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CONODONT DISTRIBUTION AND CORRELATION OF THE TACKET SHALE (MISSOURIAN, UPPER PENNSYLVANIAN) IN SOUTHEASTERN KANSAS AND EASTERN OKLAHOMA

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Thesis supervisor: Professor Philip H. Heckel

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CERTIFICATE OF APPROVAL

MASTER'S THESIS

This is to certify that the Master's thesis of

John A. Pavlicek

has been approved by the Examining Committee for the thesis requirement for the Master of Science degree in Geology at the May 1986 graduation.

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ABSTRACT

The Tacket Shale is composed of a thick sequence of gray to black "core" shales near the base of the Missourian section in southeastern Kansas and eastern Oklahoma. Since Jewett et al. (1965), there have been several attempts to correlate these shales with units to the north and south using only lithostratigraphic techniques. Ravn (1981) was the first to recognize the Tacket as being part of a cyclothem.

Using both lithostratigraphy and biostratigraphy, the Tacket Shale can be divided into three distinct units: 1) the lower Tacket Shale, which contains a black fissile, phosphatic shale, 2) the middle Tacket limestone or "marl zone", 3) the upper Tacket Shale, which contains a black fissile, phosphatic shale. Both black shales and adjacent gray shales contain abundant conodonts dominated by Idiognathodus, Idioprioniodus and Gondolella, a fauna that is considered offshore. The middle carbonate zone also contains abundant conodonts dominated by Idiognathodus, with some Idioprioniodus, but also contains Hindeodus and Adetognathus, a fauna that is considered nearer-shore. The black shales represent two separate periods of maximum

transgression, which are separated by a shallower-water, but still offshore limestone or very fossiliferous gray shale. The lower Tacket black shale facies contains *Idiognathodus* sp. 1, *I.* cf. *I.* sp.3 and *Gondolella bella*, while the upper Tacket black shale facies contains these three plus *I. oppletus*, *G. sublanceolata* and *G. denuda*.

On the basis of transgressive-regressive cycles, the Exline Limestone of the northern outcrop should be equivalent to the lower Tacket Shale, and the Mound City Shale of the Hertha Formation to the upper Tacket Shale. Study of the conodont faunas suggests that the Mound City is equivalent to the upper Tacket and the black shale facies of the lower Tacket, while the Exline is equivalent to only the lowest part of the lower Tacket.

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INTRODUCTION

Lower Upper Pennsylvanian (Missourian) rocks crop out in eastern Oklahoma, eastern Kansas, northwestern Missouri and southwestern Iowa. These rocks are generally characterized by an alternation of laterally persistent sandy shale formations with laterally persistent limestone formations. Each limestone is further characterized by a succession of distinctive limestone and shale members, which were regarded by Weller (1930) in Illinois as being formed by "cyclical sedimentation". Moore (1936) recognized the prescence of similar sequences, now termed cyclothems, in the Midcontinent, and stressed the importance of the cyclothem model in stratigraphic classification.

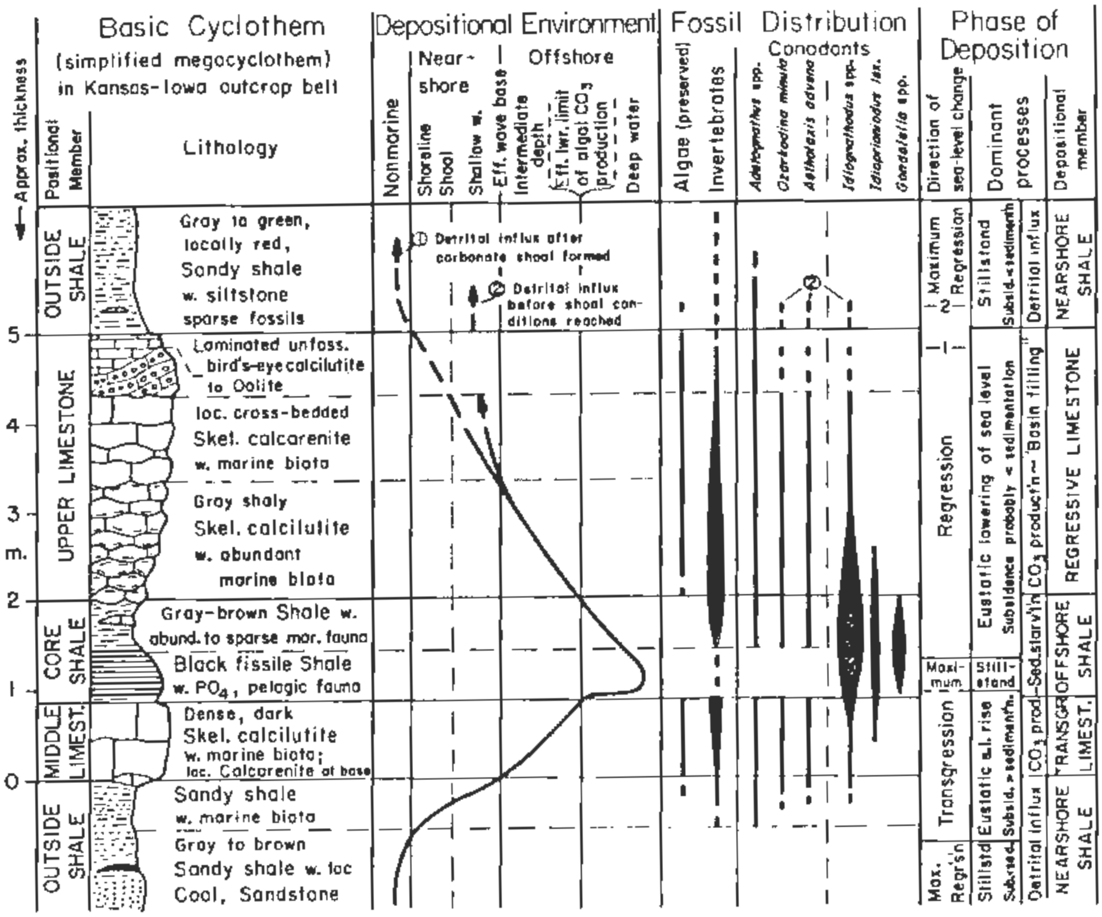
A current model for the depositional interpretation of a cyclothem formed by eustatic rise and fall of sea level was presented by Heckel (1977). In ascending order, a basic eustatic cyclothem (Figure 1) consists of: 1) thick, sandy, nearshore to nonmarine, "outside" shale, 2) thin transgressive, "middle" limestone, 3) thin, offshore, "core" shale commonly with a black phosphatic facies, 4) thick regressive "upper" limestone, 5) thick sandy, nearshore to nonmarine, "outside" shale. The "outside" shale represents the time of maximum regression, and the thin "core" shale represents the time of maximum transgression in a single eustatic rise and fall of sea level.

An important feature of the cyclothem is that different members of each cyclothem are characterized by different assemblages of conodont genera (Figure 1), which are similar in homologous members of different cyclothems throughout the Missourian (Heckel & Baesemann, 1975) and also the upper Desmoinesian (Swade, 1985).

The Tacket Shale, the subject of this study, is dominantly a black shale with phosphate nodules, which is thicker (10 to 35 ft.) than similar shales (0.5 to 3 ft.) in well known cyclothems (e.g., Swope, Dennis, Iola, Stanton). Until recently (Ravn, 1981), the Tacket was not considered part of a cyclic sequence. The name Tacket Shale was originally suggested for this unit by Emery (1962). It was formally described by Jewett et al. (1965), who gave it formation status at the top of the Pleasanton Group (Figure 2). It is considered to be underlain by the Checkerboard Limestone of the Plesanton Group and is overlain by the Hertha Limestone at the base of the Kansas City Group.

In its type area near Tacket Mound, Labette County, Kansas, the Tacket is overlain by the Hertha Limestone, in which Jewett et al. (1965) claimed to recognize all three component members (Critzer Limestone, Mound City Shale and Sniabar Limestone members, in ascending order). The Tacket

Figure 1. Basic Upper Pennsylvanian cyclothemic sequence. Environmental interpretations are based on lithology and fossil distribution. Note particularly the differences in conodont faunas between nearshore and offshore shale members. *Ozarkodina* = *Hindeodus* of this study. *Idioprioniodus lexingtonensis* now equals *Idioprioniodus typus*. Modified from Heckel (1977).



Basic Cyclothem
(simplified megacyclothem)
in Kansas-Iowa outcrop belt
Approx. thickness
Positional Member
Lithology
Depositional Environment
Nonmarine
Near-shore
Shoreline Shoal
Shallow w.
Eff. wave base
Offshore
Intermediate depth
Eff. lwr. limit of algal CO3 production
Deep water
Fossil Distribution
Algae (preserved)
Invertebrates
Conodonts
Phase of Deposition
Direction of sea-level change
Dominant processes
Depositional member
OUTSIDE SHALE
Gray to green, locally red, Sandy shale w. siltstone sparse fossils
Detrital influx after carbonate shoal formed
Detrital influx before shoal conditions reached
UPPER LIMESTONE
Laminated unfoss. bird's-eye calcilutite to Oolite
loc. cross-bedded Skel. calcarenite w. marine biota
Gray shaly Skel. calcilutite w. abundant marine biota
CORE SHALE
Gray-brown Shale w. abund. to sparse mar. fauna
Black fissile Shale w. PO4, pelagic fauna
MIDDLE LIMEST.
Dense, dark Skel. calcilutite w. marine biota; loc. Calcarenite at base
OUTSIDE SHALE
Sandy shale w. marine biota
Gray to brown Sandy shale w. loc Coal, Sandstone
m.
Maximum Regression
Regression
Maxi-mum
Transgression
Max. Regr'sn
Stillstand
Subsid.<sedimen'th
Detrital influx
Eustatic lowering of sea level
Subsidence probably < sedimentation
CO3 product'n ~ Basin filling
Still-stand
Sed. starv'n
Eustatic s.l. rise
Subsid. > sedimen'n.
CO3 prod.
Stillstd
Subsid.
NEARSHORE SHALE
REGRESSIVE LIMESTONE
OFFSHORE SHALE
TRANSGR. LIMEST.
NEARSHORE SHALE

Figure 2. Position of Tacket Formation and adjacent units in Midcontinent. Units presently recognized as Tacket Formation and probable equivalents are outlined by hachures (from Heckel, personal communications, 1985). Basic figure modified from Singler (1965).

	OKLAHOMA Oakes (1959)	KANSAS Jewett (1964), Emery (1962)	MISSOURI Howe (1961)	IOWA Hershey et. al. (1960)	
KANSAS CITY GROUP	Hogshooter Fm.	Dennis Fm.	Dennis Fm.	Dennis Fm.	
	Coffeyville Fm.	Galesburg Fm.	Galesburg Fm.	Galesburg Fm.	
		Swope Fm.	Swope Fm.	Swope Fm.	
		Ladore Fm.	Ladore Fm.	Ladore Fm.	Sniabar Lst.
	UPPER SH. MEM.	Hertha Fm.	Hertha Fm.	Hertha Fm.	Mound City Shale Critzer Lst.
PLEASANTON GROUP		Tacket Fm. UPPER SH. MEM	Upper Fm. UNNAMED SH. MEM.	Chariton Cgl.	
	MIDDLE SS. MEM.	MIDDLE LS. MEM.	WARRENSBURG SS. MEM		
	LOWER SH. MEM.	LOWER SH. MEM.	Middle Fm. UNNAMED SH. MEM		
	Checkerboard Ls. Fm.	Checkerboard Ls. Fm.	EXLINE LS. MEM	Exline Ls.	
	Seminole Fm. UPPER SS MEM	Seminole Fm. SOUTH MOUND SH. MEM.	Lower Fm. UNNAMED SH MEM		
	MIDDLE SH MEM.	HEPLER SS. MEM.	HEPLER SS MEM.		
	LOWER SS. MEM.				
MARMATON GROUP	Holdenville Fm.	Holdenville Fm.	Holdenville Fm.		
	Lenapah Fm.	Lenapah Fm.	Lenapah Fm.	Cooper Creek Fm.	

itself was considered to consist of a thick upper shale, thin middle limestone and thick lower shale units above the Checkerboard Limestone, which was considered to consist here of upper limestone, middle shale and lower limestone units.

Since 1965, new interpretations on the correlation of these units have been put forth. Ravn (1981) studied the Hertha from Tacket Mound northeastward along strike into Missouri and Iowa. His study recognized that the Sniabar Limestone is regressive, the Mound City Shale is offshore, and it considered the Critzer Limestone to be transgressive. He concluded in terms of both lithology and conodont fauna that the entire Hertha of Jewett et al. (1965) at Tacket Mound, was only the Sniabar or regressive limestone. Thus he correlated the Mound City with the Tacket and the Critzer with the Checkerboard he observed (only the upper Checkerboard of Jewett et al., 1965) at Tacket Mound. He thus regarded the Tacket Shale as the "core" shale and the Checkerboard Limestone as the transgressive limestone of the Hertha cycle.

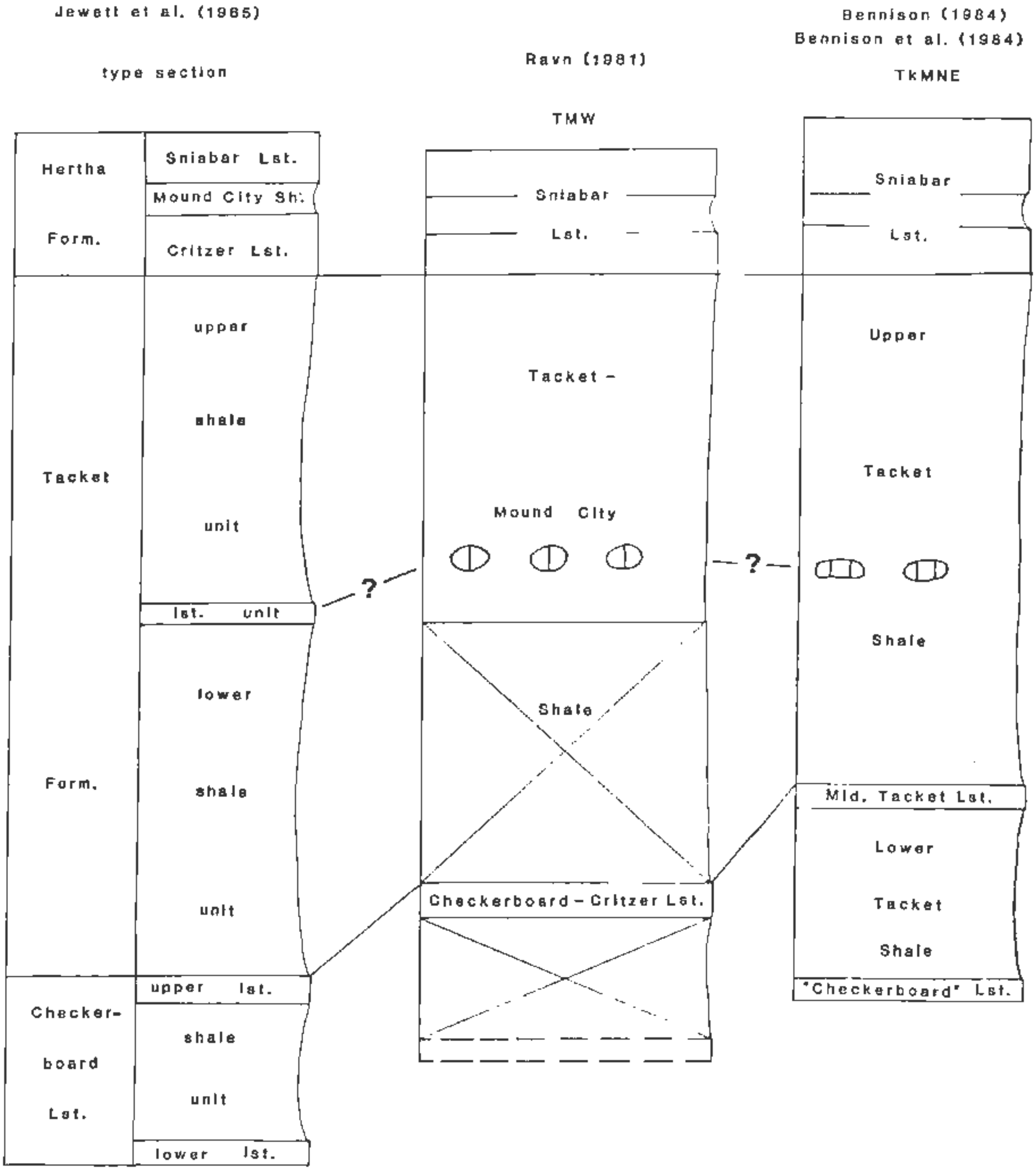
Bennison (1984) has also reevaluated Tacket Mound (Figure 3). He discovered another black, fissile shale unit within the Checkerboard middle shale of Jewett et al. (1965). He believed that only the lower limestone unit in the Checkerboard correlates with the type Checkerboard of Oklahoma. He called the entire Tacket section of Jewett et al. (1965), the upper Tacket Shale and the newly discovered black shale within their Checkerboard unit the lower Tacket Shale. He also called the upper limestone unit in the Checkerboard of Jewett et al. (1965), which was Ravn's (1981) Critzer-equivalent Limestone, the middle Tacket limestone. Bennison (1984) also traced the entire Tacket into Oklahoma where it previously was considered to be part of the lower Coffeyville Formation.

To the north, Underwood (1984) worked on a poorly understood limestone unit in Bourbon County, Kansas, informally known as the "Bourbon flags". He found evidence that the Mound City Shale thickens dramatically in a few miles to the southeast as the Critzer Limestone thins above the "Bourbon flags". He also found that the medial limestone mentioned by Jewett in older literature in the thin Mound City, commonly has a black, fissile shale unit not far beneath it in well exposed sections of the thick Mound City to the south and southeast.

Further insight into the problems in this sequence were suggested by Heckel (1984). The type Critzer Limestone in Linn County, Kansas, may constitute a minor transgressive-regressive cycle in its own right. If so, it may be equivalent to part of the lower Tacket Shale and the middle Tacket limestone (which had been considered the upper Checkerboard). This suggests that the two black shales in

Figure 3. Interpretations of sequences at Tacket Mound. This figure compares three different interpretations of Tacket Mound since 1965. The location of the type Tacket, as given by Jewett et al. (1965) is, S sec. 7 and along the west side of sec. 17, T. 32 S., R. 19 E., Labette County, Kansas. TMW (Ravn, 1981) is located in the SW 1/4, sec. 7, T. 32 S., R. 19 E. TKMNE (Bennison et al., 1984) is located in the center of sec. 7, T. 32 S., R. 19 E. The terminology of Bennison (1984) is used in this study. Two points to note in this figure are: 1) Ravn (1981) did not observe the lower Checkerboard limestone, but included it on his Figure 10, p. 46; 2) Bennison (1984, p. 122) considers that this same limestone is equivalent to the type Checkerboard in Oklahoma (quotation marks on Checkerboard are mine). Approximate vertical scale is 0.1 inch = 1 foot.

Interpretations of sequences at Tacket Mound



the Tacket may correspond to two cycles in the Hertha. Also the Exline Limestone, which is present below the Hertha in western Missouri and was correlated with the Checkerboard of Oklahoma by Singler (1965), was suggested by Heckel (1984) to possibly correlate with the South Mound Shale below the Checkerboard in Labette County, Kansas; however, based on more recent information, the Exline is now considered to correlate with at least the lower part of the lower Tacket Shale (Heckel, 1986).

Objectives

The objectives of this thesis are: 1) to determine the number and position of transgressive-regressive cycles within the Tacket Shale; 2) to determine its depositional relationship to overlying and underlying units; 3) to describe the conodont faunas of the Tacket Shale in order to form the basis for establishing the conodont biostratigraphy of the lower Missourian, as Swade (1985) has done for the upper Desmoinesian. This will be done by comparison of its conodont fauna and lithology from several complete sections where it is well developed in southeastern Kansas and eastern Oklahoma. The phase of deposition will be established using criteria of conodont abundance and generic proportions put forth by Heckel & Baesemann (1975) and Swade (1985). Correlation of the Tacket with previously established cycles to the north will be attempted by comparison of its conodont faunas with those of the Hertha and Exline studied by Swade (1985) and Heckel (personal communications).

