Type Kinderhook Ammonoids

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Type Kinderhook Ammonoids

W. M. FURNISH and WALTER L. MANGER


SYNOPSIS: Lower Mississippian rocks in the type area of North America have produced only a few scattered ammonoid cephalopods. These specimens from southeastern Iowa and northwestern Missouri lie within the general vicinity of the designated type locality, near Kinderhook, Illinois. In this area, age relationships for strata near the Devonian-Mississippian boundary have been established largely through studies of their conodont faunas. However, some of the ammonoids from within the Kinderhook and adjacent beds are critical for long-range correlation. Although most of these ammonoid occurrences have been recorded, minor changes in correlation can be suggested by reexamination of the specimens, together with a review of the physical stratigraphy and the associated conodont faunal data. The Kinderhookian Wasonville Member of the Hampton Formation in southeastern Iowa and the Chouteau Limestone of Missouri fall within the lower "Pericyclus-Stufe" of the upper Tournaisian Stage as these units are designated for the early Lower Carboniferous of Western Europe. The index genus is present, but relatively rare in North America; associated ammonoids include Gattendorfia, Prodromites and Imitoceras. All of these genera are known from the type Kinderhook area. The same genera, plus Muenteroceras and Beigrichoceras appear to characterize the overlying Osagean beds. The directly underlying Upper Devonian also contains Imitoceras, but Cynaclymenia and Cyrtoclymenia in addition.

INDEX DESCRIPTORS: Ammonoids, Mississippian Ammonoids.

Lower Mississippian rocks, constituting the Kinderhookian Series, have been known from the type area for 150 years. Exposures along the Mississippi bluffs at Burlington, in Des Moines County, Iowa, were used most often for reference. Meek and Worthen regarded this Iowa locality as an important section but applied the term "Kinderhook Group" in 1861 for an exposure across from Hannibal, Missouri, in Pike County, Illinois, about 75 miles south of Burlington. Those authors' assignment was a "postscript" to a discussion of age relationships and correlation for these strata. Originally, their definition included about the same stratigraphic units as are now classified as Lower Mississippian in the type area, but diverse opinions had been expressed previously and these differences persisted during the ensuing century.

Ammonoids are traditional index fossils in the Devonian and Carboniferous. However, the occurrence of cephalopods in the shelf sediments of the American Midcontinent is so sporadic that only general comparisons could be made with Europe. The known Kinderhook ammonoid fauna of seventy years ago, as recorded by Smith (1903), was as diverse and distinctive as that in other parts of the section; but a portion of these fossils is now regarded as representing the ensuing Osagean Series. That is, the abundant cephalopods secured from a thin localized carbonate layer at Rockford, Indiana, long regarded as typifying the stage, have been determined to be post-Kinderhookian (Lineback, 1963; Rexroad & Scott, 1964).

Until fairly recently, no latest Devonian ammonoids had been recognized in the Western Hemisphere, and some strata now identified as pre-Carboniferous were formally classified as part of the Kinderhookian. Sparsely fossiliferous "transition" dark shales (e.g. Chattanooga, Grassy Creek, etc.) were correlated with the Mississippian, because of their transgressive relationships, or mapped as "Devono-Carboniferous." As recently as twenty years ago, the stratigraphic terminology near this systemic boundary was excessively complex because of widely divergent opinion on age relationships. Meanwhile, an approved definition based upon ammonoid zonation already existed in the Saarland of Germany, and there were substantial data on the conodont faunal sequence in various areas of the United States. The boundary at the base of the Kinderhookian could be fixed within narrow limits as soon as comparable information on conodonts became available in West Germany (Collinson, 1961). Generally, this stratigraphic determination in the Upper Mississippian Valley area was the same as that advocated by some earlier accounts, such as Branson and associates (1938), but the newer analysis was based upon more critical information. Within the past two decades, conodont studies have progressed so rapidly that these fossils now constitute standard world-wide indices (Collinson, Rexroad, and Thompson, 1971). Thus, the unexpected recognition of dyenid cephalopods from the classic Burlington section was an important verification but somewhat anticlimactic (House, 1962). In other respects, the present study has little new to report in the fashion of Kinderhook ammonoid collections, beyond those described systematically by Miller & Collinson over twenty years ago (1951).

