much smaller in width and length than either of the foregoing; it appears to be trifid but on closer observation is seen to terminate in one nearly equally bifid branch and one very unequally bifid branch. There is a small trifid third lateral lobe, and a very small, slightly tridentate fourth lateral.

Acanthoscaphites duplico-nodosus, new species

Figures 12, 13

The shell is medium-sized, very convex, involute but with a relatively larger umbilicus than in the preceding form; the volutions increase rapidly in size, especially near the apertural end. The surface is ornamented with rather coarse, sharp, transverse costae, some of which bifurcate before reaching the ventral shoulder, while others cross the venter without any bifurcation. There are also finer lines, between and parallel to the costae, which start from the umbilical margin and extend about half the distance from there to the ventral shoulder. Two rows of nodes are present on each side: an inner one near the umbilical shoulder, about one-third the distance from there to the ventral shoulder, and an outer row along the ventral shoulder. The nodes of the inner row are somewhat elongated transversely, and occur on about every other rib; they are evenly spaced and increase gradually in size toward the anterior end of the shell. In the outer row, the nodes are rounded and sharp, and are rather evenly spaced on the earlier part of the shell, occurring on about every fourth rib, but in the later stages of growth they appear in pairs, with one or two ribs between the members of each pair, and four to six ribs between the pairs. These double nodes are not confined to the gerontic body chamber, but begin to appear on the septate portion of the shell before the final chamber is reached. In our specimen, they first occur about two inches back from the anterior end, which is still septate. The inner row appears to be less extensive than the outer.

The greatest diameter of our specimen is about 2 inches. The greatest width is 1.25 inches.

The sutures are very deeply incised, and consist of very long, slender lobes, and deep, variously sinuate saddles. The lobes have a very narrow "body," that of the siphonal lobe, for instance, being only oneseventh as wide as it is long; this lobe and the two lateral lobes on each side of it are all subdivided into numerous branches, and these in turn into many smaller branchlets, all of which are unusually long and slender.

This species is easily distinguished from others of the genus by its paired nodes and characteristic sutural features.