Lower Devonian Fossils Of Tennessee

By Kieran Davis

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Authors Note:
The pictures which accompany a particular fossil description are found either above or to the side of the text, never below.
Scientific terminology has been kept to a minimum but a page dedicated to defining the terms used has been included for easier understanding. It should not, however, stop the reader from referring to a good invertebrate paleontology text book.

INTRODUCTION

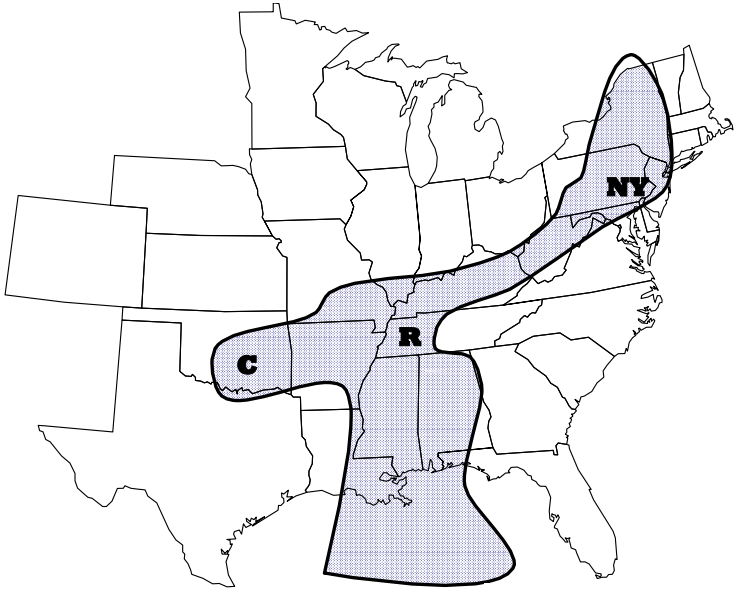
The Lower Devonian system is well represented in Tennessee, forming part of an almost unbroken sequence of deposits ranging in age from the Middle Silurian to upper Lower Devonian. The Ross Formation of west-central Tennessee contains the most diverse and abundant Lower Devonian invertebrate fauna and this guide focuses on the most fossiliferous member of the Ross—the Birdsong Shale. The fauna throughout the Ross Formation is remarkably consistent but it is the Birdsong Shale which allows the easiest access, collecting and cleaning of specimens.

The Birdsong Shale is well exposed in road cuts along State Highway 69 and in the many active and disused quarries of western Tennessee. It consists of highly fossiliferous alternating beds of argillaceous limestone and finely laminated shale. The shale beds break down easily, making them ideally suited to the collection of fossils.

The shale was laid down in a shallow marine environment known as the Ross Shelf. The Ross Shelf formed part of the western arm of the Epeiric Sea - a narrow, continental seaway which stretched from New York to Oklahoma (figure 1). The water of the Ross Shelf was only a few hundred feet deep, which was sufficient to allow sunlight to penetrate and a diverse fauna to thrive. Based on faunal similarities, the Birdsong Shale has been correlated with the Cravat Member of the Bois d'Arc Formation in Oklahoma and the New Scotland Formation in New York.

The Birdsong Shale is informally divided into 3 distinct units based on faunal differences. The lower most unit was termed the 'Brachiopod Zone' by Dunbar (1919) due to the abundance of brachiopods within the shale beds. A thinner, middle bed of massive bryozoan rich limestone was termed the 'Bryozoan Zone', and an upper most bed of trilobite rich shale was named the 'Trilobite Zone'. The Brachiopod zone is by far the most dominant member of the Birdsong Shale and is most readily collectible.

Geographical Extent of the Epeiric Ocean during the Lower Devonian.



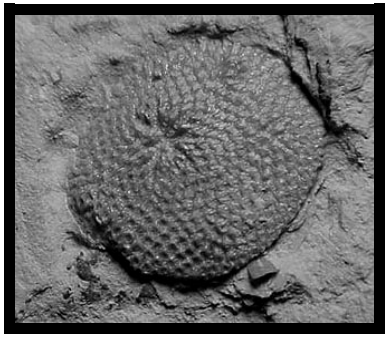
Key:
'R' Ross Shelf
'C' Cravat Formation, Oklahoma
'NY' New Scotland, New York

Geological Column of West Central Tennessee

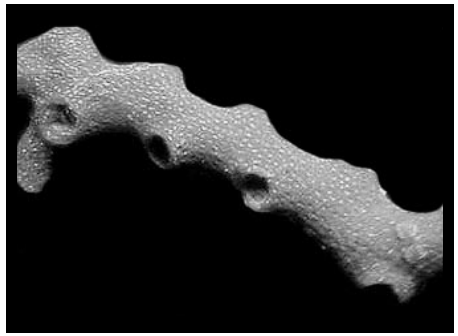
Epoch	Formation	Member	Thickness & Character
Lower Devonian	Harriman		Thin bedded limestone 45 feet thick. Fine to coarse grain. Blue/Green in colour. Interbedded with chert - 55 feet thick.
	Flat Gap		Massive, coarse grained, crinoidal limestone. 55 feet thick.
	Ross	Birdsong Shale	Clay shale, 60 feet thick. Blue/Green. Thin bedded with Limestone lenses.
		Ross Limestone	Grey, dense, argillaceous limestone. Thin bedded. 100 feet thick.
		Rock House Shale & Limestone.	Shale : Green/Grey, Silty, 25 feet thick.
			Limestone : Medium/ coarse grain. Grey. Massive. 17 feet thick.

BRYOZOA

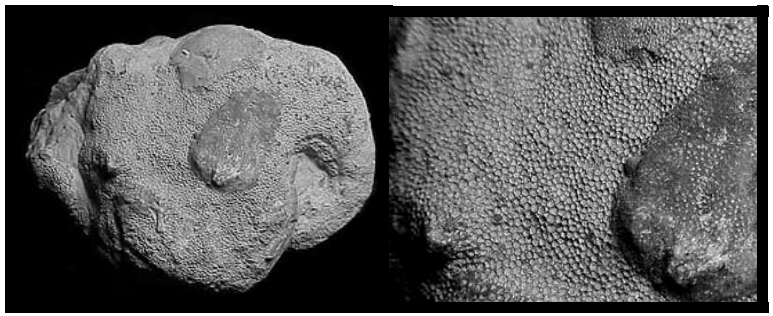
Bryozoans are extremely abundant in the Birdsong Shale. Almost two dozen species are known, occuring in vast numbers both independently or attached to other fossils. However, they are notoriously difficult to identify without using thin sections or a microscope. As a result only the most readily identifiable species are illustrated.



Ceramopora parvicella.
Almost completely flat, circular to ovoid colonies. Zooids radiating from a central point. Apertures of zooids angled at almost 90 degrees to the surface of the colony. Average width is ~10 mm. A common species, usually found attached to a host.



Leioclema pulchellum. Ovoid zooids with one to three rows of mesopores between them. Commonly found encrusting the coral **Aulopora** (as in the above figure). The large apertures are the only visible part of the coral since the bryozoan completely covers the coral surface. Figured specimen is 15 mm.



Leptotrypella sp. Massively encrusting or globular zooarium. Zooids closely spaced with rounded or polygonal apertures 0.5 mm in diameter. Occasional circular mesopores occur at the junction of three zooidal apertures. Zooidal walls in contact giving the appearance that interspaces are shared, thus giving the polygonal shape. The figured specimen is a moderately large colony measuring 100 mm wide.