Field Methods

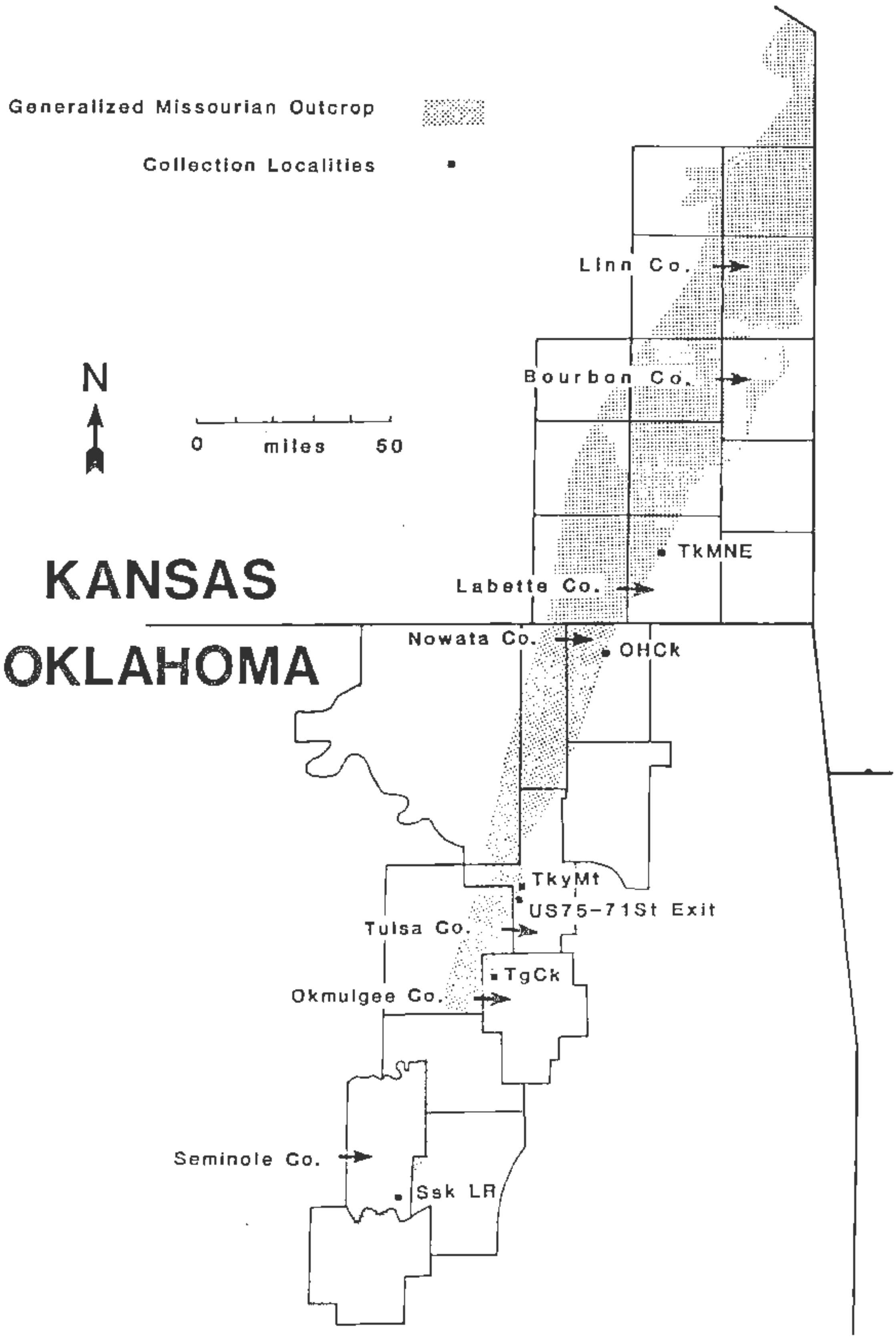
The 6 localities sampled were chosen for the completeness of section exposed (Figure 4). Each section studied was precisely measured and described at the outcrop. Channel samples were collected from each thin lithologic unit and from about 1 to 2-foot intervals within thicker lithologic units in the Tacket. A total of 126 samples were collected.

Laboratory Methods

All samples were processed for conodonts. Limestone samples of at least 0.5 kilogram were dissolved in 10% formic acid. Shale samples of 1 kilogram were first placed in Stoddard's Solvent, then if necessary in bleach (NaOCl). Due to the length of time required to break down many of the black, fissile shales, the full 1 kilogram was not processed (see Tables 1-5 for weight processed). All samples were washed through a set of 1000-, 125- and 63-micron screens.

Samples with large 125-micron residues were dealt with in one of two ways. If the residue contained argillaceous material, it was treated with the detergent Quaternary "O"

Figure 4. Location map of Tacket exposures collected. See Appendix A for exact locations. Adapted from Heckel (1978) and Fay et al. (1979).


Generalized Missourian Outcrop
Collection Localities
N
0 miles 50
KANSAS
OKLAHOMA
Linn Co.
Bourbon Co.
TkMNE
Labette Co.
Nowata Co.
OHCk
TkyMt
US75-71St Exit
Tulsa Co.
TgCk
Okmulgee Co.
Seminole Co.
Ssk LR

in a process similar to the one described by Straka (1969). This treatment helps deflocculate the clays and cleans the surface of the conodonts for better identification. If the residue was from a black shale, or contained slighty magnetic silty aggregates, the magnetic separator was used to concentrate the conodonts in the nonmagnetic fraction (Dow, 1960).

All 125-micron residues were picked for conodonts using a binocular microscope and brush. A total of 22,925 conodonts were picked and identified. All conodonts were placed in gridded micropaleontological slides. Approximately 100 specimens were photographed, using standard techniques, and 83 specimens are illustrated.

For petrographic study, 28 thin sections were prepared from limestone units in the study area. Photonegative prints were prepared from four of these thin sections to illustrate lithology.

LITHOLOGIC SUCCESSION AND CONODONT DISTRIBUTION

Tacket Mound Northeast (TkMNE)

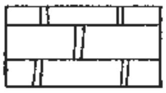
The lowest unit sampled is a 0.2-foot oxidized, orange shale, lying just below the "Checkerboard" (Figure 5), and at the top of a 3.0-foot, gray shale refered to as Hepler by Bennison et al. (1984). It had an extrapolated conodont abundance of about 120 elements/kilogram. It contained *Idiognathodus* sp. 1 of Swade (1985) and *I.* cf. *I.* sp. 3 of Swade (1985), and lesser numbers of *Idioprioniodus* and *Adetognathus* (see Systematic Paleontology for descriptions of individual elements and Table 1 for exact distribution of conodont elements at Tacket Mound Northeast).

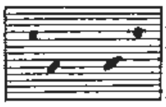
The "Checkerboard" consists of a 0.5-foot, dark gray, sparsely fossiliferous shale. Within the shale there are 0.1 to 0.4-foot diameter, dark gray sparsely skeletal calcilutite nodules. The nodules are burrowed and contain some scattered silt and fine shell debris. On the tops of some nodules and in small lenses in the shale, there is a thin skeletal calcarenite composed of echinoderm fragments and small brachiopods. The extrapolated conodont abundance is about 50 elements/kilogram. The fauna is made up entirely of *Idiognathodus* sp. 1.

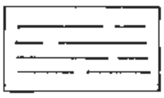
Figure 5. Lithology and conodont distribution at Tacket Mound Northeast (TkMNE). See Appendix A for exact location. Conodont genera are abbreviated as follows: Ad = *Adetognathus*, At = *Aethotaxis*, D = *Diplognathodus*, E = *Ellisonia*, G = *Gondolella*, H = *Hindeodus*(= *Ozarkodina* and *Anchignathodus* of other authors), H.p. = *Hindeodella parva*, Ig = *Idiognathodus* and Ip = *Idioprioniodus*. The letters Wx in the conodont abundance column indicates that the sample was barren or had a greatly reduced abundance due to weathering.

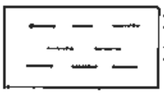
Lithologic symbols are as follows:

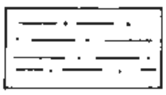

nodular or massive to thin bedded calcilutite


nodular or massive to thin bedded calcarenite


black, fissile shale w/ round or bladed phosphate nodules

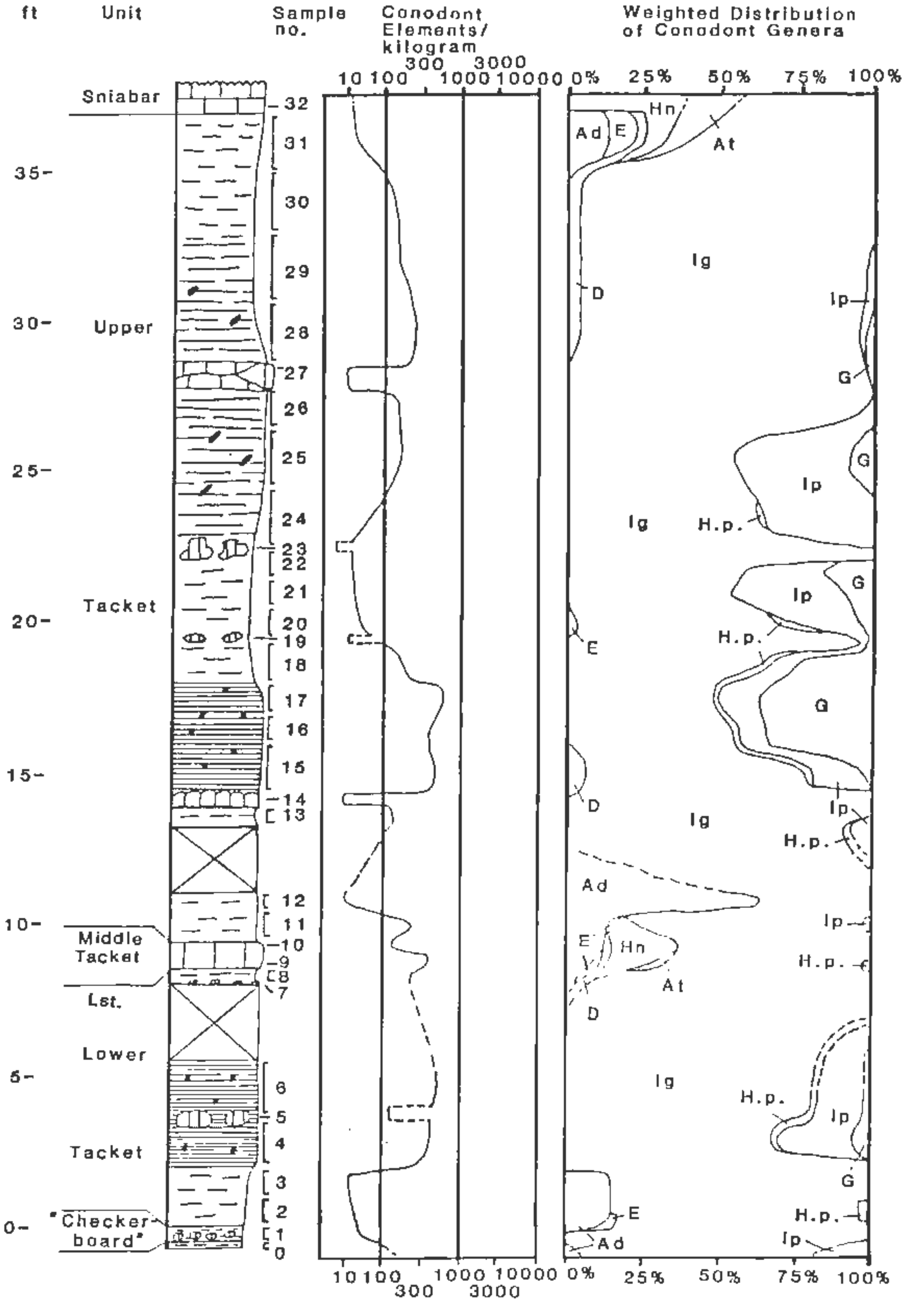

gray-black to black, non-fissile shale


med. to dk. gray non-fissile shale


silty shale


sandstone

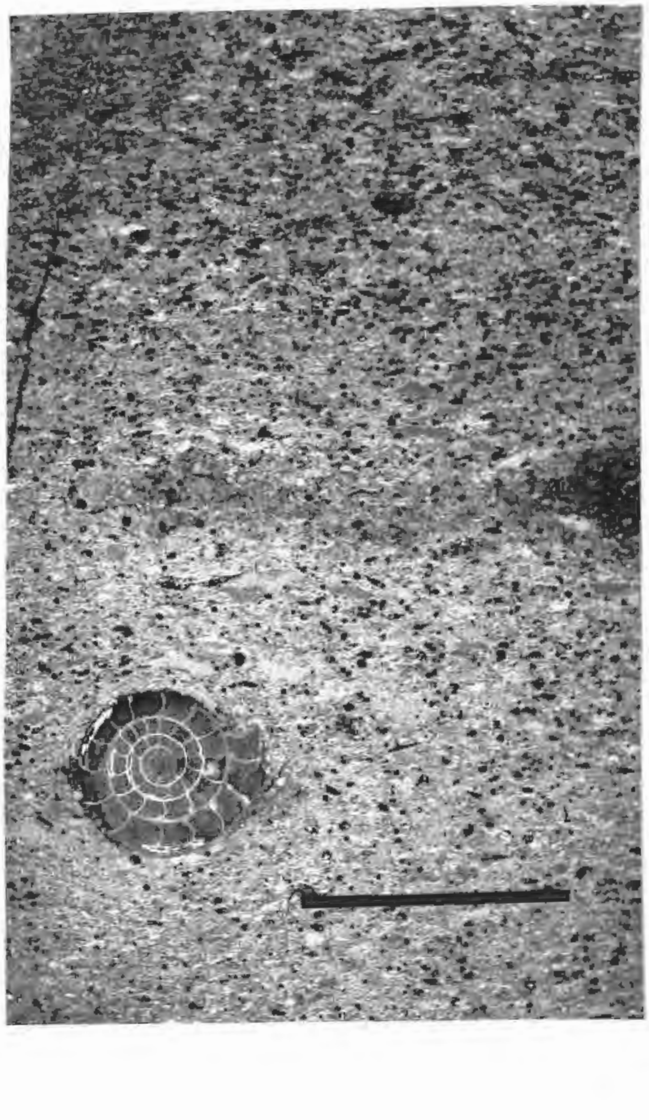
Tacket Mound Northeast (TkMNE)



Above the "Checkerboard" is 8.5 feet of lower Tacket Shale. The lowest 2.0 feet is a dark gray shale, which grades into 3+ feet of a black fissile, phosphatic shale. Within the black shale is a zone of 0.75-foot thick, black, sparsely skeletal calcilutite nodules (sample 5). The fossils in these nodules include uncrushed, juvenile ammonoids (Figure 6), and the conodonts from the nodules show remarkable preservation. These nodules also contain numerous calcite spheres approximately 0.1 to 0.15 mm in diameter; these could be altered radiolarians by size and shape comparison with well preserved phosphatized radiolarians illustrated from phosphate nodules in Midcontinent Pennsylvanian black shales by Kidder (1985). Above the black shale is a 2.5-foot covered interval, above which is a 0.25-foot zone of very weathered, rusty brown, sparsely skeletal calcilutite nodules. This is followed upward by 0.5-foot of medium gray, sparsely fossiliferous shale.

Conodont abundance in the lower Tacket is only in the tens of elements/kilogram for the lower gray shale. Its fauna is dominated by *Idiognathodus* sp. 1 and *Adetognathus*, with rare *Ellisonia* and *Hindeodella parva*. The abundance increases dramatically upward into the black shale, where it reaches about 600 elements/kilogram. The fauna is still dominated by *Idiognathodus* (*I.* sp. 1 and *I.* cf. *I.* sp. 3),

Figure 6. Photonegative print of black calcilutite nodule in lower black shale at Tacket Mound. Note uncrushed juvenile ammonoid and small calcite spheres, which may be calcite-replaced radiolarians. Bar scale = 5 mm.



but now Idioprioniodus and Gondolella bella are present. The abundance in sample 5 is not nearly as high (approximately 110 elements/kilogram) as in the adjacent black shale (approximately 600 elements/kilogram), but the fauna is basically the same. The abundance declines in the rusty nodules and shale above the covered interval to 150 and 210 elements kilogram respectively. The conodont fauna still is dominated by Idiognathodus sp. 1, but also contains Adetognathus, Diplognathodus and Ellisonia.

The middle Tacket limestone is a 0.9-foot, gray, skeletal calcilutite (Figure 7). It contains echinoderms, brachiopods and molluscs, decreasing in abundance upwards. The conodont fauna also decreases upwards, from about 420 to 110 elements/kilogram. The conodont fauna is dominated by Idiognathodus sp. 1. Also present in order of decreasing abundance are: Hindeodus, Adetognathus, Ellisonia, I. cf. I. sp. 3, Aethotaxis, Diplognathodus and Hindeodella parva.

The upper Tacket Shale lies above the middle Tacket limestone. The lowest 4.5 feet (samples 11-13) is a fossiliferous, dark gray shale, with the central portion covered. The fossils include gastropods, echinoderms, brachiopods, ostracodes, forams and juvenile ammonoids. Above this is a 0.5-foot, dark gray calcilutite (sample 14), with rare gastropods and brachiopods. Overlying this is a thick sequence of black fissile and nonfissile, phosphatic

Figure 7. Photonegative print of middle Tacket limestone at Tacket Mound. Skeletal calcilutite, with echinoderms, brachiopods and skeletal debris. Bar scale = 5 mm.

shales. The lower 4.5 feet (samples 15-17) is a black, fissile shale which grades upwards into 4.5 feet of a sparsely fossiliferous, dark gray shale (samples 18-22), containing forams and ostracodes, with rare echinoderms. Also within this shale are two zones of dense, dark gray calcilutite nodules (samples 19 & 23). The nodules from which sample 23 was taken are up to 2.0 feet in diameter and up to 1.5 feet thick, and they also contain numerous calcite-filled fractures. This gray shale grades upward into 10.0 feet of nearly black, phosphatic, platy shale (samples 24-29). Near the center of this shale is a 0.75-foot, black calcilutite (sample 27), which petrographically is very similar to the black calcilutite nodules (sample 5) in the lower Tacket Shale. This black shale grades upward into 4.25 feet of dark gray, fossiliferous shale, with brachiopods, echinoderms and clams.

The conodont faunas of the upper Tacket Shale can be divided into 3 groups. The lowest is from samples 11 to 13 in the lower gray shale. It is dominated by Idiognathodus sp. 1, with a few I. cf. I. sp. 3 present in the base. Adetognathus, Ellisonia and Hindeodus are present at the base, but absent at the top. Idioprioniodus is present at both the base and top. In the middle of the upper Tacket, samples 15 to 29 show a fauna that is dominated by

Idiognathodus, Idioprioniodus and Gondolella. The extrapolated abundance for the black, fissle shale (samples 15-17) varies from about 400 to 777 elements/kilogram. The first appearence of Idiognathodus oppletus, Gondolella sublanceolata and Gondolella denuda, in this study, occur in this shale. Diplognathodus appears in relative abundance in sample 15, and I. cf. I. sp. 3 disappears above sample 17. The same conodont genera are present in the dark gray and nearly black, platy shales above sample 17. The only difference is that they occur less abundantly (tens to a few hundred/kilogram). This could be due to an increase in deposition of fine-grained siliciclastic material, which would have diluted the conodont abundance and possibly kept the nearly black, platy shale from appearing like the more familiar fissile black shale. The highest faunal grouping occurs in the upper gray shale, and is similar to the fauna in the lower gray shale. Abundance decreases from the black, platy shale to only tens of elements/kilogram. Idiognathodus is still dominant, but the shale contains upward-increasing numbers of Adetognathus, Aethotaxis, Ellisonia and Hindeodus, along with rare Diplognathodus.

The Sniabar Limestone overlies the upper Tacket Shale. I sampled only the lowest 1.0 foot, which is a light gray, skeletal calcilutite, with brachiopods, echinoderms, bryozoans and sponges. Conodont abundance is only 11 elements/kilogram, and the fauna includes _Idiognathodus oppletus_, _I_. sp. 1, _Hindeodus_ and _Aethotaxis_.

Oklahoma Hickory Creek (OHCk)

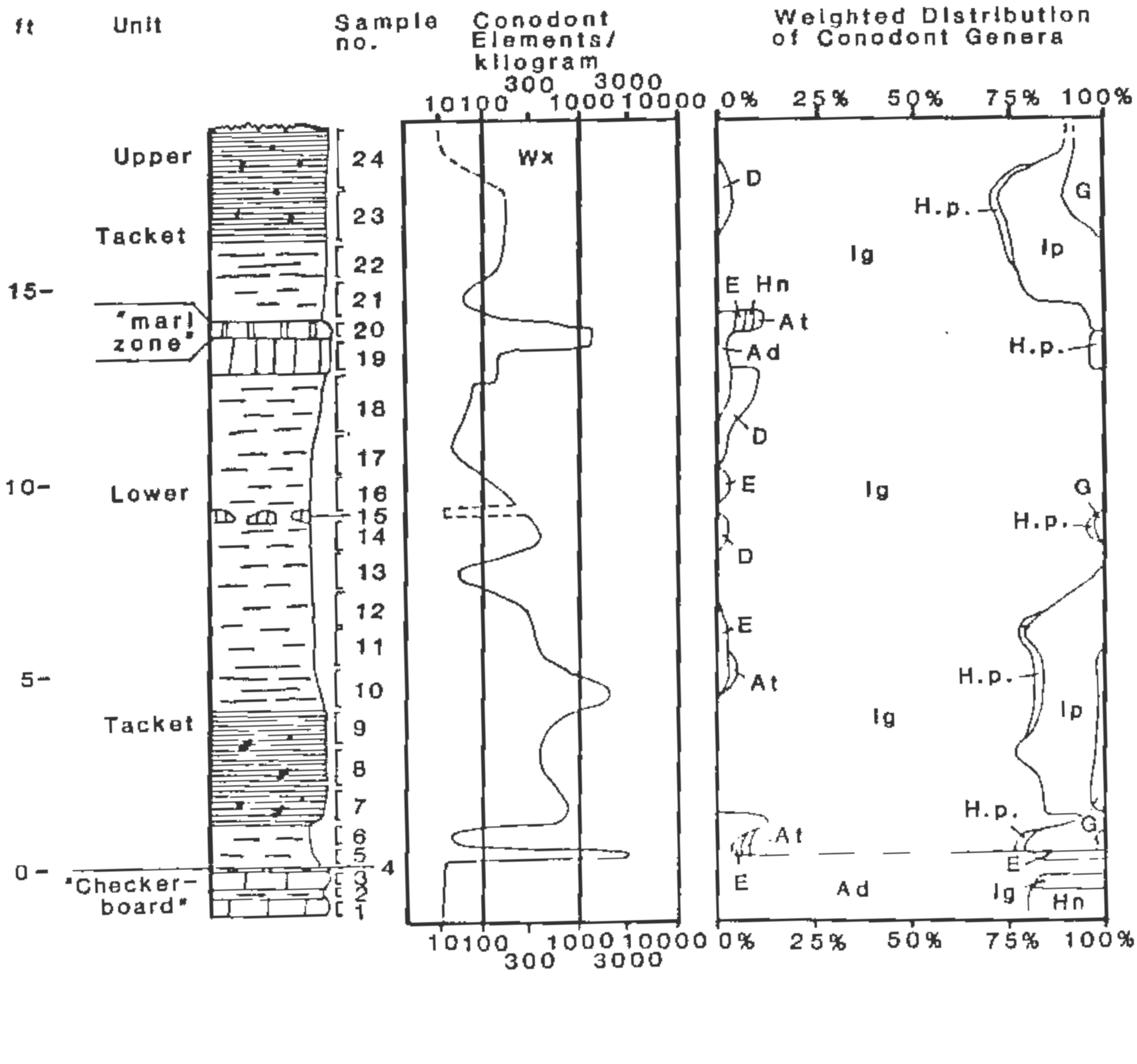
The lowest unit sampled at this locality is the "Checkerboard" Limestone (Figure 8). Here it consists of a lower 0.5-foot, green-grey, skeletal calcilutite, a middle 0.25-foot, medium gray, fossiliferous shale and an upper 0.5-foot, green-gray, skeletal calcilutite, which is overlain by a 0.1-foot, gray, skeletal calcarenite. The calcilutites contain abundant gastropods, brachiopods and bryozoans. The calcarenite contains abundant brachiopods, echinoderms, pyritized bryozoans and some mollusc fragments, most of which appear to be slightly crushed. All three carbonate units contain some silt-sized quartz. Conodont abundance in this unit is 15 to 25 elements/kilogram (see Table 2 for exact distribution of conodont elements). The fauna is dominated by _Adetognathus_, with rare _Hindeodus_, _Idiognathodus_ sp. 1 and _Ellisonia_.