AGE RELATIONSHIPS

In northeastern Missouri, the Hannibal Formation may be the only widespread representation of the restricted Kinderhookian Series. In this area, it is separated by unconformities from the Upper Devonian Louisiana Limestone below, and the Osagean Burlington Limestone above (Fig. 1). In more nearly complete sections in Missouri and adjacent Illinois, the "Clen Park" Formation is found below the Hannibal Formation and the Chouteau, or equivalent, overlies it. The Louisiana Limestone, once included within the Kinderhookian Series, has been assigned a youngest Upper Devonian age on the basis of conodonts (Ziegler, 1969). However, the Louisiana fauna is still regarded as somewhat transitional with the Mississippian (Collinson, et al., 1971), and its highest portions have yielded few diagnostic conodonts, leaving the (systemic) boundary without precise faunal def-

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Figure 1. Diagrammatic cross section to illustrate the stratigraphic relationships and ammonoid occurrences in Lower Mississippian and Upper Devonian of the Upper Mississippi Valley.

initation in the Upper Mississippi Valley. Specimens of *Imitoceras lousianense* (Rowley) occur within the base of the Louisiana Limestone at Buffalo Creek, Pike County, Missouri. This fossil is not diagnostic but the age of the ammonoid-bearing interval is not in question, youngest Upper Devonian (Substage VI by Ziegler, 1961).

The Hannibal Formation is another unit of Kinderhookian age by definition, and it contains conodonts representing zones equivalent to basal Carboniferous (Substage I through IIc) of the European goniatite succession (Canis, 1968). A single poor specimen of the long ranging ammonoid genus *Imitoceras* found in the Hannibal Formation near Monroe City, northeastern Missouri (Miller & Collinson, 1951) has not added to existing knowledge of age relationships. However, this specimen may be the oldest known Kinderhookian ammonoid occurrence in the type region.

The Chouteau Limestone and overlying Northview Shale in central and southwestern Missouri contain an ammonoid fauna regarded as characterizing the Kinderhookian Series (Miller & Collinson, 1951). Both stratigraphic units have yielded representatives of *Imitoceras, Gattendorfia, Protocanites*, and *Prodromites*, but the Northview fauna also contains *Muensteroceras*, now considered to be only doubtfully present in the Chouteau. These ammonoid genera, except *Muensteroceras*, range from basal Kinderhookian into basal Osagean strata elsewhere, and do not provide a means for precise age assignment. *Muensteroceras* characterizes Osagean faunas, but initially appears in strata of upper Kinderhookian age. On the basis of conodonts, the combined Chouteau and Northview appear to be entirely upper Kinderhookian in age, equivalent to cuIIc zone faunas of the European goniatite succession (Canis, 1968; Thompson & Fellows, 1970). Unfortunately, the ammonoid occurrences cannot be related precisely to these recent investigations of conodonts. However, this conodont correlation suggests that there are no North American ammonoid faunas of cuI age known at the present time, except for the immature specimens in the upper portion of the Exshaw Formation of Alberta (Schindewolf, 1959).

In northeastern Missouri, the Burlington Limestone represents basal Osagean Series, in those areas where the Meppen and Fern Glen Formations are absent. Although Burlington ammonoids are extremely rare, a few specimens representing *Muensteroceras rouveyi* Miller & Furnish have been recovered from near Louisiana, Missouri. The Burlington Limestone contains representations of conodont zones which are equivalent to the upper part of the European *Scaphognathus anchoralis* zone (cuIHy) on the authority of Collinson, et al. (1971).

The Wassonville Formation has produced all the Kinderhookian ammonoids known from southeastern Iowa (Fig. 1). At its type locality on the English River in Washington County, a fauna representing two species and more than a dozen specimens has been recovered from chert nodules in the upper part of the Wassonville, near the unconformable contact with Burlington. These two species represent *Imitoceras jessiae* (Miller & Gurlay) and *Gattendorfia mehli* Miller & Collinson, both originally described from the Chouteau Limestone. In addition, a single specimen of *Prodromites gorbyi* (Miller) has been found at the base of the Wassonville Formation in Burlington. Based upon conodonts, the Wassonville Formation throughout its entire extent falls within the *Siphonodella isosticha-S. cooperi* assemblage zone of the Upper Mississippi Valley (Straka, 1968). This zone correlates with cuIIc of the European Lower Carboniferous. Consequently, the Wassonville Formation, largely dolomite, is generally understood to be a direct equivalent of the Chouteau Limestone in Missouri.

Clymeniid ammonoids representing *Cyrtoclymenia strigata* House and *Clymenia striata* (Münster) are associated with *Imitoceras opimum* (White & Whitfield), in the uppermost English River Siltstone at Burlington, the "Chonepectus Sandstone" of Weller (1900). Use of the name *English River* for these strata at Burlington has been questioned by Straka (1968) because both the ammonoids and conodonts recovered from this interval indicate an Upper Devonian age (to V-VI) whereas the type English River in Washington County, is of Mississippian age (cul). The beds called *English River* at Burlington, although in continuity with that formation represent siltstones stratigraphically equivalent to the upper Maple Mill Shale.

A single exposure along Beaver Creek, near Ackley, north-central Iowa has yielded several globose ammonoids referred to *Imitoceras intermedium* Schindewolf (Fig. 1). Age and stratigraphic assignment of this horizon have been controversial (Stainbrook, 1950). Since the occurrence of *I. intermedium* transgresses the Devonian-Carboniferous boundary in Europe (Schindewolf, 1923), its occurrence adds little information to the solution of this problem in north-central Iowa. Anderson (1969) has assigned the locality to the Prospect Hill Siltstone of Kinderhookian age, based on the occurrence of *Siphonodella quadruplicata* (Branson & Mohl). Therefore, this ammonoid-bearing horizon correlates with the lower portion of the Chouteau Limestone (Canis, 1968), equivalent to cuIIc of the European goniatite succession.