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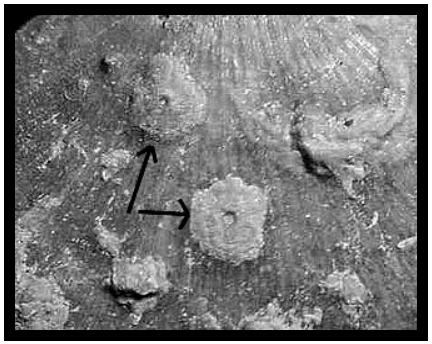
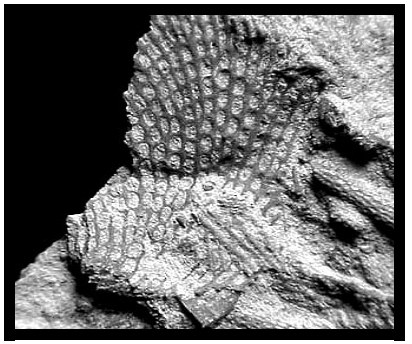
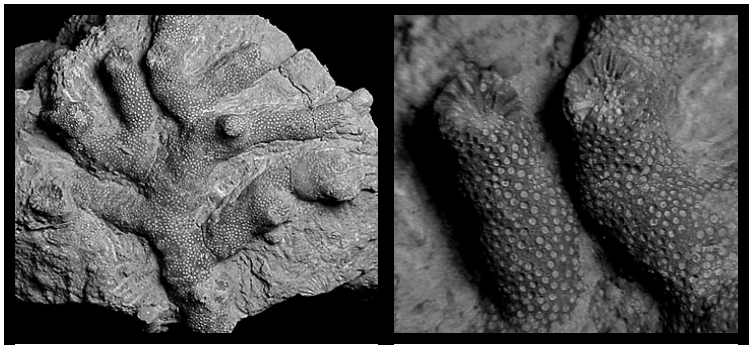


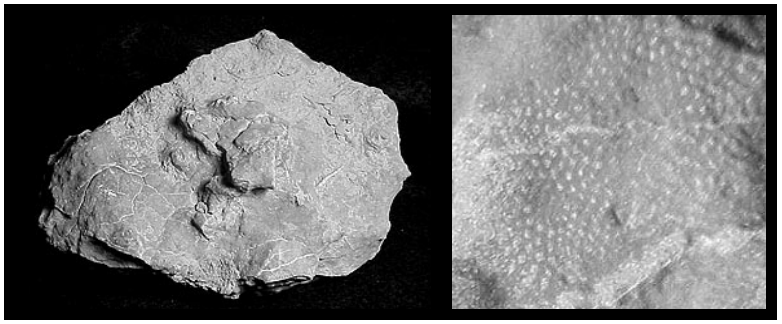
Ptylodictya tenuis. Found as smooth, isolated bases attached to the surface of brachiopods. Distinguished by their circular outline and single, central aperture. Figured specimen is 4 mm in diameter.



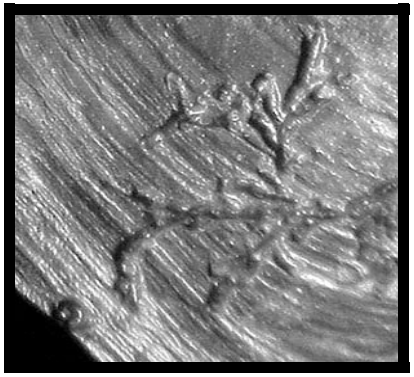
'Fenestella.' Instantly recognisable sea fan. The 'branches' of the colony all interconnect to form a net-like structure. Zooids on only one side of the colony, the other side being completely smooth. The Figured specimen is 20 mm tall



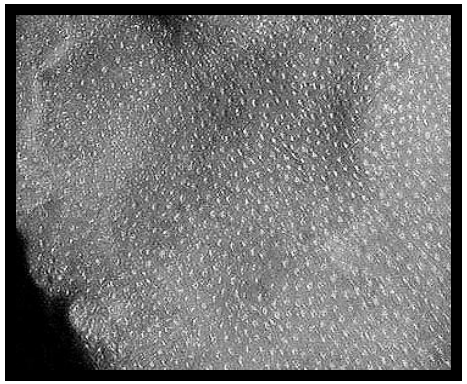
Hallopora perelegans. A thick stemmed, branching species. The branches in the figured specimens are 5 mm thick. The larger circular zooids are separated by one or two rows of mesopores. No other species of Birdsong Shale bryozoa has such robust branches making **Hallopora** easy to identify.



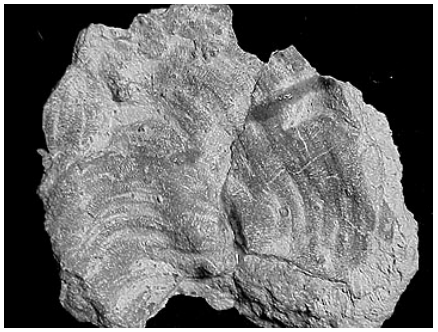
Buskopora sp. This thick, encrusting bryozoan can form mounds several metres in diameter. It can generally be differentiated from other species by the sheer size of the plate-like colonies and the gently trilobate to ovoid zooids. Interspaces usually appear smooth. Zooids approximately 0.4 mm in diameter. Figured specimen measures 150 mm in width



Hederella sp. Encrusting bryozoan consisting of delicate, cylindrical or tubular strings of zooids. Figured specimen is from the Silica Shale of Ohio but is almost identical to specimens from the Birdsong Shale. Rare. Figured measures 10 mm wide.



Fistulipora sp. Tiny zooids (0.1 to 0.3 mm) with one or two rows of minute mesopores. Usually encrusting but can form hemispherical masses. Zooidal apertures circular to oval. Very common and easily identifiable by the tiny zooids. Figured specimen is 10 mm wide.



Lichenalia serialis. A flat, circular to fan shaped colony. Often found face down so the zooids are hidden. Colonies measure ~40 mm in diameter and are characterised by their wrinkled underside and unique shape. Rare.

Intrapora puteolata. 3 mm wide, completely flat, branching colonies. Ovoid zooids occur on both sides of the branches. Branches bifurcating but often broken. Very common in the Bryozoan Zone. Figured specimen is 15 mm long.

DESCRIPTIVE TERMINOLOGY

BRYOZOANS

Zooarium—The bryozoan colony as a whole (see *Leptotrypella*, left).
Zooids—The individual 'cells' making up the colony. These contained the living animal and are seen as small openings on the bryozoan surface. Appear as long column like structures in cross section (see *Leptotrypella*, right).
Mesopores—Minute apertures between the zooids (see *Hallopora*, right)
Interspaces—The area between the zooids, commonly occupied by mesopores.

CORALS

Corallum—The coral colony as a whole (see *Favosites conicus*).
Corallite—The individual 'cells' making up the colony. These contained the living animal and are seen as small, often polygonal openings on the coral surface (see *Pleurodictyum trifoliatum*). Appear as long column like structures in cross section.
Septa—Spine like structures which project from the corallite wall and extend towards the center (see *Streptelasma strictum*).

BRACHIOPODS

Sulcus— A trough or furrow running down the center of the shell (see *Levenea subcarinata*, left top).
Fold—A strong undulation running down the center of the shell (see *Levenea subcarinata*, left bottom)
Costellae—Faint ridges in the surface of the shell (see *Costelirostra tennesseensis*).
Costae—Rib-like ridges on the shell surface. Much more pronounced that costellae and characterised by thickening of the shell (see *Anastrophia verneuilli*).
Plications—Strong, undulating, rib-like ridges which are visiible on both the interior and exterior surfaces of the shell (see *Macropleura macropleura*).
Lamellae—Delicate, shallow concentric rings on shell surface (see *Atrypa reticularis*, bottom right).
Rugae—Thick, concentric rings visible on the interior & exterior surfaces of the shell (see *Leptaena acuticuspidata*).

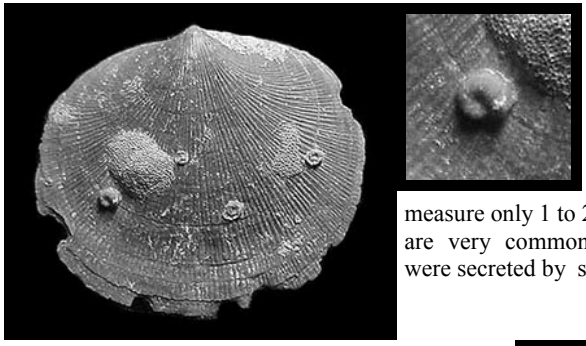
Biconvex **Plano-convex** **Concavo-convex** **Convexi-concave**

TRILOBITES

Cephalon—Head
Pygidium—Tail
Thorax—Body

TRACE FOSSILS & WORMS

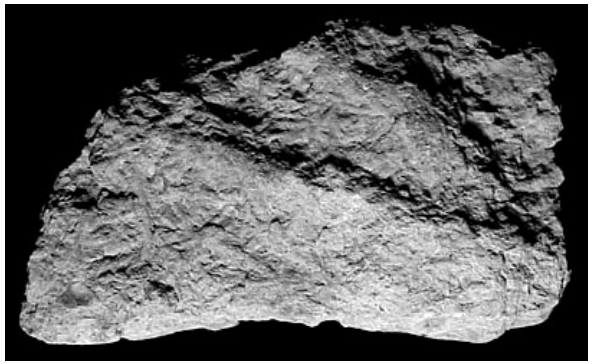
A variety of trace fossils and worms are found in the Birdsong Shale. Two species of shell secreting worm are quite common, but the trace fossils are quite rare and easily overlooked. Trace fossils usually occur in the Birdsong Shale sediment itself.



