OKLAHOMA GEOLOGICAL SURVEY
CARL C. BRANSON, DIRECTOR

BULLETIN 82

STRATIGRAPHY AND PALEONTOLOGY OF THE HUNTON GROUP IN THE ARBUCKLE MOUNTAIN REGION

PART V—BOIS D'ARC ARTICULATE BRACHIOPODS

THOMAS W. AMSDEN

NORMAN

December 10, 1958

FOREWORD

The present volume records the results of further research by Dr. Amsden on the Hunton group of rocks. These rocks are oil-bearing at many places and this careful detailed examination of the lithologies and of the unconformities within the group, detectable only by expert use of fossils, is certain to aid in exploration for petroleum and natural gas.

The State of Oklahoma should be proud of the series of first-rate scientific papers on the Hunton group. These rocks and their excellent fossils are famous throughout the world and are now, through Dr. Amsden's studies, as thoroughly known as any comparable geologic unit and fauna in the world.

Carl C. Branson

TABLE OF CONTENTS

ILLUSTRATIONS

Figure

Plates

TABLES

STRATIGRAPHY AND PALEONTOLOGY OF THE HUNTON GROUP IN THE ARBUCKLE MOUNTAIN REGION

PART V — BOIS D'ARC ARTICULATE BRACHIOPODS

THOMAS W. AMSDEN

ABSTRACT

The Bois d'Arc formation consists of two members or lithofacies, a lower cherty, argillaceous calcilutite (Cravatt member) and an upper calcarenite (Fittstown member). Both the stratigraphic and faunal evidence indicate that these are facies of one another, and that the entire formation is a facies of the Haragan formation. The Bois d'Arc brachiopod fauna consisting of 40 species (one new) referable to 32 genera is described. This fauna is very similar to that of the Haragan, with 77 percent of the total Haragan-Bois d' Arc brachiopod species common to the two formations. The Haragan-Bois d'Arc fauna is Helderbergian in age and is closely related to the New Scotland fauna of New York. These strata are also believed to be equivalent to at least a part of the Ross formation (Linden group) of western Tennessee, and to the Bailey limestone of Missouri.

INTRODUCTION

The Bois d'Arc faunas commonly have been overlooked by paleontologists collecting from the Hunton, owing in large part to the fact that it is much easier to obtain good specimens from the Haragan and Henryhouse formations. A knowledge of this fauna is, however, of primary importance to an understanding of the history of late Hunton time, as the Bois d'Arc occupies a stratigraphic position between the Haragan and the Frisco formations. In earlier papers I have discussed the stratigraphy of the Hunton group (1957), and have described the Henryhouse (1951, 1958) and Haragan (1958) brachiopods. The present paper continues this study of the articulate brachiopods, a group which strongly dominates the megafaunas of the middle and upper parts of the Hunton. In the future it is hoped that other faunal elements can be described. The present investigation is based almost entirely on specimens collected by me from carefully measured and described stratigraphic sections. This work, as well as that on the Haragan brachiopods, has been greatly facilitated by a direct comparison with Helderbergian collections at Peabody Museum—Yale University, and at the U. S. National Museum (Amsden 1958, p. 9).

PAST INVESTIGATIONS

Little work has been done in the past on the Bois d'Arc faunas. Girty (1889, p. 546-550), in his preliminary paper on the Hunton strata of Coal County, gave only meager stratigraphic data, but it seems reasonably certain that his beds 1 to 6 represent the Bois d'Arc. The fauna which he lists from these beds is essentially the same as that given for the Haragan, although Girty did express some doubts concerning the age of the fossils from the uppermost units (Nos. 1 and 2, which probably equal the Fittstown of the present report). In 1911 Reeds (p. 265-266) gave an abbreviated faunal list for the Bois d'Arc formation, but later this was amended when the Frisco was removed from the Bois d'Arc (Reeds 1926). Maxwell (1936, table 7) restricted the Bois d'Arc formation to those beds which are roughly equivalent to the Fittstown member of this report (Amsden 1957, fig. 2, p. 39), and gave a lengthy faunal list. Both Reeds and Maxwell confined their efforts to listing the fauna, and to my knowledge no Bois d'Arc fossil has been described or illustrated (Amsden 1956).

BOIS D'ARC STRATIGRAPHY

The Bois d'Arc formation was named by C. A. Reeds (1911, p. 265) for exposures along Bois d'Arc Creek in Pontotoc County (fig. 8). In his original definition Reeds included all of the post-Haragan strata in this formation, although he did note that in the type area the upper 40 feet might be Oriskany in age. Some years later he (1926, p. 13) removed the upper, massive-bedded limestone which carries an Oriskany fauna from the Bois d'Arc and placed it in his Frisco formation. My usage of Haragan, Bois d'Arc and Frisco, which is shown diagrammatically on figure 1, is essentially the same as that of Reeds. The stratigraphic relations and lithology are discussed in my 1957 paper (p. 25-26, 38-47, pl. I, pl. III, text fig. 4) and only a summary is given below.

Facies terminology: The present study clearly indicates a facies relationship for the Haragan, Cravatt and Fittstown strata. Before proceeding further with a discussion of this relationship it seems desirable to outline briefly the terminology as herein used. This is specially needed because in recent years a great deal of literature has been presented on this topic, resulting in a complicated facies terminology. Much of this literature is unsupported by actual examples and although the terminology may be useful in theory, in practice it is difficult to apply. This question was recently reviewed by J. Marvin Weller (1958, pp. 609-639) who observed that "the development of an increasingly complex nomenclature, designed to promote precision in thought and expression, has had the opposite effect." This author's suggestions for a simplified terminology are well taken, and the names which he recognizes and defines can be satisfactorily applied to express the relationship which I believe exists within the Hunton group (see also Moore 1939, p. 32). Accordingly facies is used as a general term that includes both (1) lithofacies and (2) biofacies. (1) A lithofacies is defined as a "lateral subdivision of a stratigraphic unit differentiated from other adjacent subdivisions by its lithologic characters." For example, the cherty marlstones of the Cravatt member (or lithofacies) are believed to grade laterally into the non-cherty marlstones of the Haragan formation; the calcarenites of the Fittstown member (lithofacies) are at least in part a lateral continuation of the Cravatt beds. A biofacies is defined as "a lateral subdivision of a stratigraphic unit differentiated from other adjacent subdivisions by its biologic characters . . . . ." For example the fauna of the Fittstown is somewhat different from that of the Cravatt, resulting in a Fittstown biofacies and a Cravatt biofacies (as well as a Fittstown lithofacies and a Cravatt biofacies). It should be noted that the Haragan, Cravatt and Fittstown strata are closely related in age, and are believed to represent more or less continuous deposition in the same area.

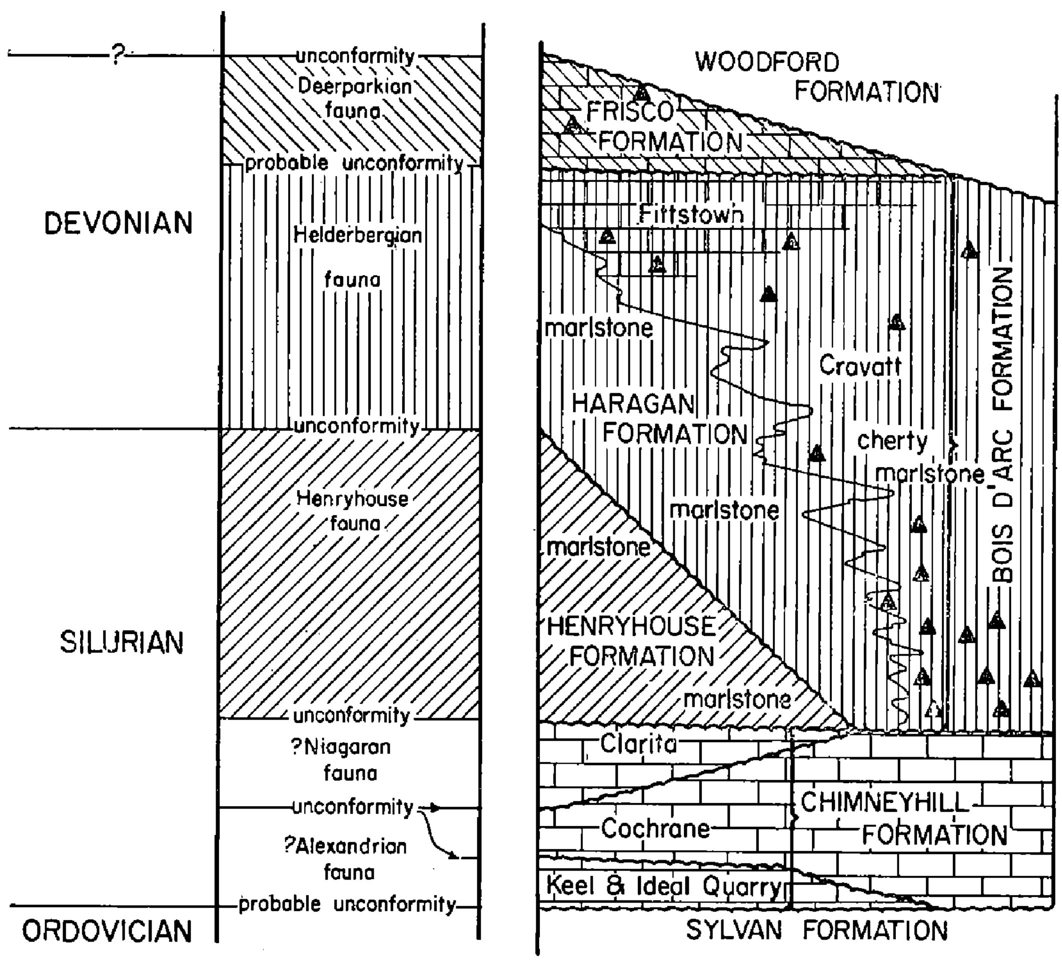


Figure 1. Diagrammatic section summarizing the stratigraphic and faunal relationships of the Hunton formation and members (from Amsden 1957).

Lithology: The Bois d'Arc formation is essentially a carbonate sequence with varying amounts of chert. The lower part (Cravatt member) consists of argillaceous and silty calcilutites or marlstones (Amsden 1957, p. 5) which in most areas grade upwards and locally laterally, into relatively pure calcarenites (Fittstown member). The lower part is everywhere cherty, this being the characteristic used to distinguish it from the Haragan, and commonly chert is scattered throughout the formation in varying amounts. In the lower part the chert is generally a brown-weathering, porous type, whereas in the upper part it is commonly a solid, vitreous chert.

Members: The Bois d'Arc is divided into two members, a lower Cravatt member and an upper Fittstown member (Amsden 1957, p. 41-47, fig. 4). The Cravatt is predominantly a thin-bedded, fossiliferous, argillaceous calcilutite or marlstone which everywhere has chert nodules in its lower part, and in most areas is cherty throughout. Almost all of the HCl insoluble residues fall in the silt-clay size, only a few ranging into a fine sand; the percentage of insoluble residue (by weight) is commonly between 10 and 30 percent, few ranging as high as 50%. Beds of fossiliferous calcarenite up to 6 inches or so in thickness may be present throughout the member; these beds are generally highly fossiliferous bioclastic limestones with the silt-clay content considerably reduced from that found in the marlstones. At most places these beds of calcarenites are rare or absent in the lower part, becoming increasingly numerous towards the top of the Cravatt member, and this unit then grades into the Fittstown member which is predominantly a calcarenite sequence with only scattered beds of marlstone. The Fittstown calcarenites, which are mostly in beds from 3 to 6 inches thick, are composed largely of fossil debris. Most peels and thin-sections show well over 50% recognizable fossil material. The HCl insoluble content (excluding chert) of these strata is low, generally ranging from 2 to 8 percent, although most well exposed sections of Fittstown beds contain some marlstone, even in the upper part. Three columnar sections showing Cravatt and Fittstown lithologies with some calculated insoluble residues are shown in figure 2. These are based on actual measured and described sections, but are somewhat generalized as there are actually all gradations between the marlstones (argillaceous calcilutites) and calcarenites. It should be noted that all of the insoluble residues are made from rock samples and not channel samples.

Cravatt-Fittstown contact: The gradational nature of the Cravatt-Fittstown contact should be emphasized (fig. 2). In no section that I have studied is there a well-defined lithologic break separating these two members, and in some sections the upper calcarenites are not sufficiently well developed to distinguish as a separate member. Furthermore, the regional stratigraphic relations as determined by numerous described and measured sections strongly indicate considerable lateral gradation

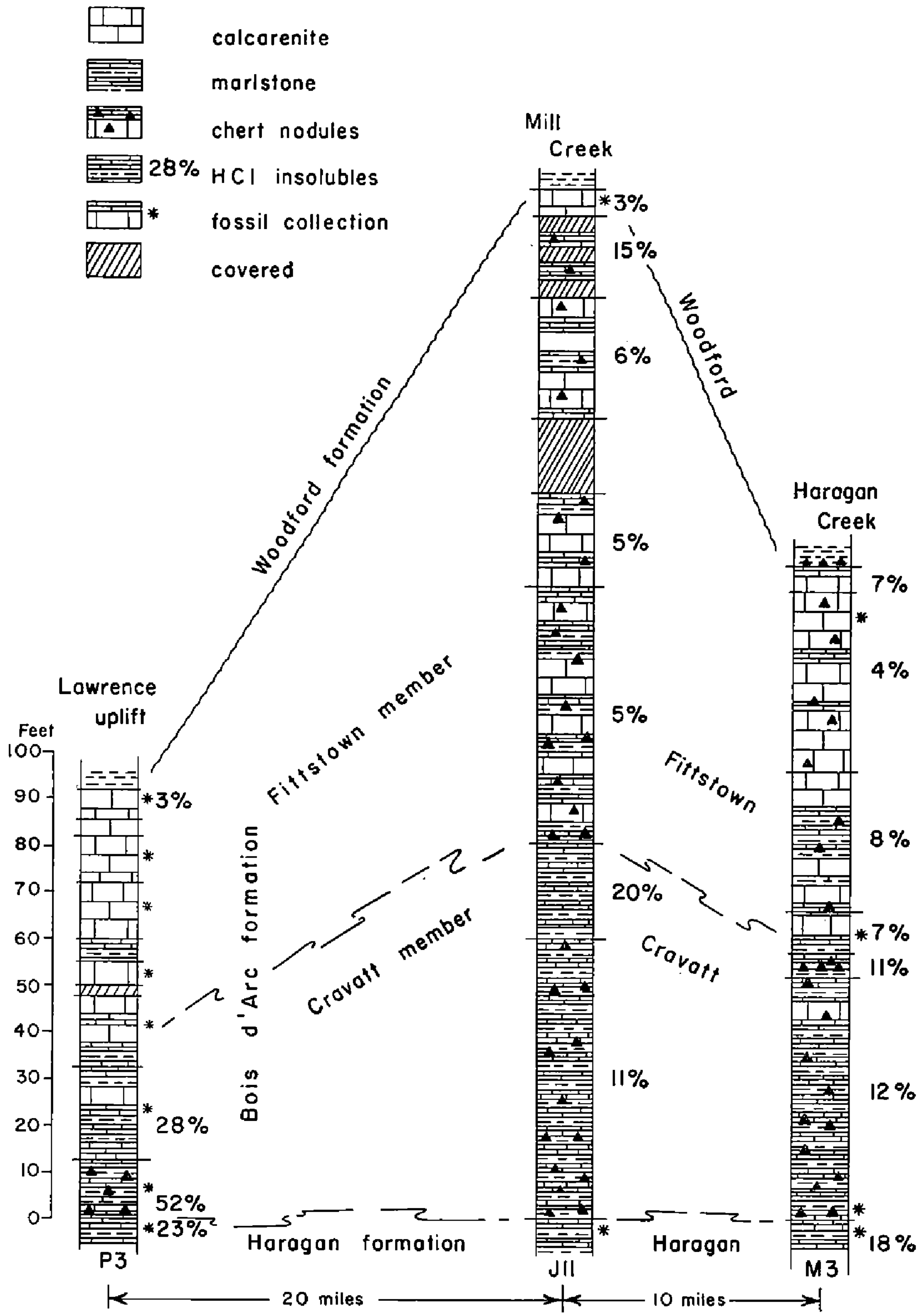


Figure 2. Three columnar sections showing the Fittstown-Cravatt relationship. These sections were measured, described and collected by me; P3 is located on Chimneyhill Creek (SE¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County); J11 is situated about ¾ mile west of Mill Creek town (SE¼ NW¼ sec. 12, T. 2 S., R. 4 E., Johnston County); M3 is on Haragan Creek, about ½ mile northwest of White Mound (SW¼ SW¼ sec. 17, T. 2 S., R. 3 E., Murray County). All insoluable residues were prepared from chert-free rock specimens (not channel samples) and were made by digesting the sample in warm, dilute HCl; calculations are by weight.

from one lithologic type to another. Thus all of the stratigraphic evidence points to a facies relationship, and this interpretation is fully supported by the faunal evidence (see below). In spite of the obscure Fittstown-Cravatt boundary and the lateral gradation of one into the other, these member divisions are stratigraphically as well as faunally useful. Lithologically there is a marked difference between the typical Fittstown lithofacies and the typical Cravatt lithofacies, and it is convenient to recognize this difference by the member category. There is also a faunal difference between these two and although this difference seems to be clearly related to lithology and not to time, it is nonetheless useful to distinguish a Cravatt biofacies and a Fittstown biofacies (see FAUNAL DISTRIBUTION).

Frisco contact: The Bois d'Arc is lithologically quite different from the overlying Frisco formation and the contact between these two is easily mapped. The most marked difference between the Frisco and the Fittstown member of the Bois d'Arc is in the character of the bedding, the latter being thin-bedded, few beds exceeding 3 or 4 inches in thickness, whereas the Frisco beds are commonly 6 to 12 inches thick. Moreover, the Fittstown tends to weather into plates or irregular slabs whereas the Frisco commonly weathers with a pitted or "pot-holed" surface. In addition most outcrops of Fittstown show at least some argillaceous partings whereas the Frisco has few if any shaly partings and is largely reasonably high calcium stone (Amsden 1957, p. 46-49, pl. III). The faunas are distinct, the Frisco carrying a Deerparkian fauna and the Fittstown a Helderbergian fauna. In those areas where the Frisco is absent the Bois d'Arc is directly overlain by the Woodford, a formation which is predominantly shale and is quite different from any of the Hunton formations or members.

Haragan contact: The base of the Bois d'Arc formation is arbitrarily placed at the base of the lowest cherty bed of any appreciable thickness. Defined in this manner the Haragan is almost chert free, although a few cherty beds have been included where such strata are thin and show little lateral persistence. Such inclusions are rare, being present in only two of my stratigraphic sections, and in both cases this can be demonstrated to be a local development.

Except for chert the marlstones of the Cravatt member are lithologically like those of the Haragan, although the latter may, on the average, have a slightly higher insoluble content. This difference is not great and the lower Cravatt beds are distinguished from the Haragan only by the presence of chert. Most sections of Cravatt carry some beds of calcarenite, especially in the upper part, a lithologic type that is extremely rare in the Haragan.

The stratigraphic evidence indicates a facies relationship between the Cravatt and the Haragan. The only basic difference between the two is the chert, but this is irregular in its development within the Cravatt. It is everywhere present in the basal part (by definition); however, in the overlying beds the chert is at places abundantly distributed throughout, and at other places these beds are almost chert free, these chert-free parts resembling the Haragan. Significantly, at least some of the individual cherty beds can be demonstrated to grade laterally into chert-free strata, thus strongly suggesting a facies relation. The regional distribution also indicates such a relationship. The Haragan is well developed in the area around old Hunton townsite where it rests upon the Silurian; farther south, in much of the area around Wapanucka, this stratigraphic position immediately above the Silurian beds is occupied by the Cravatt strata, which are lithologically and faunally similar to the Haragan, the only diagnostic difference being the presence of chert. This relationship is well illustrated in my stratigraphic section A2, which is located in Atoka County, about 4 miles southeast of Wapanucka (SE¼ NW¼ Sec. 9, T 3 S., R. 9 E).

STRATIGRAPHIC SECTION A2

Covered (Woodford float)
Bois d'Arc formation—Cravatt member

C. *Lithology*: Yellowish-gray, argillaceous calcilutite (marlstone) with some red mottling. Three insoluble residues: 7.6%, 17.5%, 21%, average 15%. Many nodules of brown-weathering, porous chert and rare nodules of vitreous chert. Beds from 2 to 6 inches. This unit is almost entirely calcilutite, only one or two beds of calcarenite. .... 45 feet

Fossils: *Levenea subcarinata pumilis, Sphaerirhynchia lindenensis, Costellirostra singularis, Nucleospira ventricosa, Atrypina hami, Coelospira virginia, Rhynchospirina maxwelli, Leptaena* sp., *Phacops* sp., *Dicranurus?* sp., *Favosites* cf. *F. conicus.*

B. *Lithology*: Limestone breccia; irregular pieces of limestone set in a red, argillaceous calcilutite; fragments up to 2 inches in diameter, some being glauconitic and probably derived from the Cochrane. Only locally present; at most places the typical Cravatt rests directly upon the Cochrane. .... 0-2 feet

Chimneyhill formation—Cochrane member

A. *Lithology*: Gray calcilutite with small, rounded nodules of glauconite. A few irregular nodules of vitreous chert. .... 15 feet

Covered

The fauna listed above from the Cravatt member is typical of the Haragan, and all of these species can be collected from the Haragan formation in the belt around old Hunton townsite (sections C1, C2) and elsewhere (see under BOIS D'ARC—HARAGAN BRACHIOPODS). The relationship between the strata described above and those cropping out a short distance north of Bromide is shown in figure 3. Since the stratigraphic evidence also points strongly to a facies relationship between the Cravatt and Fittstown members (fig. 2), it appears certain that the entire Bois d'Arc is a facies of the Haragan, a relationship strongly supported by the faunal evidence. This stratigraphic unit may therefore be spoken of as the Bois d'Arc *lithofacies* (see under *Terminology*), or it may be termed the Bois d'Arc *forma-*

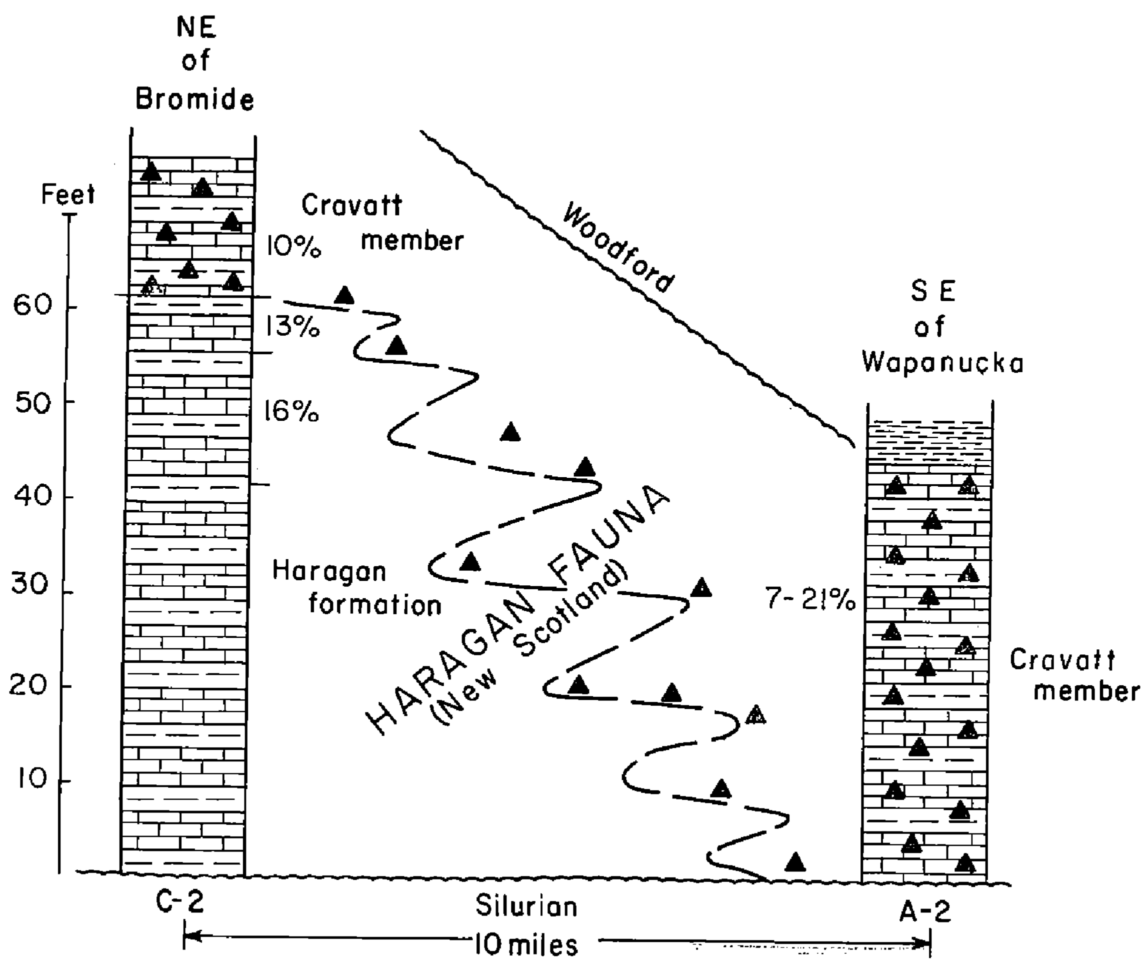


Figure 3. Columnar sections showing the inferred relation of section A2 described above and section C2 (see description under GEOGRAPHIC AND STRATIGRAPHIC SOURCE OF FOSSIL COLLECTIONS). An explanation of the symbols used is given in figure 2.

tion as it is a lithologic unit which can be mapped (Amsden 1957, p. 40), thus conforming to the conventional definition of a formation (American Geol. Institute, Glossary of Geology, 1957, p. 114).

BOIS D'ARC MEGAFAUNA

The Bois d'Arc megafauna, like that of the Haragan, is strongly dominated by the brachiopods. About half of the species listed by Reeds are brachiopods, and Maxwell's Bois d'Arc fauna (equals the Fittstown of this report) comprises 29 species of brachiopods and only 14 species of all other megafaunal elements.

The Bois d'Arc collection recently assembled is strongly concentrated in the brachiopods, both in numbers of species and in numbers of specimens. There are approximately 1,700 brachiopod specimens in this collection and only 150 specimens of all other megafaunal elements combined. The brachiopods are referred to 40 species. The other megafaunal elements have not yet been described, but a preliminary examination indicates that all of these fossils would probably not total more than two dozen species. There are 16 specimens of trilobites, most of these being either *Phacops s.l. or Dalmanites s.l.* With rare exceptions the trilobite specimens are incomplete and consist of either isolated pygidia or cranidia. The mollusks are represented by a half dozen specimens of snails, 6 pelecypods and one or two of straight cephalopods. The most common coral is a small, solitary horn coral, but there are also a few coralla of *Favosites* cf. *F. conicus* and one specimen each of *Pleurodictyum* and *Aulopora.* Bryozoa are relatively uncommon, the combined Fittstown and Cravatt collections including only 20 specimens. Locally *Scyphocrinites* bulbs (*Camarocrinus;* see Amsden 1956, pp. 59-61) are numerous in the Cravatt member, but the dorsal cups of this, or of any crinoid species, are extremely rare. Pelmatozoan debris is a common constituent of most Bois d'Arc calcarenites and some of the crinoid stems reach an unusually large size, with some specimens having a diameter of almost 40 mm. A few sponges have been collected from both the Cravatt and Fittstown members. This preliminary check indicates that most of these species are similar to, if not identical with, those from the Haragan.

I have not observed any inarticulate brachiopods, but this group is presumably present, although specimens are rare, in the

TABLE I

HARAGAN-BOIS D'ARC BRACHIOPOD SPECIES

*—Indicates species confined to the Haragan formation within the Hunton group.

#—Indicates species confined to the Bois d'Arc formation within the Hunton group.

SPECIES	Haragan formation	Bois d'Arc formation: Cravatt member	Bois d'Arc formation: Fittstown member
	Approximate number of specimens in collections		
Orthostrophia strophomenoides parva	300+	15	6
*Skenidium insigne	36	0	0
Levenea subcarinata pumilis	300+	75	6
Rhipidomelloides oblata	300+	200	100
Dicoelosia varica	125	50	1
Isorthis pygmaea	50	3	0
Platyorthis angusta	1	20	7
Anastrophia grossa	100	20	2?
Gypidula (includes specimens identified as G.? sp. and cf. G. multicostata)	4	2	1
Strophonella (S.) bransoni	60	24	25
Stropheodonta (B.) gibbera	200+	30	6
Stropheodonta (B.) arata	60	8	0
Lissostrophia (L.) lindenensis	4	1	1
Leptostrophia beckii tennesseensis	9	10	21
#Leptostrophia sp. 2	0	0	24
Leptaenisca concava	200+	12	?
Leptaena acuticuspidata	200+	12	0
Leptaena cf. L. rhomboidalis	3	70	80
Schellwienella marcidula	1?	24	25
Schuchertella haraganensis	30	2	0
*Chonetes? sp.	1	0	0
*Plectodonta petila	30	0	0
Sphaerirhynchia lindenensis	90	30	100
Sphaerirhynchia glomerosa	40	1	0
Obturamentella wadei	6	6	40
Camarotoechia? haraganensis	200+	2	0
Camarotoechia ? sp.	4	3	4
*Trigonirhynchia acutirostella	12	0	0
#Costellirostra singularis	0	5	5
#Eatonia medialis	0	10	0
#Eatonia exserta	0?	6	0
Coelospira virginia	50	18	2
Atrypina hami	90	10	0
Atrypa oklahomensis	125	36	25
Kozlowskiella (M.) velata	200	70	18
Howellella cycloptera	12	30	200
Nucleospira ventricosa	15	5	0
Meristella atoka	300+	80	40
#Meristella sp. 2	0	20	20
Cyrtina dalmani nana	24	11	2?
#Cyrtina dalmani?	0	0	2
Trematospira (probably includes at least 3 different species; see p.....?....)	7	2	1
Rhynchospirina maxwelli	200+	35	1
Rensselaerina haraganana	50	10	1

Bois d'Arc strata. The forty species of articulate brachiopods described in this report are listed in Table 1.