The lower Tacket Shale contains 2.0 feet of medium gray, fossiliferous shale at the base (samples 5-6), which grades upward into 4.0 feet of black, fissile to platy, phosphatic shale (samples 7-10), which in turn grades upward into 7.5 feet of medium gray, fossiliferous shale (samples 11-18). Near the center of the upper gray shale is a zone of gray, argillaceous, sparsely fossiliferous calcilutite nodules (sample 15), which contain large gastropods and small ammonoids. In the lower gray shale, fossils are most abundant near the base, and include echinoderms, small brachiopods and bryozoans. In the upper gray shale, fossils are most abundant near the zone of nodules and near the top of the shale unit, and include gastropods, ostracodes, and echinoderms.

There are three zones of relatively high conodont abundance in the lower Tacket Shale. The lowest is in sample 5, which directly overlies the skeletal calcarenite at the top of the Checkerboard, and contains slightly over 3600 elements/kilogram. It is dominated by Idiognathodus sp. 1, but contains no I. cf. I. sp. 3. Idioprioniodus and Adetognathus are fairly numerous. Also present are rare Ellisonia, Aethotaxis, Hindeodella parva and Gondolella bella. Sample 6 shows a great decline in abundance. The second zone of high abundance is in the black shale, which is dominated by Idiognathodus sp. 1 and I. cf. I. sp. 3, with numerous Idioprioniodus and rare Gondolella bella, the fauna more characteristic of "core" shales. The extrapolated conodont abundance exceeds 395 elements/kilogram in all samples of this black shale. It exceeds 2500 elements/kilogram in sample 10, which is a black, platy shale overlying the black, fissile shale. The

Figure 8. Lithology and conodont distribution at Oklahoma Hickory Creek (OHCk). See Appendix A for exact location. See Figure 5 for explanation of symbols.

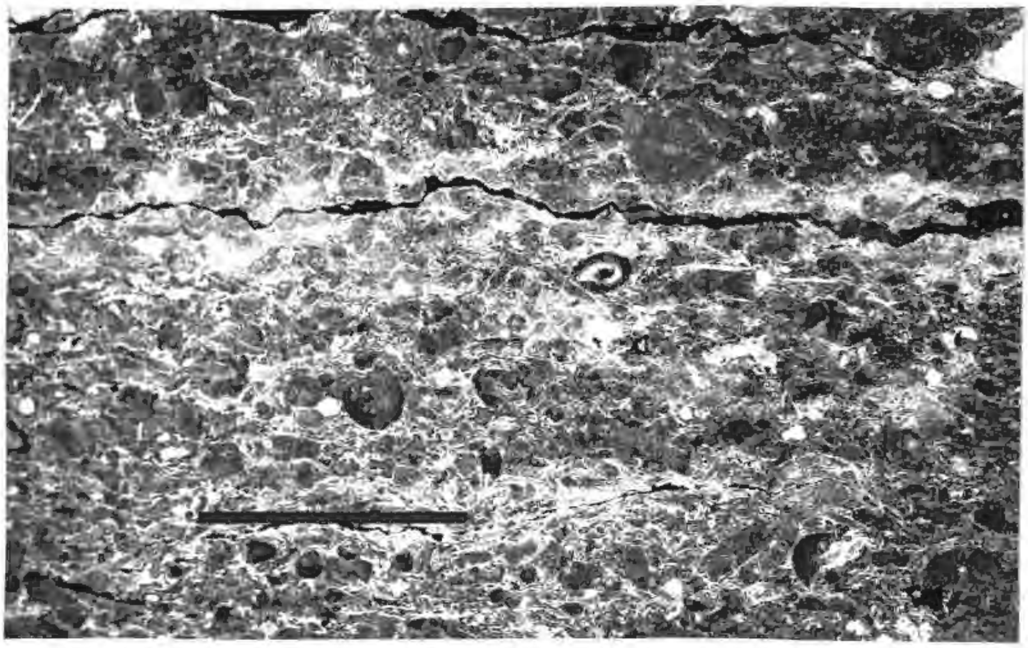
Oklahoma Hickory Creek (OHCk)



third abundance peak is in the upper gray shale in sample 14, where there are over 750 elements/kilogram, dominated by Idiognathodus sp. 1, but also containing Diplognathodus and 1 Gondolella bella Pa element. Below and above the nodule zone, conodont abundance decreases to less than 100 elements/kilogram. The fauna at the top is dominated by Idiognathodus sp. 1, with minor numbers of Adetognathus, Diplognathodus and Ellisonia.

Overlying the lower Tacket Shale are two limestones. The lower is a 1.0-foot, green-gray, argillaceous skeletal calcilutite (sample 19). The fossils include gastropods, brachiopods, bryozoans and echinoderms. The extrapolated conodont abundance is about 170 elements/kilogram. It is dominated by Idiognathodus sp. 1, with rare I. cf. I. sp. 3, Hindeodella parva and Adetognathus. It has a sharp contact with the overlying 0.5-foot, grey, argillaceous calcarenite (sample 20), which contains abundant echinoderm and some brachiopod debris (Figure 9). All grains are overpacked, and many have corroded margins. This and similar units to the south have been informally referred to as "marl zones" (A. P. Bennison, personal communication, 1983), a practice that is also followed here (see Figure 8). The extrapolated conodont abundance is over 1200 elements/kilogram. The fauna is dominated by Idiognathodus sp. 1, with rare I. cf. I. sp. 3, Aethotaxis, Hindeodus, Idioprioniodus, Ellisonia and Adetognathus.

Figure 9. Photonegative print of "marl zone" at Hickory Creek. It is a skeletal calcarenite, composed almost entirely of echinoderms and brachiopods. Notice overpacking of grains. Bar scale = 5 mm.



Above the "marl zone" is 5.0 feet of upper Tacket Shale. The base is 2.0 feet of dark gray, sparsely fossiliferous shale, and grades upward into 3+ feet of black, fissile shale, which is badly weathered at the top. The extrapolated conodont abundance increases from about 70 elements/kilogram upward to over 200 elements/kilogram at the base of the black, fissle shale. The gray and black shales are dominated by Idiognathodus sp. 1. Idiognathodus cf. I. sp. 3 and Idioprioniodus are also present, in smaller numbers, in both shales. At the base of the black shale Diplognathodus occurs along with three species that were not present in the lower Tacket Shale: specifically, Idiognathodus oppletus, Gondolella sublanceolata and Gondolella denuda.

The uppermost sample (24) contained only 10 elements, which appear chalky white. The shale contained impressions of many more elements than that, so I have concluded that most of the elements originally in this sample were destroyed by weathering (Wx on Figures 8, 10, 11 and 12). This situation is much more prevalent in sections sampled to the south, where unfortunately many of the black, fissile shale samples were barren or nearly so.

Turkey Mountain (TkyMt)

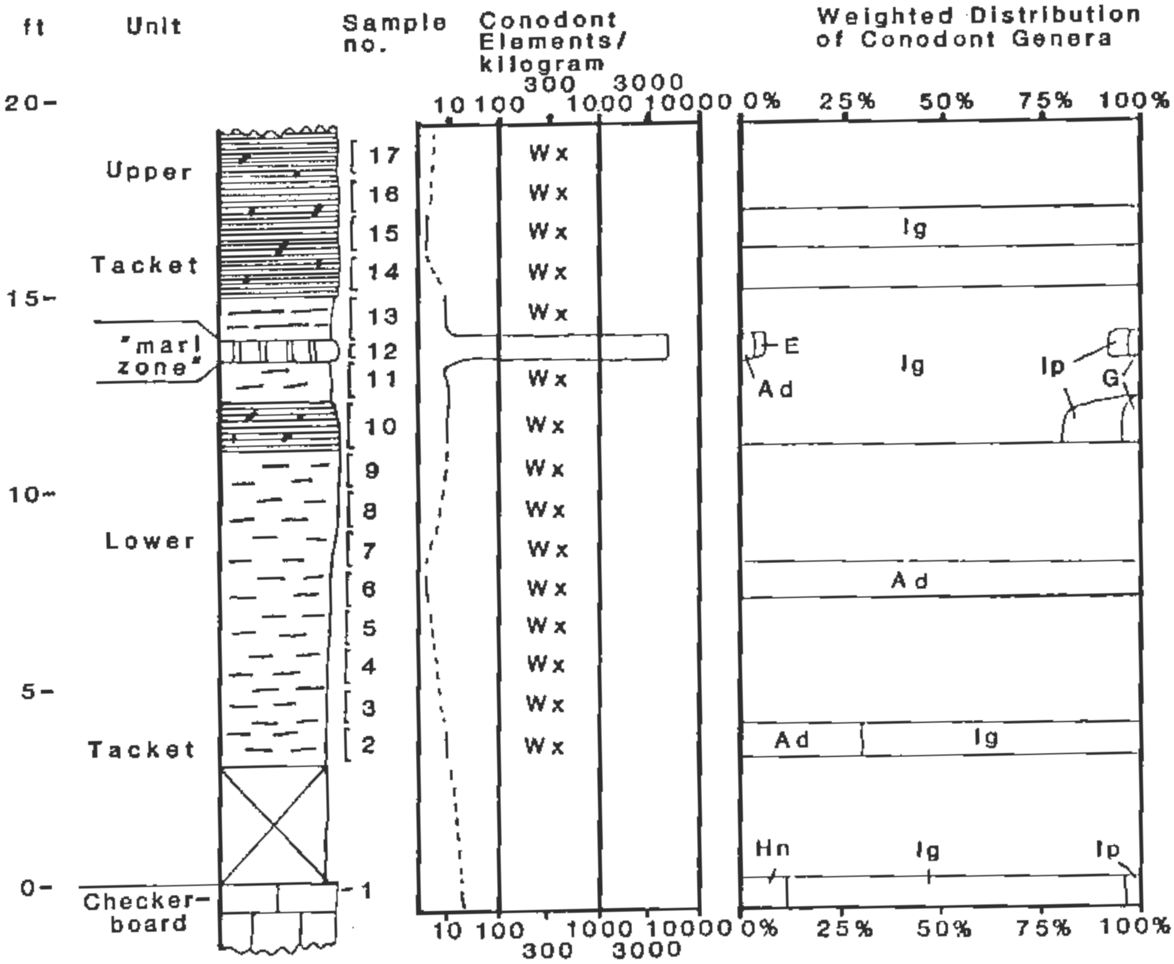
Only the top 2.0 feet of the Checkerboard Limestone, a thick-bedded gray, sparsely skeletal calcilutite, is exposed at this locality (Figure 10). It has an abundance of 33 elements/kilogram, and is by dominated *Idiognathodus* sp. 1, with rare *Hindeodus* and *Idioprioniodus* elements (see Table 3 for exact distribution of conodont elements).

Overlying the Checkerboard is 13.3 feet of lower Tacket Shale, with the lower 3.0 feet covered. All of the shale samples above the Checkerboard show signs of weathering, therefore discussion of extrapolated conodont abundance for these samples would be useless (see conodont abundance curve on Figure 10). Above the covered interval there is 8.0 feet of a dark gray, sparsely fossiliferous shale, which yielded forams and ostracodes. This shale grades upwards into 1.3 feet of a black fissile, phosphatic shale. Above this is 1.0-foot of iron stained, medium gray shale.

The lower gray shale yielded only a few *Adetognathus* in the lower part (sample 2) and a few *Idiognathodus* scattered throughout. The black, fissile shale contained only a few *Idiognathodus* sp. 1 and *I.* cf. *I.* sp. 3, along with rare *Idioprioniodus* and *Gondolella bella*. The gray shale above the black, fissile shale contained only a few *Idiognathodus* sp. 1 and *I.* cf. *I.* sp. 3.

Figure 10. Lithology and conodont distribution at Turkey Mountain (TkyMt). See Appendix A for exact location. See Figure 5 for explanation of symbols.

Turkey Mountain (TkyMt)



Between the lower and upper Tacket Shales is a "marl zone", which is a 0.4-foot tan, skeletal calcarenite, composed mainly of echinoderm fragments, with phosphate nodules in the base. Petrographically it is very similar to the "marl zone" at Hickory Creek, in that it shows overpacking and corroded grain margins. This sample (12) has an extrapolated conodont abundance of over 7000 elements/kilogram. It is dominated by Idiognathodus sp. 1 and I. cf. I. sp. 3., which make up over 90% of the fauna. Also present in order of decreasing abundance are: Idioprioniodus, Adetognathus, Gondolella, and Ellisonia.

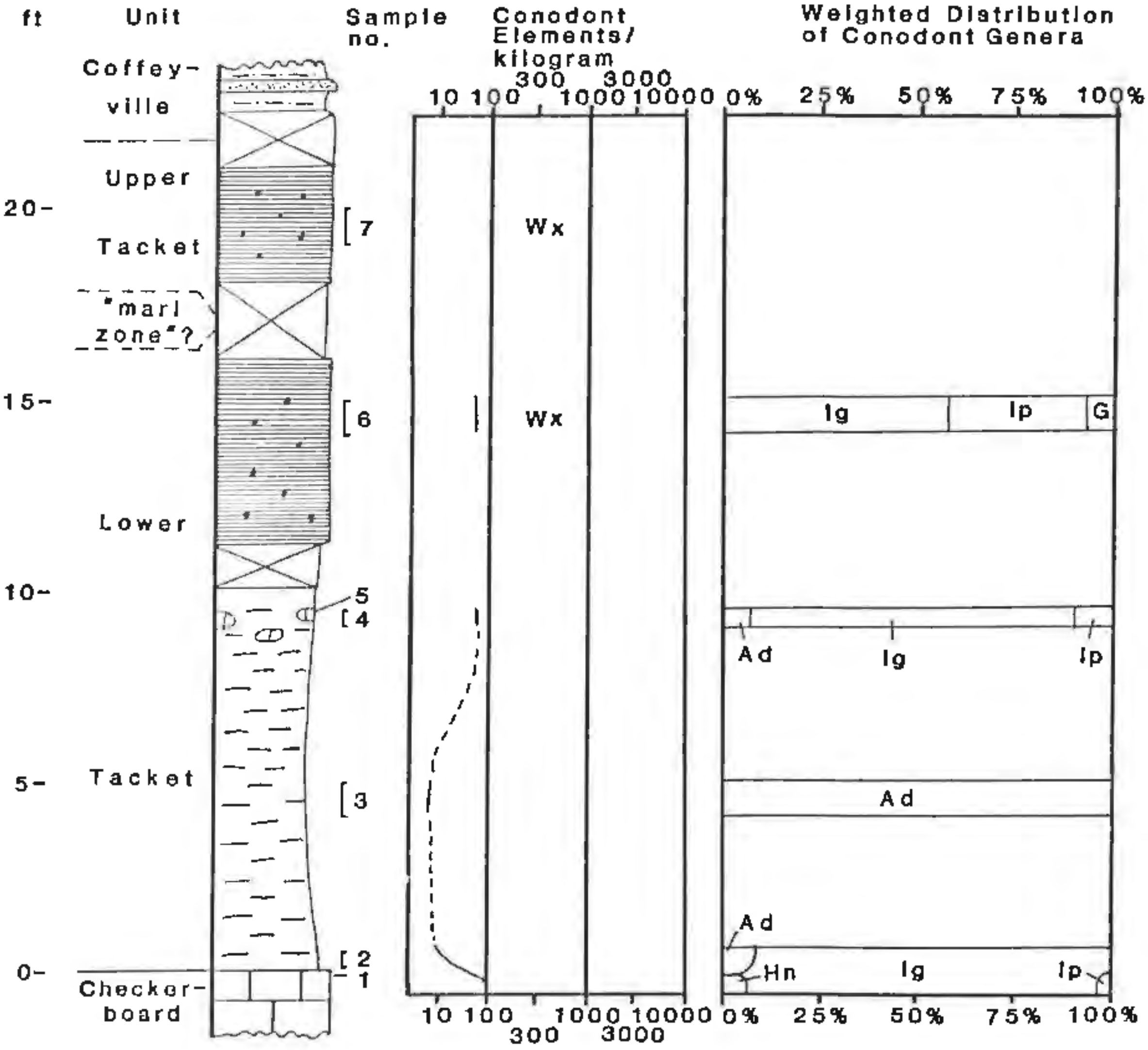
All of the upper Tacket Shale exposed here is a 1.3-foot, gray-black shale grading into 4+ feet of black fissile, phosphatic shale. These shales also are severely weathered. The only conodonts recovered were a few Idiognathodus oppletus and I. cf. I. sp. 3 Pa elements.

U.S. 75-71 St. Exit

This section is similar to Turkey Mountain with respect to lithology and conodont faunas (Figure 11). Sample 1 was taken from the top of the 1.5 feet exposed of Checkerboard Limestone, a thick-bedded, gray, skeletal calcilutite. Conodont abundance is about 90 elements/kilogram. The fauna is dominated by Idiognathodus sp. 1, with rare Hindeodus and Idioprioniodus elements.

Figure 11. Lithology and conodont distribution at U.S. 75-71 St. Exit. See Appendix A for exact location. See Figure 5 for explanation of symbols.

U.S. 75 - 71 St. Exit



Above this limestone is 16+ feet of lower Tacket Shale. The lower 10.0 feet is a medium gray, sparsely fossiliferous shale, which contains gastropods, small brachiopods, echinoderms and juvenile ammonoids. Near the top of this gray shale, there is a zone of 0.5-foot diameter, gray silty, calcilutite nodules. Above this there is a 1.5-foot covered interval, with 5.0 feet of black fissile, phosphatic shale above that.

In the gray shale, conodont abundance increases upward from about 10 elements/kilogram, in the base and center, to about 80 elements/kilogram just below the covered interval. Sample 5 from one of the nodules was barren. _Adetognathus_ is present throughout and was the only genus present in sample 3 in the middle of the gray shale. _Idiognathodus_ sp. 1 is present in sample 2 and dominant in sample 4. _Idioprioniodus_ also occurs in sample 4 (see Table 3 for exact distribution of conodont elements). Only one sample (6) was taken in the black fissile, phosphatic shale. The conodonts showed signs of weathering, and the abundance was extrapolated to only 81 elements/kilogram. Present were _Idiognathodus_ cf. _I._ sp. 3 and _Idioprioniodus_, along with rare _Gondolella_ _bella_ elements.

Between the lower and upper Tacket Shales is a 2.0-foot covered interval. Bennison et al. (1984, p. 45) shows a "marl zone" at this interval, which I did not observe.

Above this covered interval is 3+ feet of upper Tacket black fissile, phosphatic shale. One sample (7) was taken, but it was found to be totally barren, due to weathering.

Above the black shale is another short covered interval, then several feet of interbedded sandstones and sandy shales of the Coffeyville Formation.

Tiger Creek (TgCk)

At this section the sampling interval began 7.0 feet below the black, fissile facies in the lower Tacket Shale (Figure 12). Although the type locality of the Checkerboard Limestone (exposures along Checkerboard Creek in sec. 22, T. 15 N., R. 13 E., Okmulgee County, Oklahoma) is only about 1.5 miles away, the limestone could not be located in Tiger Creek. The lower part of the measured lower Tacket Shale consists of a 5.0-foot medium gray, sparsely fossiliferous shale (samples 1-6). This shale contains a 0.4-foot zone (sample 5) of very fossiliferous shale, containing small, gray calcilutite nodules and echinoderms, brachiopods, gastropods and small solitary rugose corals. This zone is informally called the "lower marl zone". The gray shale grades upward into 2.0 feet of weathered, black, nonfissile shale (samples 7-8), which in turn grades upward into 2.0-feet of black fissile, phosphatic shale (samples 9-10). Above this is 1.0-foot of black, nonfissile shale (sample

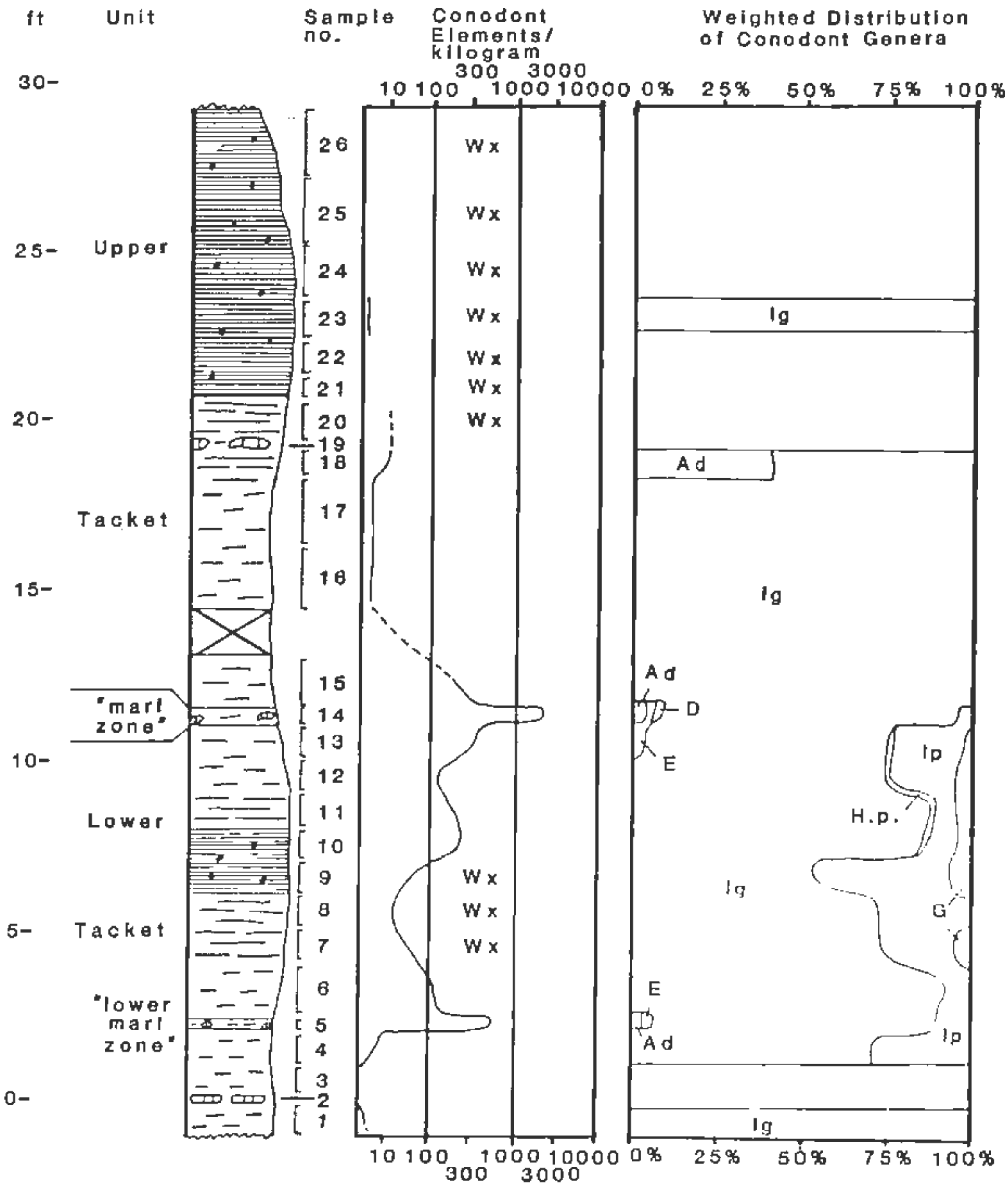
11), which grades upwards into 2.0 feet of medium gray, fossiliferous shale (sample 12-13), containing echinoderms, brachiopods, gastropods and small clams.