Spirorbis laxus. Small, coiled shells, usually attached to the surface of brachiopods, crinoid stems and other fossils. They measure only 1 to 2 mm in diameter but are very common. These tiny shells were secreted by small worms.

Cornulites sp. A cone shaped shell with coarse rings (just visible in the left image). Usually found on the surface of brachiopods, especially near the shell edge where the could benefit from the feeding arms of the brachiopod bringing food within its reach.

Helminthopsis sp. U-shaped tubes found in the shale matrix of the Birdsong Shale. Tubes are 1 mm wide and are preserved as lighter, discolored depressions. Very rare. Presumably made by a worm.

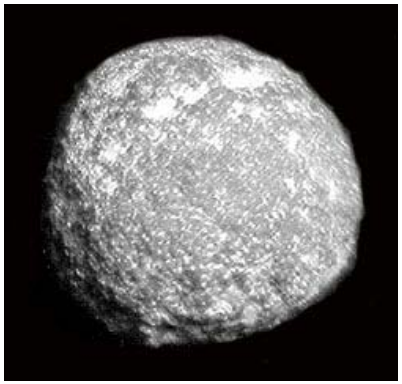


Burrows. The figured limestone slab contains two different sized burrows or tubes. The large tubes measure 10 mm wide and run across the centre of the slab. The smaller tubes completely cover the slab surface and are 1 to 2 mm wide. It is probable the smaller tubes are the result of worm action, but the organism that made the larger tubes is unknown. Both are undescribed and very rare.

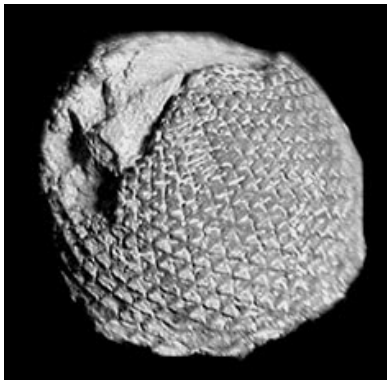
SPONGES & RECAPTICULITIDS

Sponges from the Birdsong Shale are quite easy to identify, but are unfortunately rare. The majority of species which do occur are restricted to the upper part of the Birdsong Shale in the 'Bryozoan Zone'. A recent paper by Rigby and Clement (1995) described the sponges of the Birdsong Shale in great detail and serious parties should refer to this article for more information.

Recapticulitids are enigmatic fossils of unknown affinity. They are believed to have been primitive colonies of animals which collected food particles from the water column, much like the corals and bryozoans. However, they are not closely related to either phylum and remain in their own taxonomical group.



Hindia sphaeroidalis. Rare, but the most common sponge. The specimens are almost perfect spheres but can be found squashed flat. An average specimen is 10 mm in diameter and has a densely pitted surface.

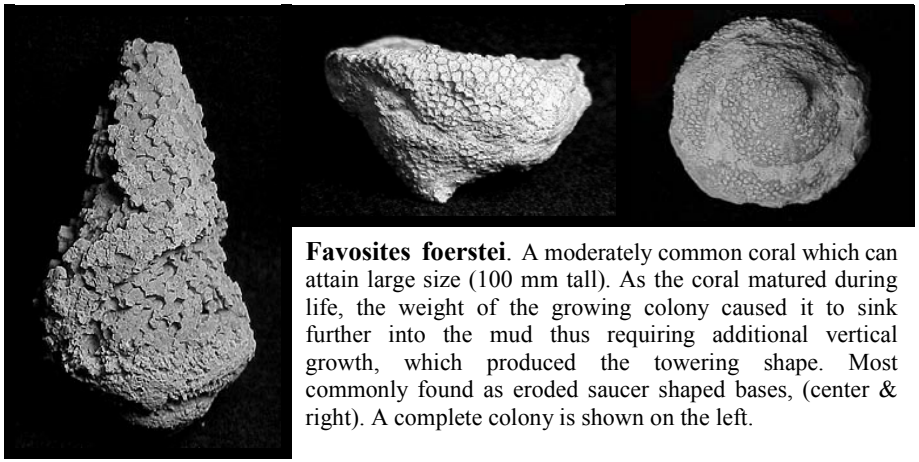


Solenoides sp. A single specimen of this recapticulitid was found in 'Trilobite Zone'. Easily Identifiable by the rhomboidal surface pattern. The figured specimen is 10 mm wide. Very rare.

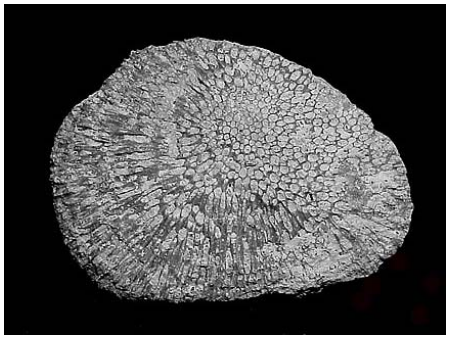
CORALS

Corals form an important part of the Birdsong Shale fauna. Although they are extremely abundant the number of species is restricted. Eight types are known, varying in abundance from rare to very common. All are easy to identify and are usually well preserved.

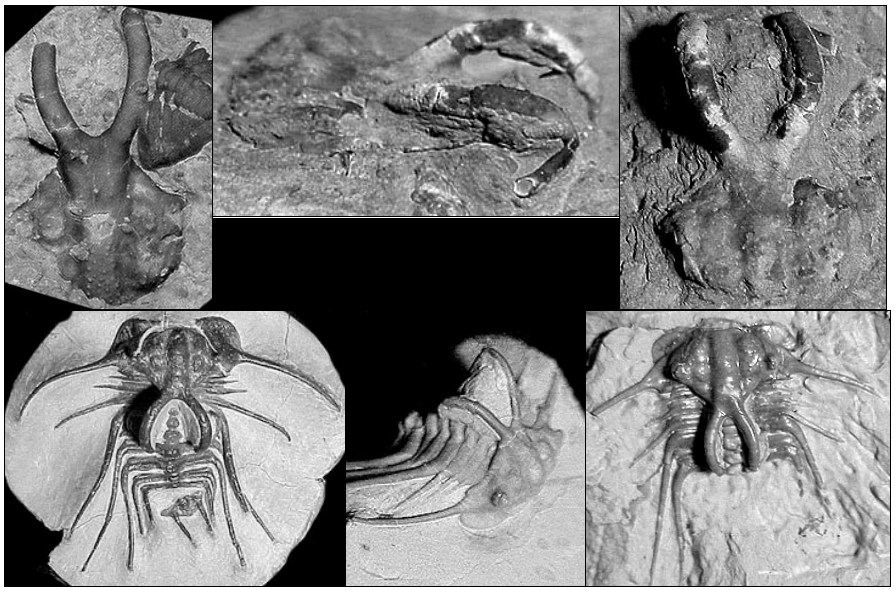
Corals have proven invaluable in helping reconstruct the palaeoenvironment of the Birdsong Shale. Modern corals require daylight to survive and if we assume corals from the Devonian required the same conditions then they must have been growing in only a few hundred feet of water. Any deeper and light would not have penetrated and the corals would have been unable to survive. The discovery of corals which have been overturned, crushed or damaged are all good indicators that catastrophic events were occurring on the Ross Shelf. These catastrophic events most likely came in the form of seasonal storms, perhaps like the Monsoon of the Indian Ocean today, which stirred up the ocean bottom and pounded the shelf with strong wave activity resulting in the damage seen in the fossils. The morphology of the corals also allows us to conclude that the ocean bottom was soft and muddy. This is determined from the fact that the corals all exhibit either pronounced lateral or vertical growth—a situation essential in keeping the animal above the mud. Vertical growth (as seen in **Streptelasma)** kept the coral high above the mud, whereas lateral growth (as in **Pleurodictyum**) produced a 'snow-shoe' effect by distributing weight over a greater surface area, thus preventing sinking.