FAUNAL DISTRIBUTION

The Bois d'Arc formation has been studied in all outcrop belts in the Arbuckle Mountain region and the Criner Hills, and an effort has been made to get fossils from all parts of the formation in all geographic areas. The location of the stratigraphic sections from which collections were made is given in the chapter on STRATIGRAPHIC AND GEOGRAPHIC LOCATION OF FOSSIL COLLECTIONS, and is shown in figure 8.

Before discussing this brachiopod fauna it should be noted that it is more difficult to collect good specimens from the Bois d'Arc strata than from the Haragan, because Haragan fossils commonly weather out free whereas this condition is rare in the Bois d'Arc. In a few places shells do weather out of the basal Cravatt, mostly as silicified steinkerns, and rarely free specimens can be broken out of the Fittstown; however, most of the collection consists of specimens partly embedded in matrix. Fossil silicification is not uncommon in the Bois d'Arc and in several places collections have been obtained from the Cravatt strata by etching. Unfortunately the silicification in most beds is incomplete and the preservation poor. The writer has found only one locality (P2, near Fittstown) where the silicification is excellent and from which a moderately large and well preserved fauna has been etched out of the basal Cravatt member. These fossils, many of which show the internal character, have aided greatly in studying the Cravatt fauna, and several are illustrated on the plates accompanying this report. In spite of the collecting difficulties it has been possible to assemble a fairly large Bois d'Arc collection with good representation of most species.

I have determined the precise stratigraphic position of all fossils used in this report and have assigned each specimen to either the Cravatt or Fittstown member. Stratigraphically these two members grade into one another, but the calcarenites and marlstones which comprise the lithologic extremes are distinct, and the fossils collected from these two rock-types are somewhat different. Actually there is a greater similarity between the fauna of the Cravatt marlstones and that of the Haragan, than between the fauna of the Cravatt marlstones and that of the Fittstown calcarenites (fig. 5). This more or less distinct faunal character of the calcarenites has been observed by earlier investigators. Girty (1889, p. 547) noted that that fauna from his bed No. 2 (a white limestone almost certainly equivalent to the Fittstown of this report) "is dissimilar to everything else in the section, and the fauna, while containing several species common to the other beds [i.e. Cravatt and Haragan], shows much individuality." Maxwell (1936, p. 131-136) went even further and restricted the Bois d'Arc formation to the calcarenites (=Fittstown), stating that "its fauna and lithology separate it distinctly from the Cravatt" (which he united with the Haragan in his Kite group). There is no doubt that the Cravatt and Fittstown show faunal differences; however, in my opinion these differences reflect changes in ecology rather than time. This faunal variation can be directly related to lithology; for example certain species are most abundant in (but generally not restricted to) the calcarenites and wherever this lithologic type is present this particular fossil is present, regardless of whether it is high or low in the stratigraphc section. Before taking up the entire fauna it might be well to cite the stratigraphic distribution of *Howellella cycloptera* and *Kozlowskiella (M.) velata* as these two brachiopods give an excellent example of the relationship between lithology and abundance of specimens. An examination of the range of these two species as given in figure 4 shows that although both range throughout the Haragan, Cravatt and Fittstown, their relative abundance within these units is in inverse ratio. From this it would seem logical to conclude that *H. cycloptera* preferred the clearer waters of the Fittstown facies whereas *K. (M.) velata* was better adapted to the somewhat turbid waters of the Cravatt and Haragan facies.

The distribution of all Haragan, Cravatt and Fittstown brachiopod species is given in figure 4, a chart designed to show the range of species and the relation between the number of specimens (relative abundance) and lithology. Before discussing the topic of brachiopod distribution some comments are needed on two aspects of this illustration. *First*, it is easier to collect from the Haragan than from the Cravatt, and easier from the Cravatt than from the Fittstown. This undoubtedly affects the distribution

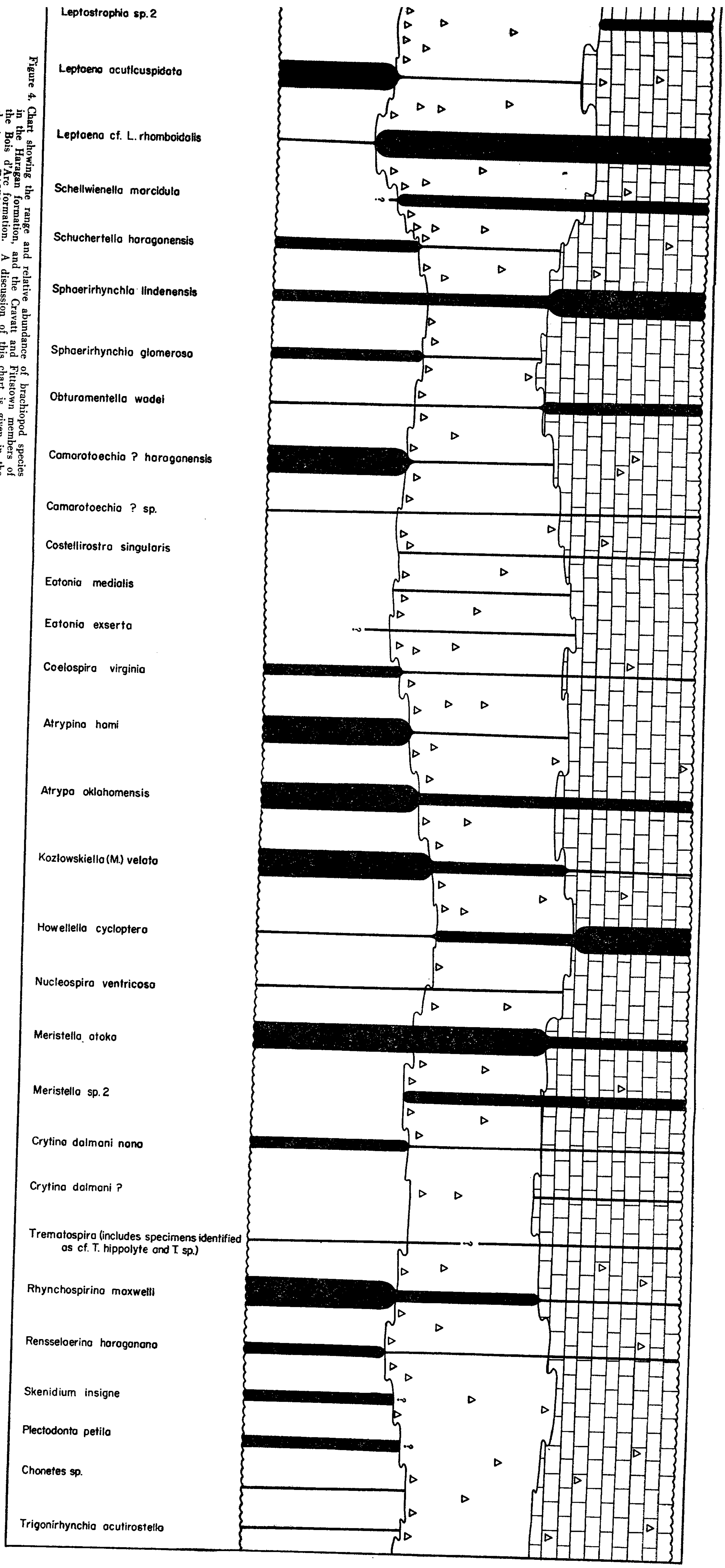


Figure 4. Chart showing the range and relative abundance of brachiopod species in the Haragan formation, and the Cravatt and Fitstown members of the Bois d'Arc formation. A discussion of this chart is given in the chapter on FAUNAL DISTRIBUTION.

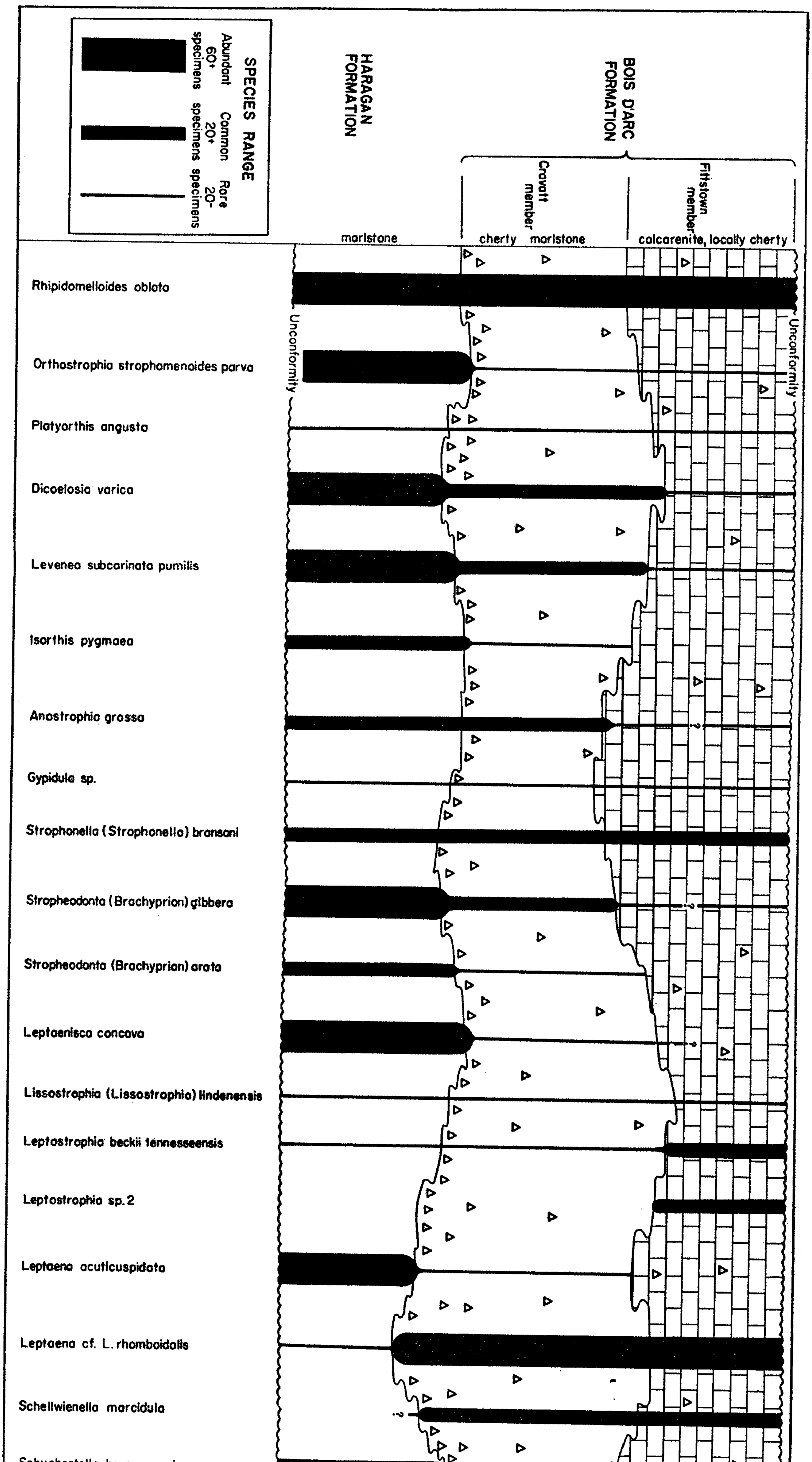


Figure 4. Chart showing the range a
in the Haragan formation,
the Bois d'Arc formation.
chapter on FAUNAL DIST

shown in figure 4, although if it were the dominant or controlling factor all species would show a progressive decline in abundance from the Haragan to the Fittstown, whereas a glance at the chart shows that such is not the case. Nevertheless, it seems probable that some of the species which are rare in the marlstone and unknown from the calcarenites may actually be present in the latter although difficult to find owing to rarity. *Second,* this chart represents a generalization of the stratigraphic and lithologic information which I have assembled. Only 3 lithologic types, or lithofacies, are given (marlstone, cherty marlstone and calcarenite), and the boundaries separating these types are shown as abrupt, whereas there is actually a complete gradation from a marlstone with high insoluble content to a calcarenite with low insoluble content. The transitional nature of the stratigraphic contact is more realistically depicted in figure 2, but even in this illustration only 3 lithofacies are shown. The range chart will be more understandable if it is kept in mind that the change in relative abundance of any particular species is gradational as are the lithologic types.

Forty Bois d'Arc brachiopods are listed in the range chart (fig. 4; table 1) of which 28 species, or 70% are common to both the Cravatt and Fittstown biofacies. This is a substantial percentage of common species, especially in view of the lithologic differences between the two members. Furthermore, since it is more difficult to collect from the calcarenites than from the marlstones, the greater number of species present in the Cravatt (38) than in the Fittstown (29) may be at least in part artificial*. This chart plainly brings out the relationship between lithology and abundance. In spite of the large number of species common to the two members the relative abundance of most species is different; some species which are numerous in one member are rare in the other, and the total effect of this is to produce two faunas showing "much individuality". In the writer's opinion the Bois

* Another factor is worth mentioning although its effect is of lesser significance. Some species such as *Nucleospira ventricosa* and *Stropheodonta* (*B.*) *arata*, which at the present time are unknown from the Fittstown member, have an actual range from the Haragan formation almost throughout the Bois d'Arc formation. Both of these species are present in the upper part of the Cravatt member at P17-D, in a bed that is only a few feet below the Frisco contact; the Fittstown lithofacies is extremely thin, being only 5 feet thick at P17, and most of the Bois d'Arc in this area is in the Cravatt lithofacies.

d'Arc fossils are all part of a single, closely related fauna, and such differences as exist within the formation are the result of local ecological variations at the time of deposition.

HARAGAN—BOIS D'ARC BRACHIOPODS

A comparison of the Bois d'Arc and Haragan brachiopod faunas reveals a close similarity and strongly supports the stratigraphic evidence of a facies relationship. Almost all of the brachiopod genera represented in the Bois d'Arc formation are also present in the Haragan (figs. 4, 6), and of the total number of Haragan-Bois d'Arc brachiopod species (44), 34 species or 77% are common to both formations, and 26 species or 59% are common to the Haragan and both the Cravatt and Fittstown members. The relationship of the Haragan, Cravatt and Fittstown in terms of brachiopod species is shown graphically in figure 5. This frequency diagram, which is a summary of the data given in figure 4 (and table 1), shows that the number of species which are restricted to a particular formation or member is small. It will be noted that a fair number of species are confined to the combined Haragan-Cravatt, but this is not surprising in view of the lithologic similarity of these two. In my opinion the Haragan-Bois d'Arc fossils comprise a compact and closely related fauna, which for purposes of correlation with faunas of other areas should be treated as a single faunal entity.

PALEOECOLOGY

The lithologic and faunal character of the Cravatt member, exclusive of chert,* points to an environment of deposition like that of the Haragan (Amsden 1958, p. 17). The almost complete absence of shallow water features such as cross-bedding and channelling, combined with the fine-grained character of the insoluble clastic content (Amsden 1957, p. 42) suggests deposition in quiet waters below the zone of effective wave action. Some of the fossil preservation equals or surpasses that of the Haragan in its excellence, and at location P17-D specimens of *Howellella cycloptera* and *Nucleospira ventricosa* have been found with the

* It is difficult to evaluate the chert in terms of the environment of deposition, as it is not known whether this is a primary, chemically precipitated chert (including a penecontemporaneous replacement chert), or a secondary replacement taking place after deposition and induration.

delicate, hair-like spines preserved in place; such shells must have been buried in place by extremely quiet deposition (biocoenose). The waters were slightly turbid, and the bottom muddy, as the Cravatt lithofacies commonly has between 10 and 30 percent HCl insolubles. On the other hand, the calcarenites of the Fittstown lithofacies point to deposition in much clearer waters, as these strata have a clastic content (excluding the carbonate por-

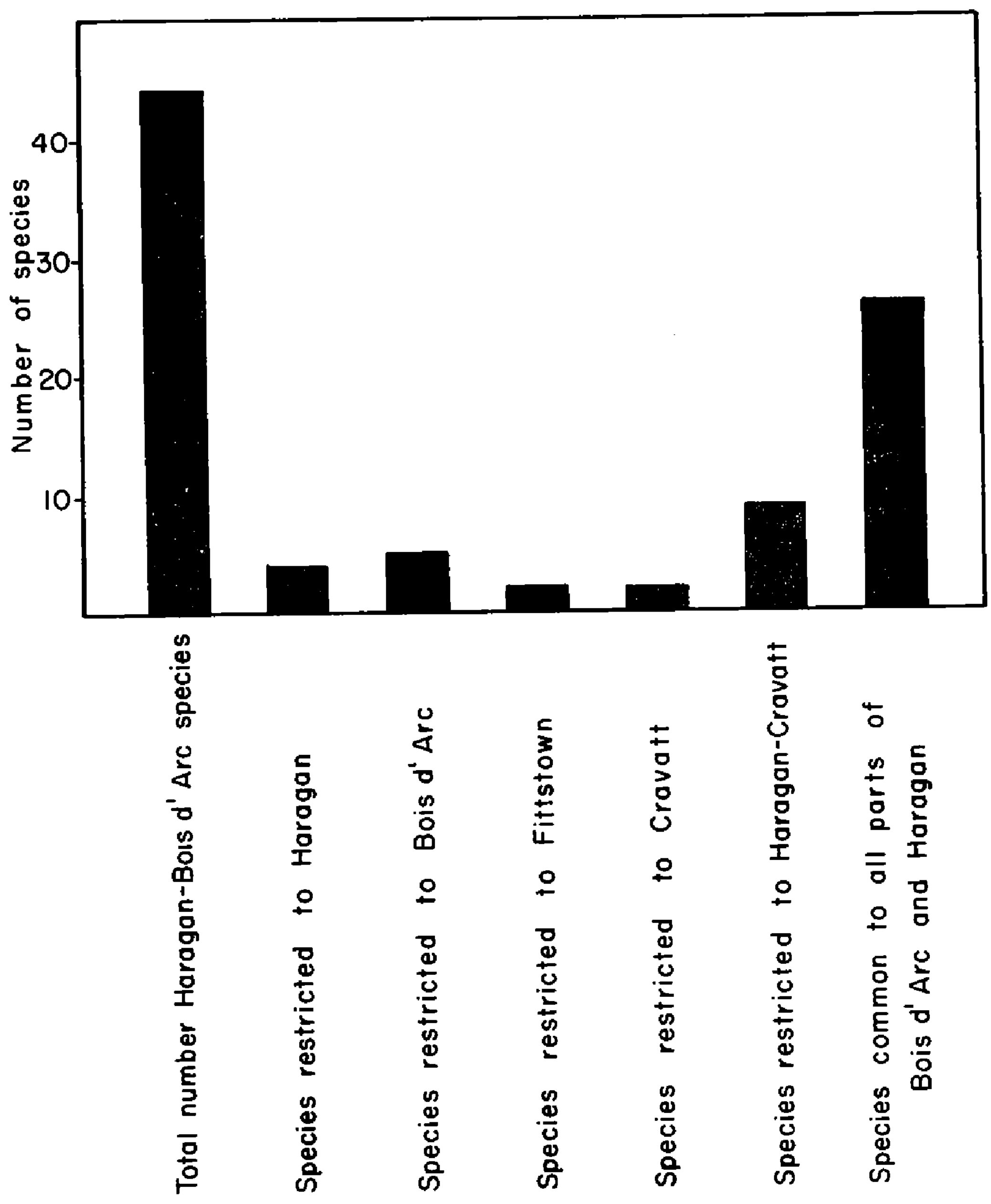


Figure 5. Frequency diagram showing the distribution of brachiopod species within the Haragan and Bois d'Arc formations. This is based on the data given in table I and figure 4.

tion) which is generally below 10 percent. The Fittstown seas must have teemed with life as the rock is composed in large part of fossil debris. Brachiopods, along with such other groups as the trilobites and Bryozoa, contribute substantially to the rock, but the predominant fossil material is composed of pelmatozoan plates and at least locally the Fittstown seas (as well as the Cravatt and Haragan seas) must have been inhabited by large crinoid colonies. Peels and thin-sections show that much of the fossil material consists of fragments which are partly or wholly engulfed in a matrix of clear calcite. Some of the fragmentary character appears to be the result of recrystallization, but at least a part seems to be the result of breakage during deposition. Part of the shells of the Fittstown fauna were probably moved by current action, being concentrated into shell beds. According to this interpretation at least some of the fossil material represents a thanatocoenose, an explanation further supported by the fact that most of the brachiopods collected from this member are free valves. Such current action, however, must have been mild as the Fittstown is generally evenly bedded with almost no evidence of channelling, and no doubt many of the Fittstown organisms were buried almost in situ. Moreover, although most of the fossils are found as free valves they show only minor evidence of abrasion. The clearer waters of calcarenite deposition must have shifted from place to place, being locally displaced at frequent intervals by the more turbid waters of the Cravatt facies. In general the Haragan-Bois d'Arc seas cleared towards the close of this time, because in most areas the depositional sequence is towards a decreasing clastic (insoluble) content. This is not everywhere true as there are a number of places where the uppermost Bois d'Arc beds have a relatively high insoluble content.

AGE AND CORRELATION

Girty treated the fossils from that part of the Hunton strata now referred to the Haragan and Bois d'Arc formations as a single collection, although he did note that the fossils from the upper limestones were slightly different (see FAUNAL DISTRIBUTION). He assigned this fauna an early Helderbergian age and stated that it was approximately equivalent to the *Delthy-*

ris shaly limestone (New Scotland) of New York (1899, p. 550). Girty also remarked on its similarity to the Helderbergian strata of western Tennessee. Some years later Reeds (1911, p. 258; 1926, p. 13) separated the Bois d'Arc from the Haragan and correlated the latter with the New Scotland and the Bois d'Arc with the Becraft. Maxwell also recognized New Scotland and Becraft equivalents in the Hunton, but his stratigraphic and faunal division did not coincide with that of Reeds. He united the Haragan and Cravatt in a Kite group and correlated the fauna with that of the New Scotland of New York. The Bois d'Arc formation was restricted to the upper limestones (approximately equivalent to the Fittstown of this report) and was correlated with the Becraft of New York.

The interpretation given in this report is different from that of either Reeds or Maxwell. I can find no stratigraphic nor paleontologic evidence for a time break within the Haragan-Bois d'Arc sequence and the fossils from these strata are believed to represent a single faunal entity (see HARAGAN-BOIS D'ARC BRACHIOPODS). This fauna is Helderbergian in age and has a substantial number of species in common with the New Scotland of New York. In an earlier paper I (1958, p. 18-21) have compared the Haragan and New Scotland brachiopod faunas at some length, and with only slight modifications this comparison is applicable to the Bois d'Arc brachiopod fauna, as it is substantially the same as the Haragan (figs. 4, 5; table 1). There are 5, possibly 6, Bois d'Arc brachiopod species which are not present in the Haragan. Three of these, *Leptostrophia* sp. 2, *Meristella* sp. 2, and *Eatonia exserta* (which may be present in the Haragan) are known only from Oklahoma and therefore have no application to regional correlation. The other two, *Eatonia medialis* and *Costellirostra singularis* are common in the New Scotland beds of New York where they are associated with a characteristic Helderbergian fauna.

It is interesting to note that the Ross limestone and Birdsong shale of Tennessee, which were formerly considered to have discrete faunas of slightly different age (Dunbar 1919, p. 63-64), are now believed to be facies of one another (Wilson 1949, p. 280-306; Amsden 1958, p. 22-24). It seems quite possible that

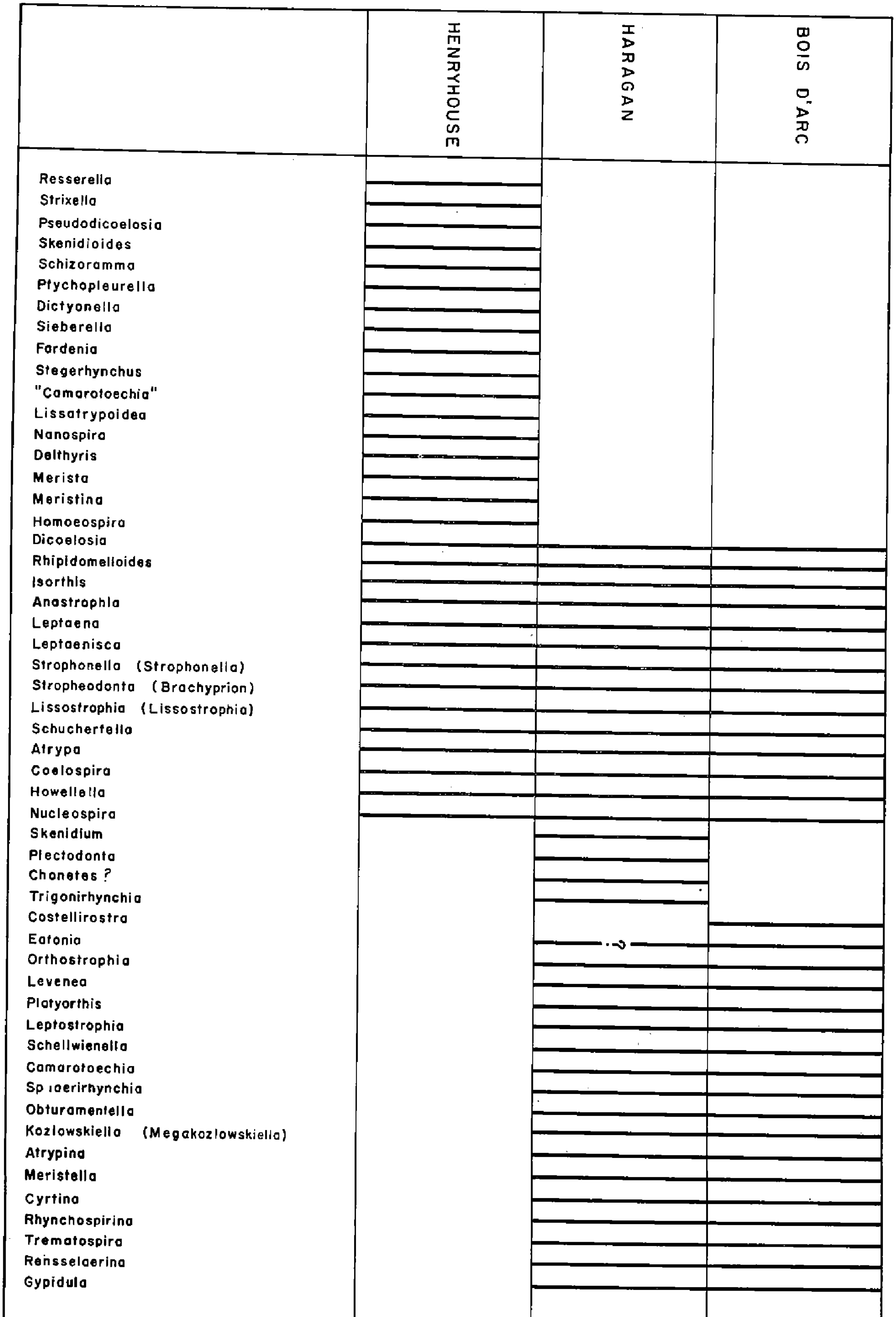


Figure 6. Chart showing the range of brachiopod genera in the Henryhouse,

the subdivisions of the New York Helderberg represent a similar facies relationship, but this can only be substantiated by a careful biostratigraphic study.

The Haragan-Bois d'Arc fauna is believed to be equivalent to that of at least a part of the Ross formation or Linden group (Amsden 1958, p. 22-23) of western Tennessee and the Bailey limestone of Missouri.

HENRYHOUSE—HARAGAN—BOIS D'ARC BRACHIOPODS

I have previously made a detailed comparison of the Henryhouse and Haragan brachiopods (1958, p. 15-17), but it seems desirable at this time to summarize the data pertaining to brachiopod distribution in the Henryhouse-Haragan-Bois d'Arc strata. It should be emphasized that no species is common to the Henryhouse and Haragan-Bois d'Arc, although a number of the Henryhouse genera do range into the overlying beds. Figure 6 was prepared to show the range of brachiopod genera in the post-Chimneyhill, pre-Frisco part of the Hunton, and those data given on this chart are graphically summarized in the frequency diagram, figure 7. These illustrations bring out the similarity between the generic suites of the Haragan and the Bois d'Arc, and the marked difference between these assemblages and that of the Henryhouse. The unconformity separating the Henryhouse from the overlying Haragan-Bois d'Arc covers a considerable span of time. An early Ludlovian age is now assigned to the Henryhouse so that this time break represents most of the Upper Silurian.