The lowest 4 samples of the lower Tacket Shale are basically barren except for a few scattered Idiognathodus Pa elements (see Table 4 for exact distribution of conodont elements). Sample 5 ("lower marl zone") has an extrapolated conodont abundance of about 800 elements/kilogram. Idiognathodus sp. 1 makes up about 90% of the fauna. Also present in decreasing order of abundance is: Idioprioniodus, Adetognathus, and Ellisonia. Above this zone conodont abundance drops, due to weathering, up to the top of the black, fissile shale (sample 10). At the base of the black shale, Ellisonia and Adetognathus are lost, but Gondolella and I. cf. I. sp. 3 appear. Sample 10 shows the highest extrapolated conodont abundance in the black, fissile shale, at about 270 elements/ kilogram. It is dominated by Idiognathodus, and also contains Idioprioniodus, Hindeodella parva and Gondolella bella. Above sample 10, abundance fluctuates somewhat, but the fauna stays basically the same.

Separating the lower and upper Tacket Shale is sample 14, a 0.5-foot medium gray, very fossiliferous shale, refered to in this study as a "marl zone" (see Figure 12). It contains small, gray calcilutite nodules as well as

Figure 12. Lithology and conodont distribution at Tiger Creek (TgCk). See Appendix A for exact location. See Figure 5 for explanation of symbols.

Tiger Creek (TgCk)



abundant echinoderms, brachiopods and molluscs. Its extrapolated conodont abundance is 1810 elements/kilogram. It is dominated by Idiognathodus, both I. sp. 1 and I. cf. I. sp. 3, which make up 75% of the fauna. Also present in decreasing order of abundance are: Idioprioniodus, Ellisonia, Adetognathus and Diplognathodus.

The lower part of the upper Tacket Shale is composed of 7.75 feet of medium gray, fossiliferous shale (samples 15-18), with echinoderms, small brachiopods and clams and ostracodes. This grades upward into 1.3 feet of iron-stained, black, nonfissile shale (sample 20). At the interface between these two shales, there is a zone of 1.0-foot diameter, brown calcilutite septarian nodules (sample 19), which appear brecciated or desiccated internally, with the void space filled by blocky calcite (Figure 13). The black, nonfissile shale grades upward into 8+ feet of black fissile, phosphatic shale (samples 21-26).

Above the "marl zone", conodont abundance in the upper Tacket markedly decreases, and mainly Idiognathodus is present. Sample 18 (just below the brown calcilutite nodules) shows a slight increase in abundance, from 4 to 20 elements/kilogram, but Adetognathus reappears making up just over 35% of the sample. The 8 samples of upper Tacket black, nonfissile and fissile shale just above sample 18 yielded only 1 indeterminate Idiognathodus Pa element. The poor recovery is due to weathering.

Figure 13. Photonegative print of septarian nodule in upper Tacket Shale at Tiger Creek. Void space in sparsely fossiliferous calcilutite is filled with blocky calcite. Bar scale = 5 mm.

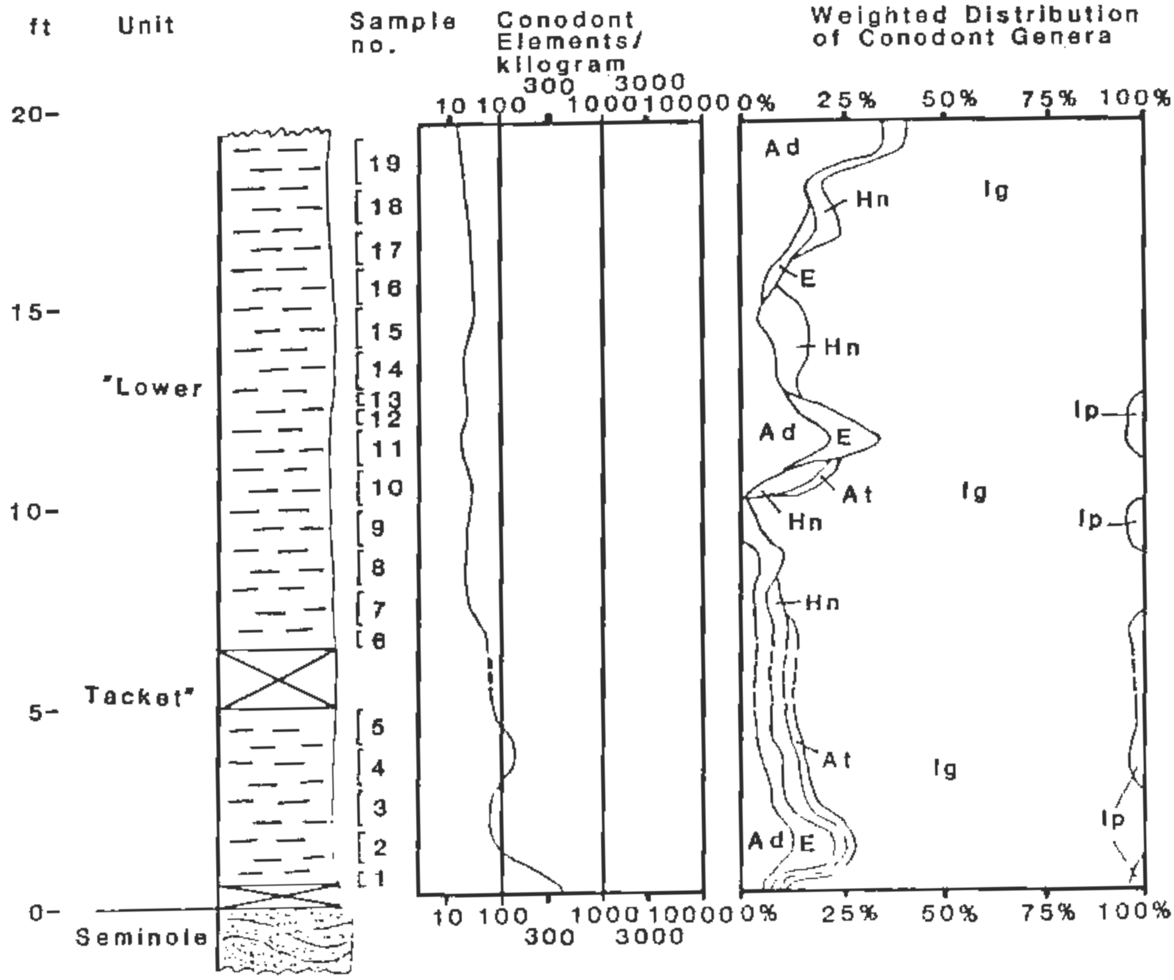
Sasakwa Little River (Ssk LR)

At Sasakwa the studied interval consists of 18+ feet of medium gray, fossiliferous shale lying above the Seminole Sandstone (Figure 14). The fossils include echinoderms, forams, ostracodes, bryozoans and unidentified shell debris. In this study this interval is refered to as "lower Tacket" because it overlies the terrestrial Seminole Formation, which underlies the Checkerboard Limestone elsewhere, and because A. P. Bennison (personal communications, 1984) believes that the upper Tacket becomes separated from the lower Tacket by sandstone south of Tiger Creek.

At the base of the section, conodont abundance is almost 350 elements/kilogram. This value decreases upward, then from sample 7 remains at about 20 to 40 elements/kilogram to the top of the measured sequence. The composition of the conodont fauna is fairly constant throughout the section. It is dominated by medium-sized Idiognathodus sp. 1, but I. cf. I. sp. 3 is not present at this locality. Adetognathus, Ellisonia and Hindeodus are almost continuously present. Aethotaxis and Idioprioniodus are more sporadically present (see Table 5 for exact distribution of conodont elements). This section contains the only occurrence of Hindeodus ellisoni, which Swade (1985) indicated makes its lowest stratigraphic appearence in the Cooper Creek and Exline Limestone in Iowa.

Figure 14. Lithology and conodont distribution at Sasakwa Little River (Ssk LR). See Appendix A for exact location. See Figure 5 for explanation of symbols.

Sasakwa Little River (Ssk LR)



DEPOSITIONAL INTERPRETATION OF LITHOLOGIES

Depositional and diagenetic interpretations can be made for the lithologies of the Tacket Shale by comparing the lithologic and paleontologic data with models put forth by Heckel & Baesemann (1975), Heckel (1977, 1980, 1983) and Swade (1985). All these models are based on eustatic rise and fall of sea level as the basic control (see Figure 1). These models differ greatly from the algal flotant model of Merrill (1975), which has the black, fissile shale as the most nearshore component of a cycle. Because the entire Tacket and immediately adjacent limestones contain no otherwise demonstrably shallow-water facies, the evidence from this study best fits the eustatic cyclothem model in which phosphatic black shales are offshore deposits.

Black, Fissile and Nonfissile Shales

In this study, both varieties of black shale dominate the other lithologies at most localities, where they are found together grading into one another (e.g., Hickory Creek samples 7-10 and Tiger Creek samples 20-26). Other than conodonts, only rare forams were found in the black shale, and ammonoids were found in the black calcilutite nodules within the shale. The combination of black color and lack of benthic fauna strongly suggests that the sea bottom was anoxic at the time of deposition.

In the black shales there are no nonskeletal grains larger than fine silt size; therefore sources of coarse detritus were quite distant during their deposition. Phosphate nodules also are common in the black shale of both the lower and upper Tacket Shale. The deposition of phosphate is most likely in deeper, low-oxygen water (Heckel, 1977; Kidder, 1985). According to this model phosphate is deposited around the time of maximum transgression, when a thermocline developed and quasi-estuarine circulation was allowing dissolved phosphate to concentrate in the bottom water. All this evidence indicates that the black shales of the lower and upper Tacket Shale were deposited around the time of maximum transgression, when the sea bottom waters were cold and anoxic.

The nonfissile shales generally have a lower conodont abundance than the fissile shales. This could be due to an increased sedimentation rate of fine silt and clay, which would dilute the abundance. For these shales the seas probably had not yet reached, or had already passed through, the point of maximum transgression, and therefore the sources of fine detrital influx were a little closer. In all black shale, Idiognathodus dominates the faunas, often accompanied by Idioprioniodus, Gondolella and rarely Diplognathodus. This fauna is characteristic of many other Pennsylvanian Midcontinent "core" shales (Heckel & Baesemann, 1975; Swade, 1985).

Medium to Dark Gray Shales

The greatest differences between the gray and black shales is the presence of benthic fauna and the lower abundance of conodonts in the gray shales. Invertebrates such as brachiopods, echinoderms, bryozoans, gastropods and clams indicate more oxygenated bottom waters. Nevertheless, the fact that these sediments still contain little or no coarser silt, indicates that the gray shales also were deposited offshore below effective wave base, in the "core" shale of the cyclothem model of Heckel (1977).

The conodont fauna also supports this. Although conodont abundance is lower than in the black shale, rarely over 100 elements/kilogram, this decrease may mainly be due to an increase in deposition of fine argillaceous material. The fauna is still dominated by Idiognathodus, and adjacent to the black shale, Idioprioniodus and rare Gondolella can be found (e.g., Tacket Mound samples 18 to 22; Tiger Creek samples 12 & 13). Farther from the black fissile facies, that is, nearer to the transgressive and regressive limestones, Ellisonia, Hindeodus, Aethotaxis and Adetognathus appear in greater numbers.

It appears that the gray shales were deposited offshore, both before and after maximum transgression, when the water was too shallow for a strong thermocline to be established, but still below the zone of abundant algal carbonate mud production.

Skeletal Calcilutites

Bedded gray, skeletal calcilutites have relatively abundant fossils that include brachiopods, gastropods, bryozoans, echinoderms and encrusting forams. The bottom was oxygenated, and water depth was far enough above the base of the photic zone that there was some algal carbonate mud production. The "Checkerboard" at Hickory Creek is slightly silty and is underlain by a sandy shale. This would indicate that it is a transgressive ("middle") limestone. The Sniabar at Tacket Mound is overlain by a thick sandy shale; thus it is a regressive ("upper") limestone. The middle Tacket limestone at Tacket Mound appears to be the maximum regressive (though still offshore) deposit between two zones of maximum transgressive black shale. Low numbers of Idiognathodus, Adetognathus and Hindeodus commonly found in these bedded calcilutites support the somewhat nearer-shore shallower water environment, though still below effective wave base. Gray calcilutite nodules are not nearly as fossiliferous and are found in gray shales. They are argillaceous and contain rare molluscs or fine shell debris. They probably represent carbonate mud production too weak to form a continuous bed.

<u>Nodular Black Calcilutites</u>

Nodular (and bedded), black calcilutites are found in black shales (e.g., Tacket Mound samples 5 & 27). Fossils that are present are pelagic, such as ammonoids and possible radiolarians. All black nodular calcilutites show conodont abundance that is greatly reduced from that of the surrounding shale. This conodont fauna is dominated by <u>Idiognathodus</u>, with a scattering of the other genera found in the surrounding shale, and therefore appears to represent essentially the same environment.

Because the lack of benthic fossils, particularly in nodules where pelagic ammonoids were preserved, indicate an environment too hostile for benthic life, algal production of the carbonate mud is precluded. This leaves the probability of an early diagenetic origin. In all nodules studied, the conodont fauna is similar in composition to the surrounding shale but at much lower abundance. Many nodules also contain uncrushed ammonoids and possible replaced radiolarians. Early diagenetic growth of calcium carbonate in soupy uncompacted mud could have prevented compaction of original material in the nodules, and greatly lowered the abundance of conodonts from that apparent in the surrounding compacted shales. It also would have protected the ammonoids from sea-floor dissolution that apparently often ravaged aragonite organisms in deep water Pennsylvanian "core" shales (Malinky, 1984).

Calcarenites

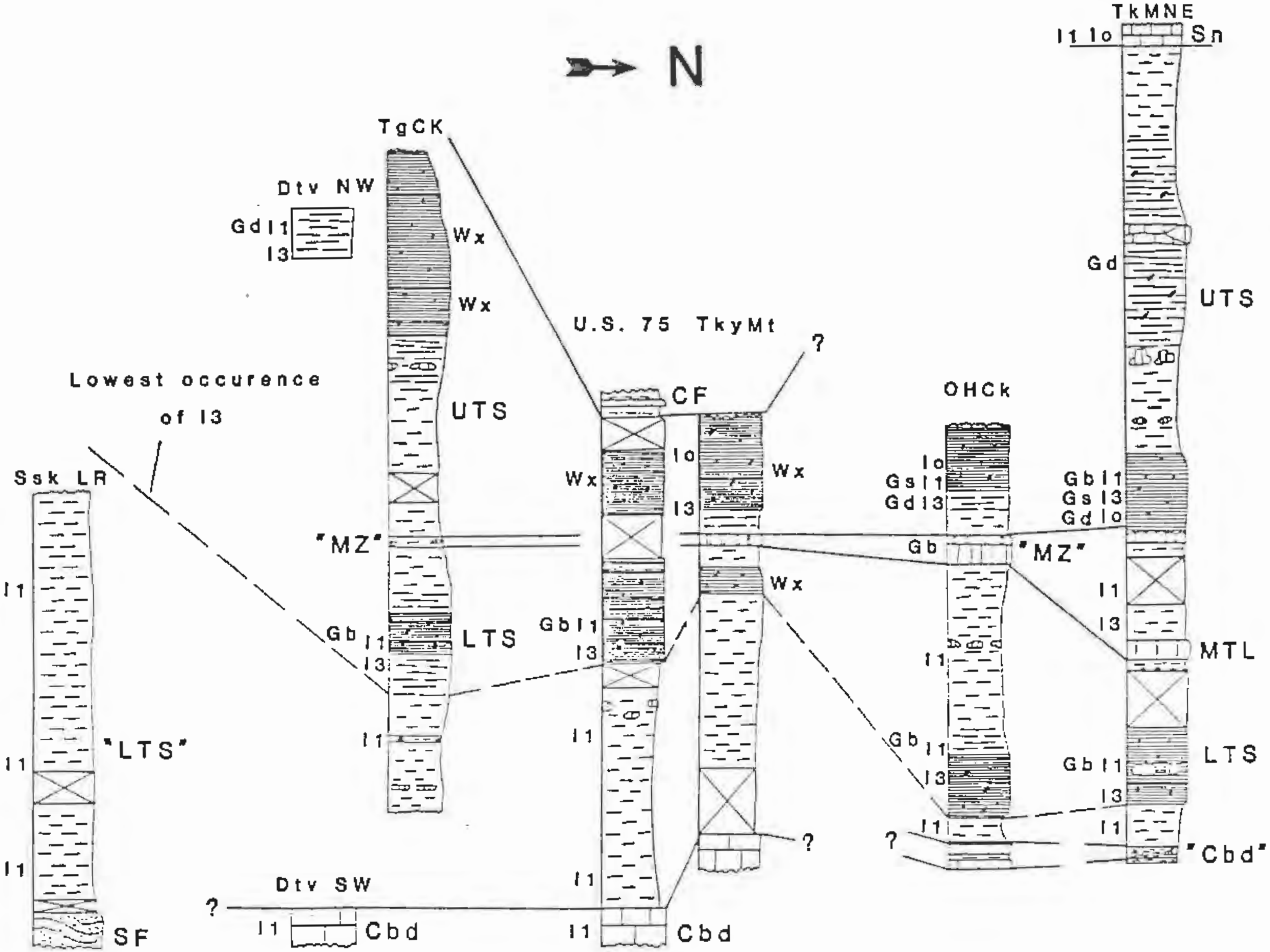
Most calcarenites in this study consist of the "marl zone" developed at two localities, Hickory Creek and Turkey Mountain, which are composed almost entirely of overpacked echinoderm and brachiopod fragments with very little matrix. They probably were deposited in water as deep as that of the adjacent gray shales during times of little or no fine detrital sediment influx, or of gentle winnowing by deep water currents. The grains were not cemented at or following the time of deposition, so as the sediments underwent burial, the grains became overpacked, and many were crushed, as Heckel (1983) described for transgressive and deep-water calcarenites. Many also show corroded margins, which probably reflect the same sea-floor dissolution that removed the aragonite shells in thin core shales studied by Malinky (1984).

BIOSTRATIGRAPHIC ASPECTS OF THE CONODONT FAUNA

Since this formation has undergone attempted correlations based on lithology (e.g., Jewett et al., 1965; Singler, 1965), which have lead to miscorrelations (Figure 2), it would be useful to develop a biostratigraphic approach. Of the 8 genera and 1 form genus described in this study, 2 appear to be of biostratigraphic value in the Tacket. *Idiognathodus* occurs throughout the Tacket, and *Gondolella* appears in and around the black shale facies.

For purposes of discussing biostratigraphy, the exposures of Tacket Shale in this study are subdivided into the following general units (Figure 15) in ascending order: 1) a basal transgressive skeletal calcilutite (Checkerboard Limestone), 2) lower Tacket: a) gray shale, overlain by b) black fissile and nonfissile, phosphatic shale, overlain by c) gray shale, 3) skeletal calcilutite, calcarenite, or very fossiliferous shale (middle Tacket limestone/"marl zone"), 4) upper Tacket: a) gray shale, overlain by b) black fissile and nonfissile, phosphatic shale, overlain by c) gray shale, and 5) capping Sniabar Limestone (to north) or sandy Coffeyville Formation (to south).

Figure 15. Occurrence of biostratigraphically useful conodont species in Tacket sequence of study area. See Figure 5 for lithologic symbols. Abbreviations for lithologic units are as follows:
Sn = Sniabar Limestone
CF = Coffeyville Formation
UTS = Upper Tacket Shale
MTL = Middle Tacket Limestone
"MZ" = Marl Zone
LTS = Lower Tacket Shale
"LTS" = supposed Lower Tacket Shale
Cbd = type Checkerboard Limestone
"Cbd" = supposed Checkerboard Limestone
SF = Seminole Formation
Abbreviations for conodont species are as follows:
I1 = *Idiognathodus* sp. 1
I3 = *I.* cf. *I.* sp. 3
Io = *I. oppletus*
Gb = *Gondolella bella*
Gs = *G. sublanceolata*
Gd = *G. denuda*
Horizontal scale is relative, vertical scale is 1.3 inches = 10 feet.