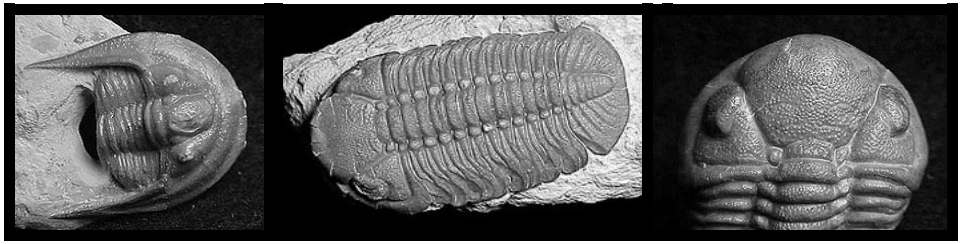
Favosites foerstei. A moderately common coral which can attain large size (100 mm tall). As the coral matured during life, the weight of the growing colony caused it to sink further into the mud thus requiring additional vertical growth, which produced the towering shape. Most commonly found as eroded saucer shaped bases, (center & right). A complete colony is shown on the left.



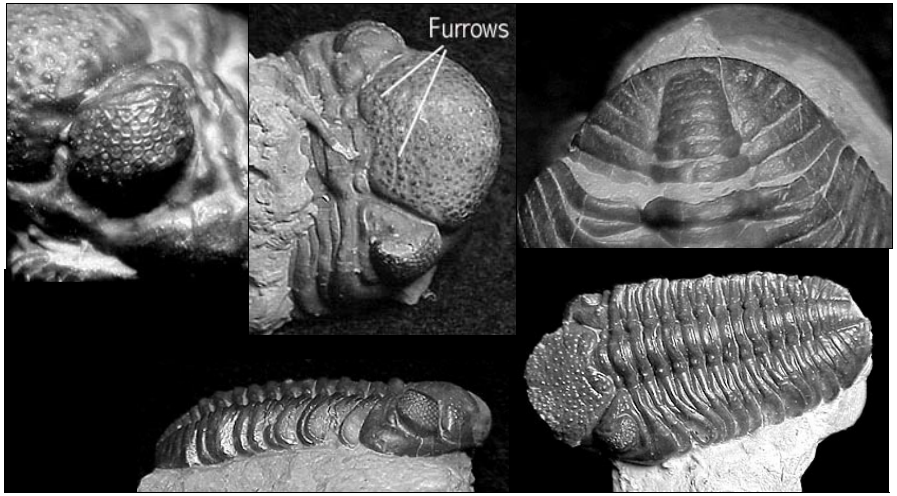
Favosites helderbergiae
A large tabulate coral. The corallum is wide and flat. Corallites hexagonal in shape. The figured specimen is 100 mm wide and is photographed from the underside to show the cross section and profile views of the corallites. A larger but very similar type occurs in the Ross Limestone and can reach sizes of over 300 mm wide. Very rare.



Dicranurus sp. The specimens figured were collected by Hal Love of Nashville, Tennessee and donated to the author for study. Although incomplete these two specimens are an important find in that they mark the first record of this genus from Tennessee. This ornate species is characterised by two large horns which arch backwards from the rear of the cephalon. It is not possible to allocate a specific assignment to the specimens but the size does match specimens found in Bois d'Arc Formation of Oklahoma. **Dicranurus** is extremely rare and is known almost exclusively from the upper 'Trilobite Zone'. A single partial thorax has been found from lower strata. A Moroccan specimen (lower left) & 2 Oklahoman specimens (lower middle & right) are figured for comparison.



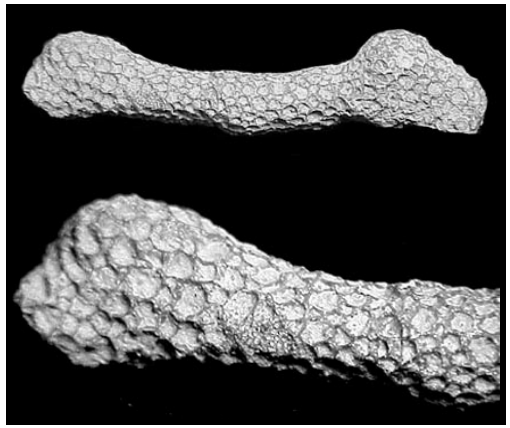
Cordania sp. (left) **& Reedops deckeri** (middle and right). A single, poorly, preserved specimen of **Cordania** has been found in the lower Brachiopod Zone. Unfortunately it is so poorly preserved that it is not figured as it would not help in identification. The specimen is preserved in ventral view with only the large cephalic border and genal spines giving any true idea to the identification of the species. A specimen from Oklahoma is figured for identification purposes. 25 mm long.
Reedops deckeri. Found in the upper Brachiopod Zone and the Trilobite Zone, **Reedops** is a rare trilobite measuring up to 60 mm long. **Reedops** can be distinguished from **Paciphacops** by the number of lenses in the eye—in **Reedops,** there are up to 21 files with as many as 11 lenses per file. Two specimens from Oklahoma are figured as a good Tennessee specimen was unavailable.



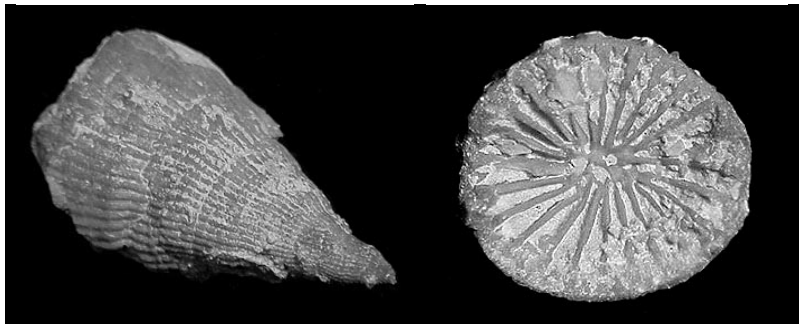
Paciphacops birdsongensis. A large phacopid which appears to be restricted to the 'Trilobite Zone'. Resembles **Paciphacops logani** but is conspicuously larger, measuring up to 50 mm long. The broadly rounded outline of the glabella helps distinguish this species from **P. logani**. Three different morphs of this species exist—a large eyed form, a small eyed form and an intermediate form. The small eyed morph is characterised by 14 files (columns) of lenses with a total lens count of 31-39. The intermediate sized morph has 15 files with 39-55 lenses, whereas the large eyed morph has 17 files with 63-83 lenses. Furrows at the rear of the glabella are well pronounced and can be used to aid identification. They occur as two parallel lines on either side of the glabella, although it is the posterior furrow which is the most distinct (top, centre picture). The pustulose decoration well illustrated in the lower right image. It is slightly coarser and more distinct than **P. logani** and the pustules are larger in size.

Maurotarion sp. Very rare. Known from only a single partial cephalon (top left). A very small trilobite with the preserved remains measuring only 3 mm in diameter. The specimen seems to correspond with **Maurotarion axitiosum** from the Bois d'Arc Formation of Oklahoma (middle and right) but a specific assignment of the Birdsong material is not yet possible. The only known specimen is from the upper Birdsong Shale 'Trilobite Zone' and is previously unrecorded in the literature. The occurrence of this species in combination with **Dicranurus** (see over) and large numbers of **Huntonia** and phacopids allows us to confirm that the upper strata of the Birdsong Shale is strongly correlated both temporally & palaeoenvironmentally with the Bois d'Arc Formation of Oklahoma.