The generic ranges as given in figure 6 apply only to the Hunton strata in Oklahoma, and several of the genera which are restricted in their local development have a much more extensive geologic range elsewhere. This list of genera is, of course, subject to future revisions and since such studies generally tend to recognize finer subdivisions (sometimes bluntly referred to as splitting), the effect will probably be towards increased emphasis on the Henryhouse-Haragan faunal break.

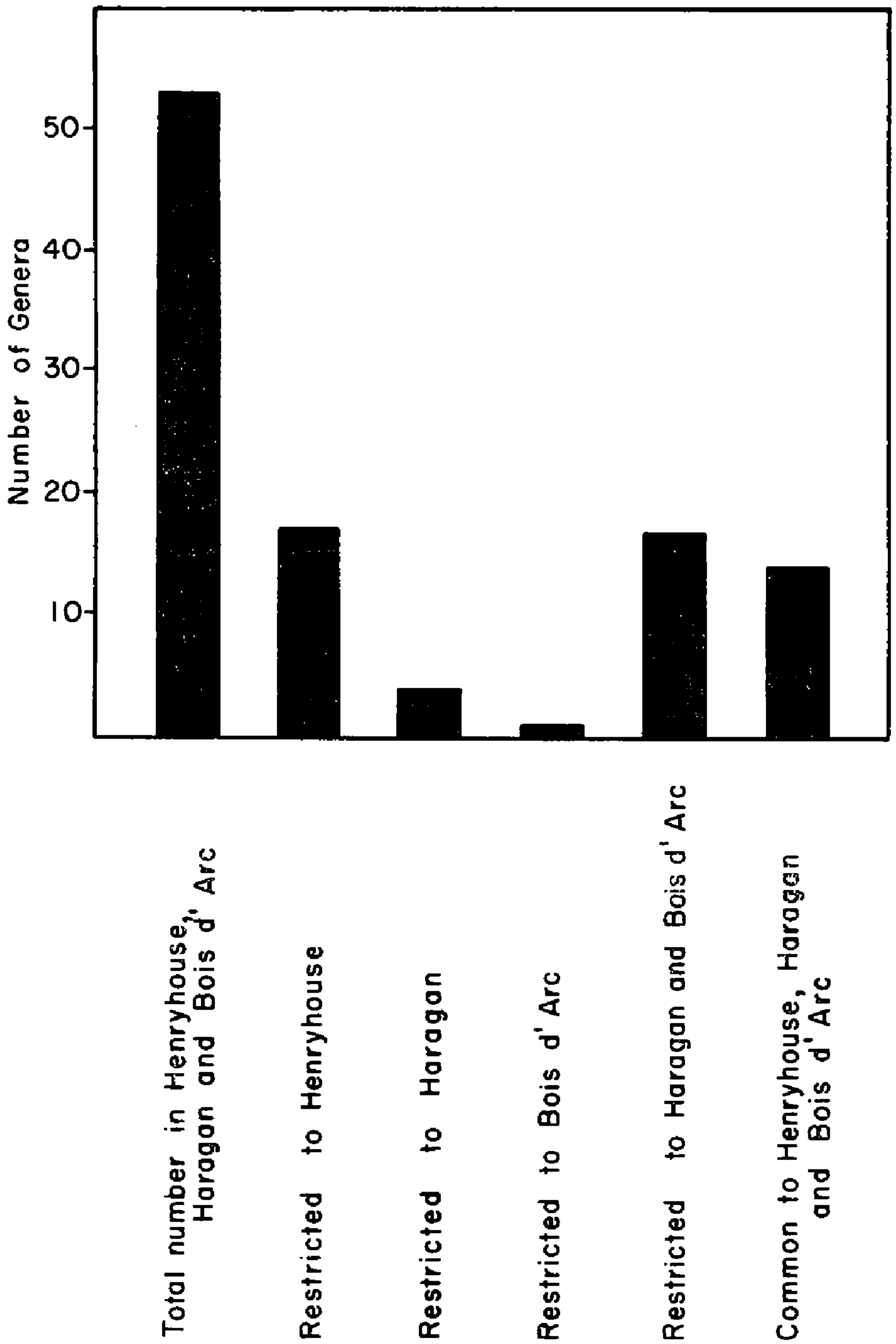


Figure 7. Frequency diagram showing the distribution of brachiopod genera in the Henryhouse, Haragan and Bois d'Arc formations. This is based on the data shown in figure 6.

GEOGRAPHIC AND STRATIGRAPHIC SOURCE OF FOSSIL COLLECTIONS

The geographic and stratigraphic distribution of each species is given in the section on BRACHIOPOD DESCRIPTIONS, and, for the illustrated specimens, on the plate explanations. This information is presented in an abbreviated form; for example; Cravatt member, collection J11-F; Fittstown member, collection M3-E. The first letter and number refer to the stratigraphic section, i.e. J11 is stratigraphic section 11 in Johnston County and M3 is stratigraphic section number 3 in Murray County. The geographic location of all sections is given in the following pages and is also shown on figure 8. The letter following the section number refers to the stratigraphic position of the fossil collection. Thus collection F of J11 was made 60 to 80 feet above the base of the Cravatt member(see page 32), and colletion E of M3 was made 39 to 78 feet above the base of the Fittstown member (see page 34). The stratigraphic information is here presented in much abbreviated form, but it is based on measured sections for which comprehensive data are available. In a future publication I plan to describe these and other sections in detail, giving insoluble residues, chemical analyses, information from peels and thin-sections, as well as faunal lists. In this report only skeletal sections are given, furnishing formation and member names with summary lithologic descriptions, and the stratigraphic position of all fossil collections herein mentioned. This method naturally omits much vital data, but it has the advantage of permitting collections to be readily located, both geographically and stratigraphically.

STRATIGRAPHIC SECTION A2

Southeast of Wapanucka

This section is described in the chapter on BOIS D'ARC STRATIGRAPHY

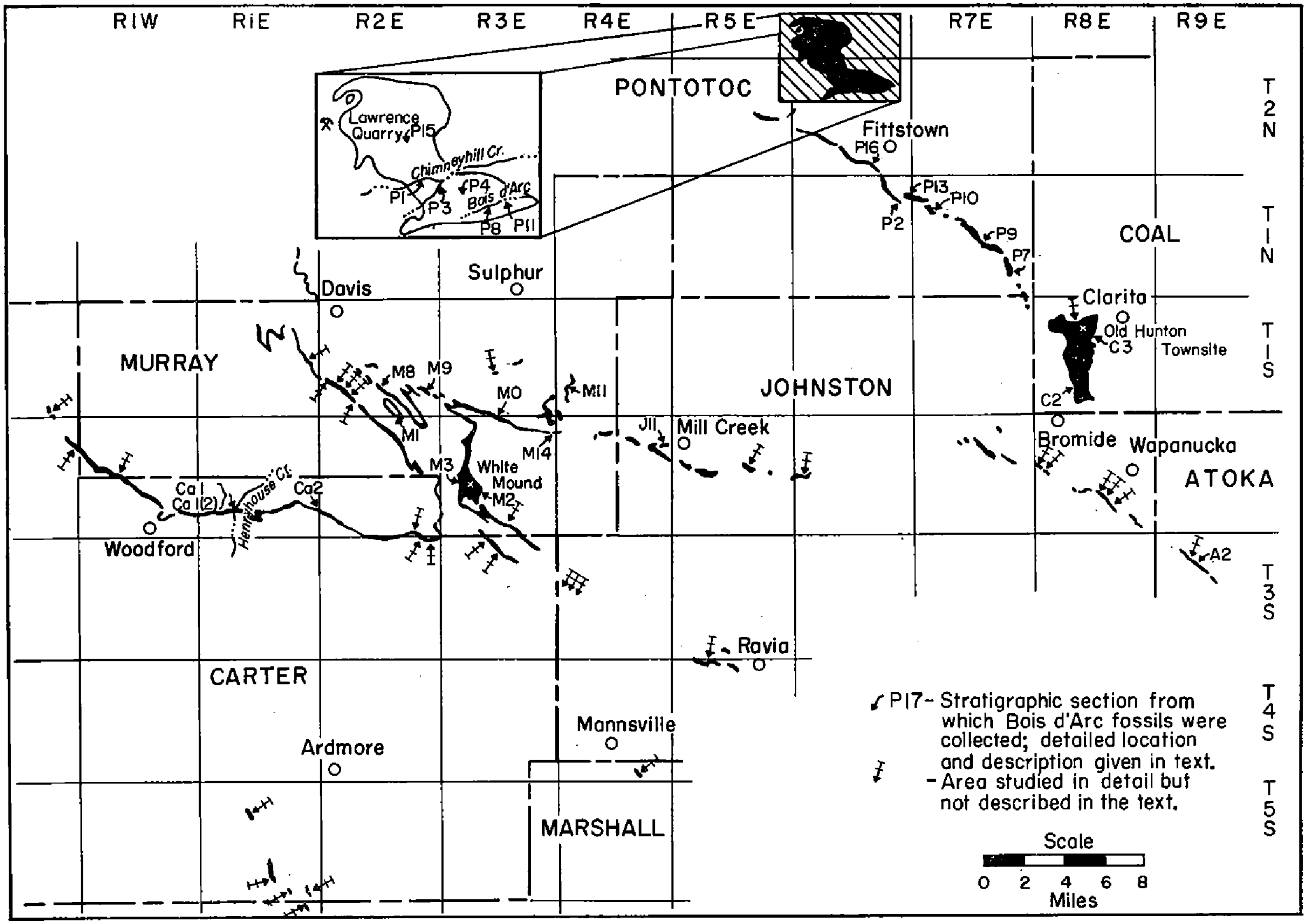


Figure 8. Generalized outcrop map of the Hunton group showing the location of the stratigraphic sections from which the fossils used in this study were collected.

STRATIGRAPHIC SECTION C1

Near old Hunton townsite

Location: NW½ sec. 8, T. 1 S., R. 8 E., Coal County, Oklahoma.

Covered

Bois d'Arc formation

Fittstown member: gray, fossiliferous, coarse calcarenite; HCl insoluble residue 1.8%.

feet above Haragan-Bois d'Arc contact

C1-Q .... 105 to 107

Covered (Cravatt?) .... 55 to 105

Cravatt member: yellowish-gray marlstone with nodules of brown-weathering, porous chert; marlstone HCl insoluble residue 19%.

C1-P .... 0 to 55

Haragan formation: yellowish-gray marlstone (see Amsden 1958, p. 26).

STRATIGRAPHIC SECTION C2

Northeast of Bromide

Location: NW¼ sec. 33, T. 1 S., R. 8 E.; this section is located about 1 mile northeast of Bromide, near the southern end of the Hunton outcrop belt that includes old Hunton townsite.

Covered

Bois d'Arc formation

Cravatt member: yellowish-gray marlstone with many nodules of brown-weathering, porous chert; marlstone HCl insoluble residues 10.4%.

C2-K .... 40 feet (exposed to top of hill).

Haragan formation: yellowish-gray, marlstone, partly covered in the lower part; two HCl insoluble residues calculated, 13.1% and 15.8%. This interval is fossiliferous and yields such characteristic Haragan fossils as *Levenea subcarinata pumilis, Orthostrophia strophomenoides parva, Meristella atoka* and *Camarotoechia? haraganensis.* In this area the Haragan rests upon the Henryhouse formation (see Amsden 1958, p. 26; also fig. 3 of this report).

STRATIGRAPHIC SECTION C3

Southwest of Clarita

Location: NE¼ NE¼ sec. 16, T. 1 S., R. 8 E.; this is located in a small gully about 1½ miles southwest of Clarita, Coal County, Oklahoma.

Frisco formation: gray to brownish-gray calcarenite; beds to a foot or so in thickness, weathering with a pitted or "pot-holed" surface; megafossils rare.

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite with marlstone partings; beds to 5 or 6 inches. Collection C3 from the upper 2 or 3 inches in which all of the rock including the fossils is silicified.

STRATIGRAPHIC SECTION Ca1

West side of Henryhouse Creek

Location: SE¼ sec. 30, T. 2 S., R. 1 E.; this section is located about 300 feet west of Henryhouse Creek. I have measured two stratigraphic sections in the Henryhouse Creek area, the present one, designated Ca1 [or Ca1 (1)], and a second, Ca1 (2) [see below], located in the bed of Henryhouse Creek.

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous marlstone with nodules of brown-weathering, porous chert; partly covered.
Ca1-X .... 25 feet (to top of hill)

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 27).
Ca1-W ....

STRATIGRAPHIC SECTION Cal (2)

Bed of Henryhouse Creek

Location: SE¼ sec. 30, T. 2 S., R. 1 E., this section is located in the bed of Henryhouse Creek, about 300 feet east of section Cal described above.

Woodford formation
Covered .... 3 feet
Bois d'Arc formation

Fittstown member: gray, fossiliferous calcilutite and calcarenite with nodules of vitreous, blue-white chert; two insoluble residues made from the limestone, 3% and 5.5%.
Cal (2)-V .... 18 feet thick

Cravatt member: yellowish-gray, fossiliferous marlstone with nodules of brown-weathering, porous chert; upper part with beds of calcarenite like above and some vitreous chert; contact with above gradational. Two insoluble residues made of chert free samples, 14% and 18%.

	feet above base of formation
Cal (2)-U	61 to 73
Cal (2)-T (covered)	40 to 61
Cal (2)-S	0 to 40

Haragan formation: yellowish-gray, fossiliferous marlstone.
Cal (2)-R ....

STRATIGRAPHIC SECTION J11

West of Mill Creek town

Location: SE¼ NW¼ sec. 12, T. 2 S., R. 4 E.; section located in the bed of a small stream, about 3/4th mile west of Mill Creek town, Johnston County, Okla. (See fig. 2 of this report and Amsden 1958, p. 28).

Covered (much Woodford float)

Bois d'Arc formation

Fittstown member: gray calcarenite with beds of yellowish-gray marlstone; nodules of vitreous chert present; HC1 insoluble residues range from 3% to 15%, most being under 6%. There is considerable argillaceous material present, especially in the lower part, and the boundary with the underlying Cravatt is poorly defined and difficult to locate (see fig. 2).

	feet above base of formation
J11-L	135 to 140
J11-K	117 to 135
J11-J	91 to 117
J11-I (covered)	75 to 91
J11-H	55 to 75
J11-G	0 to 55

Cravatt member: yellowish-gray marlstone with nodules of vitreous and porous chert; rare beds of calcarenite; HC1 insoluble residues range from 10 to 20%.

	feet above base of formation
J11-F	60 to 80
J11-E	0 to 60

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 28).

J11-D ....

STRATIGRAPHIC SECTION M1

Vines dome

Location: NW¼ NW¼ sec. 2, T. 2 S., R. 2 E.: located at the southeastern end of Vines dome, Murray County, Oklahoma. (See Amsden 1958, p. 29).

Woodford formation

Bois d'Arc formation

Cravatt member: argillaceous, yellowish-gray, fossiliferous calcilutite and marlstone; nodules of brown-weathering, porous chert in the lower part, becoming vitreous in the upper part. HCl insoluble residues range from 5 to 30%, averaging about 15%.

	feet above base of member
M1-N and O	26 to 52
M1-M	0 to 26

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 29).

STRATIGRAPHIC SECTION M2

Southeast of White Mound

Location: SE¼ NE¼ sec. 20, T. 2 S., R. 3 E.; located about 1,000 feet southeast of White Mound, Murray County, Oklahoma. (see Amsden 1958, p. 29; 1958 C, p. 134, fig. 5).

Bois d'Arc formation

Cravatt member: yellowish-gray marlstone with nodules of brown-weathering, porous chert; HCl insoluble residues, 11%. The basal part of the Cravatt member caps a small ridge, and the fossils collected from this member and marked M2-0 are all from the lower 10 feet.

M2-0 ....

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 30).

STRATIGRAPHIC SECTION M3

Northwest of White Mound

Location: SW¼ SW¼ sec. 17, T. 2 S., R. 3 E., Murray County, Oklahoma. This section is located in the bed of Haragan Creek, about 3,000 feet northwest of White Mound, (see fig. 2; Amsden 1958 C, p. 134, fig. 5).

Woodford formation

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite with some beds of calcilutite, especially in the lower part; grades into underlying strata; nodules of vitreous chert. Insoluble residues range from 4 to 10%, average about 7%.

	feet above base of member
M3-F	78 to 83
M3-E	39 to 78
M3-D	9 to 39
M3-C	0 to 9

Cravatt member: yellowish-gray, fossiliferous marlstone with nodules of vitreous to porous chert; few beds of calcarenite in upper part and this member grades into the overlying strata. Insoluble residues range from 9 to 17%, average about 12%.

	feet above base of formation
M3-B	52 to 57
M-3-A	0 to 52

Haragan formation: yellowish-gray, fossiliferous marlstone.

STRATIGRAPHIC SECTION M8

Southeast of Dolese Bros. Rayford Quarry

Location: SE¼ NE¼ sec. 28, T. 1 S., R. 2 E.; this section is located about ¼ mile southeast of the Dolese Rayford Quarry, Murray County, Okla. (see Amsden 1958, p. 31).

Covered (Woodford float)

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering tripolitic chert in the lower part, becoming vitreous above; few beds of calcarenite in upper part.

	feet above base of formation
M8-R	28 to 47
M8-Q	25 to 28
M8-P	0 to 25

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 31).

STRATIGRAPHIC SECTION M9

West of Southern Rock Asphalt Quarry

Location: NW¼ SE¼ sec. 25, T. 1 S., R. 2 E.; a short distance west of the Southern Rock Asphalt Quarry, Murray County, Okla. (see Amsden 1958, p. 32).

Covered

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous marlstone with nodules of vitreous to porous chert. There is about 20 feet of this member exposed in the scarp face and collection M9-E was collected from this basal part of the member.

M9-E ....

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 32).

STRATIGRAPHIC SECTION M10
Buckhorn Ranch

Location: SW¼ SE½ sec. 33, T. 1 S., R. 3 E.; this section is located on the Buckhorn Ranch, just east of a small stream flowing north into Little Buckhorn Creek (see Amsden 1958, p. 32).

Bois d'Arc formation

Fittstown member: Gray, fossiliferous calcarenite in beds to 6 inches; locally with much glauconite. No beds of calcilutite observed and the contact with the underlying Cravatt member is abrupt and well defined which is unusual for these members.

M10-P .... 25 feet thick

Cravatt member: yellowish-gray, fossiliferous marlstone with nodules of brown-weathering, porous chert in the lower part.

	feet above base of formation
M10-0	20 to 47
M10-N	0 to 20

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 32).

STRATIGRAPHIC SECTION M11
East of Little Buckhorn Creek

Location: SW¼ SE¼ sec. 30, T. 1 S., R. 4 E.; this section is located on the C. H. Abernathy Ranch, about 1 mile east of the Little Buckhorn Creek, Murray County, Okla. (see Amsden 1958, p. 33).

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering, tripolitic chert in the lower part. The lower part is highly argillaceous but this decreases upwards; only rare calcarenite beds present in the upper portion.

	feet above base of formation
M11-E	128 to 148
M11-D	68 to 128
M11-C	0 to 68

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 33).

STRATIGRAPHIC SECTION M14

West of Oklahoma Highway 18

Location: NE¼ SE¼ sec. 2, T. 2 S., R. 3 E.; this section is located about 100 yards west of Oklahoma Highway 18, near the place where the highway crosses a small stream; Murray County, Okla. (see Amsden 1958, p. 33).

Covered (Woodford float)

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite in beds to 6 inches; parts strongly glauconitic; no chert observed.

M14-L .... 25 feet thick

Cravatt member: yellowish-gray, argillaceous calcilutite with nodules of chert, porous in lower part becoming vitreous above; beds of calcarenite in upper part and grading into the overlying member.

	feet above base of formation
M14-K	32 to 50
M14-J	0 to 32

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 33).

STRATIGRAPHIC SECTION P1

Chimneyhill Creek

Location: This section is located along the banks of Chimneyhill Creek (South Fork of Jackfork Creek) extending from about the center SE¼ sec. 5 into the SW¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County, Oklahoma. (see Amsden 1958, p. 34).

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous calcilutite with nodules of brown-weathering, porous chert; there is 20 to 30 feet of this member partially exposed between the Haragan and the top of the hill, and the fossil collection P1-V was made from this part.

P1-V ....

Haragan formation: yellowish-gray, fossiliferous marlstone with a 2 to 3 feet bed of gray, highly fossiliferous calcarenite (see Amsden 1958, p. 34).

STRATIGRAPHIC SECTION P2

South of Fittstown

Location: This section covers the strata exposed in a small quarry about 200 feet east of Oklahoma Highway 99, about 3 miles south of Fittstown, Pontôtoc County, Oklahoma; NW¼ sec. 12, T. 1 N., R. 6 E. (see Amsden 1958, p. 34).

Bois d'Arc formation

Cravatt member: yellowish-gray, argillaceous calcilutite with some beds of coarse calcarenite; nodules of brown-weathering, porous chert. The base of this member forms the lip of the quarry with about 10 feet of strata well exposed above this; the lower 4 or 5 feet of P2-B carries well-silicified fossils and a number of excellent specimens were obtained by etching.

P2-B ....

Haragan member: yellowish-gray, fossiliferous marlstone.

P2-A ....

STRATIGRAPHIC SECTION P3

Cedar Hill

Location: The complete section P3 covers the entire Hunton group and extends over a large geographic area, from the NW¼ sec. 9 to the NE¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County. That part covering the Bois d'Arc formation, which is the only part here summarized, extends from Cedar Hill (SE¼ sec. 4) north along Chimneyhill Creek to the NE¼ sec. 4. A columnar section of this is illustrated in figure 2. The Haragan and Henryhouse parts of P3 are summarized in Amsden 1958, p. 35.

Woodford formation

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite; interbedded with argillaceous calcilutite in the lower part and grading into the underlying member.

	feet above base of member
P3-JJ	53 to 58
P3-II	51 to 53
P3-HH	40 to 51
P3-GG	27 to 40
P3-FF	23 to 27
P3-EE	18 to 23
P3-DD	15 to 18
P3-CC	0 to 15

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering, porous chert in the lower part. Upper part with beds of calcarenite and grading into overlying member.

	feet above base of formation
P3-BB	12 to 33
P3-AA (=P3-Y)	0 to 12

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 35).

STRATIGRAPHIC SECTION P4

Small quarry southeast of Cedar Hill

Location: This section includes a small quarry on the southeast side of the road, SW¼ SW¼ sec. 3, T. 2 N., R. 6 E., Pontotoc County, Oklahoma. (see Amsden 1958, p. 36).

Bois d'Arc formation

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering, tripolitic chert; the basal part of the Cravatt member caps the ridge and collection P4-C was taken from the lower 20 feet.

P4-C ....

Haragan and Henryhouse formations: (see Amsden 1958, p. 36).

STRATIGRAPHIC SECTION P8

Bois d'Arc Creek

Location: SW¼ NW¼ sec. 11, T. 2 N., R. 6 E.; this section starts in the bed of Bois d'Arc Creek and goes north to the top of the ridge bordering the creek; Pontotoc County, Okla. A photograph of the Fittstown (P8-G) - Frisco (P8-H) contact at Section P8 is shown on plate III-B of Amsden 1957.

Frisco formation: gray, fossiliferous calcarenite in beds ranging from 6 to 18 inches in thickness; weathers to a pitted or "pot-holed" surface.

HCl insoluble residue less than 1%.

P8-H ....

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite in beds to 6 inches; beds of yellowish-gray, argillaceous calcilutite present, becoming numerous in the lower part and grading into the underlying member.

HCl insoluble residues range from 2 to 4%.

	feet above base of member
P8-G	27 to 41
P8-F	6 to 27
P8-E	0 to 6

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering, porous chert in the lower part.

	feet above base of formation
P8-D	13 to 27
P8-C	0 to 13

Haragan formation: yellowish-gray, fossiliferous, argillaceous calcilutite.

P8-B ....

STRATIGRAPHIC SECTION P9

Coal Creek

Location: This section is located on the north side of Coal Creek, NW¼ sec. 22, T. 1 N., R. 7 E., Pontotoc County, Oklahoma. (see Amsden 1958, p. 37).

Frisco formation: gray, fossiliferous calcarenite with nodules of light-gray, vitreous chert; beds up to 18 inches in thickness; no argillaceous limestone observed.

P9-R

Bois d'Arc formation

Fittstown member?: gray to yellowish-gray calcarenite and argillaceous calcilutite with nodules of vitreous chert; bedding to 6 inches; this interval has a substantial amount of argillaceous calcilutite or marlstone present and is not therefore typical of the Fittstown member; it grades into the underlying beds.

	feet above base of member
P9-Q	12 to 54
P9-P	0 to 12

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering porous chert.

	feet above base of formation
P9-0	56 to 83
P9-N	34 to 56
P9-M	14 to 34
P9-L	0 to 14

Haragan formation: yellowish-gray, fossiliferous marlstone (see Amsden 1958, p. 37).

STRATIGRAPHIC SECTION P10

Southeast of Fittstown

Location: This section is located about ½ mile south of Oklahoma Highway 61 and approximately 3 miles southeast of Fittstown; NE¼ SE¼ sec. 7, T. 1 N., R. 7 E., Pontotoc County, Oklahoma (see Amsden 1958, p. 37).

Frisco formation: gray, fossiliferous calcarenite with nodules of vitreous chert; beds range up to 3 feet in thickness.
P10-V

Bois d'Arc formation

Fittstown member?: gray, fossiliferous calcarenite with much argillaceous, yellowish-gray calcilutite; nodules of vitreous chert. This is not typical of the Fittstown because of the high percentage of marlstone; it grades into the underlying strata.

	feet above base of member
P10-U	6 to 54
P10-T	0 to 6

Cravatt member: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering, porous chert.

	feet above base of member
P10-S	43 to 54
P10-R	35 to 43
P10-Q	12 to 35
P10-P	8 to 12
P10-0	0 to 8

Haragan formation: yellowish-gray, fossiliferous marlstone; some beds with pink mottling (see Amsden 1958, p. 38).

STRATIGRAPHIC SECTION P11

Bois d'Arc Creek

Location: Bed of Bois d'Arc Creek, about ½ mile east of P9, NW¼ NE¼ sec. 11, T. 2 N., R. 6 E., Pontotoc County, Oklahoma (see Amsden 1958, p. 38). A photograph of the Fittstown (P10-B) - Frisco (P10-C) contact at this section is shown on plate III-A of Amsden 1957.

Frisco formation: gray, fossiliferous calcarenite in beds up to 2 feet thick.

P10-C ....

Bois d'Arc formation

Fittstown member: gray, fossiliferous calcarenite with beds and partings of argillaceous calcilutite; beds to 6 inches in thickness.

	feet below Frisco contact
P10-B	10 to 13
P10-A	0 to 10

STRATIGRAPHIC SECTION P13

Southeast of Fittstown

Location: This section is located in a small quarry on the north side of Oklahoma Highway 61, about 2½ miles southeast of Fittstown; SW¼ SE¼ sec. 1, T. 1 N., R. 6 E., Pontotoc County, Okla. (see Amsden 1958, p. 39).

Covered

Bois d'Arc formation

Cravatt member: yellowish-gray to gray, fossiliferous, argillaceous calcilutite with some beds of calcarenite; nodules of chert. There is about 20 feet of strata exposed in the quarry from which collection P13 was obtained.

STRATIGRAPHIC SECTION P15

North of Chimneyhill Creek

Location: Small hill top glade a short distance east of the section line road, NW¼ sec. 33, T. 3 N., R. 6 E., Pontotoc County.

Bois d'Arc formation

Cravatt member: yellowish-gray marlstone with nodules of brown-weathering porous chert. The Cravatt strata capping this small hill are thin and poorly exposed; collection P15 made from these beds.

P15 ....

Haragan and Henryhouse formations.

Covered .... 10 feet

Henryhouse formation: yellowish-gray, fossiliferous marlstone. A few feet of this formation is exposed in a small glade on the west side of the section line road, NE¼ sec. 32; collection P12 made from these beds (see Amsden 1958, p. 39).

STRATIGRAPHIC SECTION P16

Southwest of Fittstown

An exposure of the upper part of the Fittstown member about a mile southwest of Fittstown; NE¼ SW¼ sec. 35, T. 2 N., R. 6 E., Pontotoc County, Oklahoma. The fossils (collection P16) were collected from the upper 2 to 3 feet of exposed calcarenite; the strata above are covered but probably represent Woodford shale as the Frisco formation appears to be absent in this belt.

STRATIGRAPHIC SECTION P17

Goose Creek

Location: This section is located on the east side of Goose Creek, NW¼ SE¼ sec. 26, T. 1 N., R. 7 E., Pontotoc County, Oklahoma.

Frisco formation: Light-gray, fossiliferous calcarenite in beds to 2 or 3 feet thick; weathers with a "pot-holed" appearance.

P17-A ....

Bois d'Arc formation

Fittstown member: Light-gray, fossiliferous calcarenite with marlstone partings; beds to 6 or 8 inches. Contact with Frisco well exposed.