The concept of a Kinderhookian ammonoid fauna has been based primarily on the Chouteau and Rockford, Indiana, occurrences. However, the Chouteau fauna is now believed to lack the characteristic Rockford ammonoid *Muensteroceras*. On the basis of conodonts the Chouteau can be restricted to a late Kinderhookian (=*Pericyclus* Stufe, cuIIc) age (Canis, 1968). The Northview Shale, also of late Kinderhookian age, contains *Muensteroceras* at King Butte, Greene County, southwestern Missouri, but there is no associated conodont...
information from this locality. The classic Indiana Rockford ammonoid fauna is now thought to be restricted to basal Osagean Series; associated conodonts confirm an earlier suggestion by Lineback (1963). In addition, the “Walls Ferry” (=St. Joe) fauna described by Gordon (1965) from northern Arkansas contains ammonoid genera represented in both the Chouteau and Rockford faunas including *Proacanites lonyi* (Meek & Worthen). This Arkansas occurrence has also been shown to be associated with a basal Osagean conodont fauna (Thompson & Fellows, 1970). Consequently, the Kinderhookian fauna has somewhat changed its identity; for such characteristic species as *Proacanites lonyi* and *Protomites gorbyi*, previously thought to be restricted to Kinderhookian strata, now are known to range into the Osage.

The only other North American Lower Mississippian ammonoid occurrences, which contain genera in common with faunas of the type region, still lack associated conodont information. The Coldwater Shale-Marshall Sandstone fauna from Michigan is enigmatic and possibly mixed, but it is undoubtedly Osagean in age because of the occurrence of *Merocanites* and *Begrichoceras* (Miller & Garner, 1955). However, the Marshall also contains representatives of the older genera *Kazakhstania* and *Gattendorfa*, not known to range into Osagean or equivalent strata elsewhere. Similarly, the upper Cuyahoga-Logan ammonoid fauna from Ohio includes representatives of *Imitoceras*, *Gattendorfa*, *Muensteroceras*, and *Proacanites* found in kinderhookian occurrences (Manger, 1971). In addition the Ohio strata contain *Kazakhstania* and *Karagnostoceras*. This interval is thought to be late kinderhookian in age, because of the association of *Gattendorfa* and *Proacanites* with older forms such as *Karagnostoceras* and *Kazakhstania*. However, recent revisions in ammonoid ranges based on associated conodonts suggest that this fauna could possibly be of basal Osagean age.

In summary, all ammonoid occurrences in the type region appear to be late kinderhookian (=*Pericyclus Stufe cuill*) in age on the basis of associated conodonts. Although a single Hannibal specimen may be older, it cannot be related to conodont occurrences at the present time. Thus, there are no early kinderhookian (=*Gattendorfa Stufe cuil*) ammonoids known from the type region. In addition, there appear to be no other early kinderhookian faunas known elsewhere from North America, with the exception of those from the Exshaw Formation of Alberta. Finally, the late kinderhookian ammonoid fauna consists of long-ranging genera and lacks sufficient identity to define the kinderhookian-Osagean boundary.

**Acknowledgments**

This kinderhook ammonoid project was suggested by Harrell L. Strimple, who contributed materials and helped with advice. It should also be recognized that a comprehensive survey of most of these fossils by A. K. Miller and Charles Collinson was published in 1951; so we have largely relied on their data and merely reviewed it in terms of present stratigraphic and taxonomic concepts. Additional materials came from the John B. Owen and the Merrill A. Stainbrook Collections, at the University of Iowa. Particularly, we wish to acknowledge Gilbert Klapper for advising us regarding current research and conclusions based upon significant conodont studies. Also, Jürgen Kullman has given us the benefit of his knowledge concerning details of European ammonoid species near the Devonian Carboniferous boundary. Northwestern University partially defrayed travel expenses for Manger during preparation of the study, and the University of Iowa provided laboratory facilities.

**Systematics**

**Genus Gattendorfa** Schindewolf, 1920

Type species: *Goniatus subinvolutus* Münster, 1839; O.D. An ammonoid associated with *Imitoceras* and with basically the same simple suture pattern is distinguished by more open coiling in the mature stage of growth. The characteristic whorl section in *Gattendorfa* also shows a distinct umbilical shoulder and a pronounced umbilical wall with the umbilical lobe centered on this portion of the conch. In gross external features, the shell of *Gattendorfa* thus resembles *Muensteroceras* Hyatt and also *Pericyclus* Mojsisovics, early goniatoids with a divided ventral lobe.