N
TgCK
Dtv NW
Gd l1
l3
Wx
Wx
UTS
U.S. 75 TkyMt
?
Lowest occurence
of l3
CF
Ssk LR
lo
Wx
Wx
l3
"MZ"
Wx
Gb l1
l3
LTS
Gb l1
l3
l1
l1
"LTS"
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Dtv SW
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l1
Cbd
l1
Cbd
SF
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OHCk
lo
Gs l1
Gd l3
Gb
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Gb l1
l3
l1
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TkMNE
l1 lo
Sn
Gd
UTS
Gb l1
Gs l3
Gd lo
l1
l3
MTL
LTS
Gb l1
l3
l1
"Cbd"

The Checkerboard Limestone around Tulsa (Turkey Mountain, U.S. 75) is dominated by Idiognathodus sp. 1, with lesser amounts of Hindeodus, Adetognathus and rare Idioprioniodus. About 25 miles south of Tulsa at a locality (Dentonville SW) about 3 miles from the type Checkerboard, the fauna in the limestone similarly is dominated by Idiognathodus sp. 1, with Hindeodus. This fauna is quite different from that in the basal limestone ("Checkerboard") at Hickory Creek about 60 miles north of Tulsa, which is dominated by Adetognathus. Above the Checkerboard in the Tulsa area is a horizon dominated by Adetognathus (Turkey Mountain, sample 3; U.S. 75, sample 3), which is not found above the basal horizon ("Checkerboard") to the north. Because the "Checkerboard" at OHCK is dominated by Adetognathus, it might either be equivalent to this post-type-Checkerboard horizon to the south, or represent a nearer-shore biofacies of the type Checkerboard.

The lower gray shale of the lower Tacket at localities Tacket Mound, Hickory Creek and Tiger Creek is dominated by Idiognathodus sp. 1, with lesser numbers of Adetognathus, Ellisonia, Idioprioniodus and rare Gondolella bella. Hickory Creek sample 5 and Tiger Creek sample 5 have extraordinarily high conodont abundances, which may reflect deposition at a time of reduced sedimentation rates during a transgressive pulse. The black shale facies of the lower

Tacket at Tacket Mound, Hickory Creek and Tiger Creek is dominated by Idiognathodus (both I. sp. 1 and I. cf. I. sp. 3), with Idioprioniodus and Gondolella bella. The lower black shales sampled in the Tulsa area were too weathered to produce enough conodonts to be utilized. The upper gray shale of the lower Tacket is dominated by Idiognathodus sp. 1, with increasing amounts of Adetognathus, Ellisonia and Diplognathodus. G. bella and Idioprioniodus are present in decreasing numbers.

The middle Tacket limestone of Tacket Mound is dominated by Idiognathodus sp. 1, but with some I. cf. I. sp. 3, Adetognathus lautus, Hindeodus, Ellisonia and Diplognathodus. The three samples of "marl zones" in the middle part of the Tacket to the south are dominated by Idiognathodus sp. 1, and contain I. cf. I. sp. 3, Adetognathus lautus, Hindeodus, Ellisonia and Diplognathodus. They also include Idioprioniodus and G. bella. The middle Tacket limestone and the lowest part of the upper Tacket Shale at Tacket Mound are probably equivalent to the "marl zones" to the south, because the former two together possess both a shallow and deep water conodont fauna as do the "marl zones" by themselves.

The lower gray shales of the upper Tacket Shale are dominated by Idiognathodus (I. sp. 1 and I. cf. I. sp. 3), with Adetognathus, Ellisonia and Idioprioniodus. The black shale of the upper Tacket Shale is dominated by

Idiognathodus (*I.* sp. 1, *I.* cf. *I.* sp. 3), and contains the first occurrences in the sequnce of *I. oppletus*, with *Idioprioniodus*, *Gondlella bella*, and the only occurrence in the sequence of *Gondolella sublanceolata* and *Gondolella denuda*, in the northern localities at Tacket Mound and Hickory Creek. At Dentonville NW, about 2 miles from Tiger Creek, *G. denuda* was found in a dark shale that appears to be in the same stratigraphic position as the upper Tacket at Tiger Creek, which was too weathered to yield conodonts. The fauna of the upper gray shale in the upper Tacket is characterized by *Idiognathodus* sp. 1, with rare *Adetognathus*, *Diplognathodus*, *Ellisonia* and *Hindeodus*.

The conodont fauna of the Sniabar Limestone at Tacket Mound includes *Idiognathodus oppletus* and *Hindeodus*. Conodonts were not recovered from the Coffeyville sandy shales.

The conodont faunas in the Tacket show good lateral continuity in the sections sampled, where conodonts were recovered. This makes it possible to compare these faunas with possible equivalents to the north.

Heckel (1984) indicated that the Exline Limestone within the thick Pleasanton Group in north-central Missouri (Figure 2) contains a shaly crinoidal facies with abundant conodonts. The Exline near Chillicothe, Missouri (Midland Brick and Tile pit), is dominated by *Idiognathodus* sp. 1, with *Hindeodus*, *Idioprioniodus* and *Aethotaxis*. This limestone shales out in western Missouri and its horizon is difficult to find in the thick Pleasanton Shale. In Linn County, Kansas (locality U.S. 69 northwest of Prescott), a probable Exline-equivalent crionoid-rich shale contains abundant conodonts, dominated by Idiognathodus sp. 1, with Idioprioniodus and Adetognathus. As the Pleasanton thins to the south, the Exline horizon may be represented by the whole lower Tacket (see below) or just the lower part, in which Idiognathodus sp. 1 occurs without I. cf. I. sp. 3. The entire Tacket section measured in east-central Oklahoma (Sasakwa Little River) also may constitute a thickened Exline equivalent, because it too contains Idiognathodus sp. 1, but not I. cf. I. sp. 3.

The Mound City Shale within the overlying Hertha Formation (Figure 2) contains a thin black shale in the Kansas City area (locality U.S. 71) and also in Bourbon County, Kansas (localities LORB & BLO), where the entire Mound City thickens substantially to the southeast and joins the top of the Pleasanton (Underwood, 1984). The faunas from these black shales look very similar to the faunas in both of the Tacket black shales to the south at Tacket Mound. They are dominated by Idiognathodus sp. 1, and contain I. cf. I. sp. 3, Idioprioniodus and Gondolella bella. However, Gondolella sublanceolata and Gondolella denuda have not been found in the Mound City Shale to the north. Their stratigraphically next closest reported occurrence is in the Hushpuckney Shale of the overlying Swope Formation (Ellison, 1941) of the Kansas City area.

In terms of transgressive-regressive sequences, the Exline should be equivalent to the lower Tacket and the Mound City to the upper Tacket. Three conodonts that seem stratigraphically useful in the Tacket, I. oppletus, G. sublanceolata and G. denuda, have not been found in supposed equivalents to the north. So any biostratigraphic correlations at this point must be based on Idiognathodus sp. 1 in the lowest portion of the lower Tacket and I. cf. I. sp. 3 in the overlying strata. Both occur together in the Mound City, but only I. sp. 1 occurs in the Exline. If the Exline is equivalent to the entire lower Tacket, then during that time, I. cf. I. sp. 3 was present only over the deeper stable water of the thermocline responsible for the black facies, which is absent in the Exline and its equivalent gray shale horizon in eastern Kansas. An alternative is that the Mound City is equivalent to both the lower and upper Tacket black shales, and the Exline is equivalent to only the thin gray shale below the lower Tacket black shale facies.

SYSTEMATIC PALEONTOLOGY

The locational notation system used in this study was proposed by Sweet *in* Clark et al. (1981, p. W18).

Phylum CONODONTA Eichenberg, 1930

Order CONODONTOPHORIDA Eichenberg, 1930

Genus ADETOGNATHUS Lane, 1967

Type species.--*Cavusgnathus lautus* GUNNELL, 1933, p. 286, Pl. 31, figs. 67, 68.

Diagnosis.--Apparatus seximembrate: Pa element scaphate, Pb element angulate, M element dolabrate, Sa element alate, Sc_1 and Sc_2 elements bipennate[Austin & Rhodes *in* Clark et al., 1981, p. W158-159].

Remarks.--*Adetognathus* was established by Lane for *Cavusgnathus* spp. in which the free blade is longer than the fixed blade. He considered all Pennsylvanian *Cavusgnathus* spp. to belong to *Adetognathus*.

In this study two species were found. The two species were distinguished by the difference in the dextral Pa element. The ramiforms for these two species are described together after *A. gigantus*.

Range.--Upper Chesterian-Lower Permian

Adetognathus lautus (Gunnell, 1933)

Pa ELEMENT

Pl. 1, figs. 14, 15, 18, 19.

Cavusgnathus lautus GUNNELL, 1933, p. 286, Pl. 31, figs. 67, 68; Pl. 33, fig. 9.

Adetognathus lauta (Gunnell). LANE, 1967, p. 933-934, Pl. 121, figs. 1-5, 7, 10, 11, 15, 17, 18.

Adetognathus lautus (Gunnell). P element. BAESEMANN, 1973, p. 697, Pl. 2, figs. 29-31, 34.

Description.--See Lane (1967, p. 933-934).

Remarks.-- There are both dextral and sinistral Pa elements in the A. lautus apparatus. The dextral Pa element of A. lautus can be distinguished from that of A. gigantus by the lack of a large denticle at the posterior end of the blade. The sinistral elements of both species are of similar morphology.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone", upper Tacket Shale and Sniabar Limestone.

Material.--120 dextral specimens, 93 sinistral specimens. Figured specimens SUI 52226, 52227.

Adetognathus gigantus (Gunnell, 1933)

Pa ELEMENT

Pl. 1, figs. 20, 21, 24, 25

Cavusgnathus gigantus GUNNELL, 1933, p. 286, Pl. 33, figs. 7, 8.

Adetognathus giganta (Gunnell). LANE, 1967, p. 931-933, Pl. 120, figs. 16, 18, 19; Pl. 121, figs. 8, 12, 13, 16.

Adetognathus gigantus (Gunnell). P element. BAESEMANN, 1973, p. 696, Pl. 2, figs. 36, 38-41.

Description.--See Lane (1967, 931-933).

Remarks.--A. gigantus also has both dextral and sinistral Pa elements. As previously indicated the dextral Pa element of A. gigantus possesses a large denticle at the posterior end of the blade.

Occurrence.--Checkerboard Limestone, lower and upper Tacket Shale.

Material.--68 dextral specimens, 79 sinistral specimens. Figured specimens SUI 52230, 52231.

Adetognathus sp.

Pb ELEMENT

Pl. 1, fig. 13

Cavusgnathus lautus Gunnell. Oz element. von BITTER, 1972, p. 64, Pl. 8, figs. 1a-1d.

Ozarkodina sp. A. von BITTER, 1972, p. 74, Pl. 8, fig. 29.

Adetognathus gigantus (Gunnell). O_1 element. BAESEMANN, 1973, p. 696, Pl. 2, figs. 33, 37.

Description.--See Baesemann (1973, p. 696).

Remarks.--This element of Adetognathus has fewer but larger denticles than the corresponding element in the Idiognathodus apparatus (see Pl. 3, figs. 4, 7).

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--43 specimens. Figured specimen SUI 52225.

M ELEMENT

Pl. 1, fig. 12

Cavusgnathus. Ne element. von BITTER, 1972, p. 64, Pl. 9, figs. 5a, 5b.

Adetognathus gigantus (Gunnell). N element. BAESEMANN, 1973, p. 696, Pl. 2, figs. 26, 35.

Description.--See Baesemann (1973, p. 696).

Remarks.--The anterior process is short, adenticulate and outwardly curved. These characteristics distinguish it from the M elements of Idiognathodus and Hindeodus.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--20 specimens. Figured specimen SUI 52224.

Sa ELEMENT

Adetognatus gigantus (Gunnell). A_1 element. BAESEMANN, 1973, p. 696, Pl. 2, figs. 28, 32.

Description.--See Baesemann (1973, p. 696).

Remarks.--The *Adetognathus* Sa element has a posterior process, in contrast to the *Hindeodus* Sa element.

Occurrence.--Checkerboard Limestone.

Material.--2 specimens.

Adetognathus sp. indet.

Pa ELEMENT

Remarks.--These elements represent partial platform fragments and thus are specifically indeterminate.

Material.--60 specimens.

Genus AETHOTAXIS Baesemann, 1973

Type species.--*Aethotaxis advena* BAESEMANN, 1973, p. 697, Pl. 3, figs. 6-21.

Diagnosis.--Apparatus quadrimembrate: Sa element alate, Sb element nearly symetrical, Sc_1 and Sc_2 elements bipennate[Sweet & Clark *in* Clark et al., 1981, p. W167].

Remarks.--Baesemann (1973) found *A. advena* in the Critzer Limestone and the Mound City Shale, and one of his paratypes came from the Sniabar Limestone. Although this indicates that *A. advena* could be present in rocks of this study, I have not identified these specimens to the species level due to their fragmentary nature.

Range.--Upper Pennsylvanian

Aethotaxis sp.

Indet. S ELEMENTS

Remarks--The specimens recovered were too fragmentary to positively differentiate between the four S elements in this apparatus. These fragments can be recognized by the relative thickness of the process. There is also a noticeable color difference between the white matter in the cusp and denticles, and the amber colored process.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone", upper Tacket Shale and Sniabar Limestone.

Material.--25 specimens.

Genus DIPLOGNATHODUS Kozur & Merrill *in* Kozur, 1975

Type species.--*Spathognathodus coloradoensis* MURRAY & CHRONIC, 1965, p. 606, Pl. 72, figs. 11-13.

Diagnosis.--Apparatus seximembrate: Pa element scaphate, Pb element angulate, M element dolabrate, Sa element alate, Sb and Sc element bipennate[Sweet and Clark *in* Clark et al., 1981, p. W167].

Remarks.--One species is recognized in this study. Though an apparatus has been reconstructed for this genus, the only element identified in this study is the Pa element.

Range.--Upper Carboniferous-Upper Permian.

/ *Diplognathodus illinoisensis* Merrill, 1975

Pa ELEMENT

Pl. 3, figs. 1-3

Ozarkodina n. sp. B. P element. BAESEMANN, 1973, p. 707, Pl. 2, fig. 17 (only).

Diplognathodus illinoisensis MERRILL, 1975, p. 50-51, Fig. 1, nos. 38-40; Fig. 2, no. 3.

Description.--See Merrill (1975, p. 50-51).

Remarks.--Pa elements of *D. illinoisensis* have a longer platform length and greater number of discrete denticles than those of *D. iowensis* SWADE (1985). The Pa element of *D. illinoisensis* has a length/height ratio of 2.0 or more, while *D. iowensis* has a ratio of 1.7 or less (Swade, 1985). *D.* sp. 2 of SWADE (1985), has posteriorly fused denticles, which distinguish it from *D. illinoisensis*.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--54 specimens. Figured specimens SUI 52252-52254.

Genus ELLISONIA Müller, 1956

Ellisonia MÜLLER, 1956, p. 822.

Stepanovites KOZUR, 1975, p. 22.

Ellisonia MÜLLER. von BITTER & MERRILL, 1983, p. 17.

Type species.--*Ellisonia triassica* Müller, 1956, p. 822, Pl. 96, figs. 12-14.

Diagnosis.--Apparatus seximembrate: Pa element angulate, Pb element digyrate, M element digyrate, Sa element alate, Sb element digyrate and Sc element bipennate[Sweet *in* Clark et al., 1981, p. W152].

Remarks.--One species, *E. conflexa*, was found in this study. Von Bitter & Merrill (1983) state that this species does not contain a Pa element, and there were no elements resembling a Pa element identified in this study.

E. conflexa is characterized by robust elements, with a large basal cavity, and few denticles with wide spacing. The Pb, M and Sb elements are difficult to confuse with any other Pennsylvanian genus due to their large, flaring basal cavities.

Range.--Lower Pennsylvanian-Upper Triassic.

Ellisonia conflexa (Ellison, 1941)

Pb ELEMENT

Pl. 1, figs. 16, 17

Delotaxis? *conflexa* (Ellison). Oz? element. von BITTER, 1972, p. 73-74, Pl. 14, figs. 4a, 4b.

Ellisonia conflexa (Ellison). Oz element. von BITTER & MERRILL, 1983, p. 19, Pl. 3, figs. 4, 8; Pl. 4, figs. 1, 4, 7, 10, 14, 18; Pl. 5, figs. 12, 20; Pl. 6, figs. 1, 5, 9, 13, 16, 20, 26; Pl. 7, figs. 11, 15, 19, 23, 28, 30, 34.

Description.--See von Bitter & Merrill (1983, p. 19).

Remarks.--The wide, flaring basal cavity and lateral bowing make this element easily distinguishable.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--20 specimens. Figured specimens SUI 52228, 52229.

M ELEMENT

Pl. 1, figs. 22, 23

Delotaxis? *conflexa* (Ellison). Ne? element. von BITTER, 1972, p. 73, Pl. 14, figs. 2a, 2b.

Ellisonia conflexa (Ellison). Ne element. von BITTER & MERRILL, 1983, p. 19, Pl. 3, figs. 12, 16, 21; Pl. 4, fig. 15; Pl. 6, fig. 2; Pl. 7, figs. 7, 20.

Description.--See von Bitter & Merrill (1983, p. 19).

Remarks.--The elliptical basal cavity and large horn like cusp make this element easily recognizable.

Occurrence.--Lower Tacket Shale and "marl zone".

Material.--6 specimens. Figured specimens SUI 52232, 52233.

Sa ELEMENT

Pl. 1, fig. 29

Delotaxis? *conflexa* (Ellison). Tr element. von BITTER, 1972, p. 73, Pl. 16, figs. 1a-1d.

Ellisonia conflexa (Ellison). Tr element. von BITTER & MERRILL, 1983, p. 19, Pl. 3, figs. 3, 7, 15, 19, 23; Pl. 4, figs. 9, 13, 17, 21; Pl. 5, figs. 7, 11; Pl. 6, figs. 12, 22, 29; Pl. 7, figs. 2, 4, 6, 10, 14, 18, 27, 33, 36.

Description.--See von Bitter & Merrill (1983, p. 19).

Remarks.--The robust nature of the element, wide spacing of the denticles and the wide aboral groove beneath all three processes distinguish this element from the Sa element of *Idioprioniodus*.

Occurrence.--Lower Tacket Shale, middle Tacket limestone and "marl zone".

Material.--8 specimens. Figured specimen SUI 52237.

Sb ELEMENT

Pl. 1, fig. 28

Prioniodus? *conflexus* ELLISON, 1941, p. 114, Pl. 20, fig. 25.

Delotaxis? *conflexa* (Ellison). Pl? element. von BITTER, 1972, p. 73, Pl. 14, figs. 1a-1c.

Unassigned B_3 element. BAESEMANN, 1973, p. 708, Pl. 1, fig. 4.

Ellisonia conflexa (Ellison). Pl element. von BITTER & MERRILL, 1983, p. 19, Pl. 3, figs. 1, 5, 9, 13, 17, 20; Pl. 4, figs. 2, 5, 11, 19; Pl. 5, figs. 1, 4, 5, 8, 9, 13, 14, 16, 17, 21; Pl. 6, figs. 3, 6, 7, 10, 14, 17, 24, 25, 27.

Description.--See von Bitter & Merrill (1983, p. 19).

Remarks.--This element has a large, triangular-shaped basal cavity and large recurved cusp, which make it easily recognizable.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--13 specimens. Figured specimen SUI 52236.

Sc ELEMENT

Pl. 1, figs. 26, 27

Delotaxis? *conflexa* (Ellison). Hi element. von BITTER, 1972, p. 73, Pl. 12, figs. 1a-1c.

Unassigned B_1 element. BAESEMANN, 1973, p. 708, Pl. 1, fig. 1.

Ellisonia conflexa (Ellison). Hi element. von BITTER & MERRILL, 1983, p. 19, Pl. 3, figs. 2, 6, 10, 11, 14, 18, 22; Pl. 4, figs. 3, 6, 8, 12, 16, 20; Pl. 5, figs. 2, 3, 6, 10, 15, 18, 19; Pl. 6, figs. 4, 8, 11, 15, 18, 21, 28.

Description.--See von Bitter & Merrill (1983, p. 19).

Remarks.--This element differs from the Sc element of *Idioprioniodus* by being more massive and having a wider aboral groove and more widely spaced denticles.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone and "marl zone".

Material.--55 specimens. Figured specimens SUI 52234, 52235.

Genus GONDOLELLA Stauffer & Plummer, 1932

Type species.--*Gondolella elegantula* STAUFFER & PLUMMER, 1932, p. 41-42, Pl. 3, figs. 5, 8, 9.

Diagonsis.--Apparatus septimembrate: Pa element segminate or segminiplanate, Pb element angulate, M element dolabrate, Sa element alate, Sb element digyrate, Sc and Sd elements bipennate[modified from von Bitter, 1976, p. 5].

Remarks.--In this study, three species of *Gondolella* were recognized by their Pa element. There are two platformed species, *G. bella* and *G. sublanceolata*, and one nonplatformed species, *G. denuda*.

Two slightly different Pb elements were found in this study. One possibly belongs with the platformed species, the other with *G. denuda*. The remaining ramiforms could not be distinguished among the three species.

Range.--Middle Pennsylvanian-Lower Permian

Gondolella bella Stauffer & Plummer, 1932

Pa ELEMENT

Pl. 4, figs. 9-11

<u>Gondolella</u> <u>bella</u> STAUFFER & PLUMMER, 1932, p. 42, Pl. 3, figs. 3, 4; CLARK & MOSHER, 1966, p. 383-384, Pl. 45, figs. 1-9; Pl. 46, figs. 3-6.

<u>Gondolella</u> sp. 2. SWADE, 1985, p. 63-64, fig. 18, nos. 35, 36.

<u>Description</u>.--Clark & Mosher (1966, p. 383-384).

<u>Remarks</u>.--<u>G</u>. <u>bella</u> can be distinguished from <u>G</u>. <u>sublanceolata</u> by the presence of only a short free blade in the Pa element, if one is present at all.

<u>Occurrence</u>.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

<u>Material</u>.--155 specimens. Figured specimens SUI 52280-52282.