P17-B .... 5 feet

feet below Friso contact

Cravatt member: Yellowish-gray, fossiliferous marlstone with a few thin beds of calcarenite; no chert observed.

	feet below Frisco contact
P17-C	5 to 8
P17-D	8 to 12

(the following brachiopods collected from P17-D: *Atrypa* sp., *Cyrtina dalmani nana, Howellella cycloptera, Kozlowskiella* (*M.*) *velata, Leptaena* sp., *Meristella atoka?, Nucleospira ventricosa, Obturamentella wadei, Rhipidomelloides oblata, Rhynchospirina* sp., *Sphaerirhynchia lindenensis, Stropheodonta* (*B.*) *arata, Trematospira* sp.

BRACHIOPOD DESCRIPTIONS

The articulate brachiopod fauna described on the following pages consists of 40 species, of which one is new, assigned to 32 genera, none new (a complete list is given in Table 1). This fauna was collected by me and all specimens are from the Bois d'Arc formation unless otherwise noted. The distribution according to members is given although the indistinct nature of the Fittstown-Cravatt boundary leaves the stratigraphic assignment of some collections in doubt (see under BOIS D'ARC STRATIGRAPHY). In an earlier paper (Amsden 1958) on the Haragan brachiopods most of these species have been described at some length and therefore many of the present diagnosis are brief, in many cases confined to a few remarks on the nature of the Bois d'Arc material. If, however, I have any doubts concerning an identification it is clearly stated.

CLASS ARTICULATA (PYGOCAULIA)

SUPERFAMILY ORTHACEA

ORTHOSTROPHIA Hall 1883

ORTHOSTROPHIA STROPHOMENOIDES PARVA

Amsden 1958

Plate I, figure 10.

Orthostrophia strophomenoides parva Amsden 1958 (p. 41-45, pl. I, figs. 22-32, text figs. 3, 4, table 1).

Discussion: This subspecies, which is abundantly represented in the Haragan formation, is rare in the Bois d'Arc, only 20 specimens having been collected from this formation and most of these are fragmentary. In so far as can be determined from this meager representation the Bois d'Arc specimens are like those from the Haragan. They have a transverse shell with a length/width ratio of about 0.86 and a rib count of 8 to 9 costellae in a distance of 5 mm. A poorly preserved pedicle interior and a brachial interior show a structure similar to those from the Haragan.

Figured specimen: Locality P4-C; catalog number OU-1134.

Distribution: My original description of this subspecies was based on specimens from the Haragan formation in which it is well represented at most localities. The Cravatt member of the Bois d'Arc has yielded 15 specimens, most being poorly preserved, from the following localities: C1-P; M1-M; M8-P; M14-J; P4-C; P8-C; P9-L, -M, -N; P10-R. Only 6 fragmentary specimens have been collected from the Fittstown member: Cal-S(2); P10-T; P3-JJ; M3-C; M11-E.

SUPERFAMILY DALMANELLACEA

LEVENEA Schuchert and Cooper 1931

LEVENEA SUBCARINATA PUMILIS Amsden 1958

Plate I, figures 22 - 27

Levenea subcarinata pumilis Amsden 1958 (p. 46-51, pl. I, figs. 1-11, text figs. 5, 6, table 2).

Discussion: The Bois d'Arc specimens of this subspecies are internally and externally like those from the Haragan. The length/width ratio averages about 0.87, and the costellae count averages about 18 per 5 mm, averages which are closely matched by those from Haragan shells (Amsden 1958, table 2, text fig. 6).

The Bois d'Arc specimens of *L. subcarinata pumilis* range up to almost 20 mm in length. The dimensions of 6 specimens from the Cravatt member are given below:

Length mm	Width mm	Ratio Length / Width	Costellae Number in 5 mm
12	14	0.86	19
14	15	0.93	19
16	18	0.89	20
16	18	0.89	18
18	21	0.86	16
18.3	22	0.83	17

This subspecies is rare in the Fittstown calcarenites, but is moderately common in the Cravatt lithofacies although most specimens are fragmentary. I have etched out a moderate collection of silicified shells from the lower part of the Cravatt at locality P2-B. This collection consists of a dozen free valves, manv of these being nearly complete and showing the internal as well as the external characters (pl. I, figs. 24, 25, 27).

Figured specimens: Localities Cal-S(2); P2-B; P9-M. Catalog numbers OU-1129 to OU-1133.

Distribution: The original description of this subspecies was based on specimens from the Haragan formation. There are approximately 75 specimens in the collections from the Cravatt member (including 25 etched shells from locality P2-B); the following localities are represented: A2-C; C1-P; Cal-S(2); Cal-X(1); M1-M, -O; M2-D; P2-B; P3-Y; P8-C; P9-M, -N, -O, -P; P10-P, R; P13. It is rare in the Fittstown member; 6 fragmentary specimens were obtained from the following: Cal-V(2); M3-C; P3-JJ; P9-Q; P10-T.

RHIPIDOMELLOIDES Boucot and Amsden 1958
RHIPIDOMELLOIDES OBLATA (Hall) 1857

Plate I, figures 2-9

Orthis oblata Hall 1857 (p. 41, figs. 1-5).
Rhipidomelloides oblata (Hall). Amsden 1958 (pp. 55-61, pl. II, figs. 1-16; pl. XII-A; see this paper for a more complete synonymy).

Discussion: This species, which is one of the most abundant in the Haragan, is also common in the Cravatt and Fittstown members of the Bois d'Arc formation. There appears to be no essential morphologic difference between the Haragan and Bois d'Arc shells, although the latter may be slightly larger (the largest specimen in the collection is a Cravatt shell which is about 32 mm long). This difference in size is not great and could be due entirely to environment. The reduced silt-clay content of the Cravatt lithofacies, and more especially that of the Fittstown lithofacies, suggests clearer water which may have favored the development of larger individuals. The relative proportion of length to width and the shape and the ornamentation of the Bois d'Arc shells shows no significant change from those found in the Haragan.

A large number of well preserved specimens were obtained from locality P2-B by etching. The dimensions of a selected lot of these silicified specimens is given below:

Length mm	Width mm	Ratio Length / Width	Costellae Number in 5 mm
5.5	5.7	0.96	....
9.6	10.6	0.90	13
10.0	11.4	0.88	14
10.4	10.9	0.95	10
17.3	18.7	0.93	12
20.4	23.2	0.88	11
20.1	22.2	0.90	....

This species is common in some of the calcarenite beds of the Fittstown, and the dimensions of a selected group of larger specimens is given below:

Length mm	Width mm	Ratio Length / Width	Costellae Number in 5 mm
21	23	0.91	11
22	25	0.88	11
22	25	0.88	....
23	28	0.82	11
23	27	0.85	....
24	28	0.85	....
25	30	0.85	10
26	30	0.87	....
26	32	0.81	12

The Bois d'Arc specimens of this species exhibit the same variation in shell morphology as do those from the Haragan formation (Amsden 1958, p. 56, 59-60).

R. oblata has the flat, grooved, internal marginal crenulations that characterize the genus *Rhipidomelloides* (Boucot and Amsden 1958, p. 165-170, fig. 42). This type of structure is quite different from the rounded crenulations of such genera as *Rhipidomella* s. s. and *Pseudodicoelosia* (Boucot and Amsden 1958, p. 162, fig. 42). For comparison the subrectangular crenulations of *R. oblata* and the rounded crenulations of the Henryhouse species *Pseudodicoelosia henryhousensis* (Amsden 1951, p. 76, pl. 15, figs. 30, 32-38; 1958, p. 148-149, pl. 14, fig. 18) are illustrated on figures 1 and 4 of plate I.

Internal views of the pedicle and brachial valves are shown on plate I, figures 3, 7, 9.

Figured specimens: Localities P2-B; P3-CC; P8-F; P11-A; P13. Catalog numbers, OU-1121 to OU-1128.

Distribution: Hall based his description of this species on specimens from the New Scotland of New York. It is abundant in the Haragan formation; see Amsden 1958, p. 56 to 61.

There are about 200 specimens in the collections from the Cravatt member; the following localities are represented: C1-P; Cal-X(1); Cal-S(2); M1-M, -O; M3-C; M9-F; M11-E; P2-B; P3-Y, -BB; P4-C; P8-C, -D; P9-L, -M, -N, -O, -P; P10-P; P13; P17-D. There are about 100 specimens from the Fittstown member at the following localities: Cal-V(2); M3-C; M10-P; P3-CC, -EE, -GG, -HH, -JJ; P8-F; P9-Q; P11-A, -B.

DICOELOSIA King 1850
DICOELOSIA VARICA (Conrad) 1842

Plate I, figures 29-31

Delthyris varica Conrad 1842 (p. 262, pl. 14, fig. 20).
Dicoelosia varica (Conrad). Amsden 1958 (p. 51-54, pl. I, figs. 12-21; pl. 12, fig. 18, text fig. 7, table 3; see this paper for a more complete synonymy).

Discussion: This species is moderately common in the Cravatt member of the Bois d'Arc formation, especially in the cherty portions. It appears similar to the Haragan specimens in all respects, including size. There is some variation in the anterior lobation as shown in the illustrations on plate I, but this is also true of the Haragan, as well as the New Scotland representatives.

The measurements of 5 Cravatt specimens is given below:

Length mm	Width mm	Thickness mm
4.1	4.9	2.3
5.0	6.4	3.4
5.5	6.4	......
5.5	6.9	......
5.7	6.9	3.1

This species is rare in the Fittstown calcarenites, but one specimen has been found on section P10 about 30 feet below the Frisco-Fittstown contact.

Figured specimens: Localities C1-P; M1-M; P9-M. Catalog numbers OU-1135 to 1137.

Distribution: Conrad based his description of *D. varica* on specimens from the Helderberg of New York. It is a common species in the Haragan formation (see Amsden 1958, p. 54 for additional information on distribution).

About 50 specimens of this species have been collected from the Cravatt member at the following localities: C1-P; M1-M; M2-O; M9-E; P3-Y; P8-C; P9-M; P10-P, -R; Ca9-L. Only one specimen has been collected from the Fittstown member, P10-U.

ISORTHIS Kozlowski 1929
ISORTHIS PYGMAEA (Dunbar) 1919

Plate I, figures 32-33

Dalmanella pygmaea Dunbar 1919 (p. 52, pl. 2, fig. 5; 1920, pp. 121-122, pl. II, figs. 4, 5).
Isorthis pygmaea (Dunbar). Amsden 1958 (p. 62-64, pl. XI, figs. 5-14; pl. XIII, fig. 24).

Discussion: There are only 3 specimens of this species in the Bois d'Arc collections, all from the Cravatt member. These shells are, however, reasonable complete and appear to be typical for this species. The specimen illustrated on plate I measures 5.5 mm long, 5.9 mm wide, 3.2 mm thick.
Distribution: Three specimens from the Cravatt member at localities M14-J, P2-B, and Cal-S(2).

PLATYORTHIS Schuchert and Cooper 1931
PLATYORTHIS ANGUSTA Amsden, new species

Plate I, figures 11-21

Description: Shell subcircular in outline, width slightly greater than the length (length/width ratio about 0.9). Lateral profile plano-convex; pedicle convexity weak; brachial valve almost flat with a shallow convexity developed near the posterior end. On a few shells the brachial valve shows a slight sulcus near the front end, but this is in all cases poorly defined; the pedicle valve is without a fold although the convexity is fairly sharp in the region of the umbo. Finely costellate, 15 to 18 costellae occupying a space of 5 mm. Punctate.

The dimensions of 5 shells is given below:

Length mm	Width mm	Thickness mm	Costellae Number in 5 mm
11.4	12.3	5.0	15
12.1	13.1	4.5	15
14.6	15.1	......	16
15.1	17.2	......	18
18.0	20.5	7.3	16

The brachial interior of this species is similar to that of specimens of *Platyorthis* from the New Scotland of New York. It has a prominent, bilobed cardinal process and a fairly large muscle field (pl. I, fig. 13). The pedicle musculature is different from that of *Platyorthis planoconvexa* from the Oriskany, the diductor scars being long and narrow rather than flabellate (see discussion below).

Discussion: *Platyorthis angusta* is similar to *P. planoconvexa* (Hall 1859, p. 168-169, pl. 12, figs. 1-6). Hall based his species on specimens from the Helderberg (New Scotland) of New York and the Oriskany sandstone (Ridgeley sandstone) of Maryland. Most later authors have continued to regard the Helderberg and Oriskany specimens as conspecific (Schuchert 1897, p. 202; Schuchert and Maynard 1913, p. 298; Cooper 1944, p. 355) although the Oriskany specimens examined by me appear to be somewhat larger and more coarsely ribbed. A direct comparison of the Bois d'Arc specimens with shells from the New Scotland shows some similarity; however, *P. angusta* is finer ribbed and has a greater width in proportion to the length. For comparison the dimensions of 3 specimens from the New Scotland near Clarkesville, New York, are given below:

Length mm	Width mm	Thickness mm	Costellae Number in 5 mm
13	15	6	13
14	17	6	12
20	25	......	12

P. angusta is characterized internally by its relatively narrow pedicle muscle scars. The genus *Platyorthis* is distinguished internally by its flabellate pedicle musculature as exemplified by the genotype, *P. planoconvexa* (Schuchert and Cooper 1932, pl. 19, fig. 23; this illustration is of a shell from the Oriskany. The writer has not seen the pedicle interior of a New Scotland specimen).

In this feature *P. angusta* is not typical of the genus *Platyorthis,* but in other respects it appears to be normal.

Holotype: Locality P2-B; Catalog number OU-1139.

Figured specimens: Localities P2-B; P3-Y; P8-F. Catalog numbers OU-1138 to OU-1143.

This is an uncommon shell in the Bois d'Arc formation. There are 28 specimens in the collections, but 18 of these are etched shells from a single locality, P2-B. In addition there are 2 Cravatt specimens from P3-Y, and 7 Fittstown specimens from C1-Q; P3-EE, -GG, -HH; P8-F; P10-T; P11-A.

I have found only a single specimen of *P. angusta* in the Haragan formation. Maxwell (1936, p. 89) lists *Dalmanella planoconvexa* (presumably equals *P. angusta*) from his Kite group, a stratigraphic interval which equals the combined Haragan and Cravatt of the present report (Amsden 1957, p. 39-41).

SUPERFAMILY SYNTROPHIACEA
ANASTROPHIA Hall 1867
ANASTROPHIA GROSSA Amsden 1958

Plate I, figures 34-36

Anastrophia grossa Amsden 1958 (p. 65-68, pl. II, figs. 18-28, pl. XII-B, figs. 10-13, text figs. 12-14, table 6).

Discussion: There are about 25 specimens of this species in the Bois d'Arc collections, although most of these are incomplete. The fragmentary nature of most of these shells precludes a precise determination of the relative shell proportions, but all are large anastrophias with costation like that of the Haragan specimens (8 to 9 costae in a space of 15 mm), and there is little doubt that the Bois d'Arc and Haragan shells are conspecific. Several silicified specimens which have been cleaned by etching show that the pedicle and brachial interiors are like those of the Haragan shells. The largest specimen in the collections is a brachial valve which measures 25 mm long by 28 mm wide.

Figured specimens: Localities C1-P; P9-M, -N. Catalog numbers OU-1145 to 1146.

Distribution: My original description of this species was based on specimens from the Haragan. Twenty-three specimens have been collected from the Cravatt member at the following localities: C1-P; M1-M; P9-M, -N, -O; P10-R. Two specimens have been collected from stratigraphic section P10 (P10-T) in the transitional beds between typical Cravatt and typical Fittstown lithology; the specimens came from a calcarenite bed and are therefore assigned, with question, to the Fittstown member.

SUPERFAMILY PENTAMERACEA

GYPIDULA Hall 1867

GYPIDULA? sp.

Plate I, figure 28

Discussion: The Bois d'Arc collections under study include 3 fragmentary pedicle valves of a pentameroid brachiopod. These have the external shape of a Gypidulinae, probably either *Gypidula* or *Sieberella,* but in the absence of any brachial valves no definite generic assignment can be made. The specimen illustrated is from the Fittstown member and is somewhat more coarsely costate than are the two Cravatt specimens.

Figured specimen: Locality P3-CC. Catalog number OU-1147.

Distribution: There are two specimens from the Cravatt member at locality P9-0 and 1 from the Fittstown at P3-CC.

SUPERFAMILY STROPHOMENACEA

STROPHONELLA Hall 1879

STROPHONELLA (STROPHONELLA) BRANSONI

Amsden 1958

Plate II, figures 1-3

Strophonella (*Strophonella*) *bransoni* Amsden 1958 (p. 70-73, pl. IV, figs. 15-21, text fig. 15, table 7).

Discussion: This species is common in the Cravatt and Fittstown members although most of the specimens are incomplete. The rib count ranges from 6 to 9 with an average of 7 to 8 per 5 mm. It is difficult to determine the precise length/width ratio due to the fragmentary nature of the specimens, but this ratio is estimated to average between 0.7 and 0.8. The profile is convexi-concave, the degree of curvature being variable although always strong. Several specimens show the internal structure of the pedicle valve (pl. II, fig. 3) and this appears to be identical to that of the Haragan representatives; no brachial interiors observed.

Many of the Bois d'Arc shells are large (especially those from the Fittstown lithofacies), ranging up to 60 mm in width. Measurements of 3 large Fittstown specimens are given below:

Length	Width
32 mm (est.)	44 mm (est.)
35	45
40	60

Figured specimens: Localities P2-B; P3-GG. Catalog numbers OU-1150, OU-1151.

Distribution: My original description of this species was based on specimens from the Haragan formation. It is locally abundant in the Haragan, and is moderately common throughout the Bois d'Arc formation. There are about 2 dozen Cravatt specimens from the following localities: C1-P; Cal-X(1); Cal-S(2); M1-M; M11-E; M14-J; P2-B; P3-Y; P4-C; P8-D; P9-N; P13. The Fittstown collections include about 25 specimens: J 11-L; M10-P; P3-EE, -GG, -JJ; P9-Q; P10-T; P11-A, -B; P16.

STROPHEODONTA Hall 1852
STROPHEODONTA (BRACHYPRION) Shaler 1865
STROPHEODONTA (BRACHYPRION) GIBBERA

Amsden 1958

Plate II, figures 4, 5

Stropheodonta (Brachyprion) gibbera Amsden 1958 (p. 73-75, pl. IV, figs. 6-14, text fig. 16).

Discussion: This species is moderately common in the Cravatt member of the Bois d'Arc formation. Although most of the specimens are fragmentary there is enough material to give a reasonably good idea of the outline, profile and ornamentation. The costellae are low and rounded, and are separated by narrow interspaces; the spacing averages 9 to 10 costellae in 5 mm. Most specimens are strongly concavo-convex, and on some shells the profile is gibbous. In all morphological aspects the Cravatt specimens appear to be like those from the Haragan formation. Most of the Bois d'Arc shells are about the same size as those from the Haragan, however, there are a few which are slightly larger, the largest measuring 30 mm long by 40 mm wide (the greatest width of any in the Haragan collections is 30 mm).

No brachial interiors have been observed. There is one pedicle interior in the collections and this appears to be identical to that of the Haragan shells.

Six Fittstown specimens are referred to this species. Four of these appear to be typical representatives in all respects and are included in *S.* (*S.*) *gibbera* without question. The other two, the best of which is illustrated on plate II, figure 6, possess slightly more transverse shells and such ornamentation as remains suggests a somewhat more angular costellation than is characteristic for this species. It is therefore possible that the Fittstown lithofacies may carry a second species of this subgenus, but more material is needed before this can be confirmed.

Figured specimens: Localities P9-N; P3-EE. Catalog numbers OU-1148, 1149.

Distribution: The original description of this species was based on specimens from the Haragan formation. It is common in that formation, being especially abundant at White Mound (M4) and old Hunton townsite (C1), but is much less common in the Bois d'Arc formation. There are approximately 30 specimens in the collections from the Cravatt member: C1-P; M1-M; M2-O; M8-P; P9-M, -N; P10-P, -R; P13. There are six Fittstown specimens from the following localities: Cal-V(2); P3-EE (?); P10-T; P16.

STROPHEODONTA (*BRACHYPRION*) ARATA Hall 1859

Plate II, figures 10-11

Strophodonta [*sic*] *varistriata arata* Hall 1859 (p. 183, pl. 18, fig. 1).
Stropheodonta (*Brachyprion*) *arata* (Hall). Amsden 1958 (p. 75-77, pl. 4, figs. 1-5, pl. 5, fig. 16, text fig. 16; see this publication for a more complete synonymy).

Discussion: The collections under study include 8 specimens from the Cravatt member which have an outline, profile and ornamentation like those from the Haragan. The costellae are of two ranks, 7 to 8 of the major ones occupying a space of 5 mm; each of the broad, flat interspaces is occupied by 4 to 6 fine costellae. The largest specimen in the collections measures 20 mm long by 22 mm wide.

No interiors have been observed.

Figured specimens: Locality P9-M. Catalog number OU-1152.

Distribution: Hall's original description of this species was based on specimens from the Helderberg of New York. It is only moderately well represented in the Haragan, and rare in the Bois d'Arc. The collections under study include 8 specimens from the Cravatt member at the following localities: M9-E; P9-M, -N.; P10-R; P17-D. I have not found any in the Fittstown member.

LISSOSTROPHIA Amsden 1949
LISSOSTROPHIA (*LISSOSTROPHIA*) Williams 1950
LISSOSTROPHIA (LISSOSTROPHIA) LINDENENSIS (Dunbar) 1920

Plate II, figures 25, 26

Pholidostrophia lindenensis Dunbar 1920 (p. 126, pl. 2, figs. 15, 16).
Lissostrophia (*Lissostrophia*) *lindenensis* (Dunbar). Amsden 1958 (p. 77-78, pl. 7, figs. 1-4, pl. 12-E).

Discussion: I have collected only two specimens of this species from the Bois d'Arc formation. The shell illustrated on plate II is crushed on one side so it is difficult to determine the length-width relationship, however, its smooth shell, lateral profile and size leave little doubt that it is a representative of *L.* (*L.*) *lindenensis*.

Figured specimen: Locality P13. Catalog number OU-1160.

Distribution: Dunbar based his description of this species on specimens from the Birdsong shale of western Tennessee. It is rare in both the Haragan and Bois d'Arc formations. One specimen was collected from the Cravatt member at locality P13, and one from the Fittstown member at P3-EE (this last specimen later lost).

LEPTOSTROPHIA Hall and Clarke 1892
LEPTOSTROPHIA BECKII TENNESSEENSIS Dunbar 1920

Plate II, figures 7-9; text figure 9

Leptostrophia beckii tennesseensis Dunbar 1920 (p. 129, pl. 3, fig. 18); Amsden 1958 (p. 78-80, pl. 3, figs. 15-20, pl. 6, fig. 1, pl. 11, figs. 27-28).

Discussion: I have previously described and illustrated the Bois d'Arc representatives of this species so the discussion given herein will be limited to a few additional comments on the curvature and ornamentation. The Fittstown specimens range up to 60 mm in width although the larger shells are all fragmentary. The pedicle is by far the most common valve in the collections and has a very gentle curvature at all growth stages (fig. 9). The brachial valve is extremely rare but there is one good specimen about 30 mm long in the collections and it is almost flat. This species exhibits variable costellae spacing, ranging from 11 or 12 per 5 mm down to 7 or 8 on the larger shells. In all cases the costellae are low and rounded, and are separated by narrow interspaces. Rugae are present although quite irregular in their devel-

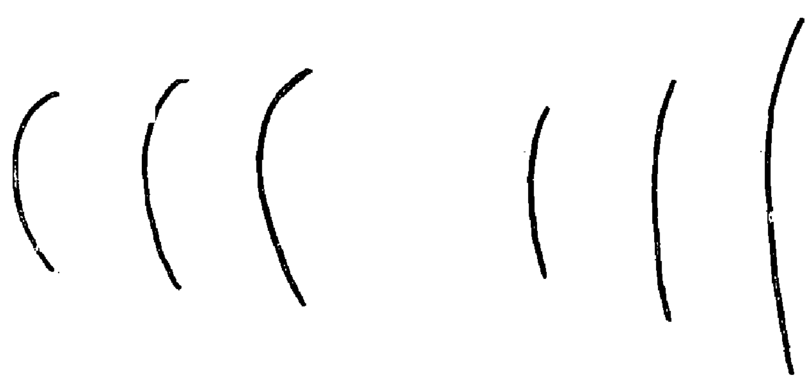


Figure 9. *Leptostrophia* sp. 2 (3 figures on the left) and *Leptostrophia beckii tennesseensis* Dunbar (3 figures on the right), from the Fittstown member of the Bois d'Arc formation (x 1). These are profile drawings of the pedicle valve comparing the degree of convexity.

opment; on most specimens the rugae are more subdued than on the Tennessee shells.

For a comparison with *Leptostrophia* sp. 2 see below.

Figured specimens: Localities P8-F, -G; M11-E. Catalog numbers OU-1161 to OU-1163.

Distribution: Dunbar's specimens came from the Birdsong shale of western Tennessee. This species is rare in the Haragan, becoming more common in the Bois d'Arc. There are 10 Cravatt specimens from the following localities: M11-E; P2-B; P9-L. There are 21 Fittstown specimens from the following localities: C1-Q; J11-L; P3-CC, -EE, -GG, -JJ; P4-C; P8-F, G; P10-T; P11-A, -B; P16.

LEPTOSTROPHIA sp. 2

Plate II, figures 20-24; Text figure 9.

Description: The shells of this species are transversely elliptical in outline with a straight hinge-line that represents the maximum, or nearly the maximum, shell width; from the cardinal extremities forward the shell is smoothly rounded. The pedicle valve is gently and uniformly convex from the beak to the anterior margin (text figure 9); the umbo of this valve has a moderately well developed curvature and is marked off from the posterio-lateral margins by a flattening, or on some shells by a reversal of curvature. No brachial valves have been observed. The ornamentation consists of low costellae separated by relatively wide interspaces (pl. II, fig. 23); 9 to 12 costellae occupy a space of 5 mm. Both the interspaces and the costellae are crossed by fine, concentric filae.

This species has a smaller shell than does *L. beckii tennesseensis,* the largest specimen being about 24 mm long. The measurements of 9 specimens are given below:

Length mm	Width mm	Number of costellae in 5 mm
11	....	12
11	13	12
14	18	11
16	20	......
18	21	12
19	22	......
18	21	12
21	26	10
23	26	9

There is one steinkern in the collections which is questionably referred to this species and which shows the pedicle internal structure. This has a large, fan-shaped muscle scar similar to that of *L. beckii tennesseensis.* No brachial interiors observed.

Discussion: This species, which is well represented in the Fittstown collections by a number of pedicle valves, almost certainly represents a new species, but since the brachial valve is completely unknown the species is not named. It differs from *L. beckii tennesseensis* Dunbar in several respects: (1) the pedicle valve of *Leptostrophia* sp. 2 is more deeply convex (text figure 9); (2) the ornamentation is different, *Leptostrophia* sp. 2 having the costellae separated by relatively wide interspaces whereas on *L. beckii tennesseensis* the interspaces are narrow (despite the wide interspaces the costellae count of *Leptostrophia* sp. 2 is generally higher). (3) *Leptostrophia* sp. 2 has a considerably smaller shell than does *L. beckii tennesseensis.*

Leptostrophia sp. 2 is moderately common in the Fittstown lithofacies of the Bois d'Arc formation. *L. beckii tennesseensis* is also fairly common, thus giving a substantial Fittstown representation to this genus.

Figured specimens: Localities P3-EE, -JJ; P8-G. Catalog numbers OU-1164 to OU-1167.

Distribution: About 24 specimens have been collected from the Fittstown member at the following localities: J11-L; P3-EE, -GG, -JJ; P8-G, -F; P11-A, -B. None has been found in the Cravatt member, or in the Haragan formation.

LEPTAENISCA Beecher 1890
LEPTAENISCA CONCAVA (Hall) 1857

Plate II, figures 18, 19

Leptaena concava Hall 1857 (p. 47); Hall 1859 (p. 197, pl. 18, figs. 2).

Leptaenisca concava (Hall). Amsden 1958 (p. 80-83, pl. V, figs. 10-24, text fig. 17, table 8; see this publication for a more complete synonymy).

Discussion: The Bois d'Arc specimens of *L. concava* agree in all respects with those from the Haragan. Most of these are mature, free shells although some show the pedicle scar of attachment (see Amsden 1958, p. 82-82 for a discussion of the immature forms of this species). Most of the Bois d'Arc shells are similar in size to those from the Haragan, but the two shells from locality M11-E are unusually large, the largest being 20 mm long and 35 mm wide. No brachial interiors observed.

Figured specimens: Localities C1-P; P9-M. Catalog numbers OU-1153, OU-1154.

Distribution: Hall based his description on specimens from the New Scotland of New York. It is fairly common in the Haragan formation, much less so in the Bois d'Arc formation. The collections include 12 specimens from the Cravatt member at the following localities: C1-P; M1-O; P2-B; P9-M, -N, -O, -P; P13. Two specimens have been collected from stratigraphic section M11-E in the transitional beds between typical Cravatt and typical Fittstown lithologies; the specimens actually came from a bed of calcarenite, but most of the rock in this interval is calcilutite, somewhat argillaceous, and so it is assigned, with question, to the Cravatt member. For additional information on the distribution of this species see Amsden 1958, p. 83.