Schindewolf's genus typifies the *Gattendorfa-Stufe* or lower Tournaisian (lowermost Carboniferous) of the Rhenish Highlands area, but does occur in younger strata. Miller & Youngquist (1947) were apparently the first to recognize the genus in North America. They described a fairly typical appearing representative of the genus, *G. bransoni*, from the Caballero Formation of New Mexico. Nevertheless, some doubt still exists concerning generic assignment, for the divided ventral lobe has not yet been substantiated in that species, while the goniatitid *Muensteroceras* is known to occur in the same fauna. *Gattendorfa* is a rare but characteristic ammonoid of the Chouteau Limestone in the type kinderhook region; but no certain true goniatitids, such as *Muensteroceras*, have been found associated there; a possible exception exists in *Muensteroceras osangense* (Swallow), as interpreted by Smith, 1903. At Rockford, Indiana, *Muensteroceras* is abundant, but there are no representatives of *Gattendorfa*; the older “Rockford” of northern Indiana described by Gutschick & Treckman (1957) has the Chouteau ammonoid fauna. Similarly, in southwestern Missouri, the late kinderhook Northview Siltstone and Shale carries *Muensteroceras* but apparently no true *Gattendorfa*. Thus, it seems that there is a consistent zonal relationship and a sequential occurrence for these two similar-appearing genera. Nevertheless, in the Marshall Sandstone of Michigan (Miller & Garner, 1955) and in the upper Cuyahoga-lower Logan Formations of Ohio (Manger, 1971) the two genera are found in direct association. Other records are somewhat uncertain; e.g. *Gattendorfa* spp. (Gordon, 1965) of the “Walls Ferry Limestone” (=St. Joe Limestone according to Thompson & Fellows, 1970) in northern Arkansas presumably represent *Muensteroceras* in an immature stage.

**Gattendorfa mehli** Miller & Collinson, 1951

*Pl. 1, figs. 1, 2.*

**Gattendorfa mehli** MILLER & COLLINS, 1951, Jour. Paleontology, 25(4), 469–470, pl. 70, fig. 11

**Muensteroceras** spp. [part] MILLER & COLLINS, 1951, Ibid., 474, pl. 69, figs. 3, 4 (not pl. 68, figs. 12, 13).

The taxon designated *Gattendorfa mehli* was based upon a single large compressed specimen from the lower Chouteau Limestone in central Missouri. Additional smaller specimens from the same general level and locality referred to *Muensteroceras* spp. by Miller & Collinson (1951) are, in part at least, to be associated with *G. mehli*. The single specimen these authors identified as *G. aff. bransoni* is fractured and

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Figures 1, 2. Gattendorfia mehli Miller & Collinson? Hypotype (SUI 6799), X2, type Wassonville Dolomite, Washington County, southeastern Iowa.


Figures 5-7. Imitoceras jessiae (Miller & Gurley). Fig. 5, hypotype (SUI 13972), X1.6; fig. 6, 7, hypotype (SUI 6792) X1.4, type Wassonville Dolomite.

Figures 8-10. Proconocites gorbyi (Miller). Fig. 8, hypotype (SUI 13927), X1, Chouteau Limestone north of Sedalia, Pettis County, central Missouri—with a fragment of the angular keel visible in the uppermost part of the figure; fig. 9, hypotype (SUI 13929), X1.8, same locality; fig. 10, hypotype (SUI 9540), X1.8, Northview Shale near Northview in Webster County, Missouri. Figures 11-15. Imitoceras intermedium Schindewolf. Fig. 11, 12, hypotype (SUI 11511), X1.4; fig. 13-15, hypotype (SUI 37058), X1, Prospect Hill Siltstone in Butler County, east of Ackley, north-central Iowa.

distorted but seems to be more globular and widely umbilicate than G. mehli; sutures of the two are similar. Another Kinderhook ammonoid involved in this group of specimens is from weathered chert of the Wassonville Dolomite in southeastern Iowa. The Iowa specimen (Pl. 1, figs. 1, 2) is small and does not retain a trace of the sutures, but the conch form resembles the Chouteau Gattendorfia specimens, rather than the associated Imitoceras or comparably sized representatives of Muensteroceras.

Gattendorfia occurs in Ohio and Michigan as G. andrewsi and G. ochiensis of Winchell (1870) and G. stummi Miller & Garner, 1955. The last species, from the Marshall Sandstone certainly represents a post-Kinderhook age, because of Muensteroceras, Beurichoceras, and Merocantes in association. Nevertheless, these three designated species from Ohio, Michigan and G. mehli from Missouri are closely similar.

Genus Imitoceras Schindewolf, 1923

Type species: Ammonites rotatorius deKoninc, 1844; SD Schindewolf, 1926, Senckenbergiana 8(2), 70.