<u>Gondolella</u> <u>denuda</u> Ellison, 1941

Pa ELEMENT

Pl. 4, figs. 14, 15

<u>Gondolella</u> <u>denuda</u> ELLISON, 1941, p. 212, Pl. 20, fig. 54; Pl. 21, figs. 1, 2, 36; CLARK & MOSHER, 1966, p. 385, Pl. 46, figs. 15-19; von BITTER & MERRILL, 1980, p. 29-33, figs. 9A-9J.

<u>Description</u>.--See Clark & Mosher (1966, p. 385).

<u>Remarks</u>.--<u>G</u>. <u>denuda</u> is distinguished from the other species of <u>Gondolella</u> in this study by not having a platform.

<u>Occurrence</u>.--Upper Tacket Shale.

Material.--108 specimens. Figured specimens SUI 52284-52285.

Gondolella sublanceolata Gunnell, 1933

Pa Element

Pl. 4, figs. 12, 13

Gondolella sublanceolata GUNNELL, 1933, p. 278, Pl. 32, figs. 53-55; CLARK & MOSHER, 1966, p. 387-388, Pl. 45, figs. 20-30; P element. BAESEMANN, 1973, p. 708, Pl. 1, figs. 5, 9.

Description.--See Clark & Mosher (1966, p. 387-388).

Remarks.--G. sublanceolata has a long free blade with the anteriormost denticles mostly higher than the posterior denticles.

Occurrence.--Upper Tacket Shale.

Material.--55 specimens. Figured specimen SUI 52283.

Gondolella sp.

Pb ELEMENT

Pl. 4, figs. 1, 8

Bryantodus cameratus GUNNELL, 1933, p. 268, Pl. 32, fig. 47.

Prioniodina? camerata (Gunnell). ELLISON, 1941, p. 118, Pl. 20, figs. 48, 49, 53.

Gondolella sublanceolata Gunnell. Oz element. von BITTER, 1976, p. 12, figs. 2C, 2D, 6A-6F.

Gondolella denuda Ellison. Oz element. von BITTER & MERRILL, 1980, p. 33, figs. 9K, 9L.

Description.--See von Bitter (1976, p. 12).

Remarks.--This Pb element can easily be distinguished from the Pb element of _Idiognathodus_ by its short posterior process.

In this study two types of gondolellid Pb elements were recognized. The specimen in Pl. 4, fig. 1 represents the type of Pb element found with _G. denuda_ in the upper Tacket Shale. Except for the posterior process, this Pb element with its nearly erect cusp and denticles, resembles the Pa element of _G. denuda_.

The specimen in Pl. 4, fig. 8 represents the type of Pb element found with the platformed species, _G. bella_ and _G. sublanceolata_, in the lower and upper Tacket Shale. The denticles and cusp are more reclined and the posterior process bends downward at a steeper angle.

Occurrence .--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--32 specimens. Figured specimens SUI 52272, 52273.

M ELEMENT

Pl. 4, fig. 3

Gondolella sublanceolata Gunnell. Ne element. von BITTER, 1976, p. 18, figs. 9A-9H.

Gondolella denuda Ellison. Ne element. von BITTER & MERRILL, 1980, p. 29-33, figs. 9O, 9P.

Description.--See von Bitter (1976, p. 18).

Remarks.--This element can be distinguished from the Sb element of *Gondolella* by its lack of a prominent apron (von Bitter, 1976, p. 20). Also the denticles on the anterior process of the M element are smaller than those on the posterior process.

Occurrence.--Lower and upper Tacket Shale.

Material.--15 specimens. Figured specimen SUI 52275.

Sa ELEMENT

Pl. 4, fig. 2

Gondolella sublanceolata Gunnell. Tr element. von BITTER, 1976, p. 22, figs. 2M, 11A-11E.

Gondolella denuda Ellison. Tr element. von BITTER & MERRILL, 1980, p. 29-33, fig. 8N.

Description.--See von Bitter (1976, p. 22).

Remarks.--This Sa element is easily distinguished from other Sa elements in this study. Its processes are usually broken close to the cusp. The tips of the cusp and denticles are white in color, while the lower parts of the element are amber.

Occurrence.--Lower and upper Tacket Shale.

Material.--7 specimens. Figured specimen SUI 52274.

Sb ELEMENT

Pl. 4, fig. 4

Synprioniodina microdenta ELLISON, 1941, p. 199, Pl. 20, figs. 43-46.

Gondolella sublanceolata Gunnell. Syn element. von BITTER, 1976, p. 20-22, figs. 2K, 2L, 10A-10F.

Gondolella denuda Ellison. Syn element. von BITTER & MERRILL, 1980, p. 29-33, figs. 9S, 9T.

Description.--See von Bitter (1976, p. 20-22).

Remarks.--Von Bitter (1972, p. 60; 1976, p. 20, 22) noted that the types of *Synprioniodina microdenta* are elements of *Gondolella*, but that later authors have used the name for the M element of *Idiognathodus*. Von Bitter (1972, p. 60; 1976, p. 22) indicated that the specimens Ellison described have more robust processes, are more nearly symmetrical and have a more prominent inner apron than the M element of *Idiognathodus*.

Occurrence.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--40 specimens. Figured specimen SUI 52276.

Sc ELEMENT

Pl. 4, fig. 5

O_1 element. (*Prioniodus? obtusa*) Ellison. BAESEMANN, 1973, p. 708, Pl. 1, figs. 3, 7.

Gondolella sublanceolata Gunnell. Hi element. von BITTER, 1976, p. 16, figs. 2G, 2Q, 8A-8E.

Gondolella denuda Ellison. Hi element. von BITTER & MERRILL, 1980, p. 29-33, figs. 9M, 9N.

Description.--See von Bitter (1976, p. 16).

Remarks.--This element is easily recognized by its high slender cusp and its strong arch.

Occurrence.--Lower and upper Tacket Shale.

Material.--33 specimens. Figured specimen SUI 52277.

Sd ELEMENT

Pl. 4, figs. 6, 7

Gondolella sublanceolata Gunnell. Lo element. von BITTER, 1976, p. 14, figs. 2E, 2F, 7A-7H.

Gondolella denuda Ellison. Lo element. von BITTER & MERRILL, 1980, p. 29-33, figs. 9Q, 9R.

Description.--See von Bitter (1976, p. 14).

Remarks.--Although it also has a high cusp, this element differs from the Sc element. The processes of the Sd element are set approximately at a 90-degree angle, whereas in the Sc element, the processes are nearly straight.

Occurrence.--Lower and upper Tacket Shale.

Material.--15 Specimens. Figured specimens SUI 52278, 52279.

Genus HINDEODUS Rexroad & Furnish, 1964

Hindeodus REXROAD & FURNISH, 1964, p. 671.

Anchignathodus SWEET, 1970, p. 7.

Spathognathodus BRANSON & MEHL. MERRILL, 1973, p. 303.

Ozarkodina BRANSON & MEHL. BAESEMANN, 1973, p. 704.

Hindeodus REXROAD & FURNISH. SWEET, 1977, p. 203-205.

Type species.--*Trichonodella imperfecta* REXROAD, 1957, p. 41, Pl. 4, figs. 4, 5 = *Spathognathodus cristulus* YOUNGQUIST & MILLER, 1949, p. 621, Pl. 101, figs. 1-3.

Diagnosis.--Apparatus seximembrate: Pa element scaphate, Pb element angulate, M element dolabrate or digyrate, Sa element alate, Sb element digyrate and Sc element bipennate[Sweet & Clark *in* Clark et al., 1981, p. W167].

Remarks.--In this study, two species were recognized by their Pa elements, *H. minutus* and *H. ellisoni*. The remaining elements of the two species are described together because of their great similarity.

Range.--Lower Mississippian-Lower Triassic.

Hindeodus ellisoni (Merrill, 1973)

Pa ELEMENT

Pl. 1, fig. 1

Spathognathodus ellisoni MERRILL, 1973, p. 305, Pl. 1, figs. 16-27; Pl. 2, figs. 29-37.

Ozarkodina n. sp. A. P element. BAESEMANN, 1973, p. 706-707, Pl. 2, figs. 18, 21, 22.

Description.--See Merrill (1973, p. 305).

Remarks.--The Pa element of *H. ellisoni* can be distinguished from *H. minutus* by its lack of a large cusp, more numerous denticles and less arching.

Occurrence.--Lower Tacket.

Material.--18 specimens. Figured specimen SUI 52213.

Hindeodus minutus (Ellison, 1941)

Pa ELEMENT

Pl. 1, figs. 5, 10

Spathodus minutus ELLISON, 1941, p. 120, Pl. 20, figs. 50-52.

Anchignathodus minutus (Ellison). von BITTER, 1972, p. 65-66, Pl. 6, figs. 2a-2i.

Spathognathodus minutus (Ellison). MERRILL, 1973, p. 305-308, Pl. 1, figs. 1-14; Pl. 2, figs. 1-28.

Ozarkodina minuta (Ellison). P element. BAESEMANN, 1973, p. 704-705, Pl. 2, figs. 14, 15, 19, 20.

Description.--See Merrill (1973, p. 305-308).

Remarks.--The denticles of *H. minuta* become more reclined toward the posterior end of the platform. Also see under the *Remarks* for *H. ellisoni*.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone" and Sniabar Limestone.

Material.--42 specimens. Figured specimens SUI 52219, 52220.

Hindeodus sp.

Pb ELEMENT

Pl. 1, figs. 2, 6

Ozarkodina? *curvata* Rexroad. von BITTER, 1972, p. 74-75, Pl. 8, figs. 5a-5f.

Ozarkodina *minuta* (Ellison). O_1 element. BAESEMANN, 1973, p. 705, Pl. 2, figs. 6, 11-13.

Description.--See Baesemann (1973, p. 705).

Remarks.--The steep downward growth of the anterior process and the great inward curvature of the whole element distinguish it from the other Pb elements of this study.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--24 specimens. Figured specimens SUI 52214, 52215.

M ELEMENT

Pl. 1, figs. 7, 8

<u>Ellisonia</u> <u>teicherti</u> Sweet? Ne element. von BITTER, 1972, p. 70-71, Pl. 10, figs. 1a-1d.

<u>Ozarkodiona</u> <u>minuta</u> (Ellison). N element. BAESEMANN, 1973, p. 705, Pl. 2, figs. 4, 5.

<u>Description</u>.--See Baesemann (1973, p. 705).

<u>Remarks</u>.--This M element is distinguished by the inward bending of the posterior process and the postion of the anterior process.

<u>Occurrence</u>.--Middle Tacket limestone and "marl zone".

<u>Material</u>.--6 specimens. Figured specimens SUI 52221, 52222.

Sa ELEMENT

Pl. 1, fig. 3

<u>Ellisonia</u> <u>teicherti</u> Sweet? Tr element. von BITTER, 1972, p. 72, Pl. 15, fig. 5.

<u>Ozarkodina</u> <u>minuta</u> (Ellison). A_3 element. BAESEMANN, 1973, p. 706, Pl. 2, fig. 7.

<u>Description</u>.--See Baesemann (1973, p. 706).

<u>Remarks</u>.--The <u>Hindeodus</u> Sa element differs from the other Sa elements of this study in that it lacks a posterior process.

<u>Occurrence</u>.--Checkerboard Limestone and middle Tacket limestone.

<u>Material</u>.--3 specimens. Figured specimen SUI 52216.

Sb ELEMENT

Pl. 1, figs. 4, 9

Ellisonia teicherti Sweet? Pl element. von BITTER, 1972, p. 71, Pl. 10, figs. 2a-2f.

Ozarkodina minuta (Ellison). A_2 element. BAESEMANN, 1973, p. 706, Pl. 2, figs. 1, 8-10.

Description.--See Baesemann (1973, p. 706).

Remarks.--The strong inward curvature of this element distinguishes it from the other Sb elements in this study.

Occurrence.--Lower Tacket Shale, middle Tacket limestone and upper Tacket Shale.

Material.--6 specimens. Figured specimens SUI 52217, 52218.

Sc ELEMENT

Pl. 1, fig. 11

Ellisonia teicherti Sweet? Hi element. von BITTER, 1972, p. 71-72, Pl. 11, figs. 1a-1c.

Ozarkodina minuta (Ellison). A_{1b} element. BAESEMANN, 1973, p. 706, Pl. 2, fig. 3.

Description.--See Baesemann (1973, p. 706).

Remarks.--This element can be distinguished from the Sc elements of *Idiognathodus* by its denticulation. The Sc element of *Hindeodus* generally has only 2-3 smaller denticles separating the larger ones, whereas in

Idiognathodus there are 4-5 smaller denticles in the same position (Baesemann, 1973, p. 702).

On the end of the anterior process of the *Hindeodus* Sc element there is also an anticusplike projection, which the Sc elements of *Idiognathodus* lack.

Occurrence.--Lower Tacket Shale and middle Tacket limestone.

Material.--16 specimens. Figured specimen SUI 52223.

Genus IDIOGNATHODUS Gunnell, 1931

Idiognathodus GUNNELL, 1931, p. 249.

Streptognathodus STAUFFER & PLUMMER, 1932, p. 47.

Type species.--*Idiognathodus claviformis* GUNNELL, 1931, p. 294-250, Pl. 29, figs. 21, 22.

Diagnosis.--Apparatus is at least seximembrate: Pa element scaphate, Pb element angulate, M element dolabrate, Sa element alate, Sb element bipennate, Sc_1 and Sc_2 elements bipennate[Austin & Rhodes *in* Clark et al., 1981, p. W161].

Remarks.--Baesemann (1973) considered *Idiognathodus* and *Streptognathodus* to be synonyms, and that practice also is followed in this paper.

Three species of *Idiognathodus* were found in this study. The first two I have referred to in open nomenclature, the last to *Idiognathodus oppletus* (Ellison, 1941). The Pb and ramiform elements are described together because of their similarity.

Range.--Lower Pennsylvanian-Lower Permian.

Idiognathodus sp. 1 of Swade, 1985

Pa ELEMENT

Pl. 3, figs. 14-21

Idiognathodus sp. 1. SWADE, 1985, p. 59, Fig. 18, nos. 4, 5, 10, 11, 19, 20, 27, 37, 38, 46.

Description.--See Swade (1985, p. 59).

Remarks.--This species can be distinguished from *I*. cf. *I*. sp. 3 of SWADE (1985) and *I*. *oppletus* by the presence of well developed transverse ridges on the platform surface.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone", upper Tacket Shale and Sniabar Limestone.

Material.--10,167 specimens. Figured specimens SUI 52264-52271.

Idiognathodus cf. *I*. sp. 3 of Swade, 1985

Pa ELEMENT

Pl. 2, figs. 1-3, 6-14

cf. *Idiognathodus* sp. 3. Swade, 1985, p. 60, Fig. 18, nos. 22, 29, 39, 40.

Description.--The upper platform surface consists of diagonal to transverse rows of nodes and some, short transverse ridges. The outer accessory lobe may be as small as 1-2 nodes and is poorly differentiated from the rest of the platform. The inner accessory lobe is easier to discern; in some specimens concentric rows of nodes can be observed, in others the nodes are fused into ridges. The length/width ratio for the average sized specimen is 2.0. In very large, mature specimens, the ratio may reach 1.5.

Remarks.--Rows of nodes on the platform surface distinguish this species from *I.* sp. 1, and presence of accessory lobes further distinguish it from *I. oppletus*.

Although the present species is similar to *I.* sp. 3 of SWADE (1985), there are some differences. The present species generally has a larger length/width ratio, and the accessory lobes are smaller and better differentiated. Only the largest, most mature specimens are difficult to distinguish from *I.* sp. 3 of SWADE (1985).

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--1823 specimens. Figured specimens SUI 52238-52249.

Idiognathodus oppletus (Ellison, 1941)

Pa ELEMENT

Pl. 2, figs. 4, 5

Idiognathodus multinodosus GUNNELL, 1933, p. 279, Pl. 33, fig. 5.

Streptognathodus oppletus ELLISON, 1941, p. 132, Pl. 22, figs. 13, 14, 16; Sp element. von BITTER, 1972, p.54-55, Pl. 2, figs. 5a-5c.

Description.--See Ellison (1941, p. 132).

Remarks.--The Pa element of this species has a carina with shallow troughs on either side extending from the anterior end along most of the platform surface. The carina passes in to a single or double line of nodes posteriorly. These features distinguish the Pa element of *I. oppletus* from those of *I*. sp. 1 and *I*. cf. *I*. sp. 3.

Occurrence.--Upper Tacket Shale and Sniabar Limestone.

Material.--46 specimens. Figured specimens SUI 52250, 52251.

Idiognathodus sp. indet.

Pa ELEMENT

Remarks.--This category includes fragments of platform elements and juvenile specimens. There were 796 indeterminate fragments and 5160 juvenile specimens counted.

Juvenile specimens have a platform length of 0.5 mm or less. Platforms of this small size appear similar and are impossible to identify to the specific level.

Material.--5956 specimens.

Pb ELEMENT

Pl. 3, figs. 4, 7

Bryantodus delicatulus STAUFFER & PLUMMER, 1932, p. 29, Pl. 2, fig. 27.

Ozarkodina delicatula (Stauffer & Plummer). ELLISON, 1941, p. 120, Pl. 20, figs. 40-42, 47.

Streptognathodus and Idiognathodus. Oz element. von BITTER, 1972, p. 60, Pl. 7, figs. 4a-4e.

Idiognathodus delicatus Gunnell. O_1 element. BAESEMANN, 1973, p. 700, Pl. 1, figs. 16, 17.

Description.--See Baesemann (1973, p. 700).

Remarks.--This Pb element can be easily recognized by its regularly spaced, similarly sized denticles, relatively small cusp, and slight arching.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone, "marl zone", upper Tacket Shale and Sniabar Limestone.

Material.--1003 specimens. Figured specimens SUI 52255, 52256.

M ELEMENT

Pl. 3, fig. 6

Streptognathodus and Idiognathodus. Ne element. von BITTER, 1972, p. 60, Pl. 9, figs. 2a, 2b.

Idiognathodus delicatus Gunnell. N element. BAESEMANN, 1973, p. 701, Pl. 1, fig. 14.

Description.--See von Bitter (1972, p. 60).

Remarks.--See Remarks under Gondolella sp. Sb element.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--196 specimens. Figured specimen SUI 52258.

Sa ELEMENT

Pl. 3, fig. 12

Streptognathodus and *Idiognathodus*. Tr elements. von BITTER, p. 61, figs. 4a-4d.

Idiognathodus delicatus Gunnell. A_3 element. BAESEMANN, p. 702-703, Pl. 1, fig. 20.

Description.--See Baesemann (1973, p. 702-701).

Remarks.--The *Idiognathodus* Sa element is more robust than the *Adetognathus* Sa element. It also has the characteristic *Idiognathodus* pattern of denticulation, that is 4-5 small denticles separating the larger denticles.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone and upper Tacket Shale.

Material.--33 specimens. Figured specimen SUI 52263.

Sb ELEMENT

Pl. 3, fig. 5

Idiognathodus delicatus Gunnell. A_2 element. BAESEMANN, 1973, p. 702, Pl. 1, fig. 12.

Description.--See Baesemann (1973, p. 702).

Remarks.--This element can be distinguished from the *Idiognathodus* Sc elements by the slight downward and inward curvature of the anterior process.

Occurrence.--Checkerboard Limestone, lower Tacket Shale, middle Tacket limestone and upper Tacket Shale.

Material.--18 specimens. Figured specimen SUI 52257.

Sc_1 ELEMENT

Pl. 3, fig. 9

Streptognathus and Idiognathodus. Hi element. von BITTER, 1972, p. 60-61, Pl. 11, figs. 3a, 3c (only).

Idiognathodus delicatus Gunnell. A_{1a} element. BAESEMANN, 1973, p. 702, Pl. 1, fig. 13.

Description.--See Baesemann (1973, p. 702).

Remarks.--The anterior process of this element has a greater inward and downward curvature than that of the Sb element, but less than in the Sc_2 element. Also see Remarks under the Hindeodus sp. Sc element.

Occurrence.--Checkerboard Limestone, lower and upper Tacket Shale.

Material.--33 specimens. Figured specimen SUI 52260.

Sc_2 ELEMENT

Pl. 3, fig. 8

Hideodella sp. ELLISON, 1941, p. 118, Pl. 20, fig. 18 (only).

Streptognathodus and Idiognathodus. Hi element. von BITTER, 1972, p. 60-61, Pl. 11, fig. 3b (only).

Idiognathodus delicatus Gunnell. A_{1b} element. BAESEMANN, 1973, p. 702, Pl. 1, fig. 15.

Description.--See Baesemann (1973, p. 702).

Remarks.--This element can be distinguished from the Sc_1 element by the 90-degree inward curvature and strong downward projection of the anterior process. Also see *Remarks* under the *Hindeodus* sp. Sc element.

Occurrence.--Lower Tacket Shale, middle Tacket limestone, "marl zone" and upper Tacket Shale.

Material.--134 specimens. Figured specimen SUI 52259.

Genus IDIOPRIONIODUS Gunnell, 1933

Type species.--*Idioprioniodus typus* GUNNELL, 1933, p. 265, Pl. 31, fig. 47.

Diagnosis.--Apparatus seximembrate: Pb element angulate, M element dolabrate, Sa element alate, Sb_1 and Sb_2 elements digyrate and Sc element bipennate[modified from Klapper & Bergström *in* Clark et al., 1981, p. W149].

Remarks.--*Idioprioniodus typus* is the only species of the genus present. Absence of the form genus, *Metalonchodina bidentata* (Gunnell, 1931), indicates that *Idioprioniodus conjunctus* is not present in the faunas under study.

Idioprioniodus has large denticles and a keel running down the side of each cusp to the processes. In the faunas under study, the processes of the Sb_1, Sb_2 and Sc elements are often broken. Their position of attachment in relationship to the basal cavity must be preserved in order to identify the element (Baesemann, 1973, p. 703).

Range.--Upper Mississippian-Upper Pennsylvanian

Idioprioniodus typus Gunnell, 1933

Pb ELEMENT

Pl. 4, figs. 21, 24, 25

Lonchodina? ponderosa ELLISON, 1941, p. 116, Pl. 20, figs. 37-39; von BITTER, 1972, p. 79, Pl. 12, figs. 5a-5c.

Lonchodina megacuspata MURRAY & CHRONIC, 1965, p. 102-103, Pl. 73, figs. 17, 23.