LEPTAENA Dalman 1928

LEPTAENA cf. L. RHOMBOIDALIS (Wilckens) 1769

Plate II, figures 12-15; text figures 10, 11; table 2

Leptaena, cf. *L. rhomboidalis* (Wilckens). Amsden 1958 (pl. 3, figs. 10-14, table 10).

Description: These shells are irregular in outline although most tend to be somewhat subrectangular. On many specimens both the postero-lateral and the antero-lateral margins are extended (pl. II, figs. 13, 15), and this produces a markedly quadrate outline. The visceral disc is almost flat with only moderate convexity in the umbonal region; at the front edge of the disc the shell is sharply bent, generally approximating a right angle, and extends into a trail which may equal or even exceed the length of the disc.

TABLE II

Leptaena cf. *L. rhomboidalis* (Wilckens)

Length mm	Width mm	Ratio Length/Width	Number of costellae in 5 mm
	Fittstown member		
12	28	0.4	13
13	22	0.5	13
14	24	0.5	16
14	24	0.5	16
14	23	0.6	13
14	25	0.5	11
15	22	0.6	17
15	27	0.5	14
16	30	0.5	15
17	32	0.5	......
17	28	0.6	14
28	54	0.5	12
	Cravatt member		
10	20	0.5	......
12	20	0.6	14
12	19	0.6	14
15	23	0.6	......
16	30	0.5	14
16	27	0.5	15
17	24	0.4	14
19	31	0.6	14
20	38	0.5	12
20	40	0.7	......
24	32	0.7	16
28	48	0.5	......
29	49	0.6	15
35	50	0.7	......

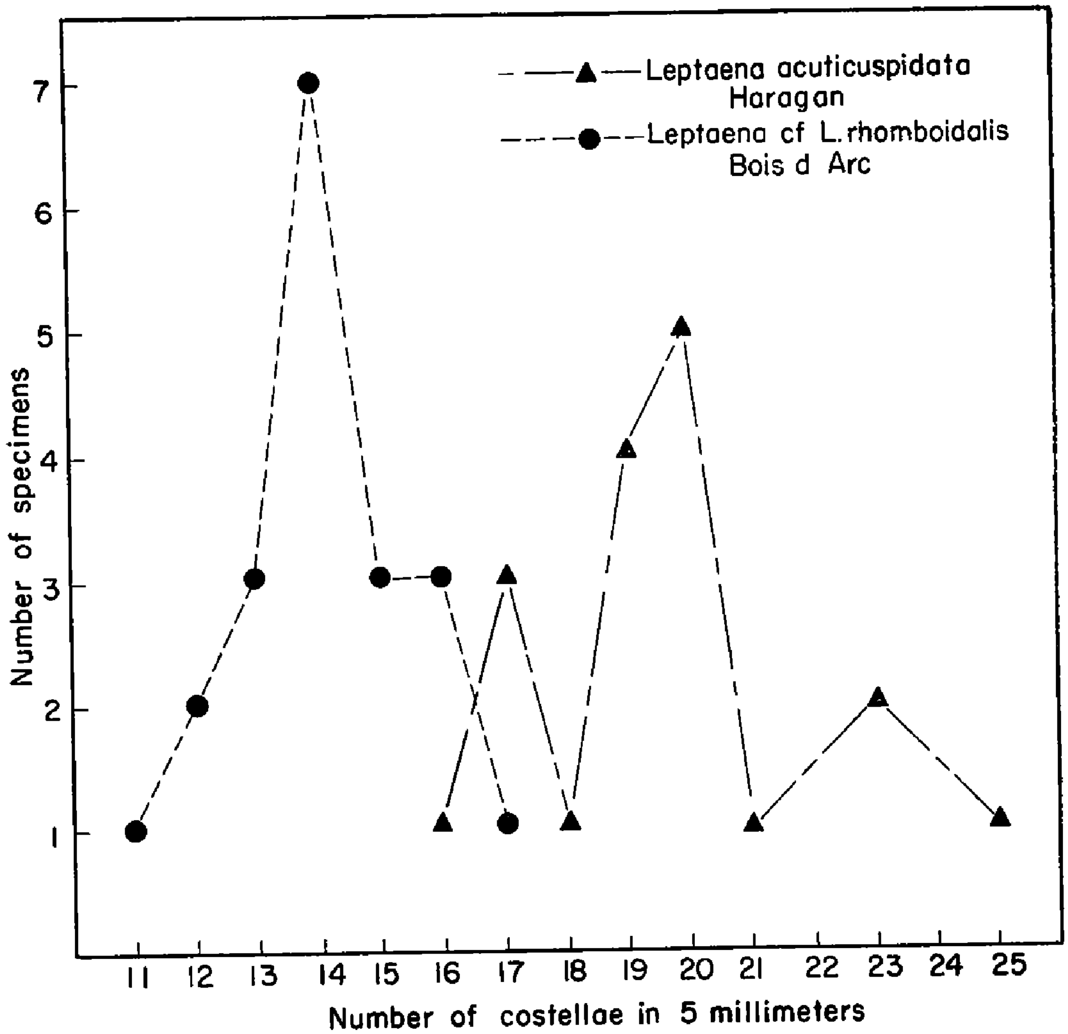


Figure 10. Frequency diagram comparing the costellae of *Leptaena acuticuspidata* Amsden from the Haragan formation with that of *Leptaena* cf. *L. rhomboidalis* (Wilckens) from the Bois d'Arc formation.

The disc has well developed, concentric rugae. Both the visceral disc and the trail are finely costellate, although the costellae are weaker on the trail. The costellae are low and rounded, 11 to 17 occupying a space of 5 mm (table 2; fig. 10).

Some of these shells are large with one specimen attaining a width of 60 mm (Amsden 1958, pl. 3, figs. 10, 13, 14). Most of the large specimens are from the Cravatt member although one of the Fittstown specimens which I illustrated in 1958 (pl. 3, fig. 10) is over 50 mm wide. The dimensions of specimens from both members of the Bois d'Arc formation are given in table 2.

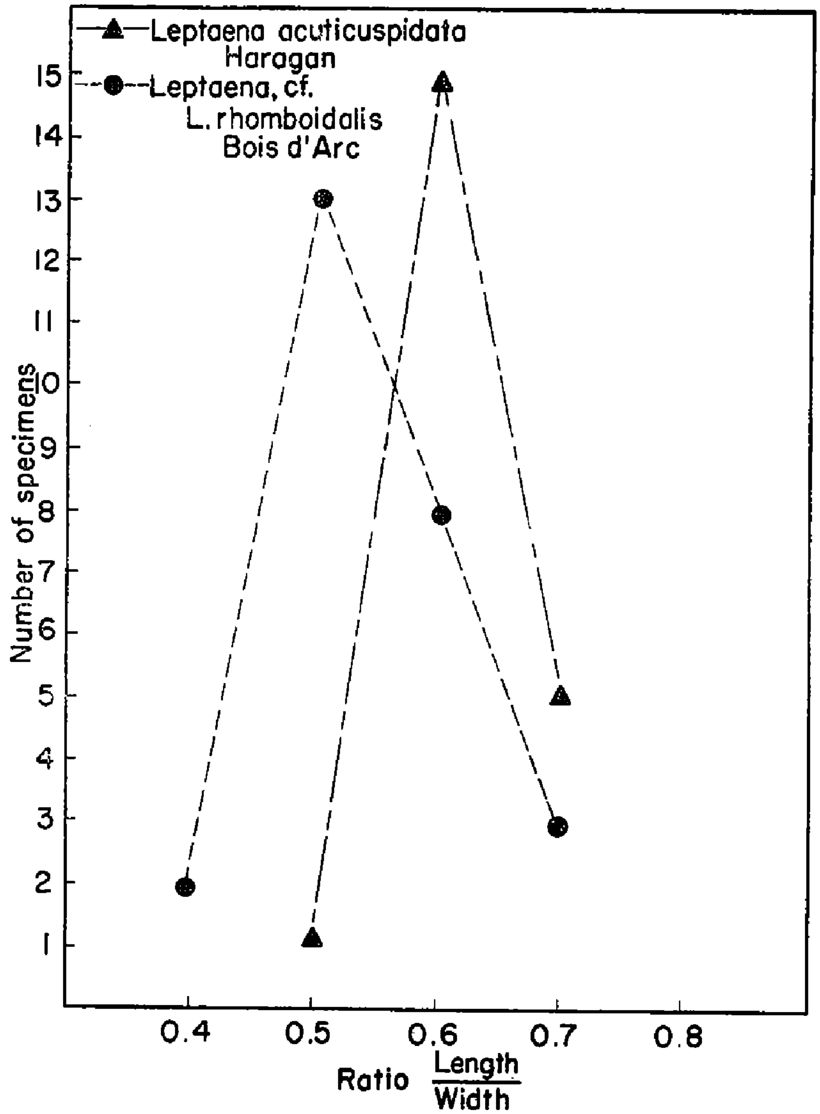


Figure 11. Frequency diagram comparing the length/width ratio of *Leptaena acuticuspidata* Amsden from the Haragan formation with that of *Leptaena* cf. *L rhomboidalis* (Wilckens) from the Bois d'Arc formation.

The internal structure of both valves appears to be typical for this genus (Amsden 1958, pl. 3, figs. 13-14; pl. II, fig. 13 of this report).

Discussion: This species is largely confined to the Bois d'Arc formation, only 2 or 3 specimens having been found in the upper part of the Haragan. On the other hand, *L. acuticuspidata* Amsden is almost entirely restricted to the Haragan, with only a few individuals being present in the Cravatt member of the Bois d'Arc. Since most shells of *L.* cf. *L. rhomboidalis* are larger than *L. acuticuspidata,* they might be regarded as representatives of the latter which had attained a greater size in the somewhat clearer seas of the Bois d'Arc. However, on strictly morphologic grounds there appear to be adequate reasons for separating the two (Amsden 1958, p. 86). First, the outline of *L.* cf. *L. rhomboidalis* is more rectangular than is that of *L. acuticuspidata*; the antero-lateral margins are extended (pl. II, fig. 15) to produce angular corners at the front as well as at the rear end. Second, the trail on *L.* cf. *L. rhomboidalis* tends to be more strongly developed, even on small shells; the specimen illustrated on plate II, figure 14, is about the same size as an average Haragan shell, but the length of the trail exceeds the length of the disc. Third, the costellae are distinctly coarser, as shown in figure 10; this costellae spacing applies to all growth stages. Finally, the length/width ratio is slightly greater in *L. acuticuspidata* (fig. 11); this difference is quite small and would not be considered were it not for the other differences cited above. There is no doubt that *L.* cf *L. rhomboidalis* and *L. acuticuspidata* were at least in part, probably entirely, contemporaneous with one another. These two were certainly closely related, and from a genetic point of view may have been only two populations of the same species which were ecologically more or less isolated from one another. However, in my opinion the morphologic distinction between these two is adequate justification for assigning them to two distinct taxonomic units.

The trivial name rhomboidalis has been widely applied to a variety of Silurian and Devonian leptaenas showing a wide range in shell morphology. To my knowledge Wilcken's species has never been adequately described, and until such time as the type specimens are restudied and illustrated this name can have little taxonomic or stratigraphic significance (see Amsden 1949, text fig. 26 for a reproduction of Wilcken's original illustrations). The Bois d'Arc specimens are similar to the New Scotland shells commonly identified as *L. rhomboidalis.*

Figured specimens: Localities P3-GG; P13. Catalog numbers OU-1157, OU-1158, OU-1159 (Other specimens illustrated in Amsden 1958, pl. 3 from localities P10-T, P13; catalog numbers OU-959 to OU-963).

Distribution: This species is one of the more common in both the Cravatt and the Fittstown members of the Bois d'Arc formation. About 70 specimens were collected from the Cravatt at the following localities: C1-P; Cal-X(1); Cal-S(2); M8-P; M14-J; P2-B; P3-Y, -BB; P4-C; P8-D; P9-O, -P, -Q. There are about 80 specimens in the Fittstown collections: C1-Q; Cal-V(2); J11-L; M1-M; M3-C, -E; M10-P; P3-EE, -GG, -JJ; P8-F, -G; P11-A, P17-D?.

Three specimens have been collected from the Haragan formation at locality P2-A.

LEPTAENA ACUTICUSPIDATA Amsden 1958

Leptaena acuticuspidata Amsden 1958 (p. 83-88, pl. 3, figs. 1-9, pl. 12-D, text figs. 18, 19, table 9).

Discussion: There are about a dozen specimens of this species from the Cravatt member of the Bois d'Arc formation. These appear to be similar in all respects to the Haragan shells. For a comparison of *L. acuticuspidata* with *L.* cf. *L. rhomboidalis* see under *Discussion* of the latter.

Distribution: The Cravatt specimens came from the following localities: P8-C; P9-L, -M, -N; P10-R. None has been found in the Fittstown member.

This species is abundant in the Haragan formation.

SUPERFAMILY ORTHOTETACEA
SCHELLWIENELLA Thomas 1910

SCHELLWIENELLA MARCIDULA Amsden 1958

Plate II, figures 16, 17

Schellwienella marcidula Amsden 1958 (p. 90-92, pl. 5, figs. 3-9, pl. 13, fig. 25).

Discussion: My original description of this species was based on specimens from the Bois d'Arc formation. The illustrations in the 1958 publication are of Cravatt specimens whereas those on plate II of the present report shown Fittstown shells. There does not appear to be any difference between the Cravatt and Fittstown specimens of *S. marcidula*.

Most shells are between 25 and 30 mm in length, but there is one fragmentary Cravatt specimen which reaches a length of almost 40 mm.

Figured specimens: Localities P3-JJ; P8-F. Catalog numbers OU-1155, OU-1156. (Other specimens illustrated in Amsden 1958, pls. 5, 13 from localities P13 and P2-B, catalog numbers OU-994 to OU-1000).

Distributions This is a fairly common species in the Bois d'Arc formation. There are about 2 dozen specimens in the collections from the Cravatt member, although almost half of these are etched specimens from P2-B; in addition there are Cravatt specimens from the following localities: Cal-X(1); Cal-S(2); P2-B; P9-N, -P; P10-L, -R; P13. There are about 25 Fittstown specimens from the following localities: P11-L; P3-CC, -EE, -GG, -JJ; P8-F; P11-A.

A single specimen has been collected from the surface of the Haragan at P9-K; this may be float from the overlying Bois d'Arc formation.

SCHUCHERTELLA Girty 1904

SCHUCHERTELLA HARAGANENSIS Amsden 1958

Schuchertella haraganensis Amsden 1958 (p. 88-90, pl. 5, figs. 1-2, pl. 10, figs. 27-30, pl. 11, figs. 1-4, pl. 13, figs. 18-20).

Discussion: The collections include two pedicle valves from the Cravatt which agree with the Haragan representatives in size, shape and ornamentation; both show a complete absence of dental plates. No brachial interiors observed.

Distribution: My original description of this species was based on Haragan specimens. It is not common in the Haragan, and is rare in the Cravatt member, only two shells being found at localities P1-J and P9-L. None has been found in the Fittstown member.

SUPERFAMILY RHYNCHONELLACEA

SPHAERIRHYNCHIA Cooper and Muir-Wood 1951

SPHAERIRHYNCHIA LINDENENSIS (Dunbar) 1919

Plate V, figures 1-14; text figure 12

Uncinulus lindenensis Dunbar 1919 (p. 53, pl. 61, fig. 20; 1920, p. 133, pl. 3, figs. 5, 6).

Sphaerirhynchia lindenensis (Dunbar). Amsden 1958 (p. 97-99, pl. 6, figs. 23-28, pl. 11, figs. 15-16, pl. 13, figs. 21-23, text figs. 20, 21).

Discussion: *S. lindenensis* is common in the Cravatt member, and becomes abundant in the Fittstown, being one of the better represented species in the calcarenite lithofacies. Some free specimens can be collected from the Cravatt marlstones, but those from the Fittstown calcarenites are largely separate valves, mostly pedicles, and commonly fragmentary. It is difficult to compare these incomplete valves with the whole shells of the Haragan (and Birdsong), but most specimens can be identified with reasonable assurance. The Bois d'Arc shells assigned to this species are, for the most part, quite similar to those from the Haragan. The rib spacing is similar to that of the Haragan-Birdsong representatives, the Bois d'Arc shells showing a spacing of 3 to 4 costae per 5 mm; they also show the same delicate, concentric filae crossing the costae and interspaces. The length/width ratio ranges from 0.84 to 0.96, which compares favorably with the ratio of Haragan specimens (0.88 to 1.0). The size is also similar as is shown in the following measurements of 10 Bois d'Arc shells:

Length mm	Width mm	Costellae Number in 5 mm	Number of costae in sulcus
13.5	15.5	3	3
14.4	15.5	4	4
15.4	17.9	3	3
15.4	17.3	4	3
15.5	16.5	4	3
15.5	15.6	4	4
16.3	17.0	4	5
16.9	17.5	4	4
17.9	19.0	4	4
18.9	22.6	4	5

There are 3 Haragan rhynchonellids which are externally somewhat alike, *Trigonirhynchia acutirostella* Amsden, *Sphaerirhynchia glomerosa* Amsden and *S. lindenensis* (Dunbar). Only the last two have been identified from the Bois d'Arc, and the presence of *S. glomerosa* in this formation is based on a single, questionable Cravatt specimen. Most of the Bois d'Arc shells can be assigned to *S. lindenensis* with reasonable certainty; however, among the more fragmentary specimens placed in this species may be unrecognized representatives of *T. acutirostella* and *S. glomerosa*.

Several well preserved specimens show that the anterior and antero-lateral margins of both valves are serrate. Along the antero-lateral margins are V-shaped teeth which interlock, but on the anterior portion these become elongated into rod-like projections which extend under the opposing valve when the shell is closed (text fig. 12, pl. V, figs. 9, 11; also pl. III, figs. 13, 16). These appear much too long to be merely a device for firmly locking the valves together, and probably served as a strainer. With the valves only slightly open the incoming currents would be strained through the narrow, slit-like openings. This structure has been observed on specimens from the Birdsong, Haragan and Bois d'Arc formations.

The pedicle interior is illustrated on plate V, figure 7. No satisfactory brachial interior has been observed; most specimens

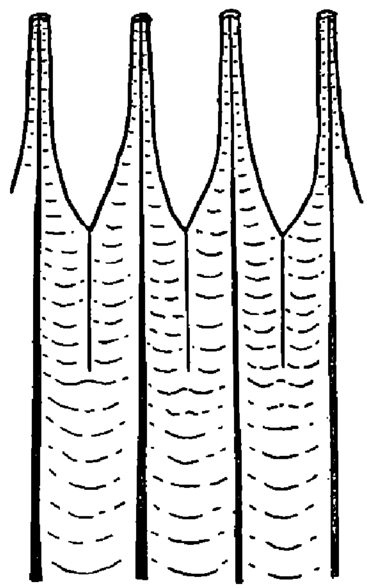


Figure 12. *Sphaerirhynchia lindenensis* (Dunbar). A portion of the anterior edge of the pedicle valve showing the tooth-like projections. Compare to figure 13, plate III, and figures 9, 11, plate V.

show some incipient silicification which prevents their study by means of serial sections.

For a discussion of this generic assignment see my 1958 paper (p. 95).

Figured specimens: Localities P1-V; P3-CC, -EE, -HH; P8-G; P9-M, -N; P10-P, -R; P11-A. Catalog numbers OU-1201 to OU-1210.

Distribution: Dunbar based his description of this species on specimens from the Birdsong shale and Ross limestone of western Tennessee. This species is moderately common in the Haragan formation and abundant in the Bois d'Arc formation, being especially numerous in the calcarenite lithofacies. About 30 specimens have been obtained from the Cravatt member at the following localities: A2-C; C1-P; C3; M8-P; M11-E; P2-B; P3-BB; P9-M, -N, -O, -P; P10-P; P13; P17-D. It is one of the more common species in the Fittstown and the present collections include about 100 specimens from the following: C1-Q; Cal-V(2); J11-L; M3-C, -E; M10-P; P3-CC, -EE, -HH, -JJ; P8-F, -G; P9-Q; P10-T; P11-A.

SPHAERIRHYCHIA GLOMEROSA Amsden 1958

Plate III, figures 13-16

Sphaerirhynchia glomerosa Amsden 1958 (p. 94-96, pl. 6, figs. 3-14).

Discussion: Only a single specimen from the Cravatt member of the Bois d'Arc is referred to this species. This shell has the gibbose profile, shallow fold and sulcus, and rounded ribs that characterize the Haragan specimens. The costae are slightly narrower than is typical for this species, but the shell is small and is probably an immature individual.

This specimen is interesting because the valves are opened slightly and show the contact relationship between the serrations on the valve margins (see *Discussion* of *S. lindenensis* and text figure 12, pl. V, figs. 9, 11). The rod-like projections on the anterior edge of the pedicle valve are well preserved and can be seen to project inside of the brachial valve (pl. III, figs. 13, 16).

Figured specimen: Locality P3-BB. Catalog number OU-1183.

Distribution: My original description of this species was based on specimens from the Haragan formation. Only a single specimen has been collected from the Cravatt member of the Bois d'Arc formation: P3-BB.

OBTURAMENTELLA Amsden 1958

OBTURAMENTELLA WADEI (Dunbar) 1919

Plate III, figures 17-24

Wilsonia wadei Dunbar 1919 (p. 52, pl. 2, fig. 8; 1920, p. 133, pl. 3, figs. 3, 4).

Obturamentella wadei (Dunbar). Amsden 1958 (p. 100-103, pl. 6, figs. 15-22, pl. 11, figs. 29-30, 32-33, pl. 14, fig. 1, text figs. 22, 23).

Discussion: This species is present in both the Haragan and Bois d'Arc formations although it is more common in the latter. In my paper on the Haragan brachiopods I included illustrations of specimens from both members of the Bois d'Arc formation. There appears to be no essential difference between the Haragan and Bois d'Arc shells, except that the latter may attain a slightly greater size. Measurements of fifteen Bois d'Arc specimens show a range in length from 7 to 12 mm, averaging about 8.7 mm, while 6 Haragan specimens range from 7 to 9.6 mm in length and average 7.8 mm (see Amsden 1958, p. 101 for additional information on size).

The costae are low and rounded, becoming obsolete towards the posterior end of both valves. Most specimens bear a single rib in the sulcus, but a few have two.

The collections include several pedicle interiors, one of these being illustrated on plate III, figure 19. No brachial interiors observed.

Figured specimens: Localities P3-EE; P9-Q; P11-A; M3-E; J11-L. Catalog numbers OU-1173 to OU-1178. (Other illustrations of Bois d'Arc specimens in Amsden 1958, localities P3-CC; P11-A; M3-E; catalog numbers OU-1012 to OU-1015).

Distribution: The original description of this species was based on specimens from the Ross limestone and Birdsong shale of western Tennessee. It is rare in the Haragan formation, becoming more common in the Bois d'Arc calcarenites. Six specimens have been collected from the Cravatt member at the following localities: P10-R; P13; P17-D. *O. wadei* is fairly common in the Fittstown member; about 40 specimens have been collected from the following: J11-L; M3-E; P3-CC, -EE, -GG, -HH; P8-G; P9-Q; P11-A.

CAMAROTOECHIA Hall and Clarke 1894
CAMAROTOECHIA? HARAGANENSIS Amsden 1958

Camarotoechia? haraganensis Amsden 1958 (p. 105-108, pl. 6, figs. 29-36, text figs. 25, 26).

Discussion: Two fragmentary Cravatt specimens are provisionally referred to this species. The rarity of *C.? haraganensis* in the Cravatt member is somewhat surprising in view of its abundance in the Haragan formation.

Distribution: Rare in the Cravatt member; specimens from P1-J and Cal-X(1). None has been found in the Fittstown member.

CAMAROTOECHIA ? sp.

Camarotoechia? sp. Amsden 1958 (p. 108-110, pl. 7, figs. 5-8, pl. 14, figs. 24-25, text fig. 27).

Discussion: Eight Bois d'Arc shells are assigned to the Haragan species identified as *Camarotoechia?* sp. Several of these specimens are fragmentary, but there is sufficient material to show that the Haragan and Bois d'Arc shells are conspecific. Nothing is known concerning the internal structure of the Bois d'Arc specimens.

Distribution: Rare; 3 shells in the Cravatt member at P9-N, -P, and four from the Fittstown member at localities Cal-V(2); P3-GG, -JJ; and P9-Q.

This species is rare in the Haragan formation. It is common in the Birdsong shale of western Tennessee (Dunbar 1919, p. 53, identified it as *C. transversa* (Hall); see Amsden 1958, p. 110 for a comparison of *C. ?* sp. with *C. transversa*).

COSTELLIROSTRA Cooper 1942

COSTELLIROSTRA SINGULARIS (Vanuxem) 1842

Plate III, figures 25-32; text figure 13

Atrypa singularis Vanuxem 1842 (p. 120-121, text fig. 26, No. 3).

Eatonia singularis (Vanuxem). Hall 1859 (p. 243, pl. 38, figs. 14-20); Hall and Clarke 1894 (pl. 61, figs. 13-16); Reeds 1911 (p. 265).

Costellirostra singularis (Vanuxem). Cooper 1942 (p. 231).

Description: Subcircular to subtriangular shells with a length-width relationship ranging from about equal to slightly wider than long. The lateral profile is unequally biconvex. In the umbonal region the pedicle valve has a slight convexity, but it flattens towards the lateral margins; the brachial valve is much deeper and on large shells becomes subgibbous. A pedicle sulcus and brachial fold begin 5 to 8 mm in front of the beaks and progressively increase in size to the front margin. The ornamentation consists of fine costellae, 18 to 22 occupying a space of 5 mm; well preserved shells show closely spaced concentric lines crossing the costellae and interspaces. On most specimens one of the costella near the center of the sulcus is larger than the others.

Hall (1859, p. 243) noted that "the inner margins of the shells are denticulate, but this character is not shown on well preserved specimens: . . . .". There is not enough material in the collections under study to confirm this observation, but the specimens do indicate that on some shells, at least, the anterior commissure was notched on each side of the fold and sulcus as shown in figure 13. Whether the margins were also denticulate cannot be determined from my specimens.

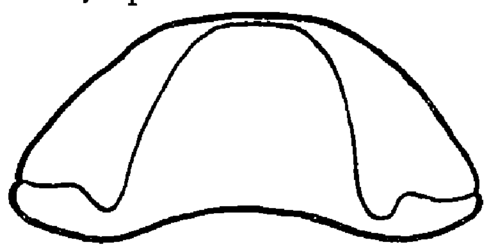


Figure 13. Sketch of the anterior end of *Costellirostra singularis* (Vanuxem) showing the notches in the anterior commissure on each side of the fold and sulcus. Bois d'Arc formation (approximately x 4).

In the pedicle interior the muscle field is large, occupying over half the valve. The diductor scars are deeply impressed and are bordered by a ridge; the adductor scars are located on a small, elevated patform which is completely enclosed by the diductors (pl. III, fig. 26). No brachial interiors observed.

There are only 10 specimens in the collections, 9 of which are small with a maximum length of about 13 mm (width approximately 14 mm, depth 7 mm). The 10th specimen is much larger; 19 mm long, 21 mm wide and 14 mm deep. Except for size this large individual appears to be identical in all respects to the smaller ones and all are regarded as comprising a single species.

Discussion: In 1942 Cooper described the genus *Costellirostra* and assigned three species to it: the genotype *Atrypa peculiaris* Conrad, *Atrypa singularis* Vanuxem, and *Eatonia tennesseensis* Dunbar. The original description of *C. peculiaris* was based on specimens from the Oriskany sandstone, but later Hall (1859, p. 244) stated that a number of specimens had also been collected from the Helderberg, and in 1944 Cooper (p. 311) listed this species from both the Oriskany and Helderberg. I have not seen any Helderberg specimens of *C. peculiaris,* but I have examined the New Scotland collections of *C. singularis* at Peabody Museum—Yale University. These appear to be typical representatives of Vanuxem's species and are morphologically distinct from the Oriskany shells assigned to *C. peculiaris,* and I suspect that a restudy of Helderberg and Oriskany costellirostras will show that *C. peculiaris* is not present in the Helderberg.

The Haragan shells appear to be similar to those from the New Scotland in all respects. Most of the Oklahoma shells are small, but these closely resemble the small individuals from New York, and there is one large Haragan shell in the collections (pl. III, figs. 29, 31) which equals or exceeds in size any of the New York shells that I have seen. The ornamentation of the Oklahoma specimens is identical to that of the New York shells including the fine, concentric ridges and the enlarged rib in the sulcus.

I have examined the Yale collections of *C. tennesseensis* (Dunbar 1919, p. 53, pl. 2, fig. 11; 1920, p. 134-136, pl. 3, figs. 9-11) from the Birdsong shale of western Tennessee. This species, as noted by Dunbar, is quite different from *C. singularis,* having coarser ornamentation and a broad, less sharply defined fold and sulcus. Tansey (1922, p. 192, pl. 49, figs. 1, 2) reports *C. singularis* from the Bailey limestone of Missouri. Reeds (1911, p. 265) reported it from the Bois d'Arc formation.

Figured specimens: Localities M11-E; P2-B; P3-EE, -GG. Catalog numbers OU-1179 to OU-1182.