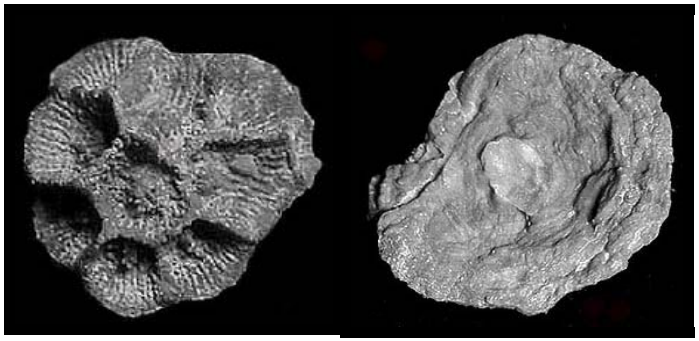
Favosites conicus. An extremely common coral throughout the Birdsong Shale. Small, with a maximum diameter of 30 mm. Specimens invariably hemispherical with a gently wrinkled base. Degree of curvature of the corallum can vary greatly and the base can be strongly wrinkled to almost smooth. It is theorized that this coral was monocarpous, meaning it lived for only one year, breeding just once before dying. This would explain the consistently small size of the coral and would also fit with the theory of seasonal storms - the corals would have to grow and breed in the time between storm seasons which would limit the size they could grow to. The flat base is an example of the 'snowshoe' adaptation to a soft substrate.



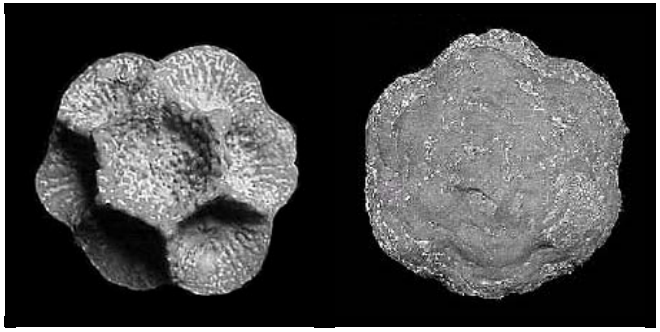
Favosites sp. This undetermined species was originally described as **Striatopora**. It is an elongate, species which ranges throughout the lower Birdsong Shale. The corallites are polygonal in outline and cover the corallum surface. Occasional specimens are found attached to a brachiopod or other host. **Striatopora** differs from this species in that it has thicker, smoother branches & the corallite walls are thicker and more circular. **Favosites sp.** is uncommon in the Birdsong Shale. The figured specimen is 50 mm long.



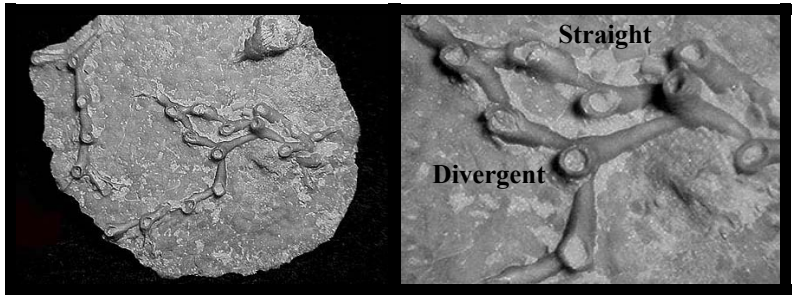
Streptelasma strictum. This is the only horn coral which occurs in the Birdsong Shale. Specimens are characterized by a conical shape and distinct longitudinal ridges on the outer surface. Internally there are many long septa but few tabulae. Very common. The figured specimen measures 35 mm long.



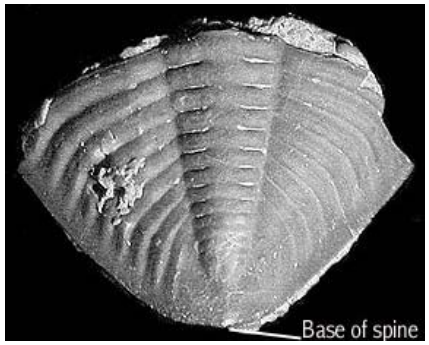
Pleurodictyum trifoliatum. Flattened to gently hemispherical in profile with a flat to concave, wrinkled base. Up to 15 corallites, usually with three, more conspicuous, larger ones. Corallite walls have short granulose septa (left image) but are shallow. The figured specimen is 15 mm wide. An uncommon species.



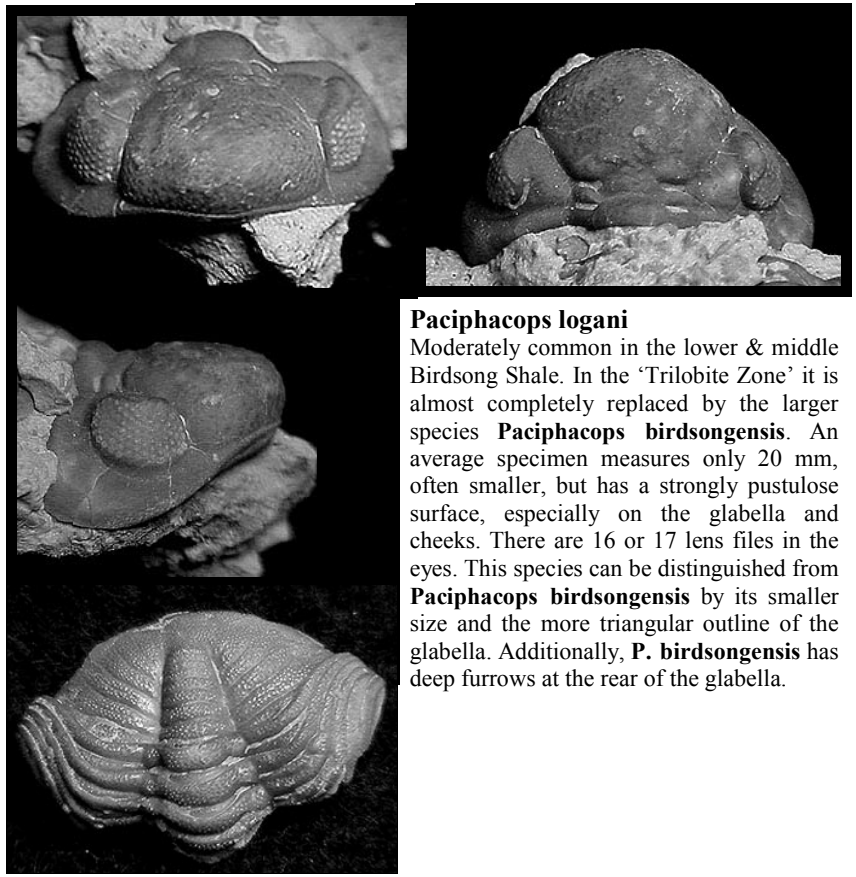
Pleurodictyum lenticulare. Hemispherical corallum with a convex or flattened base. Very regular, lobate outline. Usually symmetrical. Corallites number between 3 and 7, sometimes 8. The large central corallite is usually surrounded by 6 smaller corallites. Central corallite always the largest and deepest. Corallite interior granulose but not as distinct as in **Pleurodictyum trifoliatum**. This species is usually smaller than **P. trifoliatum**. Additionally, it has a more domed profile and fewer corallites. Locally common Figured specimen is 15 mm in diameter.



Aulopora schoharie. Moderately common. This is an encrusting, string-like coral made up of elongate, tubular corallites which expand toward the aperture and are slightly upturned from the surface of the substrate (right). The coral exhibits a mixture of straight line and divergent growth - straight line growth being produced by the budding of single corallites, whereas divergent growth is produced by the budding of two corallites (see right picture). Average corallite length is 5 mm.



Huntonia sp. A second species of **Huntonia** is present in the Birdsong Shale. It is undescribed and known only from the pygidium. It resembles **Huntonia lindenensis** in the triangular profile but has fewer pygidial rings. A very short spine is present to confirm the **Huntonia** assignment but unfortunately the spine is weathered in the figured specimen with only the base remaining. The spine is similar in length to that of **H. lindenensis**. The figured specimen is 30 mm long. Rare and at present only known from the 'Brachiopod Zone'.