There are still problems in generic assignments within the group of Upper Devonian and Lower Mississippian ammonoids usually identified as Imitoceras. Briefly, the procedures suggested by Vörhinger (1960) appear to be most appropriate in a definition of Schindewolf's genus. Petter (1959) has recommended a wider meaning for Prionoceras Hyatt, 1853, and Kullman (1961) treats Imitoceras as a subgenus of Prionoceras. That genus, normally, can be relegated to the middle Upper Devonian and typically occurs in the Probistes-Platyelgmenia Stufe (to III-IV) in Europe. There are consistent differences in the shell form that can be used to distinguish Imitoceras typically found in lower Pericyclus-Stufe (cm II 0 7 ) of the Lower Carboniferous; although exact limits between the two genera are obscure. As defined, Imitoceras has been found to occur within both Upper Devonian and Lower Mississippian strata of America, and is widely distributed elsewhere.

Several forms referable to Imitoceras in the Upper Mississippi Valley region have been described and illustrated by Miller & Collinson (1951). The six species that these authors identified, mostly in central and southern Missouri, are probably not recognizable in a practical sense. Still, detailed species differentiation is traditional for this group, and Vörhinger (1960) listed 22 comparable taxa in the Sauерland.

Imitoceras louisianense (Rowley, 1895)


Imitoceras or Gattendorfia louisianensis (Rowley) Slager and MANGER, 1971, Jour. Paleontology, 45(1), 37, 38.

Evolve inner whorls of an ammonoid species with a simple 8-lobed suture are relatively common in shale partings within the lower Louisiana Limestone at and near the type locality in northeastern Missouri. The normal specimens are only about 3 or 4 mm in diameter, so none of this material can be regarded as having reached a growth stage allowing even a certain generic assignment. House (1962) has published a set of precise drawings based upon specimens from Buffalo Creek, a mile south of Louisiana; and he has observed that no close identity with Protoconocetes exists, as suggested earlier by Schmidt (1925) and others.

Various species of Imitoceras retain evolve whorls beyond the four volutions of growth observed in I. louisianense, while representatives of the related Gattendorfia typically retain this characteristic shell form until a diameter of about 10 mm and six volutions. The general configuration of the sutures, whorl section, and other criteria such as shell constriction indicate that either Imitoceras or Gattendorfia is represented by this species. However, the genus Imitoceras is known to occur within the same stratum, whereas Gattendorfia has been found at a higher stratigraphic level. Therefore, these immature shells are being referred to the former genus; on the basis of a probability, they are also being regarded as conspecific with Aganides compressus Moore, 1928. That species is based upon a single fairly well preserved specimen from a locality about 20 miles down-river at Hamburg, Illinois. Moore's holotype is a mature shell nearly 40 mm in diameter; the whorls are slightly crushed, but suture and conch form are characteristic of other Imitoceras at about this stratigraphic level. In Vörhinger's scheme (1960), this species appears to fall within the "group of I. spheraulde."

We are indebted to Dr. Jürgen Kullmann, Tübingen, who examined a collection of the small ammonoids from the Louisiana Limestone and advised us regarding their probable relationships. His conclusion was that the combination of characters portrayed at an immature stage indicates assignment to
uppermost Famennian (\textit{Wocklumeria-Stufe}, to VI) or lower Tournaisian (\textit{Gattendorfia-Stufe}, cul). Although traditionally a part of the Kinderhook Group, the Louisiana Limestone is now excluded from it. Authorities on conodont faunas and microfloras near the Devonian-Mississippian boundary have reached general agreement concerning the Devonian age of the Louisiana Limestone equivalents (e.g. Austin, et al., 1970), but a final boundary definition is still in abeyance. Conodonts of the \textit{Siphonodella sulcata-Zone}, that constitute the base of the Carboniferous by definition, occur directly above the Louisiana. Ammonoids served to establish the original basis, but finer subdivision based upon microorganisms is now available.

The several Louisiana Limestone localities that have provided ammonoids are within the vicinity of the type locality in Pike County, Missouri and across the river at Hamburg, Calhoun County, Illinois. The only detailed information on their occurrence is at the Buffalo Creek locality (NW\# Sec. 28, T. 54 N., R. 1 W.) where the small specimens have been secured from thin shale partings within the bottom two or three feet of a limestone bluff constituting the west side of Buffalo Hill.

All of the specimens of \textit{Imitoceras louisianense} examined from Buffalo Creek are relatively well preserved limonitic internal molds; the sutures are clear and conch proportions are only slightly distorted. In contrast to published statements, the innermost portions and the protoconch can be observed. There are no real inconsistencies, for all of the available specimens appear to represent the same species. An adventitious lateral lobe appears in about the third suture (including the prosutures) and transverse constrictions were developed on the second or third volutions of the conch. Rowley's specimens from Louisiana are stated to be preserved in pyrite and his drawings appear to be somewhat disproportionate in detail; otherwise they resemble the specimens now available for study.