Distribution: Vanuxem based his description of this species on specimens from the Helderberg of New York. It has been reported from Helderberg strata at a number of different localities in central and eastern United States. *C. singularis* is a rare species in the Bois d'Arc formation. The collections include 5 specimens from the Cravatt member at A2-C, M11-E and P2-B; 5 specimens have also been found in the Fittstown member at C1-Q and P3-EE, -GG. None has been found in the Haragan formation although the specimens from P2-B were obtained from the lower foot of the Cravatt member.

EATONIA Hall 1857

EATONIA MEDIALIS (Vanuxem) 1842

Plate III, figures 1-8

Atrypa medialis Vanuxem 1842 (p. 120, fig. 4).

Eatonia medialis (Vanuxem). Hall 1859 (p. 241, pl. 37, figs. 1a-1y); Hall and Clarke 1894 (p. 206, pl. 61, figs. 29-35); Cooper 1944, p. 311, pl. 118, figs. 41-43).

Description: Shells transversely elliptical in outline, hingeline moderately straight, shoulders subdued; maximum shell width attained at about mid-length. Pedicle valve, excluding the prominent sulcus, is rather flat with only a slight convexity developed around the umbo; brachial valve, excluding the fold, is strongly and evenly convex. Pedicle sulcus and brachial fold begin about 5 mm or so in front of the beaks, becoming fairly deep at the front end. Ornamentation consists of rounded plications, spaced approximately 3 per 5 mm near the front; 3 or 4 plications on the sulcus and 4 or 5 on the fold. In addition to the plications the surface bears low, faint radial ribs and concentric filae; these are in no case conspicuous, but well preserved shells show them clearly (pl. III, fig. 5).

Most of the specimens in the collections are fragmentary so it is difficult to obtain precise measurements. One reasonably complete shell measures 19 mm long, 23 mm wide and 12 mm deep.

The diductor scars in the pedicle interior are large and completely enclose the adductors (pl. III, fig. 1). The brachial interior is shown in figure 6, plate III.

Discussion: The generic name *Eatonia* first appeared in Hall 1857 (p. 90), but the genus was not defined until 1859 (Hall 1859, p. 432). In 1897 Schuchert (p. 219) designated *Atrypa peculiaris* Conrad as the genotype; however, this was invalidated by Hall and Clarke's (1894, p. 205) earlier selection of *Atrypa medialis* Vanuxem as type.

The original description of *E. medialis* was based on specimens from the Helderberg of New York. I have not examined Vanuxem's types, but have studied the Yale University collections of this species from the New Scotland, Albany County, New York. The Haragan shells closely resemble those from New York in external and internal characters. The average New Scotland specimen is about 18 mm long, 21 mm wide and 10 mm deep; one large specimen has a length of almost 28 mm. Shells from both New York and Oklahoma show the same faint radial and concentric lirae.

Dunbar did not list this species in the Helderberg of western Tennessee, but he did report *E. eminens* Hall from the Bear Branch member (1919, p. 53, pl. 1, figs. 5-6). Tansey does not record any species of *Eatonia* from the Bailey limestone of Missouri. Neither Reeds nor Maxwell listed this species from the Hunton group.

Figured specimens: Locality C1-P. Catalog numbers OU-1168 to OU-1172.

Distribution: Vanuxem based his description on specimens from the Helderberg of New York. *E. medialis* is rare in the Cravatt member of the Bois d'Arc formation; there are 10 Cravatt specimens, all coming from locality C1-P with the exception of a single specimen from P9-P. None has been found in the Fittstown member, or in the Haragan formation.

EATONIA EXSERTA Amsden 1958
Plate III, figures 9-12

Eatonia exserta Amsden 1958 (p. 110-112, pl. 9, figs. 36-40).

Discussion: The original description of this species was based on specimens from the Bois d'Arc formation so no further diagnosis will be here given. It is easily distinguished from *E. medialis,* by its smaller size, finer plications and more sharply defined fold and sulcus. *E. exserta* is most like *E. fissicosta Dunbar* (1920, p. 136, pl. 3, figs. 7, 8) from the Rockhouse shale; however, the Tennessee shells are characterized by their peculiar split ribs which tend to be fasciculate.

Figured specimens: Localities P3-Y and P15. Catalog numbers OU-1063, OU-1184.

Distribution: This species is rare in the Cravatt member of the Bois d'Arc formation. There are 6 specimens from locality P3-Y and from near locality P15. None has been found in the Fittstown member, nor have any been identified with certainty from the Haragan formation (for additional discussion on the distribution of this species see Amsden 1958, pl. 111).

SUPERFAMILY ATRYPACEA

COELOSPIRA Hall 1863

COELOSPIRA VIRGINIA Amsden 1958
Plate V, figures 39, 40

Coelospira virginia Amsden 1958 (p. 112-114, pl. 7, figs. 29-36, pl. 12, figs. 28-30, text figs. 28, 29).

Discussion: This species is only sparingly present in the Bois d'Arc formation. About a dozen and a half specimens have been collected from the Cravatt member, although almost half of these are etched shells from a single locality (P2-B). These etched specimens are mostly pedicle valves and show the characteristic *Coelospira* interior with its wedge-shaped median ridge. Only two shells have been found in the Fittstown member.

Figured specimens: Locality P8-C. Catalog number OU-1216.

Distribution: My original description of this species was based on specimens from the Haragan formation. The Bois d'Arc collections include 18 specimens from the Cravatt member at the following localities: A2-C; Cal-S(2); M1-M; P2-B; P8-C; P10-R; P13. Two specimens were collected from the Fittstown member at J11-L and P8-F.

ATRYPINA Hall and Clarke 1894
ATRYPINA HAMI Amsden 1958

Plate V, figures 15 - 18

Atrypina hami Amsden 1958 (p. 115-116, pl. 7, figs. 9-18).

Discussion: *Atrypina hami* is poorly represented in the Cravatt member and no specimen has been found in the Fittstown member. The Bois d'Arc specimens appear to be like those from the Haragan in all respects, including size.

Figured specimens: Localities P9-M, -N. Catalog numbers OU-1217, OU-1218.

Distribution: The original description of this species was based on specimens from the Haragan formation where it is moderately common. The Bois d'Arc collections include 10 specimens from the Cravatt member at A2-C, P2-B, and P9-M, -N. None has been found in the Fittstown member.

ATRYPA Dalman 1827
ATRYPA OKLAHOMENSIS Amsden 1958

Plate V, figures 41-43

Atrypa oklahomensis Amsden 1958 (p. 116-121, pl. 9, figs. 24-35, pl. 12, 34-35, text figs. 30, 31, table 11A).

Discussion: This species is moderately common in the Cravatt member, less so in the Fittstown member. These Bois d'Arc shells are externally and internally like those from the Haragan formation. A pedicle sulcus and brachial fold are present on most mature shells, although the prominence of these structures is variable. The length and width are about equal, the ratio showing little variation as is shown in the following measurements:

Length mm	Width mm	Thickness mm	Ratio Length / Width	Costellae Number in 5 mm
15.5	16.8	......	0.92	9
15.5	15.5	8.4	1.0	10
16.1	15.0	9.8	1.07	9
16.4	15.4	......	1.06	11
17.8	17.4	......	1.02	9
18.7	16.3	12.7	1.15	9
20.0	20.2	11.3	0.99	7
20.2	18.5	13.4	1.09	8
20.9	19.7	10.5	1.06	......
24.5	23.7	14.5	1.03	8

The Bois d'Arc specimens have a costellae spacing like that found on Haragan shells, ranging from 7 to 10 with an average of about 9.

Figured specimens: Localities Cal-V(2), P9-M, -N. Catalog numbers OU-1221 to OU-1223.

Distribution: The original description of this species was based on specimens from the Haragan formation in which it is common. The Cravatt collections include about 36, specimens from the following localities: M11-E; P1-J; P3-BB; P9-M, -N, -O, -P; P10-R. Twenty-five specimens have been collected from the Fittstown member at the following localities: Cal-V(2); C1-Q; M3-C; -E; P3-GG.

SUPERFAMILY SPIRIFERACEA

KOZLOWSKIELLA (*MEGAKOZLOWSKIELLA*) Boucot 1957

KOZLOWSKIELLA (*MEGAKOZLOWSKIELLA*) *VELATA* Amsden 1958

Plate V, figures 29-34

Kozlowskiella (*Megakozlowskiella*) *velata* Amsden 1958 (p. 121-124, pl. 8, figs. 1-13, pl. 12, fig. 26, text fig. 32, table 13).

Discussion: This species has generally been referred to *Delthyris perlamellosa* (Hall), a species based on specimens from the New Scotland of New York. In 1958 A. J. Boucot made Hall's species the type of a new subgenus, *Kozlowskiella** (*Megakozlowskiella*), and a short time later I placed the Haragan shells in a new species, *K.* (*M.*) *velata*. Reeds (1911, p. 267) listed *Delthyris perlamellosa* from the Henryhouse, Haragan and Bois d'Arc

* *Kozlowskiella* Boucot 1957 is preoccupied by *Kozlowskiella* Pribyl 1953 and Boucot has recently proposed the substitute name *Kozlowskiellina* (Jour. Paleo. 1958, vol. 32, p. 1031).

formations. His specimens from the last two formations almost certainly represent *K.* (*M.*) *velata*, while his Henryhouse specimens represent *Delthyris kozlowskii* Amsden (1951, p. 91-92, pl. 18, figs. 32-38; 1958, pl. 12-F).

The Bois d'Arc specimens are like those from the Haragan in all respects. They are strongly transverse shells with a length/width ratio of about 0.7. The exterior is costate and plicate, most shells bearing 4 plications on each side of the pedicle sulcus and 3 on each side of the brachial fold; a few larger individuals bear an extra rib on each of the lateral slopes. Strongly developed concentric lamellae cross the costae and interspaces, 5 to 7 of these occupying a space of 5 mm.

Most of the Bois d'Arc shells fall within the same size range as do those from the Haragan formation (Amsden 1958, table 13), having a width of less than 20 mm. A few of the Cravatt individuals are larger, with one incomplete shell having an estimated width of 28 mm.

A number of the Cravatt shells show the internal structure of the pedicle valve. These have a well developed median septum that is partly buried in the thickened, posterior portion of the shell. The brachial interior is illustrated on plate V, figure 31.

The collections under study include a half dozen etched specimens from the basal part of the Cravatt member at locality P2-B. The size and ribbing of these shells is typical for this species, but the lamellae are more closely spaced, 9 to 10 occupying a space of 5 mm. Moreover, the posterior portion of the pedicle valve does not appear to be as greatly thickened as is common on most representatives of this species, although this observation may not be reliable as it is based entirely upon etched specimens. These probably represent only a minor morphologic variation of *K.* (*M.*) *velata.*

Figured specimens: Localities P8-F; P9-M, -N, -Q. Catalog numbers OU-1212 to OU-1215.

Distribution: My original description of this species was based on specimens from the Haragan formation in which it is abundantly represented. About 70 specimens have been collected from the Cravatt member although many of these are fragmentary; the following localities are represented: Cal-X(1); Cal-S(2); C1-P; M1-M, -0; M3-A; M8-P; M14-J; P2-B; P3-BB; P4-C; P8-C; P9-L, -M, -P; P10-P, -R; P13, P17-D. There are 18 specimens from the Fittstown member at the following localities: Cal-V(2); C1-Q; C3; M3-C; P3-CC; P8-F; P9-Q; P10-T; P11-A, -B.

HOWELLELLA Kozlowski 1946

(equals *Crispella* Kozlowski 1929, not Gray 1870)

HOWELLELLA CYCLOPTERA (Hall) 1857

Plate IV, figures 20-28; text figure 14

Spirifer cycloptera Hall 1857 (p. 58; 1859, p. 199, pl. 25, fig. 1).

Howellella cycloptera (Hall). Amsden 1958 (p. 125-126, pl. 8, figs. 14-26; see this publication for a more complete synonymy); Boucot 1958 (p. 317).

Discussion: Since preparing the description of this species for the HARAGAN BRACHIOPODS I have found several well preserved specimens at locality P17-D which show in considerable detail the structure of the spines. The spine bases are packed closely together and are arranged in concentric rows as shown in plate IV, figure 24 and text figure 14-A. These are commonly somewhat shortened by abrasion, even on choice specimens, but when complete they appear to be notched or grooved at their distal end as shown in text figures 14-B, -D. Near the posterior end of the shell these generally come off at a low angle (14-B), but towards the anterior margin their front ends are sharply elevated. Extending forward are long, slender spines; where well preserved at least some of these show a groove or notch on the upper surface, thus giving them a "double-barreled" appearance at the large end (text fig. 14-C). I suspect that these were articulated and moveable during life. They are preserved on several specimens and appear to have a random orientation; in any given region of the shell the mat of spines is, for the most part, oriented in a common direction, but this direction varies from one area to another. If the spines were fixed and immobile one would expect them to have a more or less constant direction, presumably towards the anterior. The preservation is not good enough to tell whether the spines were hollow or solid.

The finding of "double-barreled" spines on these shells raises some questions. The genus *Howellella* was proposed by Kozlowski (1929, p. 189; as *Crispella,* a preoccupied name later changed to *Howellella*) for shells which had, among other characters, simple spines. This was to encompass the group of spirifers which Hall and Clarke (1894, p. 19) called the Fimbriati-Unicispinei. These shells were characterized by having short, simple, hollow spines in contrast to the Fimbriati-Duplicispinei which had hollow, "double-barreled" spines. Hall and Clarke (1894, p. 36) included *Spirifer cyclopterus* in the Unicispinei group, although I have not been able to find any reference where either of these authors, or anyone else, has described in detail the spine structure of this

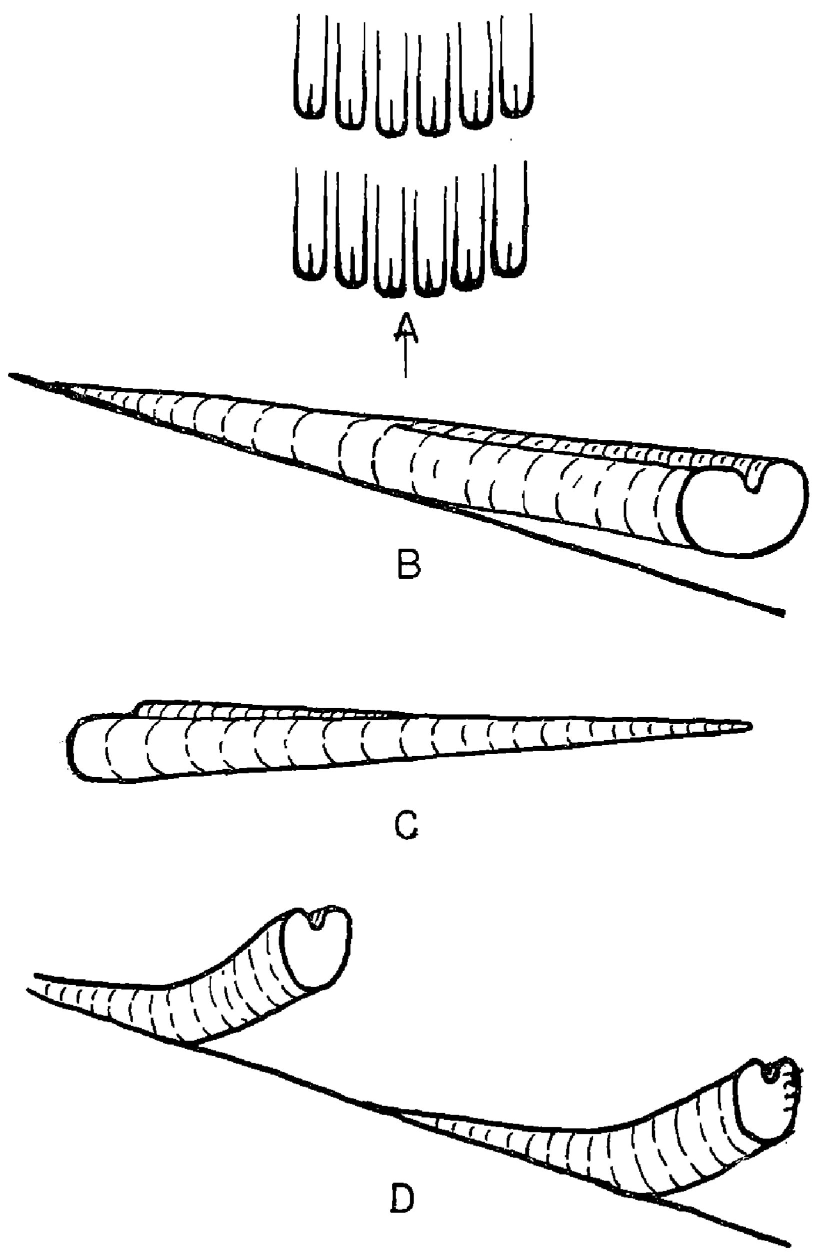


Figure 14. Sketches showing the spine structure of *Howellella cycloptera* from the Bois d'Arc formation. All greatly enlarged. A. Plan view of the spine bases showing their arrangement in concentric rows. B, D. Spine bases showing their cleft distal ends; B is located near the posterior end of the shell and D near the anterior end. C. "Double barreled" spine.

species. I have examined a large number of *H. cycloptera* at Peabody Museum—Yale University, and at the U. S. National Museum. These have a shape and ornamentation like the Haragan-Bois d'Arc shells, but none has the spines preserved. The question therefore remains whether the detailed spine structure matches that of the Oklahoma shells, or whether the latter differ in this respect, and the final answer will need to wait on a further study of New York specimens of *H. cycloptera*.

According to Hall and Clarke (1894, p. 20) the earliest representative of the Duplicispinei type is from the Oriskany. The Bois d'Arc shells are Helderbergian regardless of whether they are conspecific with those from New York.

Boucot (1957, p. 311-334) restudied the Silurian and early Devonian lamellose brachiopods and recognized two subfamilies, the Delthyrinae and the Kozlowskiellinae. Both groups had spines but the Delthyrinae had non-frilly lamellae whereas the Kozlowskiellinae had frilly lamellae (*Spirifer cyclopterus* was assigned to *Howellella* and placed in the Delthyrinae). My own study of the Haragan-Bois d'Arc species of *Kozlowskiella* (*M.*) *velata* and *Howellella cycloptera* indicates that the distinction between these two types of ornamentation is well taken. The lamellae of *K.* (*M.*) *velata* (Amsden 1958, pl. 8, fig. 2) consist of concentric shell layers, each one distinct and overlapping the next like shingles on a roof. On top of each layer are ridges which presumably represent the spine bases. In contrast the Haragan-Bois d'Arc shells of *H. cycloptera* show no shingle-like structure. The spine bases are packed closely together in concentric rows (Amsden 1958, pl. 8, fig. 22; text fig. 14-A of this report) and it is this which make the lamellae (text fig. 14-B, 14-D). When the shell is lightly exfoliated, as almost all are in the calcarenite lithofacies, the spine bases are removed and the shell appears smooth (Amsden 1958, figs. 14, 15, 17, 21). On the other hand the frilly lamellae of *K.* (*M.*) *velata* is a part of the shell and even deeply weathered specimens generally show distinct traces of lamellae. The Henryhouse species *Delthyris kozlowskii* Amsden and *Howellella henryhousensis* Amsden have a shell structure similar to *H. cycloptera* and commonly have the lamellae removed by exfoliation (Amsden 1958, pl. 12, fig. 22 shows a partially exfoliated specimen of *D. kozlowskii*).

This species is found in both the Haragan and Bois d'Arc their uneven distribution and the nature of the preservation. Most of the Haragan and Cravatt shells are well preserved, free individuals, but unfortunately they are not common, the collections including only a dozen specimens from the Haragan and about 30 from the Cravatt. In contrast this is one of the most common species in the Fittstown lithofacies, although the preservation is generally unsatisfactory. These Fittstown collections consist almost entirely of isolated valves broken out of a calcarenite matrix. Most are incomplete and so deeply exfoliated that all details of surface ornamentation are lost, making it difficult to compare with the better preserved, but less well represented, Cravatt and Haragan shells. However, in so far as can be determined the Fittstown specimens match those from the Cravatt and Haragan.

The largest specimen in the collections is from the Cravatt and has an estimated width of 40 mm (most shells are much smaller). Most Fittstown shells are so deeply exfoliated that they have lost the spine bases and appear completely smooth. The plications on the Fittstown specimens do not appear quite as strong as those from the Cravatt and Haragan shells, but this may well be the result of exfoliation.

Figured specimens: Localities P2-A; P3-JJ; P8-G, P9-P; P11-A. Catalog numbers OU-1091, OU-1094; OU-1196 to OU-1200.

Distribution: The collections include about 30 specimens from the Cravatt member although more than half of these are etched shells from localities P2-B and P13. Other Cravatt localities are: C1-P; M1-O; P9-P; P17-D. This species is extremely abundant in the Fittstown member, the collections including over 200 specimens from the following localities: Cal-V(2); C3; J11-L; M3-E; M10-P; P3-CC, -EE, -GG, -HH, -JJ; P8-F, -G; P11-A.

This species is rare in the Haragan formation, only a dozen specimens having been collected. It is interesting to compare the stratigraphic distribution of this species with *Kozlowskiella* (*M.*) *velata*, the latter being abundant in the Haragan and rare in the the Fittstown, whereas *H. cycloptera* is rare in the Haragan and abundant in the Fittstown.

SUPERFAMILY ROSTROSPIRACEA

NUCLEOSPIRA Hall 1859

NUCLEOSPIRA VENTRICOSA (Hall) 1857

Spirifer ventricosa Hall 1857 (p. 57 [not figs. 1, 2].

Nucleospira ventricosa (Hall). Hall 1859 (p. 220, pl. 14, figs. 1, pl. 28B, figs. 2-9); Amsden 158 (p. 127-128, pl. 9, figs. 14-20).

Discussion: The collections include 5 specimens from the Cravatt member of the Bois d'Arc formation. One of these, from locality P17-D, is unusual in retaining a considerable portion of its spinose surface. The spines are simple and short, packed close together to form a dense mat, with no tendency to develop concentric rows. With the removal of the spines the surface is delicately papillose, but most specimens have even this ornament worn away to give a smooth shell.

In so far as can be determined from this meager representation, the Bois d'Arc shells are similar in size and shape to those from the Haragan formation.

Distribution: Hall based his description of this species on specimens from the New Scotland of New York. It has been reported from Helderberg equivalents in various parts of the central and eastern United States (Amsden 1958, p. 127). *N. ventricosa* is uncommon in the Haragan and rare in the Bois d'Arc formation. Five specimens have been found in the Cravatt lithofacies at A2-C; P17-D and P10-R. It has not been found in the Fittstown lithofacies; however, it is known to range almost throughout the entire Bois d'Arc formation because at P17-D it is found within 8 feet of the Frisco formation, the calcarenite lithofacies facies being only a few feet thick in this area.

MERISTELLA Hall 1859

MERISTELLA ATOKA Girty 1899

Plate IV, figures 1-14; text figures 15

Meristella atoka Girty 1899 (p. 567, pl. 71, figs. 1a-f; Amsden 1958, p. 128-133, pl. 10, figs. 1-15, text fig. 33, table 14).

Discussion: The Cravatt and Fittstown members carry numerous specimens of *M. atoka* which appear to be identical in all respects to the Haragan representatives. These Bois d'Arc shells are commonly transverse, the length/width ratio being around 0.8 to 0.9; in smaller shells the length may exceed the width, but this condition is rare on individuals over 15 mm in length. The pedicle fold and brachial sulcus are generally deep and become subangular at the front end. The Bois d'Arc specimens may be slightly larger, on the average, than are those from the Haragan, but this difference is small as is shown by the following measurements of a representative suite of Cravatt and Fittstown shells.

Length mm	Width mm	Thickness mm	Ratio Length/width
14.0	12.5	8.7	1.1
17.0	17.7	13.2	0.9
17.9	19.1	12.8	0.9
18.9	21.9	12.4	0.8
22.1	26.4	15.0	0.8
22.5	25.3	19.4	0.9
24.0	29.8		0.8

Both the Fittstown and Cravatt members include a number of shells that are here referred to the genus *Meristella,* but which differ from the typical *M. atoka* in their greater size and more weakly developed fold and sulcus. These specimens are tentatively separated from *M. atoka* as *Meristella* sp.; for a complete discussion see under the latter name.

The pedicle interior of the Bois d'Arc shells appears to be identical to that found on the Haragan specimens (Amsden 1958, pl. 10, fig. 10). The brachial hinge plate is shown on plate IV, figures 10, 14; spires and jugum have not been observed.

Figured specimens: Localities M10-P; P2-B, P3-EE; P9-M, -N. Catalog numbers OU-1189 to OU-1195.

Distribution: Girty's description of *M. atoka* was based on specimens from the Haragan formation in which this species is abundant. Approximately 80 specimens have been collected from the Cravatt member at the following localities: C1-P; Cal-S(2); M1-M; M8-P; M9-E; M11-E; P2-B; P3-Y, -BB; P8-D; P9-L, -M, -N; P10-P, -R; P13; P17-D?. The Fittstown collections include about 40 specimens from the following localities: Cal-V(2); C1-Q; J11-L; M3-C; M10-P; P3-EE, -GG, -HH, -JJ; P8-F, -G; P9-Q; P11-A.

MERISTELLA sp. 2

Plate IV, figures 15-19; text figure 15

Description: This species has a large, somewhat elongate shell, with the length commonly exceeding the width. The lateral profile is moderately biconvex, the two valves being about equal; the pedicle beak is hooked towards, and generally in conjunction with, the brachial valve. A weakly developed pedicle sulcus and brachial fold are present on the anterior portion of the shell; these structures vary in their development, but are in all cases shallow and none approaches the development found on *M. atoka.*

These shells attain a large size with some specimens reaching a length of almost 40 mm. The measurements of 7 specimens are given below:

Length	Width	Thickness	
20mm	20mm	......	
22	21	......	
30	30	......	
33	27	21	
33	31	21	
37	34	......	
37	40	......	(somewhat crushed)

Only the posterior portion of a single pedicle interior has been observed (pl. IV, fig. 19); this shows a deeply impressed muscle field similar to that of *M. atoka.* The brachial interior has not been observed.

Discussion: The Cravatt and Fittstown collections include a number of specimens referred to this species, but most are fragmentary, and complete, articulated valves are rare. *M.* sp. 2 differs from *M. atoka* with which it is associated, in having a much more weakly developed fold and sulcus. Moreover, it has a considerably larger shell which tends to be elongate in contrast to the slightly transverse shell of *M. atoka* (fig. 15). The size of *M.* sp. 2 is similar to that of *M. meeki* (Hall 1857, p. 97; 1859, p. 252, pl. 44, fig. 6; Amsden 1958, p. 132, pl. 13, figs. 26-30), but Hall's species has a transverse shell (fig. 15) with a much better developed fold and sulcus. This is probably the species which Reeds (1911, p. 265; 1926, p. 10) identified as *M. laevis* (Vanuxem 1842; Hall 1859, p. 247, pl. 39, figs. 3, 4; Hall and Clarke 1894, pl. 43, figs. 3-6). I have not examined any New York specimens of this species, but judging from Hall's illustrations the Bois d'Arc shells are somewhat like those from New York. However, in view of the rather fragmentary nature of the Bois d'Arc shells, and the absence of diagnostic data on the internal characters, no specific identification is attempted.

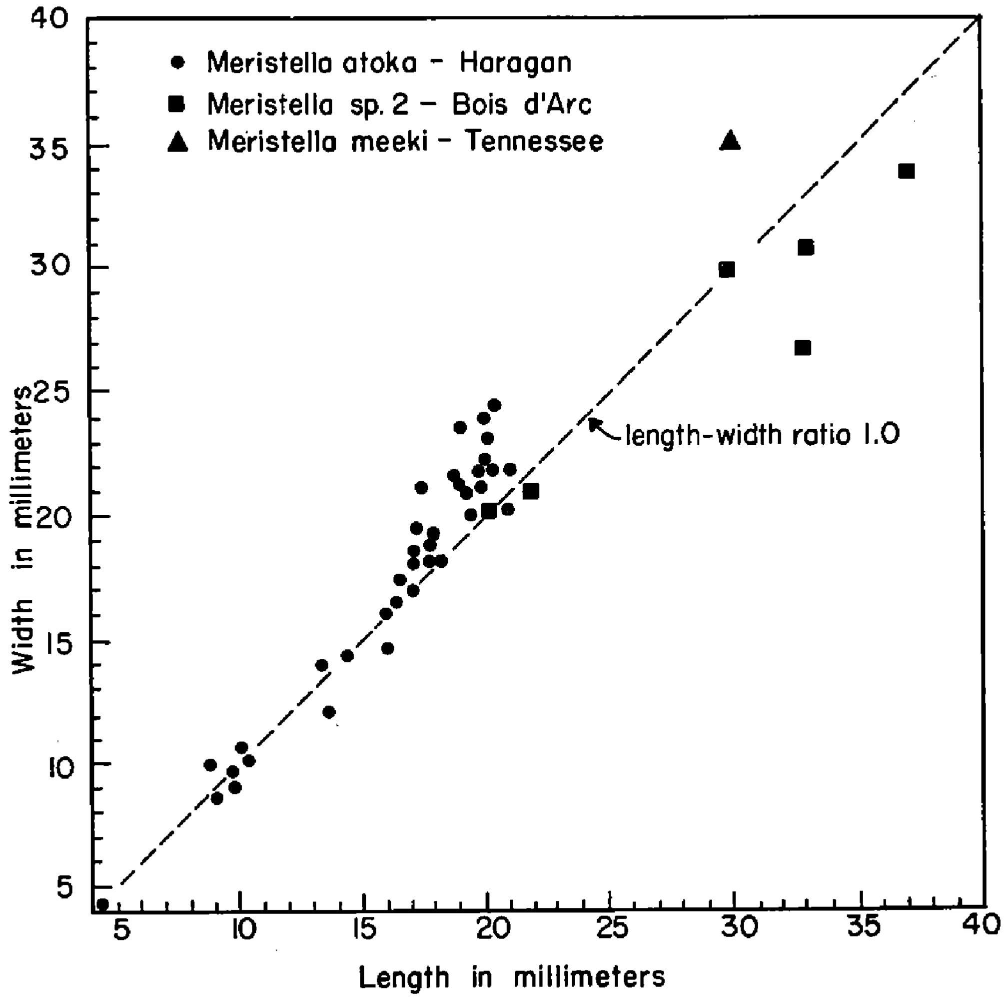


Figure 15. Scatter diagram comparing the length-width relationship of the following: *Meristella atoka* Girty, Haragan formation, Oklahoma (circles); *Meristella* sp. 2, Bois d'Arc formation, Oklahoma (squares); *Meristella meeki* (Hall), Ross limestone, Tennessee (triangle; the only specimen plotted is the holotype).