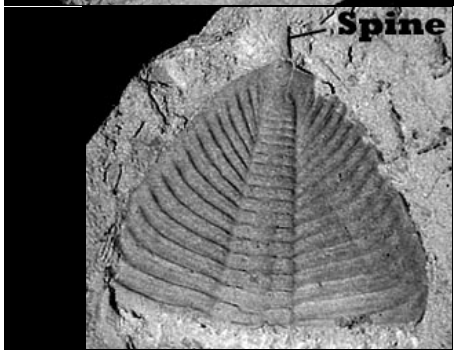


Paciphacops logani
Moderately common in the lower & middle Birdsong Shale. In the 'Trilobite Zone' it is almost completely replaced by the larger species **Paciphacops birdsongensis**. An average specimen measures only 20 mm, often smaller, but has a strongly pustulose surface, especially on the glabella and cheeks. There are 16 or 17 lens files in the eyes. This species can be distinguished from **Paciphacops birdsongensis** by its smaller size and the more triangular outline of the glabella. Additionally, **P. birdsongensis** has deep furrows at the rear of the glabella.

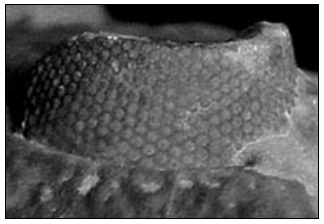
TRILOBITES

Trilobites are a common member of the Birdsong Shale fauna, but with the exception of the uppermost 'Trilobite Zone' they are only fragmentary. It is rare to find complete trilobites and at present most species are represented by only partial specimens. The trilobite fauna is, however, moderately diversified with 7 genera being known at present. The trilobite fauna has very close affinities with the trilobite beds of southern Oklahoma, suggesting a very strong correlation both in age and palaeoenvironment between the two deposits.

Dalmanites retusus. Known only from isolated pygidia. The pygidium is distinct from other Birdsong trilobites in that it has a rounded profile and lacks a pygidial spine. It can be most easily confused with **Huntonia** yet is distinguishable in that **Huntonia** has a more triangular pygidium and bears a rudimentary spine. Figured specimen is 50 mm wide. Found throughout the Birdsong Shale. Common.



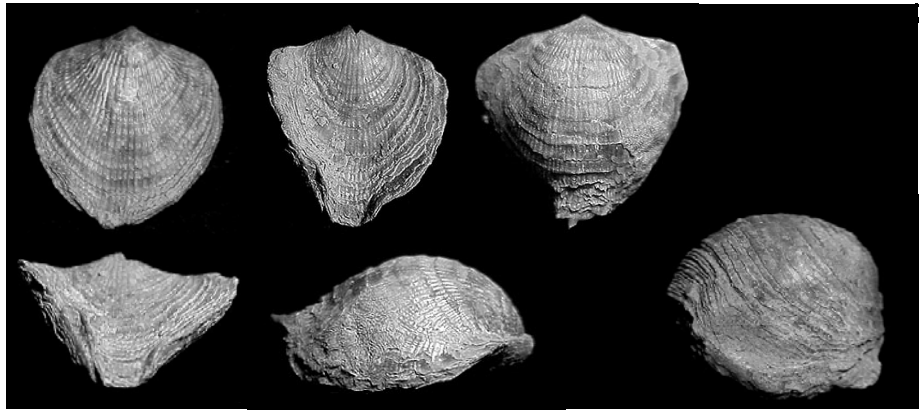
Huntonia lindenensis. Described by Delo (1940) as **Odontochile lindenensis.** Campbell (1977) revised the assignment and placed these specimens in the genus **Huntonia**. No formal description of the cephalon exists but the specimen represented here (right) seems to match those assigned by Campbell to this species. The pygidium is subtriangular in outline and has a short, upturned spine. The short spine was used by Campbell to distinguish between the genus **Dalmanites** and **Huntonia.** Moderately rare, but found throughout the Birdsong.



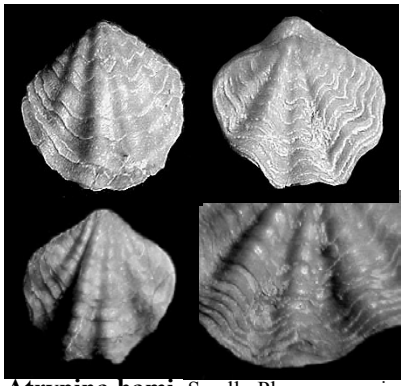
BRACHIOPODS

In terms of the number of species, brachiopods overwhelmingly dominate the Birdsong Shale fauna. In absolute numbers they are rivaled by only the bryozoans. Almost 40 different species have been identified ranging from extremely common to rare in occurrence. Brachiopods are relatively easy to identify but there are a few species which are similar and require closer analysis. Species vary in size from less than 3 mm to over 70 mm in width.

Anastrophia verneuilli. Uncommon and usually crushed or incomplete. Articulated specimens are biconvex in profile (right). In mature specimens the brachial valve is more strongly convex than the pedicle valve and bears a faint fold (not preserved in the featured specimens). Pedicle valve is sulcate, with the sulcus becoming wider and deeper towards the anterior margin. Thin shelled (which accounts for the incompleteness of the specimens) with a costate surface. Figured specimen measures 30 mm. The specimen featured on the right is from Oklahoma



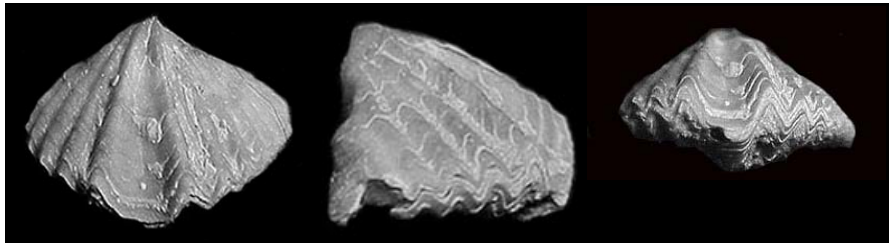
Atrypa 'reticularis'. The specific assignment is almost certainly wrong but no revision of the atrypid brachiopods has yet been done to determine exactly which species this might be. **Atrypa** shows a great variety of shell shapes but is usually unequally biconvex to almost planoconvex in profile. The brachial valve is deeply convex, the pedicle valve gently convex or almost flat. Shells subtriangular to subcircular in outline. In adult specimens the front of the shell has a distinct fold and sulcus which can be pinched into a tongue-like projection (top middle). Surface is gently to moderately costate (top left) and crossed by concentric lamellae (bottom). The figured specimens are 20 mm wide.



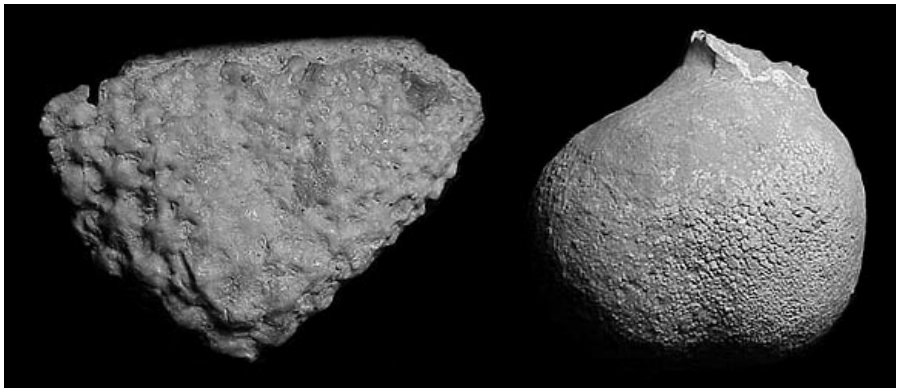
Atrypina hami. Small. Planoconvex in profile measuring ~7 mm wide. Shells plicate with concentric growth lines. Five plications on the brachial valve, 6 on the pedicle. Brachial valve faintly sulcate, pedicle valve correspondingly folded. Moderately common.