Rowley's original types have not been reexamined and apparently have never been restudied. The late R. R. Rowley was a school teacher at Louisiana for many years who collected and described fossils from that vicinity; his extensive collection was sold to the University of Illinois after his death. Smith studied material from the Gurley Collection, now at the Field Museum in Chicago, although these specimens could have been secured directly from Rowley by purchase or trade.

\textit{Imitoceras intermedium} Schindewolf, 1923


\textit{?Agoniatites opimus} [part] (White & Whitfield) WELLER, 1900, St. Louis Acad. Sci. Trans. 10, 121-123, pl. 8, fig. 1, pl. 9, fig. 1; SMITH, 1903, U.S. Geol. Survey Mon. 42, 32-33, pl. 7, figs. 1, 2.

\textit{Imitoceras intermedium} SCHINDEWOLF, 1923, N. Jahrb, Min. etc. B.-Bd. 49, 333, pl. 16, figs. 2a,b; 1952, Senkenbergiana 32, 291, pl. 1, figs. 6,7; VOHRINGER, 1960, Geol. Rheinland-Westfalen, Fortschr. 3(1), 131, pl. 3, figs. 2a,b,7,8.

\textit{Agonites intermedium} (Schindewolf) SCHMIDT, 1925, Preuss. Geol. Landesanst. Jahrb. 45, 532, pl. 19, fig. 2.

\textit{Prionoceras intermedium} (Schindewolf) PETTER, 1959, Algérie Publ. Serv. Carte géol., n.s., Paléont. Mém. 2, 251-252, pl. 19, figs. 8,8a,10,10a,12,12a.

\textit{?Imitoceras opimus} (White & Whitfield) HOUSE, 1962, Jour. Paleontology, 36(2), 277-278.

The Iowa material referred to Schindewolf's species consists of several specimens fairly well preserved in fine-grained Prospect Hill Sandstone (Lower Mississippian), from a locality in southwestern Butler County, in the north central portion of the state. Also, tentatively identified with this
taxon are the lectotype and lectoparatype of Goniatites opimus White & Whitfield, from the English River Siltstone (Upper Devonian) at Burlington, in the southeast. The two types of that species that had been secured by White, were considered by House (1962) to be indeterminate; only preparation of these specimens or discovery of topotypes could alter this circumstance. Two clymeniids, found in association and originally included within the species G. opimus, were described by House as new species. Consequently, White & Whitfield’s name is not distinguishable now, and the taxon should be relegated to the status of nomen dubium .

A width/diameter ratio for G. opimus of 40 percent is not regarded as a valid character because of probable distortion; this same ratio in the types of I. intermedium and the better Butler County specimens approximates 60 percent.

The Devonian-Mississippian exposures in the Mississippi River bluffs of southeastern Iowa have been studied intensively, with considerable variance of opinion about their identity. A hundred years ago there were building-stone quarries in operation at Burlington. The upper portion of the English River Siltstone in this vicinity, known as the “Chonopectus Sandstone,” is relatively well cemented in the uppermost foot and was used extensively in masonry construction. This portion of the section also contains the greatest concentration of a molluscan-brachiopod fauna of interest to collectors at least since the time of Owen (1852). White made a detailed collection from this bed about 1860, and Weller (1900) has presented an account of the entire fauna. Stratigraphically, there is doubt about the equivalence or continuity of this fine-grained sandstone with the type English River of Washington County (Straka, 1968), although the contact with the overlying McCraney Limestone of Kinderhookian age is sharply defined. At Burlington, the large conch and fragmentary nature of Cyrtoclymenia strigrata House in the Chonopectus-layer may have been neglected because of its apparent resemblance to a nondescript nautiloid; the holotype of that species lay unidentified in Iowa collections for 40 years until it was recognized as a clymeniid by House. Nevertheless, cephalopods are relatively rare in the sections along the Mississippi and quarrying operations in this part of the section are now greatly reduced. Sherman P. Lundy, a science teacher at Burlington who is studying the Maple Mill Formation as a research project, recently found a single small portion of an ammonoid in a shale exposure near the north edge of town. According to Brian F. Glenister (personal communication, 1972) this fossil was secured about 40 feet below the McCraney Limestone marking the base of the Kinderhook Series, and it represents Falacidlymenia sp. That genus is restricted to the middle Upper Devonian, substantiating other criteria for correlation of the Maple Mill at Burlington.

In Butler County, north-central Iowa, ammonoids occur in a siltstone, below carbonates quite definitely identified as Maynes Creek Member of the Hampton Formation. The most authoritative information was secured by Anderson (his Locality 10, 1969) who established that this siltstone should be referred to as Prospect Hill, part of the Kinderhook Group, because of the occurrence of Siphonodella quadruplicata. Only a few miles to the northwest in Franklin County, there is a carbonate identified by Stainbrook (1950) as McCraney directly underneath the Prospect Hill, but this unit is not present at Anderson’s Locality 10 just south of Austinville. The type locality for the Aplington Dolomite (a relatively thin Upper Devonian carbonate) lies only 5 miles east of the Prospect Hill ammonoid locality but the unit is not exposed on Beaver Creek and may not be represented there. A diverse molluscan fauna occurs in association with the ammonoids, and brevicone nautiloid cephalopods are relatively common; none adds to our knowledge concerning correlation or age assignment.