Figured specimens: Localities M11-E, P4-C and P3-GG. Catalog numbers OU-1185 to OU-1188.

Distribution: There are about 20 specimens from the Cravatt member at the following localities: Cal-X(1); M1-O; M11-E; M14-J; P4-C. The collections also include about 20 specimens from the Fittstown member at P3-EE, -GG, and P8-F.

This species has not been found in the Haragan formation.

SUPERFAMILY PUNCTOSPIRACEA

CYRTINA Davidson 1858

CYRTINA DALMANI NANA Amsden 1958

Plate V, figures 19-22; text figure 16

Cyrtina dalmani nana Amsden 1958 (p. 133-136, pl. 7, figs. 19-28, text figs. 34, 35).

Discussion: The Bois d'Arc representatives of this subspecies appear to be identical in all respects to those from the Haragan formation. They have a prominent pedicle palintrope which is strongly apsacline to almost catacline; the delthyrium is partly closed by a conspicuous, arched plate. The shell is costate and plicate; the costae are rounded and broad for a shell of this size; two to three costae occupy each lateral slope of the brachial valve, and three to four on each lateral slope of the pedicle valve. The Bois d'Arc shells are similar in size to those from the Haragan; the measurements of 4 complete shells are given below:

Length mm	Width mm
4.6	6.0
5.8	8.4
6.0	10.0
6.4	7.8

The length/width ratio is surprisingly variable, this being true of both the Haragan and the Bois d'Arc representatives. A scatter diagram of the length and width is shown in figure 16; the specimens provisionally referred to *C. dalmani* are included.

No pedicle or brachial interiors seen (the problem of the generic relationship is discussed in Amsden 1958, p. 135-136).

Figured specimens: Locality P9-P and P10-R. Catalog numbers OU-1219, 1220.

Distribution: The original description of this subspecies was based on specimens from the Haragan formation. It is rare in the Haragan formation and also rare in the Bois d'Arc. Eleven specimens have been collected from the Cravatt member at P9-M, -N, -P; P17-D. Two specimens were obtained from strata questionably referred to the Fittstown member at P9-Q.

CYRTINA DALMANI ? (Hall) 1857

Text figures 16, 17

Cyrtia dalmani Hall 1857 (p. 64; 1859, p. 206, pl. 24, figs. 1).

Two pedicle valves from the uppermost part of the Fittstown member are tentatively identified as *Cyrtina dalmani* (fig. 17). These specimens are significantly larger than the largest Bois d'Arc or Haragan shells of *C. dalmani nana*; the largest is 13 mm wide whereas the largest specimen of *C. dalmani nana* is about 10 mm wide (fig. 16). In addition the costellae and interspaces are nar-

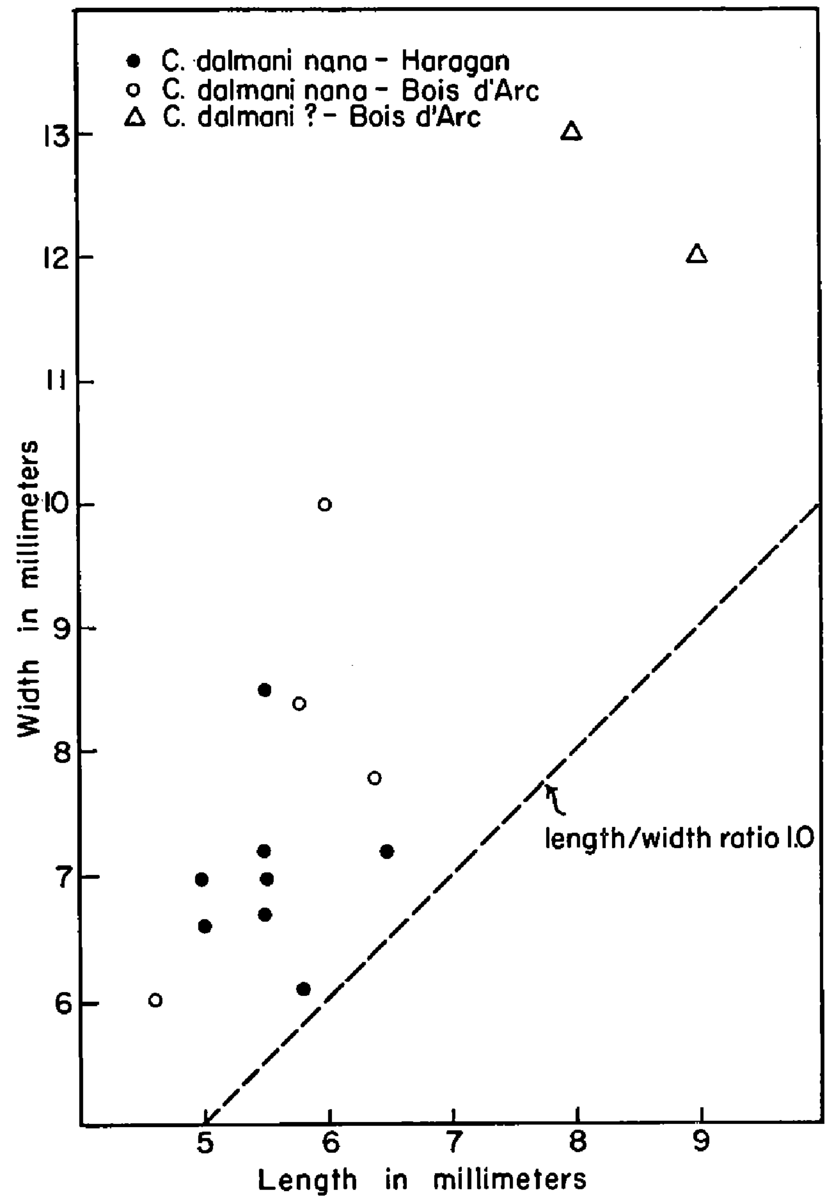


Figure 16. Scatter diagram comparing the length-width relationship of the following: *Cyrtina dalmani nana* Amsden from the Haragan formation (solid circles); *C. dalmani nana* Amsden from the Bois d'Arc formation (open circles); *C. dalmani?* (Hall) from the Bois d'Arc formation (open triangles).

rower, and there are more costellae, there being 5 (fig. 17-B) to 6 (fig. 17-A) on each side of the pedicle sulcus in contrast to the 3 or 4 found on *C. dalmani nana**. An actual comparison with specimens of *C. dalmani* from the New Scotland of New York shows striking similarities, although in the absence of more material, especially brachial valves, this identification is provisional.

* In my 1958 discussion of *C. dalmani nana* (p. 136) I compared it with *C. dalmani* (Hall) and noted that the two are alike except for size. This statement needs to be modified slightly, because not only are mature New Scotland specimens larger, but the ribs and interspaces are slightly narrower than on *C. dalmani nana.*

Distribution: Hall's description of *C. dalmani* was based on specimens from the New Scotland of New York. I have collected two specimens from the upper 2 inches of the Fittstown member; locality C3.

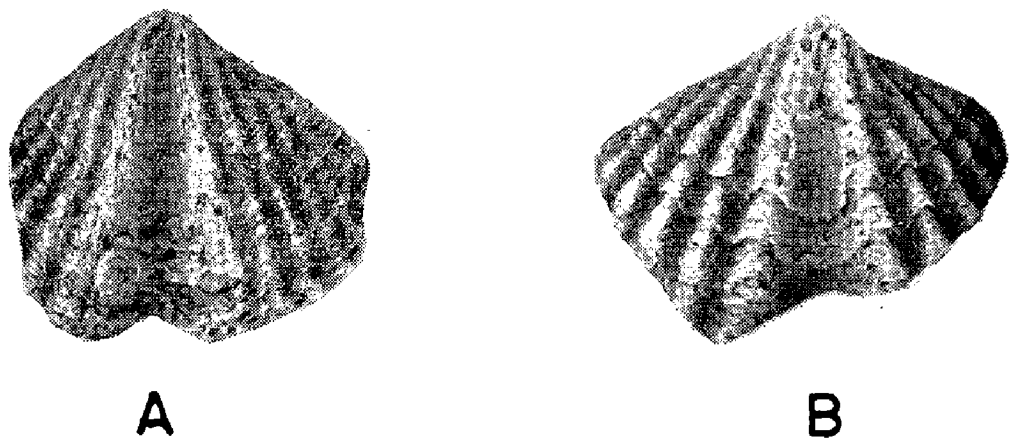


Figure 17. *Cyrtina dalmani?* (Hall). Two pedicle valves from the top of the Fittstown member at C3 (x 3). A.—Catalog number OU-1273; B.—Catalog number OU-1274.

TREMATOSPIRA Hall 1857
TREMATOSPIRA sp.
Text figure 18

Discussion: The Bois d'Arc collections include 3 specimens which are referred to the genus *Trematospira*. One of these (fig. 18-C), from locality P17-D, is a punctate shell with an outline and ribbing much like the Haragan shell which I identified as *Trematospira* cf. *T. hippolyte* (1958, p. 136-137, pl. 8, figs. 27-31). The other Cravatt specimen, which is from the same locality, is a somewhat more transverse shell with a deeper fold and sulcus (fig. 18-A, B). Its outline suggests *T. costata angusta* Dunbar (1920, pl. 4, figs. 6, 7; Amsden 1958, pl. 11, fig. 31), but it has a somewhat stronger fold and sulcus. The Fittstown has furnished a single, fragmentary pedicle valve which is questionably referred to this genus. It is poorly preserved and partly recrystallized so that the punctae, if they were originally present, are not visible. This specimen is placed in the genus *Trematospira* because it has an external shape and ornamentation somewhat similar to the Haragan-Cravatt shells identified as *T.* cf. *T. hippolyte*.

Distribution: Two specimens from the Cravatt at locality P17-D and one questionably identified shell from the Fittstown at locality P3-HH.

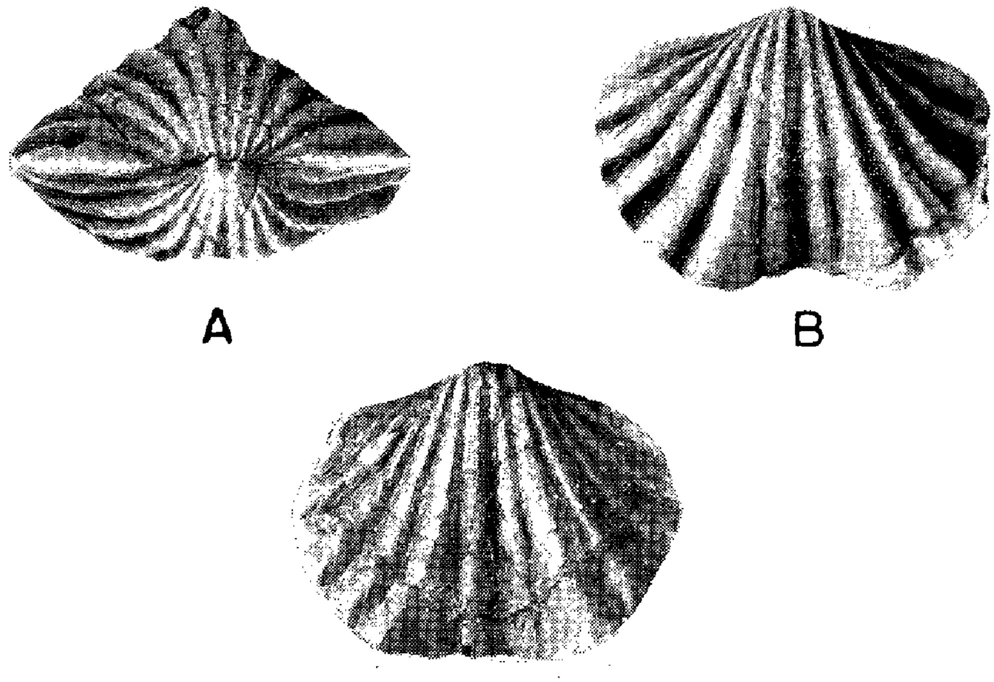


Figure 18. *Trematospira* sp. A. B. Posterior and pedicle views of the same specimen, x 3, Cravatt member, Collection P17-D (OU-1275); C. Pedicle view of a specimen similar to the Haragan shell compared to *Trematospira hippolyte* (Billings) (Amsden 1958, pl. 8, figs. 27-31), x 3, Cravatt member, Collection P17-D (OU-1276).

RHYNCHOSPIRINA Schuchert and Levene 1929

RHYNCHOSPIRINA MAXWELLI Amsden 1958

Plate V, figures 23-28

Rhynchospirina maxwelli Amsden 1958 (p. 138-142, pl. 9, figs. 1-13, text figs. 36-38, tables 15, 16).

Discussion: There are enough well preserved specimens in the Cravatt collections to demonstrate clearly that the Bois d'Arc shells are conspecific with those from the Haragan. The Cravatt specimens are elongate oval with a length/width ratio which is fairly constant at about 1.1, a ratio almost identical to that found on most Haragan shells. The lateral profile is biconvex and the pedicle beak prominent and more or less erect on small shells, but progressively leaning towards the brachial with increased size (Amsden 1958, fig. 36). Both valves bear sulci, that of the pedicle being the deepest. The costellae are low and rounded, and are separated by narrow interspaces; 4 to 7 costellae occupy a space of 5 mm.

Most of the Bois d'Arc specimens range between 10 and 12 mm in length; the largest is 16.8 mm long. The dimensions of 8 specimens are given below:

Length mm	Width mm	Thickness mm	Length/width Ratio	Costellae Number in 5 mm
8.2	7.8	6.1	1.1	7
10.0	9.0	......	1.1	6
11.1	10.4	7.6	1.1	6
11.2	10.5	7.9	1.1	6
11.4	10.9	......	1.0	6
12.3	12.3	8.1	1.0	5
14.8	13.5	10.4	1.1	5
16.8	14.7	12.0	1.1	4

The pedicle and brachial interiors have not been observed.

This species is moderately well represented in the Cravatt member, but only a single specimen has been found in the Fittstown member; however, this is a complete pedicle valve which seems to be typical in all respects for this species (pl. V, fig. 27).

Reeds (1911, table 2) recorded *Rhynchospira formosa* from the Henryhouse, Haragan and Bois d'Arc formations. His Henryhouse specimens almost certainly represent "*Homoeospira*" *subgibbosa* Amsden, and his Haragan-Bois d'Arc specimens *R. maxwelli*. See Amsden 1958 (p. 140-141) for a comparison of *R. maxwelli* with *R. formosa* and "*H.*" *subgibbosa*.

Figured specimens: Localities J11-L; P9- M, -N; P10-R. Catalog numbers OU-1224 to OU-1227.

Distribution: My original description of this species was based on specimens from the Haragan formation, in which it is abundant. The Bois d'Arc collections include about 35 specimens from the Cravatt member at localities A2-C; P2-B; P3-BB; P9-M, -N; P10-P, -R; P17-D. A single specimen has been found in the Fittstown member at locality J11-L.

RENSSELAERINA Dunbar 1917

RENSSELAERINA HARAGANANA Cloud 1942

Plate V, figures 35-38

Rensselaerina haraganana Cloud 1942 (p. 52-53, pl. 4, figs 1-7, 17-20); Amsden 1958 (p. 142-144, pl. 10, figs. 16-26, pl. 14, figs. 16, 17, table 17).

Discussion: Ten specimens have been collected from the Cravatt member, about half of these being nearly complete shells. These Cravatt shells are similar in all respects, including size, to those from the Haragan formation. A single incomplete Fittstown specimen is referred to this species, and in so far as can be determined this shell, which comprises the posterior two-thirds of a pedicle valve, appears to be identical to the Cravatt and Haragan representatives of *R. haraganana.* The specimen illustrated on plate V, figures 36 to 38, measures 19.5 mm long, 15.8 mm wide and 11.5 mm thick: the largest Bois d'Arc specimen has an estimated length of 24 mm, a width of 19.5 mm, and a thickness of 13.4 mm.

A comparison of *R. haraganana* with other species of *Rensselaerina* is given in my paper on Haragan brachiopods (1958, p. 143).

Figured specimens: Localities P9-M, -N. Catalog numbers OU-1228, OU-1229.

Distribution: Cloud based his description of this species on specimens from the Haragan formation at White Mound. It is not a common species in the Haragan and is rare in the Bois d'Arc. The collections include 10 specimens from the Cravatt member at localities P9-M, -N; P10-R; P2-B(?). A single specimen has been found in the Fittstown member at locality C1-Q.

REFERENCES

Amsden, T. W., 1949. Stratigraphy and paleontology of the Brownsport formation (Silurian) of western Tennessee: Yale Univ., Peabody Museum Nat. History, Bull. 5, p. 1-138, 34 plates, text figs.

..............................., 1951. Brachiopods of the Henryhouse formation (Silurian) of Oklahoma: Jour. Paleontology, vol. 25, p. 69-96, 6 pls., 1 text fig.

..............................., 1956. Catalog of fossils from the Hunton group, Oklahoma: Oklahoma Geol. Survey, Circular 38, p. 1-63.

..............................., 1957. Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part I—Introduction to stratigraphy: Oklahoma Geol. Survey, Circular 44, p. 1-57, 3 pls., 6 text figs.

..............................., 1958. Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part II—Haragan articulate brachiopods: Oklahoma Geol. Survey, Bull. 78, p. 1-144. 14 pls., text figs.

..............................., 1958B. Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part III—Supplement to the Henryhouse brachiopods: Oklahoma Geol. Survey, Bull. 78, p. 145-157. illustrated.

..............................., 1958C. White Mound: Okla. Geological Survey, Okla. Geology Notes, vol. 18, p. 131-135.

Boucot, A. J., 1957. Revision of some Silurian and early Devonian spiriferid genera and erection of Kozlowskiellinae, new subfamily: Senckenbergiana lethaea, vol. 38, p. 311-334, 3 pls.

————, and Amsden, T. W., 1958. New genera of brachiopods: Oklahoma Geological Survey, Bull. 78, p. 159-170, illustrated.

Cloud, P. E., Jr., 1942. Terebratuloid Brachiopoda of the Silurian and Devonian: Geol. Soc. America, Special Papers, No. 38, p. 1-182, 26 pls.

Conrad, T. W., 1842. Observations on the Silurian and Devonian systems of the United States, with descriptions of new organic remains: Acad. Nat. Science, Philadelphia, Jour., vol. 8, p. 228-280, illust.

Cooper, G. A., 1942. New genera of North American brachiopods: Washington Acad. Sciences, Jour., vol. 32, p. 228-235.

————, 1944. Brachiopoda, **in** Index Fossils of North America, edited by Shimer and Shrock: The Technology Press, Mass. Inst. Technology, p. 277-365, pls. 106-143.

————, and Muir-Wood, H. W., 1951. Brachiopod homonyms: Washington Acad. Sciences, Jour., vol. 41, p. 195-196.

Dunbar, C. O., 1919. Stratigraphy and correlation of the Devonian of western Tennessee: Tennessee Geol. Survey, Bull. 21, p. 1-127, 3 pls., text figs.

————, 1920. New species of Devonian fossils from western Tennessee: Connecticut Acad. Arts and Sciences, Trans., vol. 23, p. 113-149, pls. 1-5.

Girty, G. H., 1899. Preliminary report on Paleozoic invertebrate fossils from the region of the M'Alester Coal Field, Indian Territory: U. S. Geological Survey, 19th Annual Rept., part III, p. 539-593, pls. 70-73.

Hall, J., 1857. Descriptions of Palaeozoic fossils: New York Cabinet Nat. History, 10th Annual Rept., p. 41-186, illustrations.

————, 1859. (text; plates dated 1861). Containing descriptions and figures of the organic remains of the lower Helderberg group and the Oriskany sandstone: Palaeontology of New York, vol. 3, p. 1-532, 120 pls. text figs.

Hall, J., and Clarke, J. M., 1892 (1893). An introduction to the study of the genera of Palaeozoic Brachiopoda: Palaeontology of New York, vol. 8, pt. 1, p. 1-367, 20 pls., text figs.

————, and ————, 1894. An introduction to the study of the genera of Palaeozoic Brachiopoda: Palaeontology of New York, vol. 8, pt. 2, p. 1-314, pls. 21-84, text figs.

Kozlowski, R., 1929. Les brachiopodes de la Gothlandiens de la Podolie Polonaise: Palaeontologia Polonica, vol. 1, p. 1-254, 12 pls., text figs.

Maxwell, R. A., 1936. The stratigraphy and areal distribution of the "Hunton formation," Oklahoma: Ph. D. dissertation, Northwestern University, p. 1-120, illustrations, maps and sections. An abstract of this dissertation was published in Summaries of Doctoral Dissertations, vol. 4, Northwestern University, 1936, p. 131-136.

Moore, R. C., 1949. Meaning of facies: Geol. Soc. America, Memoir 39, p. 1-34, illust.

Reeds, C. A., 1911. The Hunton formation of Oklahoma: Amer. Jour. Science, vol. 182, p. 256-268.

...., 1926. The Arbuckle Mountains, Oklahoma: American Museum Nat. History, Jour., vol. 26, p. 463-474, 11 figs.; Oklahoma Geol. Survey, Circular 14, pp. 1-15, 11 figs.

Schuchert, C., 1897. A synopsis of American fossil Brachiopoda including bibliography and synonymy: U. S. Geol. Survey, Bull. No. 87, p. 1-464.

...., and Cooper, G. A., 1932. Brachiopod genera of the suborders Orthoidea and Pentameroidea: Yale Univ., Peabody Museum Nat. History, Memoir, vol. 4, pt. 1, p. 1-270, 29 pls. text figs.

...., and Maynard, T. P., 1913. Brachiopoda *in* Lower Devonian of Maryland: Maryland Geol. Survey, p. 290-450, pls. 1-98.

Tansey, V. O., 1922. The fauna and correlations of the Bailey limestone in the Little Saline Creek area of Ste. Genevieve County, Missouri: Missouri Bureau Geology Mines, 2nd ser.; vol. 17, p. 166-212, pls. 40-56.

Vanuxem, L., 1842. Survey of the third geological district: Geology of New York, pt. III, p. 1-306, text figs.

Weller, J. M., 1958. Stratigraphic differentiation and nomenclature: Amer. Assoc. Petroleum Geologists, vol. 42, p. 609-639.

Wilson, C. W., Jr., 1949. Pre-Chattanooga stratigraphy in central Tennessee: Tennessee Division of Geology, Bull. 56, p. 1-407, 28 pls.

PLATES I TO V

The specimens illustrated on the following plates are in the collections of the University of Oklahoma. All specimens are from the Bois d'Arc formation unless otherwise indicated. The locality and stratigraphic position for the collection numbers indicated on the plate explanations are given in the section on GEOGRAPHIC AND STRATIGRAPHIC SOURCE OF FOSSIL COLLECTIONS. None of the figures has been retouched.

PLATE I

Figure 1. *Pseudodicoelosia oklahomensis* (Amsden). 1. Brachial interior showing rounded crenulations, x 6 [Henryhouse formation; NW¼ sec. 33, T. 3 N., R. 6. E.] (OU-1211).

Figures 2-9. *Rhipidomelloides oblata* (Hall). 2. brachial view, x 1, Cravatt member, Coll. P2-B (OU-1124); 3. pedicle interior, x 1, Cravatt member, Coll. P2-B (OU-1125) 4. Internal margin of pedicle valve showing subrectangular crenulations, x 6, Cravatt member, Coll. P13 (OU-1123); 5. pedicle view, x 1, Cravatt member, Coll. P2-B (OU-1121); 6. brachial view, x 1, Fittstown member, Coll. P3-CC (OU-1127); 7. brachial interior, x 2, Fittstown member?, Coll. P11-A (OU-1128); 8. pedicle view. x 1, Fittstown member, Coll. P8-F (OU-1126); 9. pedicle interior. x 1. Fittstown member?. Coll. P11-A (OU-1122). [Other Bois d'Arc specimens of this species illustrated in Amsden 1958, pl. 2, figs. 1, 5].

Figure 10. *Orthostrophia strophomenoides parva* Amsden. 10 brachial view, x 1, Cravatt member, Coll. P4-C (OU-1134).

Figures 11-21. *Platyorthis angusta* Amsden, n. sp. 11. pediclee interior, x 2, Cravatt member, Coll. P2-B (OU-1143); 12, 13. brachial exterior (x 1) and interior (x 2), Cravatt member, Coll. P2-B (OU-1142); 14. brachial view, x 1, Cravatt member, Coll. P3-Y (OU-1141); 15, 16, 19, 20. brachial, anterior, pedicle and lateral views of the holotype, x 1, Cravatt member, Coll. P2-B (OU-1139); 17, 21. posterior (x 1) and pedicle (slightly enlarged) views, Fittstown member, Coll. P8-F (OU-1138); 18. brachial interior, x 1, Cravatt member, Coll. P2-B (OU-1140).

Figures 22-27. *Levenea subcarinata pumilis* Amsden. 22. brachial view, x 1, Cravatt member, Coll. P2-B (OU-1129). 23. pedicle view, x 1, Cravatt member, x 1, Coll. P9-M (OU-1130); 24, 25. pedicle interior and exterior views, x 1, Cravatt member, Coll. P2-B (OU-1131); 26. brachial interior, x 1, Cravatt member, Coll. Cal-S (2) (OU-1132); 27. brachial interior, x 1, Cravatt member, Coll. P2-B (OU-1133).

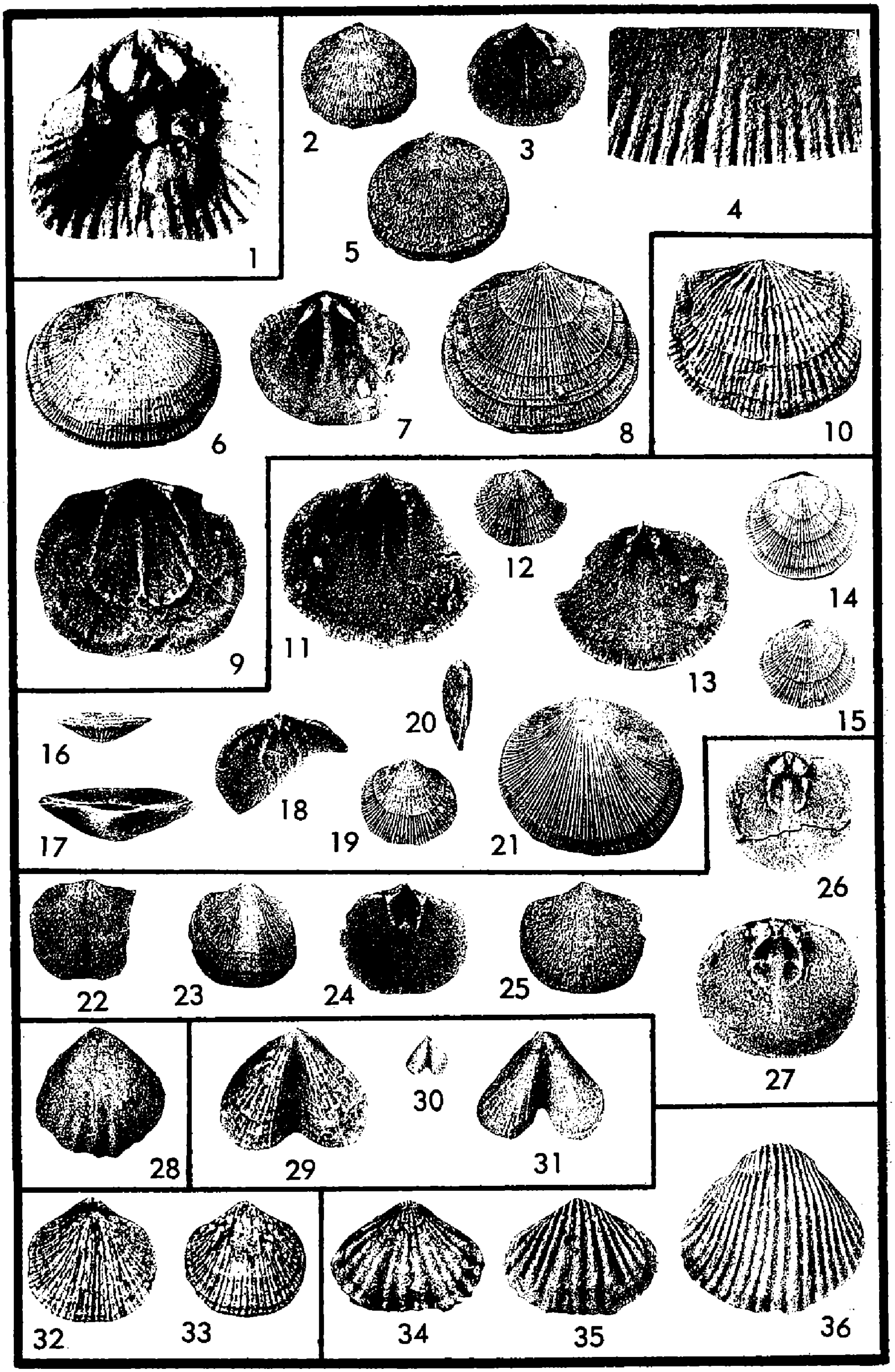
Figure 28. *Gypidula?* sp. 28. pedicle view, x 1, Fittstown member, Coll. P3-CC (OU-1147).