Coelospira virginiana. Tiny, measuring less than 5mm wide. Planoconvex in profile with a strongly convex pedicle valve. Brachial valve almost flat. Shells costate. Usually 9 costae on the brachial valve. Brachial sulcus present. Weak pedicle fold. Central two costae elevated, giving shell convex profile. Common.

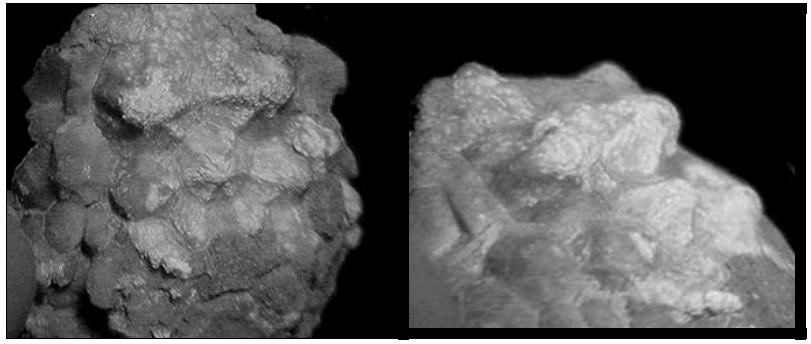
Camarotoechia sp. & Camarotoechia haraganensis Two similar looking shells of common occurrence. Both shells are subtriangular in outline and subequally biconvex. Brachial fold and pedicle sulcus occur in both species. Shells are strongly costate. Differences between the two are as follows: **Camarotoechia haraganensis** is generally smaller than **Camarotoechia sp.,** proportionately more elongate and has fewer costae.
Left: **Camarotoechia sp.**
Right: **C. haraganensis.**



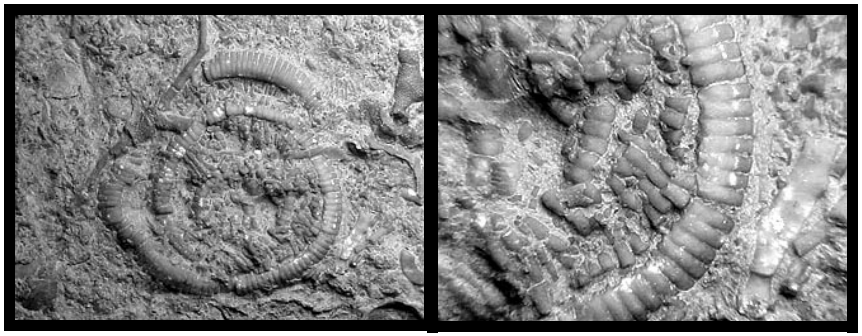
Cyrtina dalmani. Small, measuring only 8 mm in width. Shells transversely subtriangular in outline. Profile is unequally biconvex with a strongly convex pyradimal-shaped pedicle valve. Brachial valve almost flat to gently concave. Pedicle beak is often slightly twisted (see far left picture). Pedicle sulcus present with a corresponding low, brachial fold. Surface costate. Costae number 4 to 5 on either side of the sulcus. Concentric growth rings present.



Scyphocrinites stellatus. There are several species of **Scyphocrinites** reported from the lower Devonian and Upper Silurian but the most common is **Scyphocrinites stellatus**. This species is restricted to the lower and middle portions of the Birdsong Shale. It is most common in the basal 'Brachiopod Zone' among the dense limestone lenses and rapidly decreases in size and number in the middle shale beds. This species is unknown from the uppermost strata of the Birdsong. Stems of this very large crinoid are the most common crinoid fossil and can be 15 mm thick, reaching lengths of 500 mm and more. The diagnostic loboliths or float bulbs (right) are not uncommon but they are often squashed flat. Inflated specimens are however present. It is presumed that the lobolith was used to allow the crinoid to float freely in the water column and be carried by ocean currents. Calyces are rare but they can reach 150 mm tall and more. They are characterised by star shaped plates which decrease in size towards the top of the calyx (left).



Stiptocrinus nodosus. Very rare, with only one partial specimen available for study. The incomplete calyx is small, measuring only 20 mm tall but retains the prominent, bulging plates (see lower right). The plates are pyramidal in profile and have a star shaped outline (caused by the prominent ridges on the plates—see top picture, centre). The figured specimen measures 20 mm tall and was collected from a limestone lens in the basal Brachiopod Zone. Very rare.

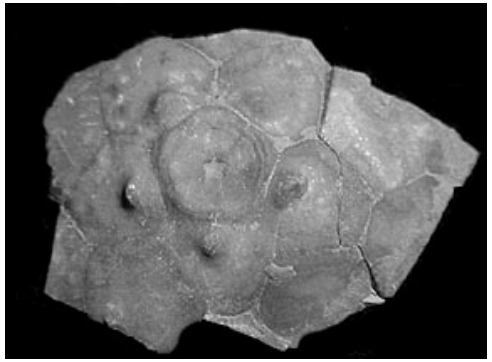


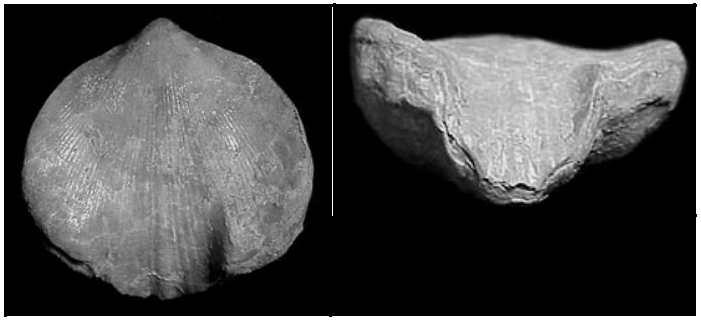
Myelodactylus sp. This distinct crinoid is rare in the Birdsong Shale but is easily identifiable. It is characterised by a simple stem and calyx which are coiled to form a loose spiral. The stem is covered with cirri and the indistinct calyx has long slender arms. The specimen on the left shows the pattern of the spiral, whilst the figure on the right shows the cirri attaching to nearly every segment of the stem. The calyx is not preserved in the figured specimen. The tightly clustered cirri are one of the most distinguishing characteristics of this crinoid and can be used to separate it from all other Birdsong Shale echinoderms. Specimen measures 50 mm in diameter.

Tyrridiocystis chelyon Very rare. Figured specimen is one of the most complete known. Plates are ornamented with concentric hexagons & the short stem is made up of simple segments. The arm bases are preserved at the top of the calyx but the nature of the arms is unknown. The figured specimen of this cystoid measures 25 mm tall.

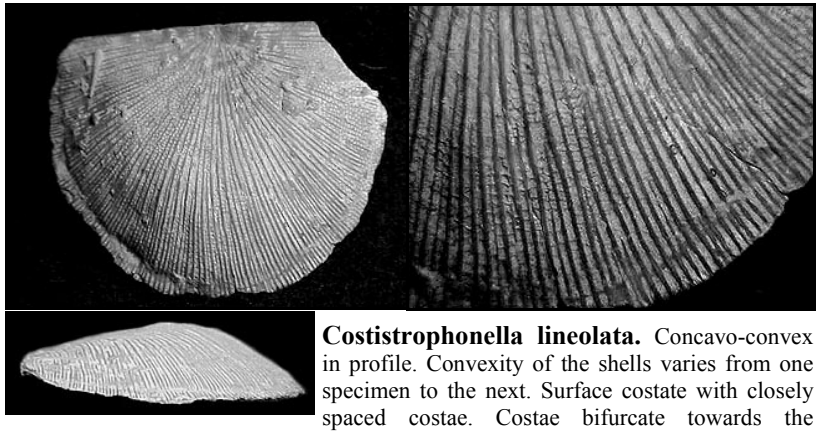
Crinoid root system. It is unknown which genera of crinoid this root system represents but it is characterised by tightly packed nodular masses which are attached to a central stem in a loosely symmetrical fashion. Uncommon.

Probalocrinus dignis. Rare, usually only found as fragmentary remains. The specimen figured on the right shows the basal plates and stem attachment. The five nodes and the pentagonal basal are the only characteristics which make this fragment identifiable. More complete specimens exhibit large, polygonal plates near the base of the calyx but few of these are preserved in the figured specimen. Figured specimen is 30 mm.