Type material from the English River at Burlington is apparently a part of the original C. A. White Collection, purchased by the University of Michigan. These specimens were secured about 1860, prior to White’s tenure as Iowa State Geologist, and the duplicate specimen (lectoparatype) was deposited in the American Museum by Whitfield. The associated clymeniids are scattered in collections at Harvard (Mus. Comp. Zool.), Field Museum (Walker Mus. Coll.), American Museum (Natural Hist.), University of Michigan (Mus. Paleont.), and University of Iowa. Some of these ammonoids had been found by Samuel Calvin and by Stuart Weller many years later than those by White. Six specimens from Butler County in north-central Iowa, were collected by M. A. Stainbrook in 1946; they are catalogue in the University of Iowa Collections (SU 11511, 37058, and 37059). Stainbrook correctly interpreted the stratum as Prospect Hill. Also, Michael R. House studied this collection of ammonoids in 1960 and concluded that they were more likely of Carboniferous age than Devonian (personal communication).

Iimitoceras jessieae (Miller & Gurley, 1896)
Pl. 1, figs. 5-7
Aganides jessieae (Miller & Gurley) SMITH, 1903, U. S. Geol. Survey Mon. 42, 115, pl. 17, figs. 18-20.
Iimitoceras abundans MILLER & COLLINSON, 1951, Ibid., 460-462, pl. 68, figs. 1-8, pl. 69, figs. 7,8.
Iimitoceras discoidale (Smith) MILLER & COLLINSON, 1951, Ibid., 463-465, pl. 68, figs. 9-11.

There is currently no real basis for evaluation of the various specific names applied to representatives of Iimitoceras from the Lower Mississippian of North America. Also, judging by other ammonoid taxa, it must be assumed that some of the 40 to 50 species named occur in both America and Eurasia-Africa; I. rotatorium (deKoninck), the type species from Belgium Lower Carboniferous, and Munster’s species from German Upper Devonian, carry about a century of priority over some other names. Critical details are generally lacking. Vöhringer (1960) arranged the European species systematically, primarily on the differences in ontogeny and shell form. Gordon (1965) made an effort to present a key for American species, but without considering possible European counterparts or growth modifications. Goniatites ixion Hall, 1879, from Rockford, Indiana, has normally been regarded as a synonym of deKoninck’s species rotatorium. However, hundreds of large (50 to 100 mm) specimens have been secured from Rockford, and they show reasonably consistent differences from deKoninck’s type, particularly in the much deeper lateral lobe of the suture. A remarkably clear photograph of the holotype of I. rotatorium was published by Delépine (1940).
The lectotype of *I. jessieae* is a well preserved mature shell about 40 mm in diameter; a paralecotype is about 50 percent larger (Miller & Collinson, 1951). The width/diameter proportion for this species is about 45-50 percent, with possibly a slight compression; many of the ammonoids from the Chouteau Limestone in Missouri are obviously distorted. Apparently, there is a close resemblance in shell form to *I. rotatorium*, the type species, although that species is larger. As a general rule, the ontogenetic stages of American Mississippian species have not been sufficiently investigated to provide a basis for comparing specimens of different sizes. The Rockford *I. ixion* is globular and somewhat involute by the second whorl and a diameter of only 2 mm (Miller & Furnish, 1937); by the seventh volution and 25 mm diameter the width/diameter ratio is about 50 percent, but this proportion is reduced to 35 percent at 100 mm diameter.

The original collections of *I. jessieae*, and most of the more recently acquired representatives of the species, have been secured from the Chouteau Limestone of central Missouri. In that area, for example from Pettis to Calloway County, the formation reaches a thickness of 60 to 70 feet (Broeson, 1938) and lies unconformably below the Burlington Limestone of the Osagean Series. Further to the northeast in Missouri, the Chouteau Limestone is regarded by Broeson (1938) and Canis (1968) as being sporadic in occurrence. An apparent outlier of Chouteau in Knox County, where two *Imitoceras* have been found, is just 20 miles from the Iowa state line and, in part, has a lithologic resemblance to the Wassonville Formation of Iowa, a presumed equivalent. In Washington County, Iowa, type Wassonville Dolomite contains representatives of small *Imitoceras* preserved in white chert, that were referred to *I. abundans* and *I. discoidale* by Miller & Collinson (1951). The three species are recorded as occurring together in the Chouteau and normally cannot be distinguished with certainty. For practical purposes, both are being treated as synonyms of *I. jessieae*.

**Genus Pericyclus Mojsisovics, 1882**

Type species: *Goniatites princeps* d'Koninck, 1842, S.D., Hyatt, 1884, p. 330.