Idioprioniodus lexingtonensis (Gunnell). B_{3b} element. BAESEMANN, 1973, p. 704, Pl. 3, figs. 4, 5.

Description.--See Ellison (1941, p. 116).

Remarks.--The specimen in Pl. 4, figs. 24, 25 seems to be more completely preserved than most of those previously illustrated. It seems very similar to *Lonchodina megacuspata* MURRAY & CHRONIC (1965). The sinuous configuration of the proesses of the present element, raise some doubt as to its assignment to the Pb position.

Only one well preserved specimen was found (Pl. 4, figs. 24, 25). All other specimens, the processes are broken at or near the cusp (e.g., Pl. 4, fig. 21).

Occrrence.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--254 specimens. Figured specimens SUI 52291, 52292.

M ELEMENT

Pl. 4, figs. 19, 20

Prioniodus conjunctus GUNNELL, 1931, p. 247, Pl. 29, fig. 7; ELLISON, 1941, p. 113-114, Pl. 20, figs. 1-3.

Neoprioniodus conjunctus (Gunnell). Ne element. von BITTER, 1972, p. 69, Pl. 9, figs. 6a, 6b.

Idioprioniodus lexingtonensis (Gunnell). M element. BAESEMANN, 1973, p. 703, Pl. 3, fig. 7.

Description.--See Ellison (1941, p. 113-114).

Occurrence.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--250 specimens. Figured specimens SUI 52289, 52290.

Sa ELEMENT

Pl. 4, fig. 16

Prioniodus subacodus GUNNELL, 1931, p. 246, Pl. 29, fig. 5.

Hibbardella subacoda (Gunnell). ELLISON, 1941, p. 118, Pl. 20, figs. 22, 26.

Neoprioniodus conjunctus (Gunnell). Tr element. von BITTER, 1972, p. 70, Pl. 16, figs. 2a, 2b.

Idioprioniodus lexingtonensis (Gunnell). B_{3a} element.
BAESEMANN, 1973, p. 704, Pl. 3, fig. 9.

Description.--See Ellison (1941, p. 118).

Occurrence.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--185 specimens. Figured specimen SUI 52286.

Sb_1 ELEMENT

Pl. 4, figs. 22, 23

Prioniodus clarki GUNNELL, 1931, p. 247, Pl. 29, fig. 8.

Lonchodina clarki (Gunnell). ELLISON, 1941, p. 116, figs. 21, 27, 30, 31.

Neoprioniodus conjunctus (Gunnell). Pl element. von BITTER, 1972, p. 69-70, Pl. 12, figs. 4a-4c.

Idioprioniodus lexingtonensis (Gunnell). B_{1b} element. BAESEMANN, 1973, p. 704, Pl. 3, fig. 2.

Description.--See Ellison (1941, p. 116).

Remarks.--The Sb_1 element has a lateral process that is attached to the inner side of the basal cavity.

Occurrence.--Lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--303 specimens. Figured specimens SUI 52293, 52294.

Sb_2 ELEMENT

Pl. 4, fig. 17, 18

Prioniodus lexingtonensis GUNNELL, 1931, p. 246, Pl. 29, fig. 4.

Ligonodina lexingtonensis (Gunnell). ELLISON, 1941, p. 115, Pl. 20, figs. 13-15; von BITTER, 1972, p. 76, Pl. 12, figs. 2a, 2b.

Idioprioniodus lexingtonensis (Gunnell). B_2 element. BAESEMANN, 1973, p. 704, Pl. 3, figs. 3, 8.

Description.--See Ellison (1941, p. 115).

Remarks.--In the Sb_2 element the posterior process is attached to the outer side of the basal cavity.

Occurrences.--Checkerboard Limestone, lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--339 specimens. Figured specimens SUI 52287, 52288.

Sc ELEMENT

Pl. 4, fig. 26

Idioprioniodus typus GUNNELL, 1933, p. 265, Pl. 31, fig. 47.

Ligonodina typa (Gunnell). ELLISON, 1941, p. 114-115, Pl. 20, figs. 8-11.

Neoprioniodus conjunctus (Gunnell). Hi element. von BITTER, 1972, p. 69, Pl. 12, fig. 3.

Idioprioniodus lexingtonensis (Gunnell). B_{1a} element. BAESEMANN, 1973, p. 703, Pl. 3, fig. 1.

Description.--See Ellison (1941, p. 114-115).

Occurrence.--Checkerboard Limestone, lower Tacket Shale, "marl zone" and upper Tacket Shale.

Material.--888 Specimens. Figured specimen SUI 52295.

Generically Unassigned Elements

Sd ELEMENT (HINDEODELLA PARVA)

Pl. 3, fig. 10, 11, 13

Hindeodella parva ELLISON, 1941, p. 117-118, Pl. 20, fig. 29; von BITTER, 1972, p. 76-77, Pl. 11, figs. 4a-4c; A_1 element. BAESEMANN, 1973, p. 708, Pl. 1, fig. 8.

Description.--See von Bitter (1972, p. 76-77).

Remarks.--*Hindeodella parva* may represent the Sd position in the apparatus of at least one species of *Idiognathodus* (cf. von Bitter, 1976, p. 33). Complete specimens are rare and preservation of the anterior process is necessary for recognition.

Occurrence.--Lower Tacket Shale, middle Tacket limestone and upper Tacket Shale.

Material.--55 specimens. Figured specimen SUI 52262.

CONCLUSIONS

The Tacket Shale in southeastern Kansas and northeastern Oklahoma is dominated by a thick sequence of gray "core" shale with two black phosphatic horizons, the lower of which was overlooked by Jewett et al. (1965) and Ravn (1981). Both black shales were deposited at maximum transgression in at least two eustatic rises and incomplete falls of sea level. After the first rise, the sea did not regress to a nearshore or non-marine environment in the study area, because the overlying middle Tacket limestone and "marl zones" were deposited offshore, below wave base. Based on a comparison of transgressive-regressive cycles in the Pleasanton-Hertha sequence to the north, the Exline Limestone should be equivalent to at least part of the lower Tacket and the Mound City Shale should be equivalent to the upper Tacket.

The conodont faunas can be used to distinguish the lower from the upper Tacket black shales. The lower Tacket contains *Idiognathodus* sp. 1, *I.* cf. *I.* sp. 3, and *Gondolella bella*, but lacks *Idiognathodus oppletus*, *Gondolella sublanceolata* and *Gondolella denuda*, all of which are present in the upper Tacket. The Mound City contains *I.* sp. 1, *I.* cf. *I.* sp. 3 and *G. bella*, but not the latter three species, which makes its fauna appear more like that of the lower Tacket. The Exline lacks _I_. cf. _I_. sp. 3. Therefore a point that needs further study is the relationship between the Hushpuckney Shale of the stratigraphically higher Swope Formation and the upper Tacket Shale. Both have similar faunas, which include _Idiognathodus oppletus_, _Gondolella sublanceolata_ and _Gondolella denuda_. These species could not be found in the supposed equivalents of the upper Tacket to the north. More study should be given to the lithologic units above the upper Tacket at Tacket Mound and to the north.

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APPENDIX A

COLLECTING LOCALITY REGISTER

COLLECTING LOCALITY REGISTER

Tacket Mound Northeast (TkMNE)--In creek and gullies on northeast side of Tacket Mound, SW 1/4, NE 1/4 and NE 1/4, SW 1/4, sec. 7, T. 32 S., R. 19 E., Parsons West Quadrangle, Labette County, Kansas.

Oklahoma Hickory Creek (OHCk)--In creek bank, NE 1/4, NE 1/4, sec. 24 and S 1/2, SE 1/4, sec. 13, T. 28 N., R. 16 E., Elliot Quadrangle, Nowatta County, Oklahoma.

Turkey Mountain (TkyMt)--On hilltop, SW 1/4, NW 1/4, sec. 36, T. 19 N., R. 12 E., Jenks Quadrangle, Tulsa County, Oklahoma.

U.S. 75-71 St. Exit--Roadcut at southwest corner of intersection, NW 1/4, NW 1/4, sec. 11, T. 18 N., R. 12 E., Sapulpa North Quadrangle, Tulsa County, Oklahoma.

Tiger Creek (TgCk)--In creek bank, NE 1/4, sec. 21 and SE 1/4, sec. 16, T. 15 N., R. 11 E., Kiefer SW Quadrangle, Okmulgee County, Oklahoma.

Sasakwa Little River (Ssk LR)--In gully, SE 1/4, NW 1/4, sec. 25, T. 6 N., R. 7 E., Sasakwa Quadrangle, Seminole County, Oklahoma.

APPENDIX B

TABULATED CONODONT DISTRIBUTIONS

Table 1

Conodont distribution at
Tacket Mound Northeast (TkMNE)

In Tables 1-5 the following letters stand for: Ad. = Adetognathus, E. = Ellisonia, D. = Diplognathodus, Hn. = Hindeodus, At. = Aethotaxis, Hd. = Hindeodella, Ip. = Idioprioniodus and G. = Gondolella.

Refer to Figures 5, 8, 10, 11, 12 and 14 for precise location of sampling interval.

CONODONT DISTRIBUTION TACKET MOUND NORTHEAST (TkMNE)

SAMPLE NUMBER		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
SAMPLE WEIGHT (g)		670	695	825	750	724	435	770	480	400	700	750	950	575	825	606	790	645	519	760	550	820	805	755	694	780	720	805	631	688	675	1000	1000	1040
Ad. lautus	Pa_d				2					3	20	6	13	1																			2	
	Pa_s									2	13	4	7	2																			1	
Ad. gigantus	Pa_d			1																														
	Pa_s			2																														
Ad. sp.	Pb										2	1	3	1																				
	M	1																																
Ad. sp. indet.	Pa	1							1																									
E. conflexa	Pb										2																						1	
	Sa			1							1																							
	Sb										1																						1	
	Sc									2	4		3									1												
D. illinoisensis	Pa								1	4	1	1					16													1	1	4	1	
Hn. minutus	Pa										14	5	4																				1	4
	Pb										3	6	2																					
	M										3	2																						
	Sa											1																					1	
	Sb										1	3	1																					
	Sc										7	3																						
At. sp. indet.	S										5																						2	2
Ig. spp.	Pa	26	20	5	11	96	29	213	63	58	120	23	107	2	65	5	153	110	120	113	3	15	9	4	1	23	27	72	7	131	91	71	15	4
Ig. sp. indet.	Pa	32	13	11		112	44	128	6	7	75	23	26		20		44	14	51	24		10	3	4	1	6	11	22		41	40	35		
Ig. sp.	Pb	7				1	15	25	4	7	12	3	7		3		33	15	16	19	3	2	1	1		2	7	6	2	8	10	6	2	1
	M		1			3	9	12			2						3	4	4	4		1					3	1		2	2			
	Sa					1	2	5			2																							
	Sb						7					1									1													
	Sc_1						23														1													
	Sc_2					1	14	7	1	1	2	1	1				6		2	5									1	1				
Hd. parva				1		2	6	3			1				1		2	1	2	1		1				1								
Ip. typus	Pb	2				9	3	8							1		6	1	6	2		1	1			3				1				
	M	1				8	4	13							1		5	3	3	3		2	2			2	6							
	Sa	2				9	3	5							2		2		5	1						2	5			1	3			
	Sb_1	2				8	1	8					1		1		8	1	3	2		1		2		3	4							
	Sb_2	2				11	5	5									6	4	7	3	1	3	2			4	7	1						
	Sc	3				32	7	27							1		26	10	26	5		1	5	1		5	12							
G. bella	Pa					14	1	2									9	4	26	36														
G. sublanceolata	Pa																	4	40	5														
G. denuda	Pa																	53	25	9	1	2	1	1			6		1					
G. sp.	Pb					2												2	8	10			1	1			1							
	M						1											3	7	2														
	Sa																1	1	4															
	Sb					1		1									4	8	21	1														
	Sc					1												6	15	6				1					1					
	Sd						1											6	8															
NO. of ELEMENTS		79	34	21	13	311	175	462	76	84	294	83	175	6	95	5	324	250	399	251	10	40	25	15	2	51	89	102	11	187	147	116	27	11

Table 2

Conodont distribution at
Oklahoma Hickory Creek (OHCk)

CONODONT DISTRIBUTION OKLAHOMA HICKORY CREEK (OHCk)

SAMPLE NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SAMPLE WEIGHT (g)		615	400	445	645	925	920	488	625	710	639	952	648	963	911	675	960	1000	955	685	712	1000	795	680	773
Ad. lautus	Pa_d	3		3																1	18				
	Pa_s	3		1																1	15				
Ad. gigantus	Pa_d		2		2	48	1												1						
	Pa_s		2		2	57													1						
Ad. sp.	Pb	1	1	2	2	1	3												1		1				
	M	1			3	3	1														3				
Ad. sp. indet.	Pa				5	37															7				
E. conflexa	Pb					1					1						1								
	M																				1				
	Sa																				1				
	Sb					1						1									1				
	Sc				3	5											1				1				
D. illinoisensis	Pa														8			2	6					7	
Hn. minutus	Pa	1																			1				
	Pb																				1				
	M																				1				
At. sp. indet.	S					1					1										1				
Ig. spp.	Pa		1			1612	26	123	73	133	696	82	114	20	460	13	62	17	39	59	324	45	66	63	2
Ig. sp. indet.	Pa					454	1	211	89	149	592	147	15		192	3	53	1	32	47	467	18	44	2	2
Ig. sp.	Pb					158	1	31	17	25	75	21	20	2	26		10	6	8	7	11	5	9	18	
	M					46		3	8	7	17	2	1		6	2		2	1				1	11	
	Sa					14					1	2			1										
	Sb							1																	
	Sc_1										2														
	Sc_2					29		5	3	3	9	4	1	1	1		1		1				1	2	
Hd. parva						6				3	6	4			3	1				1			2	2	
Ip. typus	Pb					62		9	7	6	29	9	2								1		2	3	
	M					87		6	6	6	18	12											3	3	
	Sa					61		1	3	7	14	4	2										1	2	
	Sb_1					101		2	4	12	22	4	1								1		4	4	
	Sb_2					98	1	9	4	8	29	14	1									1	6	4	
	Sc					249	1	30	28	22	97	26	8								1		17	11	1
G. bella	Pa					4		4	5	1	9				1										
G. sublanceolata	Pa																							6	
G. denuda	Pa																							5	4
G. sp.	M							1		1															
	Sb							2																	1
	Sc										2														
NO. of ELEMENTS		9	6	6	17	3335	35	438	247	383	1619	332	165	23	698	19	126	28	90	116	857	69	156	143	10

Table 3

Conodont distribution at Turkey Mountain (TkyMt) and U.S. 75-71 St. Exit

CONODONT DISTRIBUTION

TURKEY MOUNTAIN (TkyMt) — U.S. 75-71 St. EXIT

		TURKEY MOUNTAIN (TkyMt)																	U.S. 75-71 St. EXIT						
SAMPLE NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1	2	3	4	5	6	7
SAMPLE WEIGHT(g)		1015	930	700	850	925	865	690	725	690	738	945	715	830	837	918	850	708	1090	1000	700	1000	999	925	815
Ad. lautus	Pa_d												8												
	Pa_s												9							1					
Ad. gigantus	Pa_d		2																		2	2			
	Pa_s		1																		3	2			
Ad. sp.	Pb																				1	1			
	M																				3				
	Sa																				2				
Ad. sp. indet.	Pa												3								3				
E. conflexa	Pb												2												
	Sa												2												
	Sb												2												
	Sc												6												
Hn. minutus	Pa	2																	4						
	Pb	1																	1						
	Sa	1																							
Ig. spp.	Pa	22	6								12	5	2760	5			1		78	11		59		29	
Ig. sp. indet.	Pa	1	1				1				2	2	1834	2					9			4		8	
Ig. sp.	Pb	1									3	1	40						3	1		7		5	
	M											1	4												
	Sa	1											3												
	Sb	2																	1						
	Sc_1	1										1													
	Sc_2												2						1						
Ip. typus	Pb										1		42											2	
	M												32											1	
	Sa												22											1	
	Sb_1										1		62									3		5	
	Sb_2	1											46						1			1		6	
	Sc										1		109						1			4		13	
G. bella	Pa												17											4	
	Pb										1		2											1	
	Sb												1												
NO. of ELEMENTS		33	10	0	0	0	1	0	0	0	21	10	5014	7	0	1	0	0	99	13	14	83	0	75	0

Table 4

Conodont distribution at
Tiger Creek (TgCk)

CONODONT DISTRIBUTION TIGER CREEK(TgCk)

SAMPLE NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
SAMPLE WEIGHT (g)		910	940	840	900	810	460	830	770	880	880	985	970	990	855	990	990	945	955	812	935	561	726	625	687	800	795
Ad. lautus	Pa_d														3												
	Pa_s														4												
Ad. gigantus	Pa_d					6													1								
	Pa_s					6													3								
Ad. sp.	Pb					2													2								
	M																		1								
Ad. sp. indet.	Pa					2																					
E. conflexa	Pb														2												
	M													1													
	Sa													1	2												
	Sb													1	1												
	Sc					1								1	8												
D. illinoisensis	Pa														1												
Ig. spp.	Pa				4	512	37	25	6	18	118	78	46	148	989	66	3	4	11					1			
Ig. sp. indet.	Pa	1			1	37	1	1	4	6	37	35	15	52	431	92				1							
Ig. sp.	Pb					21	5	3		4	26	30	15	26	49	18			1								
	M					5			1	1	5	2	3	2	8	1											
	Sa										1																
	Sc_1													1		2											
	Sc_2					1					5	7		3	4	1	1										
Hd. parva											1	1	1	2													
Ip. typus	Pb					7	1	1		1	2	2	2	9	7												
	M					5	1		1	2	2			7	5												
	Sa				1	1		2		3	2	1	4	8	3												
	Sb_1					8		1		2	3	2	5	8	3												
	Sb_2				1	12	1		1	3	3	1	2	11	6												
	Sc					18		5	2	11	12	3	9	24	22												
G. bella	Pa							1		3	4	6	2	2													
	Pb											1	1	1													
	Sa										1																
	Sc													1													
NO. of ELEMENTS		1	0	0	7	644	46	39	15	54	222	169	105	309	1548	180	4	4	19	1	0	0	0	1	0	0	0

Table 5

Conodont distribution at
Sasakwa Little River (Ssk LR)

CONODONT DISTRIBUTION

SASAKWA LITTLE RIVER (Ssk LR)

SAMPLE NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SAMPLE WEIGHT (g)		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	797	1000	1000	1000	1000	817
Ad. lautus	Pa_d	7	6	1	2	1	1		1		2	4	3	2			1	4	1	1
	Pa_s	9	5	3	3	2	1									1	1	1	1	3
	Pb	4	2	1	1	1		1				1	1	1		1		1	2	1
	M														1		1			2
Ad. sp. indet.	Pa							1												
E. conflexa	Pb	2	2		1		2		2			1								
	M	1			2												1			
	Sb		2		1								1							
	Sc	2	3	3	2	1	2	1		1		1	2					1		
Hn. ellisoni	Pa	3	2	1		1	2	1			3				1	3		1		
Hn. minutus	Pa		1		2	2														1
Hn. sp.	Pb	1	1	1	3						1					2			1	
	Sb															1				
	Sc	1		2										1	1	1				
At. sp.	indet. S	4	2	1	2	2	1				1									
Ig. spp.	Pa	286	57	51	82	63	60	32	27	34	31	10	21	20	20	45	36	27	22	10
Ig. sp. indet.	Pa	16			15	12	5						2			1		1	2	2
Ig. sp.	Pb	12	9	10	7	7	4	2	1	3	1	2	2	5	1	3	1	5		1
	M	1	1		2	1											1			
	Sb	1										1	1	1	1					
	Sc_1				1										1					
	Sc_2		1	2	1	1														
Ip. typus	Pb	1			2															
	Sa					1							1							
	Sb_2	1			1		2													
	Sc									1		1								
NO. of ELEMENTS		352	94	76	130	95	80	37	31	39	39	21	34	30	27	58	42	41	29	21

APPENDIX C

PLATES

All specimens illustrated are X40. All illustrated specimens are reposited at The University of Iowa (SUI).

Plate 1

Adetognathus, Ellisonia and Hindeodus.

Fig. 1. *Hindeodus ellisoni* (Merrill). Pa element. Lateral view of SUI 52213; Ssk LR, Sample 10.

Figs. 2, 6. *Hindeodus* sp. Pb element. 2, Inner lateral view of SUI 52214; TkMNE, Sample 10. 6, Inner lateral view of SUI 52215; TkyMt, Sample 1.

Fig. 3. *Hindeodus* sp. Sa element. Posterior view of SUI 52216; TkyMt, Sample 1.

Figs. 4, 9. *Hindeodus* sp. Sb element. 4, Lateral view of SUI 52217; TkMNE, Sample 10. 9, Lateral view of SUI 52218; TkMNE, Sample 9.

Figs. 5, 10. *Hindeodus minutus* (Ellison). Pa element. 5, Lateral view of SUI 52219; TkMNE, Sample 10. 10, Lateral view of SUI 52220; TkMNE, Sample 9.

Figs. 7, 8. *Hindeodus* sp. M element. 7, Inner lateral view of SUI 52221; TkMNE, Sample 9. 8, Inner lateral view of SUI 52222; TkMNE, Sample 9.

Fig. 11. *Hindeodus* sp. Sc element. Inner lateral view of SUI 52223; TkMNE, Sample 10.

Fig. 12. *Adetognathus* sp. M element. Lateral view of SUI 52224; Ssk LR, Sample 16.

Fig. 13. *Adetognathus* sp. Pb element. Lateral view of SUI 52225; Ssk LR, Sample 18.

Fig. 14, 15, 18, 19. *Adetognathus lautus* (Gunnell). Pa element. 14, 15, Lateral and upper views of sinistral form, SUI 52226; TkMNE, Sample 10. 18, 19, Upper and lateral views of dextral form, SUI 52227; Ssk LR, Sample 17.

Figs. 16, 17. *Ellisonia conflexa* (Gunnell). Pb element. 16, Lateral view of SUI 52228; OHCk, Sample 5. 17, Lateral view of SUI 52229; TgCk, Sample 14.