Figures 29-31. *Dicoelosia varica* (Conrad). 29. brachial view, x 3, Cravatt member, Coll. P9-M (OU-1137); 30. pedicle view, x 1, Cravatt member, C1-P (OU-1136); 31. pedicle view, x 3, Cravatt member, Coll. M1-M (OU-1135).

Figures 32-33. *Isorthis pygmaea* (Dunbar). 32-33. brachial and pedicle views, x 3, Cravatt member, Coll. P2-B (OU-1144).

Figures 34-36. *Anastrophia grossa* Amsden. 34-35, pedcile and brachial views, x 1, Cravatt member, Coll. P9-M,-N (OU-1145); 36. brachial view, x 1, Cravatt member, Coll. C1-P (OU-1146).

All specimens from the Cravatt member at locality P2-B are silicified specimens etched out of limestone.


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
33
34
35
36

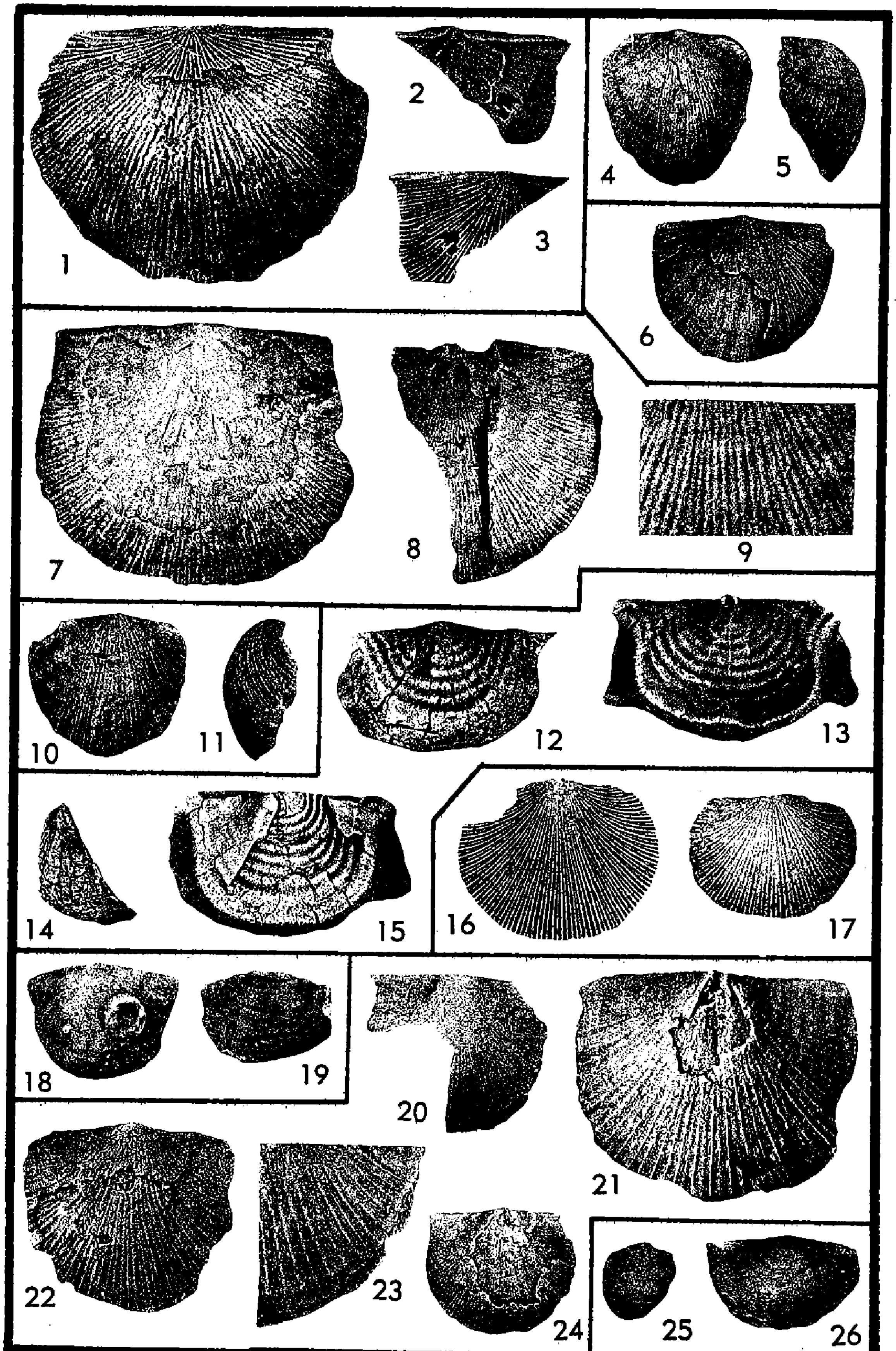

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

PLATE II

Figures 1-3. *Strophonella* (*Strophonella*) *bransoni* Amsden. 1. brachial view, x 1, Fittstown member, Coll. P3-GG (OU-1150); 2-3. pedicle interior and exterior, x 1, Cravatt member, Coll. P2-B (OU-1151). [Other Bois d'Arc specimens of this species illustrated in Amsden 1958, pl. 4, figs. 20, 21].

Figures 4-5. *Stropheodonta* (*Brachyprion*) *gibbera* Amsden. 4, 5. pedicle and lateral views, x 1, Cravatt member, Coll. P9-N (OU-1148)

Figure 6. *Stropheodonta* (*Brachyprion*) sp. 6. pedicle view, x 1, Fittstown member, Coll. P3-9E (OU-1149). [See Discussion under *Stropheodonta* (*Brachyprion*) *gibbera*].

Figures 7-9. *Leptostrophia beckii tennesseensis* Dunbar. 7. pedicle view of a large, partially exfoliated specimen, x 1, Fittstown member, Coll. P8-G (OU-1163); 8. specimen with the pedicle valve partly broken away to show brachial interior, x 1, Cravatt member, Coll. M11-E (OU-1162); 9. enlarged surface view showing costellae, x 3, Fittstown member, Coll. P8-F (OU-1161). [Other Bois d' Arc specimens illustrated in Amsden 1958, pl. 3, figs. 17, 20; pl. 6, fig. 1].

Figures 10-11. *Stropheodonta* (*Brachyprion*) *arata* Hall. 10-11. pedicle and lateral views, x 1, Cravatt member, Coll. P9-M (OU-1152).

Figures 12-15. *Leptaena* cf *L. rhomboidalis* (Wilckens). 12, 14. pedicle and lateral views, x 1, Fittstown member, Coll. P3-GG (OU-1157); 13. brachial interior, x 1, Cravatt member, Coll. P13 (OU-1159); 15. pedicle view, x 1, Fittstown member, Coll. P3-GG (OU-1158). [Other Bois d'Arc specimens illustrated in Amsden 1958, pl. 3, figs. 10-14].

Figures 16, 17. *Schellwienella marcidula* Amsden. 16. pedicle view, x 1, Fittstown member, Coll. P8-F (OU-1155); 17. brachial view, x 1, Fittstown member, x 1, Coll. P3-JJ (OU-1156). [Other Bois d'Arc specimens illustrated in Amsden 1958, pl. 5, figs. 3-9; pl. 13, fig. 25].

Figures 18-19. *Leptaenisca concava* (Hall). 18. pedicle view, x 1 [the attached fossil is probably "*Edriocrinus*" *adnascens* Dunbar]; Cravatt member, Coll. P9-M (OU-1153); 19. pedicle view, x 1, Cravatt member, Coll. C1-P (OU-1154).

Figures 20-24. *Leptostrophia* sp. 2. 20, 23. pedicle view (x 1) and enlarged view of surface showing costellae (x 3), Fittstown member, Coll. P3-EE (OU-1167); 21. pedicle view, x 3, Fittstown member, Coll. P8-G (OU-1166); 22. pedicle view, x 2, Fittstown member, Coll. P8-G (OU-1165); 24. pedicle view, x 1, Fittstown member, Coll. P3-JJ (OU-1164).

Figures 25, 26. *Lissostrophia* (*Lissostrophia*) *lindenensis* (Dunbar). 25, 26. pedicle (x 1) and posterior (x 2) views, Cravatt member, Coll. P13 (OU-1160).

PLATE III

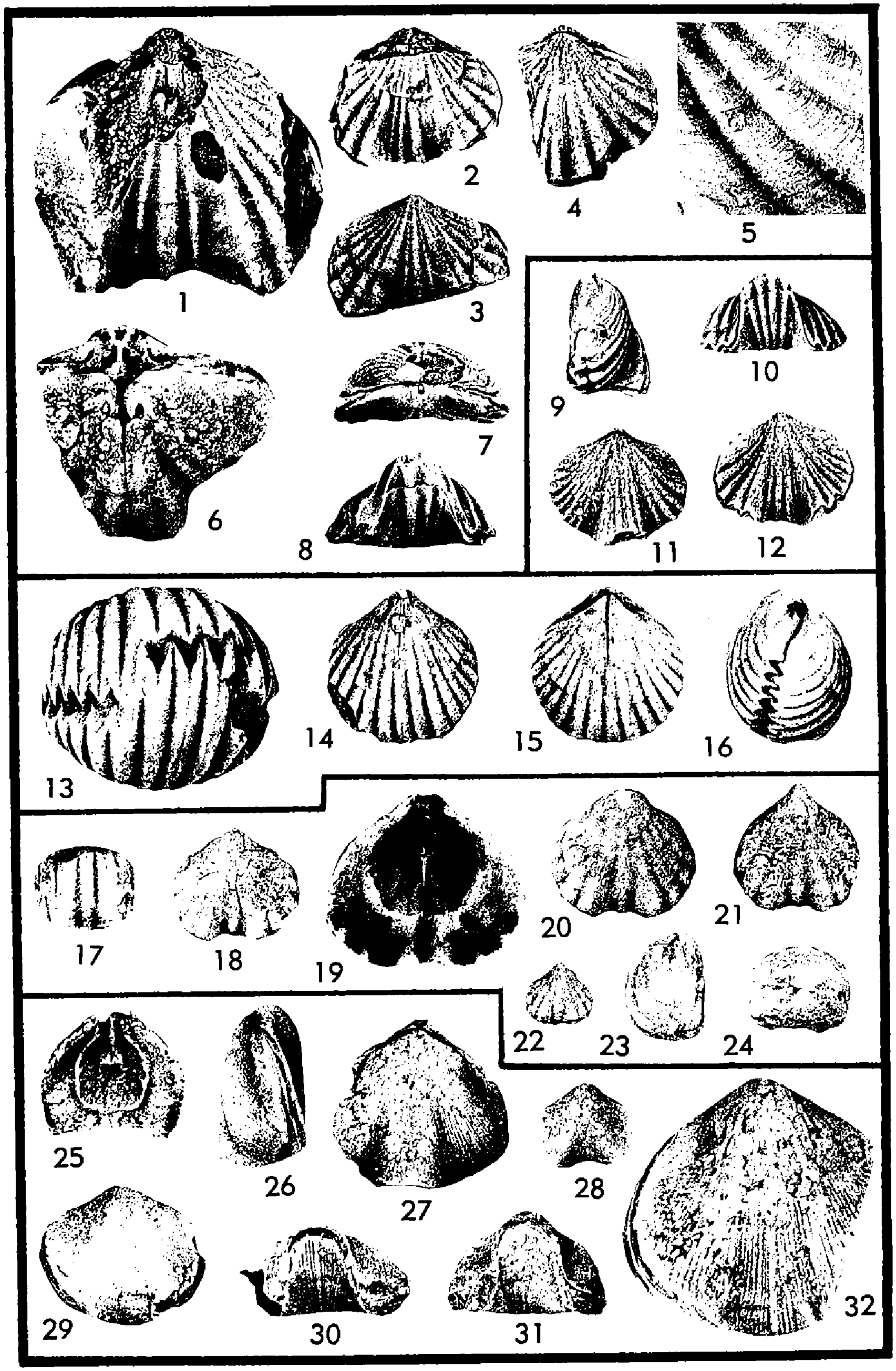
Figures 1-8. *Eatonia medialis* (Vanuxem). 1. pedicle view of a partly exfoliated specimen showing a steinkern of the pedicle interior; the small adductors and a part of the large, enclosing ,diductors are visable, x 2, Cravatt member, Coll. C1-P (OU-1171); 2, 8. pedicle and anterior views, x 1, Cravatt member, Coll. C1-P (OU-1168); 3, 7. pedicle and postrior viws, x 1, Cravatt mmbr, Coll. C1-P (OU-1172); 4. brachial view, x 1, Cravatt member, x 1, Coll. C1-P (OU-1170); 5. enlarged surface view of the specimen shown in figure 2 and 8 to show the costae and concentric filae, x 3; 6. brachial view of a silicified steinkern, x 2, Cravatt member, Coll. C1-P (OU-1169).

Figures 9-12. *Eatonia exserta* Amsden. 9, 10. lateral and anterior views of the holotype, x 1, Cravatt member, Coll. P3-Y (OU-1063) [see Amsden 1958, pl. 9, figs. 36-40 for other views of the holotype]; 11, 12. brachial and pedicle views, x 1, Cravatt member, Coll. P15 (OU-1184).

Figures 13-16. *Sphaerirhynchia glomerosa* Amsden. 13-16. antero-lateral (x 3), pedicle, brachial and lateral (x 2) views of a partly exfoliated specimen; the two valves are slightly open showing (figs. 13, 16) the marginal serrations, Cravatt member, P3-BB (OU-1183).

Figures 17-24. *Obturamentella wadei* (Dunbar). 17, 23, 24. anterior, lateral, and posterior views, x 2, Fittstown member, Coll. J11-L (OU-1176); 18. pedicle view, x 2, Fittstown member, Coll. P9-Q (OU-1178); 19. pedicle interior, x 3, Fittstown member?, Coll. P11-A (OU-1177); 20. pedicle view, x 2, Fittstown member?, Coll. P11-A (OU-1174); 21. pedicle view, x 2, Fittstown member, Coll. P3-EE (OU-1173); 22. pedicle view, x 1, Fittstown member, Coll. M3-E (OU-1175). [Other Bois d'Arc specimens illustrated in Amsden 1958, pl. 6, figs. 15, 16, 19, 19].

Figures 25-32. *Costellirostra singularis* (Vanuxem). 25. pedicle interior, x 2, Cravatt member, P2-B (OU-1180); 26, 27, 30, 32. lateral, brachial, anterior (x 2) and pedicle (x 3) views, Fittstown member, Coll. P3-EE (OU-1182); 28. pedicle view, x 1, Fittstown member, Coll. P3-GG (OU-1179); 29, 31. pedicle and anterior views of a large specimen, x 1, Cravatt member, Coll. M11-E (OU-1181).


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

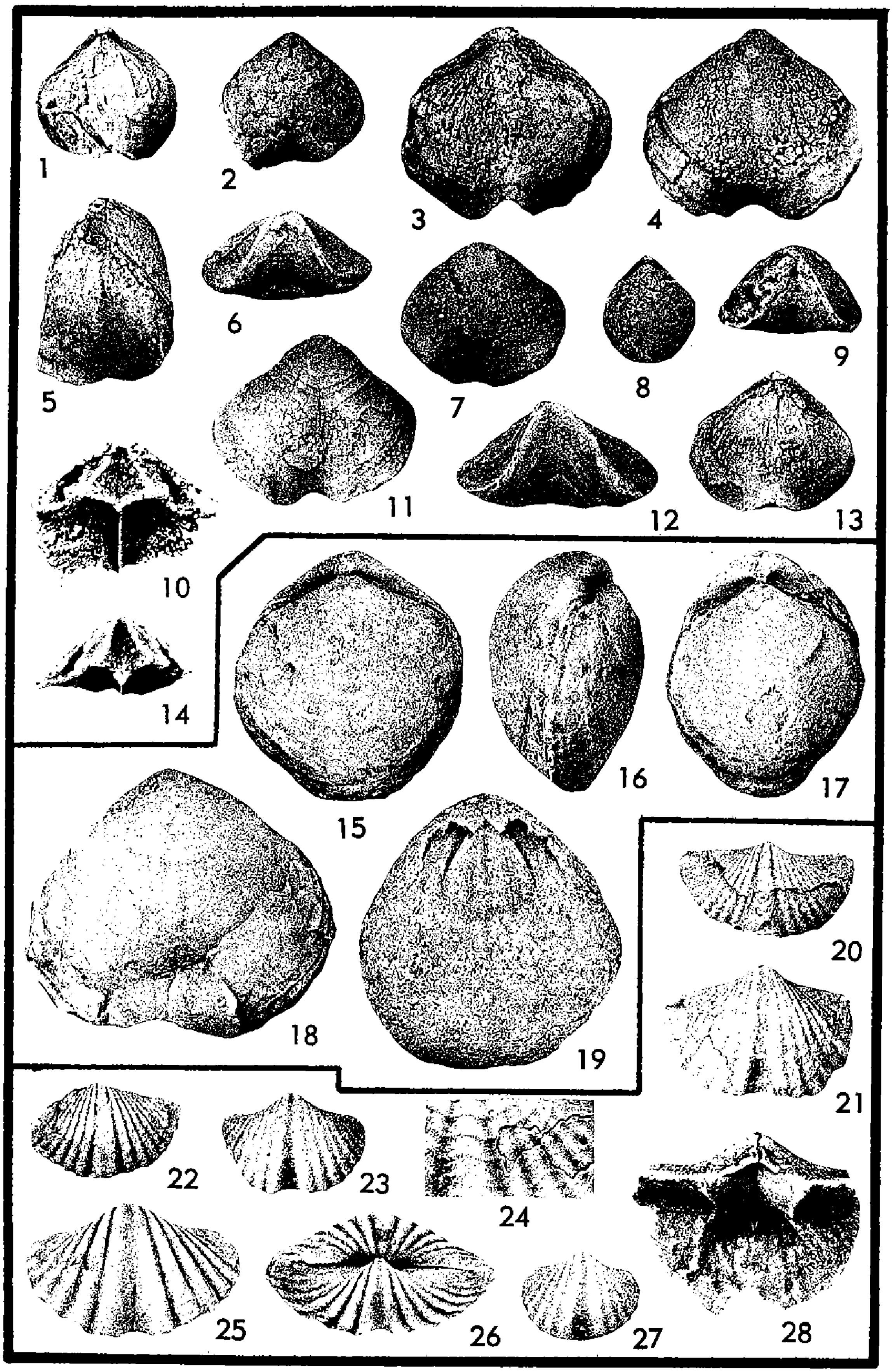

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28

PLATE IV

Figures 1-14. *Meristella atoka* Girty. 1, 2, 9. brachial, pedicle and anterior views, x 1, Fittstown member, M10-P (OU-1189); 3, 4, 5. brachial, pedicle and lateral views, x 1, Cravatt member, Coll. P9-M (OU-1191); 6, 7, 13. anterior, pedicle and brachial views, x 1, Cravatt member, Coll. P9-N (OU-1190); 8. brachial view, x 1, Fittstown member, Coll. P3-EE (OU-1192); 10. brachial hinge-plate, x 3, Cravatt member, Coll. P2-B (OU-1193); 11, 12. pedicle and anterior views, x 1, Cravatt member, Coll. P9-N (OU-1195); 14. brachial hinge-plate, x 3, Cravatt members, Coll. P2-B (OU-1194).

Figures 15-19. *Meristella* sp. 2. 15, 16. brachial and lateral views, x 1, Cravatt member, Coll. M11-E (OU-1188); 17. brachial view, x 1, Cravatt member, Coll M11-E (OU-1186); 18. pedicle view of a slightly crushed specimen, x 1, Cravatt member, Coll. P4-C (OU-1187); 19. pedicle view; the anterior portion of the shell is broken away to show the steinkern of the pedicle muscle scar, x 1, Fittstown member, Coll. P3-GG (OU-1185).

Figures 20-28. *Howellella cycloptera* (Hall). 20. brachial valve, x 1, Fittstown member, Coll. P8-G (OU-1196); 21. pedicle valve, x 1, Fittstown member, Coll. P3-JJ (OU-1200); 22. brachial valve, x 1, Fittstown member, Coll. P3-JJ (OU-1197); 23. pedicle valve, x 1, Fittstown member, x 1, Coll. P8-F (OU-1199); 24. enlarged surface view showing ornamentation, x 3, Cravatt member, Coll. P9-P (OU-1091); 25, 26. pedicle and posterior views, x 1, Coll. P2-A (OU-1094) [Haragan formation]; 27. pedicle view, x 1, same as figure 24; 28. pedicle interior, x 2, Cravatt member, Coll. P11-A (OU-1198). [Other Bois d'Arc illustrations in Amsden 1958, pl. 8, figs. 19, 20, 22, 23, 25].

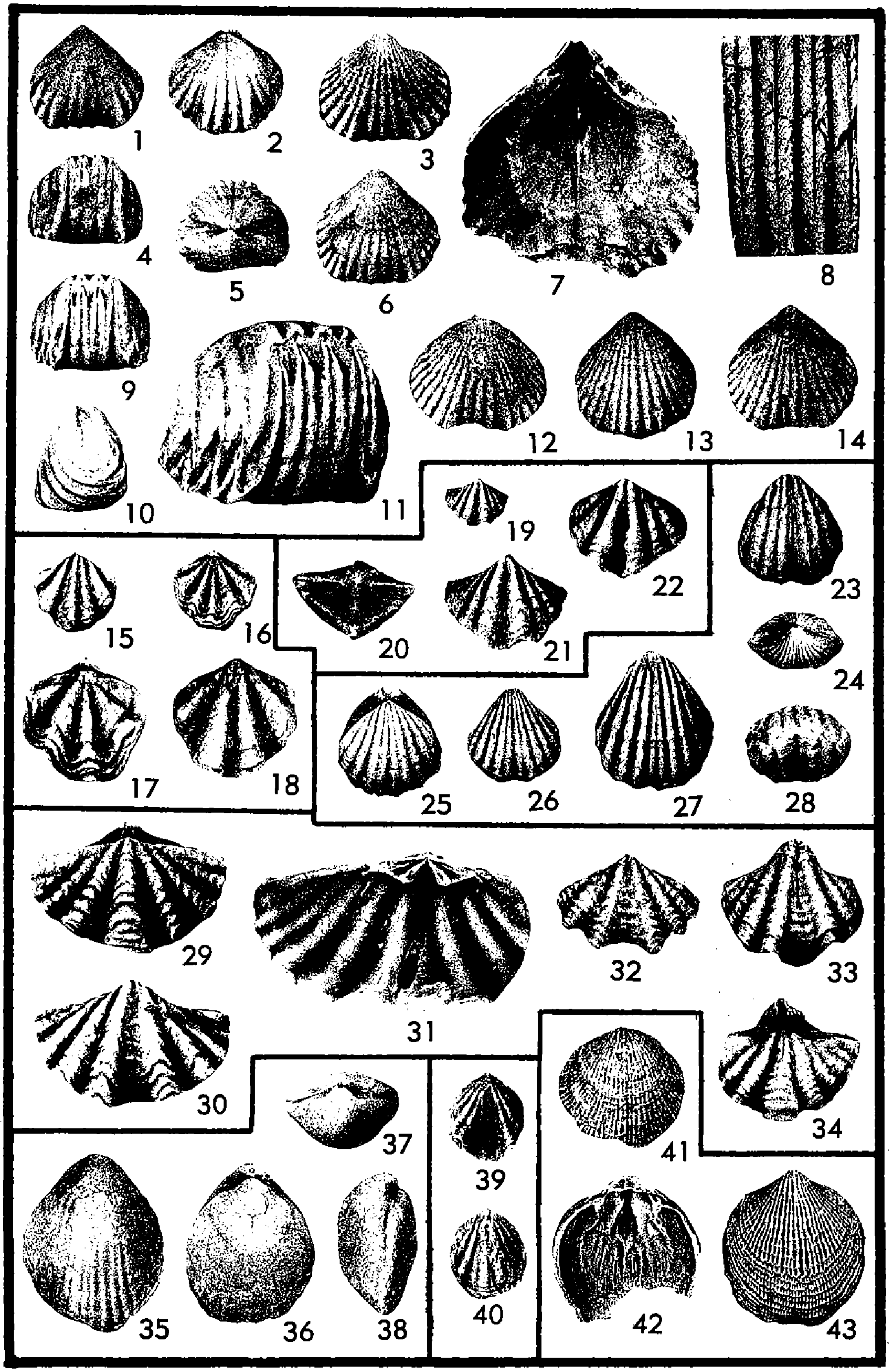

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43

PLATE V

Figures 1-14. *Sphaerirhynchia lindenensis* (Dunbar). 1, 10. pedicle and lateral views, x 1, Cravatt member, Coll. P9-M, (OU-1203); 2, 4, 5. brachial, anterior, and posterior views, x 1, Cravatt member, Coll. P1-V (OU-1202); 3. pedicle view, x 1, Fittstown member, Coll. P10-R (OU-1210); 6. pedicle view, x 1, Fittstown member, Coll. P3 EE (OU-1208); 7. pedicle interior, x 2, Fittstown member, Coll. P11-A (OU-1205); 8. enlarged surface view (x 3) of the anterior tongue of the pedicle valve showing split costellae and chevron-shaped growth-lines [compare to figs. 4, 9, 11], Fittstown member, Coll. P8-G (OU-1209); 9, 11. anterior (x 1) and lateral (x 2) views of a specimen with the valves partly open; note serrations along the lateral and anterior margins of the pedicle valve, Cravatt member, Coll. P10-P (OU-1207); 12. pedicle view, x 1, Fittstown member, Coll. P3-EE (OU-1206); 13. brachial view, x 1, Fittstown member, Coll. P3-HH (OU-1201); 14. pedicle view, x 1, Fittstown member, Coll. P3-CC (OU-1204).

Figure 15-18. *Atrypina hami* Amsden. 15, 16. pedicle and brachial views, x 1, Cravatt member, Coll. P9-M (OU-1218); 17, 18. brachial and pedicle views, x 2, Cravatt member, Coll. P9-M (OU-1217).

Figures 19-22. *Cyrtina dalmani nana* Amsden. 19-21. pedicle (x 1), posterior and pedicle (x 2) views, Cravatt member, Coll. P9-P (OU-1220); 22. pedicle view, x 2, Cravatt member, Coll. P10-R (OU-1219).

Figures 23-28. *Rhynchospirina maxwelli* Amsden. 23, 25, 28. pedicle, brachial and anterior views, x 2, Cravatt member, Coll. P10-R (OU-1227); 24. posterior view, x 1, Cravatt member, Coll. P9-N (OU-1226); 26. pedicle view, x 1, Cravatt member, Coll. P9-M (OU-1224); 27. pedicle view, x 2, Fittstown member, Coll. J11-L (OU-1225).

Figures 29-34. *Kozlowskiella* (*Megakozlowskiella*) *velata* Amsden. 29, 30. brachial and pedicle views, x 2, Cravatt member, Coll. P9-M (OU-1214); 31. brachial interior, x 2, Cravatt member, Coll. P9-N (OU-1213); 32. pedicle view, x 1, Fittstown member, Coll. P8-F (OU-1212); 33. 34. pedicle and brachial views of a silicified steinkern, x 1, Fittstown member?, Coll. P9-Q (OU-1215).

Figures 35-38. *Rensselaerina haraganana* Cloud. 35. pedicle view, x 1, Cravatt member, Coll. P9-M (OU-1229); 36-38. brachial, posterior and lateral views, x 1, Cravatt member, Coll. P9-M (OU-1228).

Figures 39-40. *Coelospira virginia* Amsden. 39, 40. brachial and pedicle views x 3, Cravatt member, Coll. P8-C (OU-1216).

Figures 41-43. *Atrypa oklahomensis* Amsden. 41. brachial view, x 1, Fittstown member, Coll. Cal-V (2) (OU-1222); 42. pedicle interior, x 1, Cravatt member, Coll. P9-N (OU-1221); 43. pedicle view, x 1, Cravatt member, Coll. P9-M (OU-1223).

INDEX

An asterisk (*) indicates the page where the subject is discussed or described.