A portion of the Mississippian (Dinantian-Lower Carboniferous) of Europe has been designated the *Pericyclus-Stufe* and the genus is abundantly represented there. The suture and whorl-form in the genus is similar to *Muensteroceras*, relatively common in America, but the conch of *Pericyclus* is strongly ribbed. A complex group of taxa at the subgeneric level has been recognized, and most authorities now consider *Ammonell'psites* to be the senior designation generically.

*Goniatites blairi* Miller & Gurlay, 1896, has been referred to *Pericyclus* by various authors, including Smith (1903). Miller & Collinson (1951) refigured the holotype of this species and also identified other Chouteau specimens as the same form. In none of these shells has a suture been observed, so it is probable that most almost all represent gastropods, rather than ammonoids. The few that we have examined are distinctly not cephalopods.

Elsewhere in North America, pericyclids have been found in Alaska, Western Canada, Kentucky, and possibly New Mexico and Nevada. The family is normally associated with a shale facies, rather than with the shelf carbonates of the Central Interior.

**Genus Prodromites Smith & Weller, 1901**

Type species: *Goniatites gorbyi* Miller, 1891, O.D.

A curious ceratitic genus first discovered by W. F. E. Gurley and described by S. A. Miller from the Chouteau Limestone of central Missouri is still an enigma phylogenetically. These ammonoids have been eagerly sought, for most of the specimens are spectacular, but the genus is still known from relatively few specimens in only six general localities within central United States. Miller & Collinson (1951) have given the most detailed account of these forms and concluded that all known specimens fall in the single species.

Critical ontogenetic stages in *Prodromites* have not yet been studied, and most of the material available does not lend itself to examination of the inner whorls. It can be observed that the first four whorls are evolute; there are faint ribs on some specimens but no constrictions. In this inner portion of the conch, also, the predominant element in the suture is a large undivided ventral lobe (Text-fig. 3). These characters, and other features as well, suggest a prolocanid relationship. Multiple auxiliary lobes in the suture of other taxa can be observed to be somewhat of a response mechanically to a thinly-lenticular involute shell form. Logically, then, no particularly close relationship need be expected with other multilobate genera of the Late Paleozoic. As Smith observed

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*Figure 3. Transverse section and sutures of inner volutions in *Prodromites gorbyi* (Miller) from Missouri. A, is a hypotype (SUI 13929), X20, from Chouteau Limestone about 3% mi. north of Sedalia, Pettis County—the inner portion of a specimen about 17 mm in diameter illustrate that the first four volutions are highly evolute with relatively broad whors and are not indicative of the narrow involute conch form assumed by the later whors. B, C, represent sutures of a well preserved hypotype (SUI 9549) from the Northview, Webster County (Pl. 1, fig. 10) at a diameter of about 6 mm, X30, and a diameter of about 13 mm, X17. The second suture prior to fig. B is similar but appears to have a deep undivided ventral lobe. Innermost volutions on this specimen are not preserved.*
70 years ago, a gap in the record and obvious differences in morphology seem to preclude a direct connection with the Devonian (Frasnian) beloceratids or triainoceratids (Bogoslovsky, 1969) although the similarity is striking. Still, no direct ancestry is known. Schindewolf (1959) described a goniatite from basal Mississippian strata of Alberta that he considered was related to Prodomites. As he indicated, there is a similarity; but the three immature specimens are distinct from any known genus of ammonoid.

At Burlington, Weller apparently secured a single well preserved Prodomites from the Wassenville Dolomite, just above the Stars Cave Oolite contact. On various bases, this stratigraphic horizon is believed to correspond directly to the lower Chouteau Limestone of central Missouri, where most of the Prodomites specimens have been found. The northern Indiana occurrence recorded by Gutschick & Treeckman (1957) is also believed to fall at the same level (Rexroad & Scott, 1984). The goniatite-bed at Rockford, central Indiana, and the Northview Siltstone and Shale beds with goniatites in southwestern Missouri, with Prodomites, are thought to lie appreciably higher in the section than the Chouteau ammonoid occurrences.

Genus Protocanites Schmidt (in Paeckelmann), 1922
Type species: Goniatites lyoni Meek & Worthen, 1880, O.D.

One of the most widespread of the Lower Mississippian ammonoid genera is an evolute simple prolocanitid. These forms are extremely rare in the Chouteau Limestone, where only a single specimen was found by E. B. Branson in central Missouri. Two representatives are known from the Northview, to the southwest.

The progenitor of an important lineage, the Prolocanitaceae, is represented in collections from Indiana, but is not common there. Isolated representatives of P. lyoni, or closely related species, have been found widely in the United States and Canada. The genus is well represented in European beds of Tournaisian age. Elsewhere, similar forms have been found in Africa, Australia, and South America. Normally, this lineage seems to be more common in association with dark-colored argillaceous sediments.

References


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