Figs. 20, 21, 24, 25. *Adetognathus gigantus* (Gunnell). Pa element. 20, 21, Lateral and upper views of sinistral form, SUI 52230; U.S. 75, Sample 3. 24, 25, Upper and lateral views of SUI 52231; U.S. 75, Sample 3.

Figs. 22, 23. <u>Ellisonia</u> <u>conflexa</u> (Gunnell). M element. 22, Lateral view of SUI 52232; Ssk LR, Sample 4. 23, Lateral view of SUI 52233; Ssk LR, Sample 16.

Figs. 26, 27. <u>Ellisonia</u> <u>conflexa</u> (Gunnell). Sc element. 26, Inner lateral view of SUI 52234; Ssk LR, Sample 2. 27, Inner lateral view of SUI 52235; Ssk LR, Sample 1.

Fig. 28. <u>Ellisonia</u> <u>conflexa</u> (Gunnell). Sb element. Inner lateral view of SUI 52236; Ssk LR, Sample 4.

Fig. 29. <u>Ellisonia</u> <u>conflexa</u> (Gunnell). Sa element. Lateral view of SUI 52237; TkMNE, Sample 2.

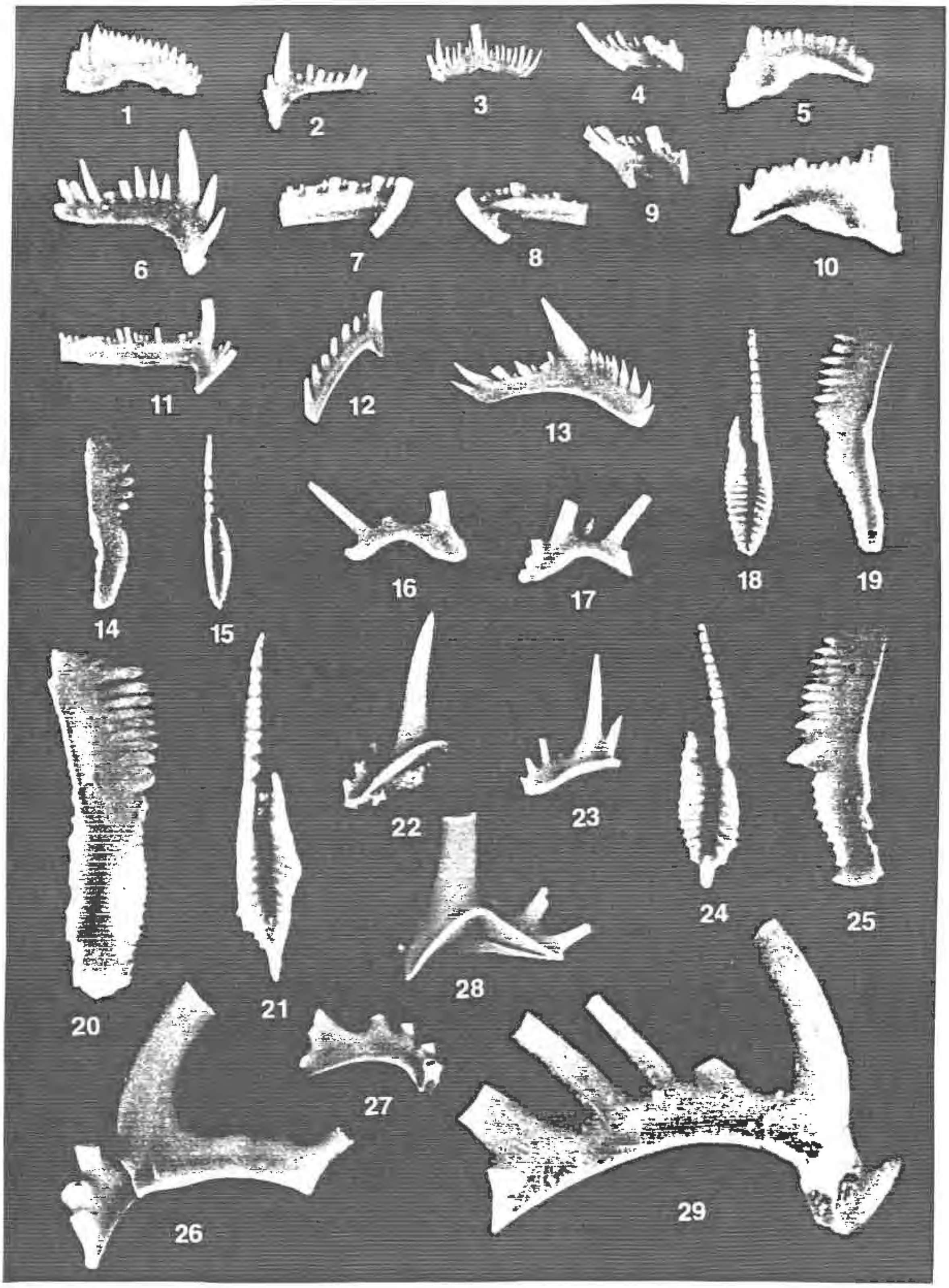
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Plate 2

<u>Idiognathodus</u>.

Figs. 1-3, 6-14. <u>Idiognathodus</u> cf. <u>I</u>. sp. 3 of Swade. Pa element. 1, Upper view of SUI 52238; OHCk, Sample 10. 2, Upper view of SUI 52239; OHCk, Sample 10. 3, Upper view of SUI 52240; TkMNE, Sample 15. 6, Upper view of SUI 52241; OHCk, Sample 10. 7, Upper view of SUI 52242; TkMNE, Sample 15. 8, Upper view of SUI 52243; OHCk, Sample 10. 9, Upper view of SUI 52244; TkMNE, Sample 15. 10, Upper view of SUI 52245; TkMNE, Sample 16. 11, Upper view of SUI 52246; TkMNE, Sample 6. 12, Upper view of SUI 52247; TkMNE, Sample 4. 13, Upper view of SUI 52248; OHCk, Sample 7. 14, Upper view of SUI 52249; TgCk, Sample 11.

Figs. 4, 5. <u>Idiognathodus</u> <u>oppletus</u> (Ellison). Pa element. 4, Upper view of SUI 52250; TkMNE, Sample 15. 5, Upper view of SUI 52251; OHCk, Sample 23.

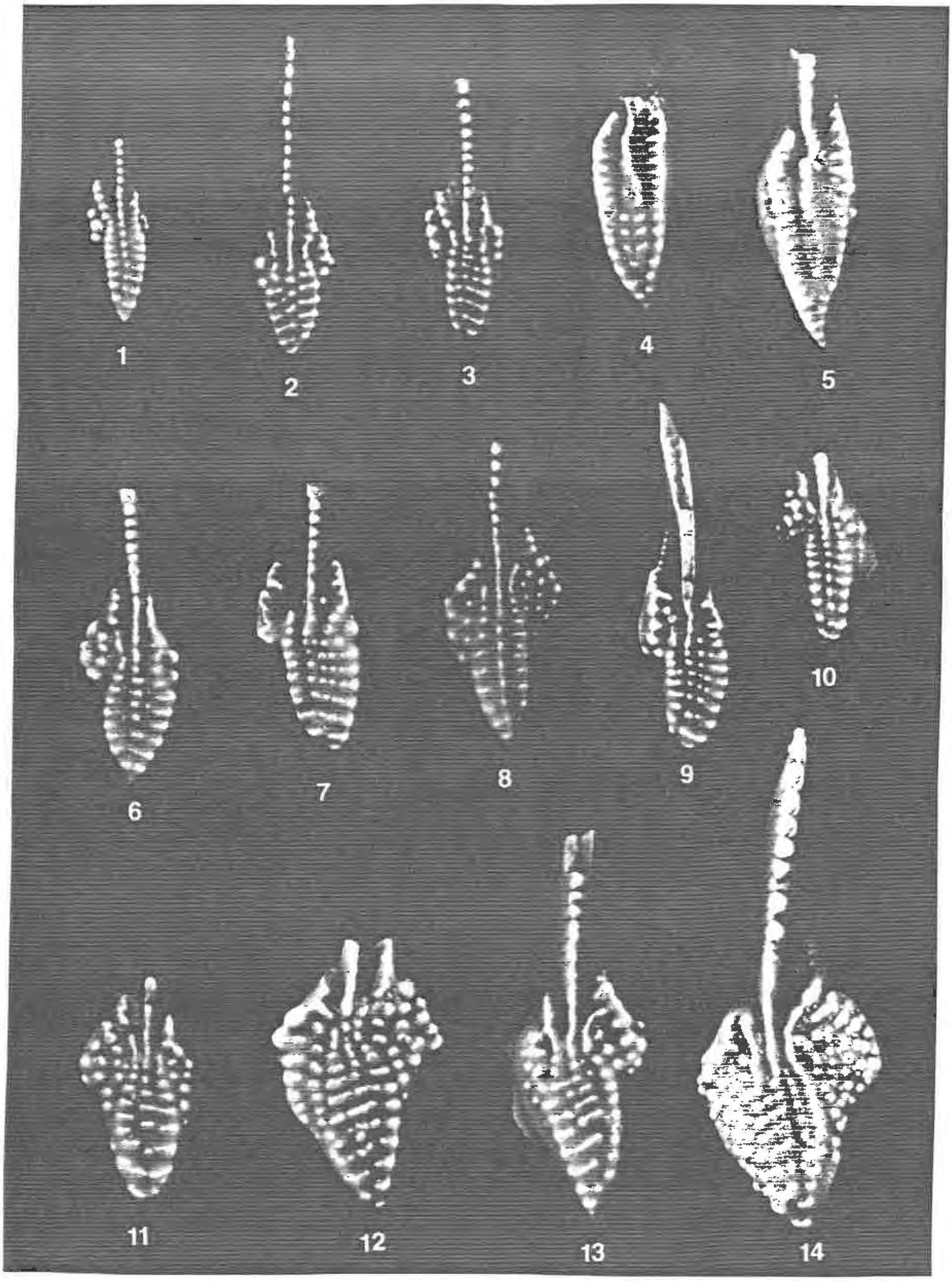
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Plate 3

Diplognathodus, Hindeodella parva and Idiognathodus.

Figs. 1-3. Diplognathodus illinoisensis Merrill. Pa element. 1, Lateral view of SUI 52252; TkMNE, Sample 15. 2, Lateral view of SUI 52253; TkMNE, Sample 15. 3, Lateral view of SUI 52254; TkMNE, Sample 28.

Figs. 4, 7. Idiognathodus sp. Pb element. 4, Lateral view of SUI 52255; Ssk LR, Sample 6. 7, Lateral view of SUI 52256; OHCk, Sample 10.

Fig. 5. Idiognathodus sp. Sb element. Inner lateral view of SUI 52257; TkMNE, Sample 5.

Fig. 6. Idiognathodus sp. M element. Lateral view of SUI 52258; Ssk LR, Sample 5.

Fig. 8. Idiognathodus sp. Sc_2 element. Inner lateral view of SUI 52259; TkMNE, Sample 5.

Fig. 9. Idiognathodus sp. Sc_1 element. Inner lateral view of SUI 52260; TkMNE, Sample 5.

Figs. 10, 11, 13. Sd element. (Hindeodella parva Ellison). 10, 13, Inner lateral and upper views of SUI 52261; TkMNE, Sample 5. 11, Inner lateral view of anterior process, SUI 52262; OHCk, Sample 10.

Fig. 12. Idiognathodus sp. Sa Element. Lateral view of SUI 52263; TkyMt, Sample 1.

Figs. 14-21. Idiognathodus sp. 1 of Swade. Pa element. 14, Upper view of SUI 52264; Ssk LR, Sample 1. 15, Upper lateral view of SUI 52265; TkMNE, Sample 15. 16, Upper view of SUI 52266; TkMNE, Sample 4. 17, Upper view of SUI 52267; TkMNE, Sample 17. 18, Upper view of SUI 52268; TkyMt, Sample 12. 19, Upper view of SUI 52269; OHCk, Sample 5. 20, Upper view of SUI 52270; OHCk, Sample 5. 21, Upper view of SUI 52271; TgCk, Sample 11.

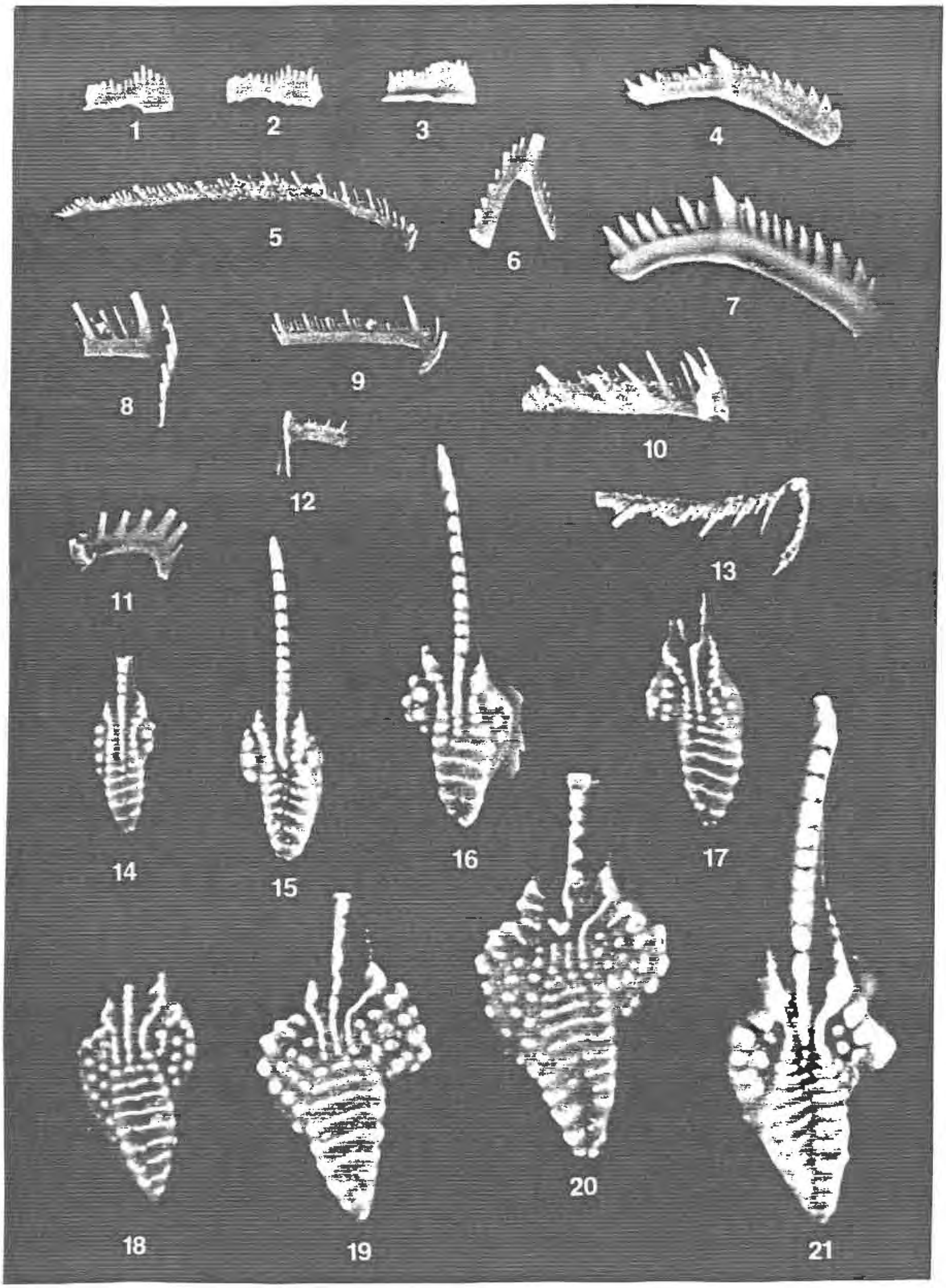
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Plate 4

Gondolella and Idioprioniodus.

Figs. 1, 8. Gondolella sp. Pb element. 1, Inner lateral view of SUI 52272; TkMNE, Sample 18. 8, Inner lateral view of SUI 52273; TkMNE, Sample 4.

Fig. 2. Gondolella sp. Sa element. Lateral view of SUI 52274 TkMNE, Sample 17.

Fig. 3. Gondolella sp. M element. Lateral view of SUI 52275 TkMNE, Sample 17.

Fig. 4. Gondolella sp. Sb element. Lateral view of SUI 52276 TkMNE, Sample 17.

Fig. 5. Gondolella sp. Sc element. Outer lateral view of SUI 52277; TkMNE, Sample 28.

Figs. 6, 7. Gondolella sp. Sd element. 6, Outer lateral view of SUI 52278; TkMNE, Sample 17. 7, Inner lateral view of SUI 52279; TkMNE, Sample 17.

Figs. 9-11. Gondolella bella Stauffer & Plummer. Pa element. 9, Upper view of SUI 52280; TkMNE, Sample 17. 10, Upper view of SUI 52281; TgCk, Sample 11. 11, Upper view of SUI 52282; OHCk, Sample 10.

Figs. 12, 13. Gondolella sublanceolata Gunnell. Pa element. Upper and lateral views of SUI 52283; TkMNE, Sample 17.

Figs. 14, 15. Gondolella denuda Ellison. Pa element. 14, Upper view of SUI 52284; TkMNE, Sample 16. 15, Lateral view of SUI 52285; TkMNE, Sample 16.

Fig. 16. Idioprioniodus typus Gunnell. Sa element. Lateral view of SUI 52286; OHCk, Sample 5.

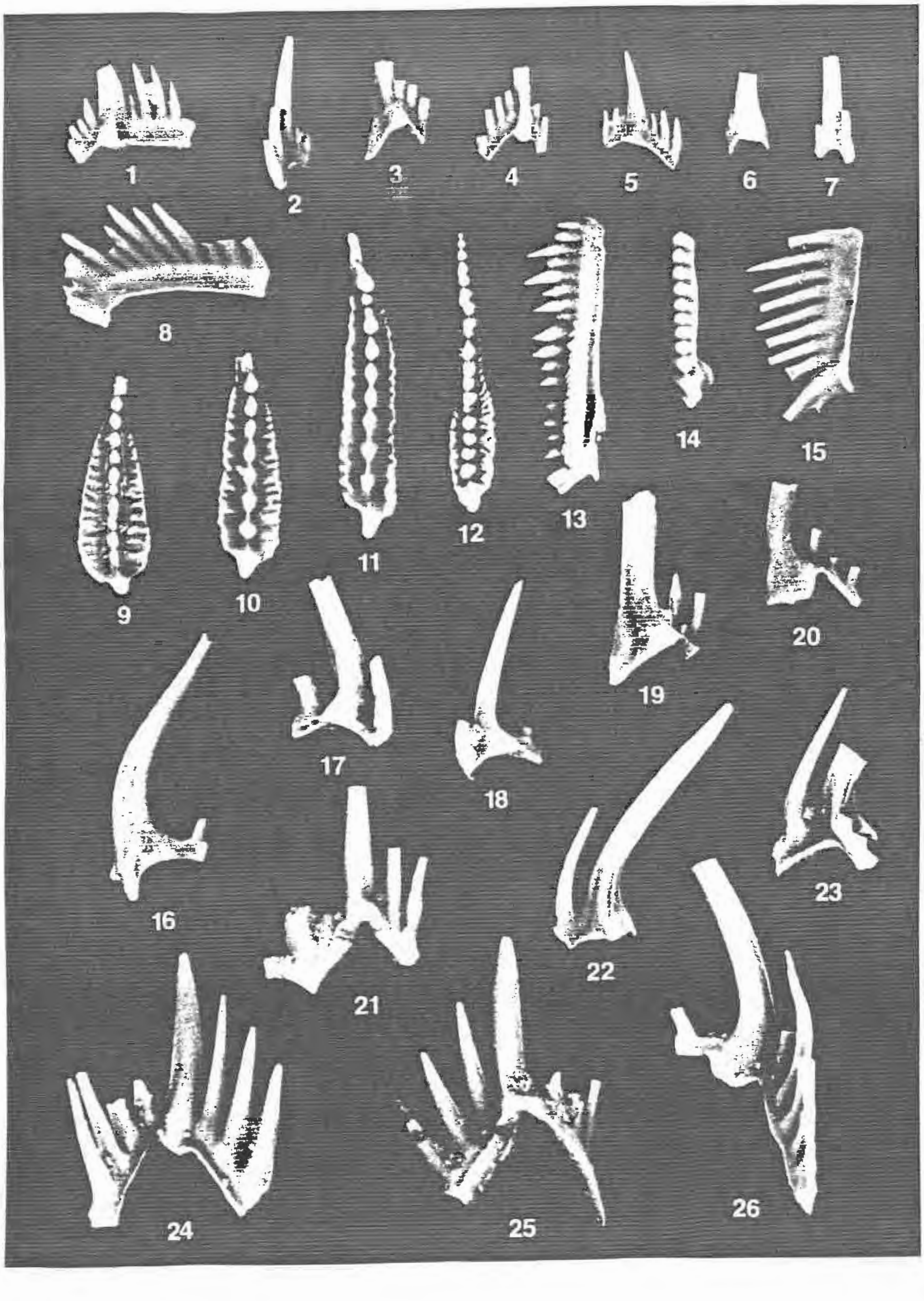
Figs. 17, 18. Idioprioniodus typus Gunnell. Sb_2 element. 17, Inner lateral view of SUI 52287; OHCk, Sample 5. 18, Inner lateral view of SUI 52288; TgCk, Sample 10.

Figs. 19, 20. Idioprioniodus typus Gunnell. M element. 19, Lateral view of SUI 52289; OHCk, Sample 10. 20, Lateral view of SUI 52290; OHCk, Sample 5.

Figs. 21, 24, 25. Idioprioniodus typus Gunnell. Pb element. 21, Lateral view of SUI 52291; OHCk, Sample 10. 24, 25, Lateral views of SUI 52292; TkMNE, Sample 5.

Figs. 22, 23. Idioprioniodus typus Gunnell. Sb, element. 22, Lateral view of SUI 52293; OHCk, Sample 10. 23, Lateral view of SUI 52294; TgCk, Sample 11.

Fig. 26. Idioprioniodus typus Gunnell. Sc element. Inner lateral view of SUI 52295; TkMNE, Sample 5.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