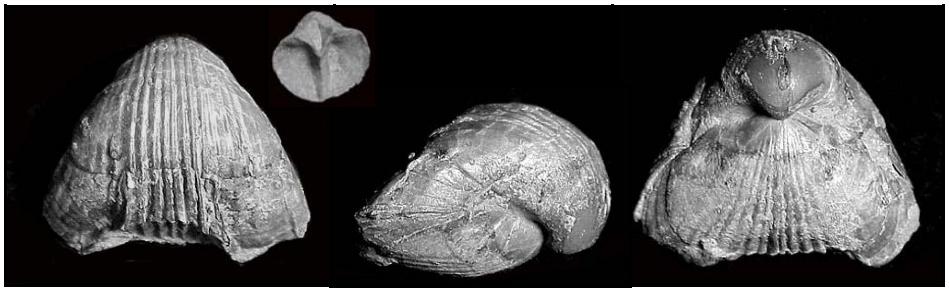
Costellirostra tennesseensis. Moderately sized, measuring 15 mm wide. Unequally biconvex in profile. Brachial valve almost flat but strongly sulcate. Pedicle valve convex with corresponding fold. Shell surface very finely costellate with closely spaced costellae. Shells almost circular in outline. Area of contact between fold and sulcus at anterior margin give the front of the shell a pinched appearance. Rare.



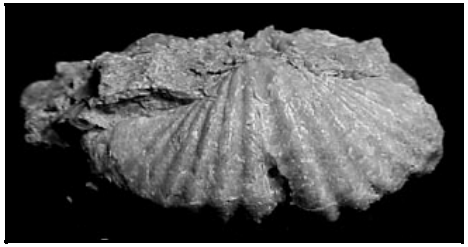
Costistrophonella lineolata. Concavo-convex in profile. Convexity of the shells varies from one specimen to the next. Surface costate with closely spaced costae. Costae bifurcate towards the anterior margin (right figure). Hingeline straight with a small beak. Rare, usually only found in the 'Trilobite Zone'.

Dicoelosia varica. Biconvex, heart-shaped valves. Each valve bears a deep sulcus, producing a distinct, bilobed appearance. Sulci widen & deepen towards anterior portion of shell. Shell outline strongly indented. Surface bears low, rounded costellae and faint concentric lamellae. Common. Figured specimen is 5 mm wide.

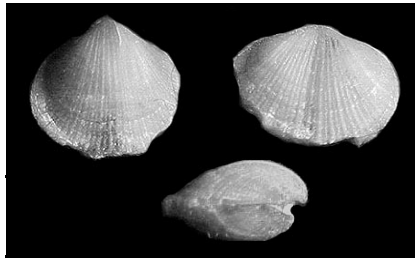
Discomyorthis oblata. An extremely common member of the brachiopod fauna. Shells of this species are subcircular in outline and unequally biconvex in profile – the brachial valve showing greater convexity. The pedicle valve is more variable in form and can be almost flat, slightly concave or even convex. The shell surface is costellate with many closely spaced, low costellae. Concentric growth rings are also evident on many specimens. The figured specimen is 20 mm wide.



Gypidula multicostata. Although this is a moderately common species, complete specimens are exceptionally rare. The figured specimen is one of the most complete specimens known. The shell is subtriangular in outline and unequally biconvex or planoconvex in profile. Brachial valve can be almost flat but the pedicle valve is very deeply convex. The pedicle valve is sulcate, the sulcus beginning approximately midway along the length of the valve and expanding towards the anterior of the shell. There are 6 costae in the sulcus. Concentric growth rings are present towards the anterior margin of the shell. This species is usually found only as isolated pedicle hinges (second image from left). The figured specimen is 40 mm long.



Howellella cycloptera. A transversely elliptical shell. Biconvex in profile. Rare in the Birdsong Shale and the thin shell edges are often broken. Strong pedicle sulcus and brachial fold, each of which widens towards the anterior margin of the shell. Surface costate with approximately 8 costae on either side of the sulcus. Surface has very delicate concentric growth lines but can look almost smooth. Figured specimen is 35 mm wide



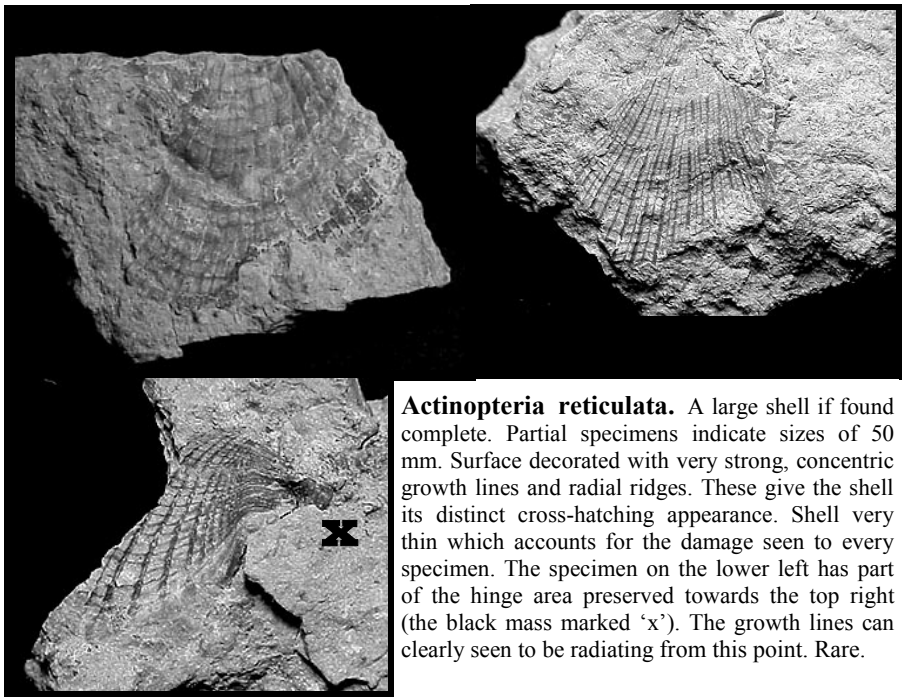
Isorthis pygmaea. A rare species often overlooked because of it's small size (~5mm). Subcircular in outline and subequally biconvex in profile. The brachial valve is weakly sulcate. The pedicle valve occasionally exhibits a faint fold. Surface is gently costellate. Concentric growth rings are present.

ECHINODERMS

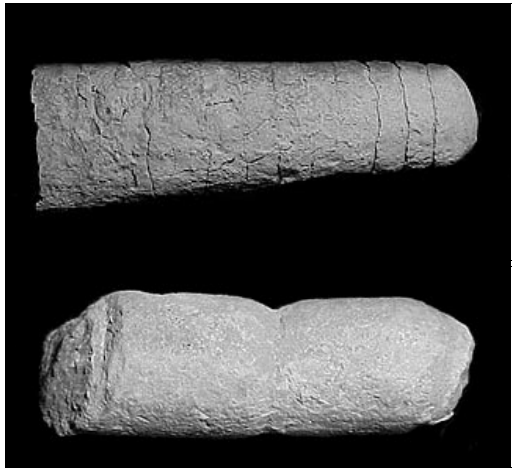
Echinoderms are fairly uncommon in the Birdsong (with the exception of crinoid stems, which are abundant). Complete calyces are rare but partial cups and isolated plates are more commonly encountered. The Birdsong Shale echinoderm fauna is quite diverse but many specimens are extremely rare, being known from only a handful of specimens. For the purposes of this work, only the most common members of the echinoderm fauna are illustrated (except where specimens are available for the rarer species).

Edriocrinus adnascans. This crinoid is a small species which only occurs attached to a host. This species is most commonly found as isolated basal plates attached to the surface of brachiopods. Sizes vary between 3 and 8 mm in diameter. No complete specimens have been reported from the Birdsong Shale. The specimen on the left represents the only known complete specimen of this crinoid and was found in the Bois d'Arc Formation of Southern Oklahoma. It still has the radial and anal plates articulated and the arm bases are folded over into the top of the calyx. The specimen measures 8 mm high.

Edriocrinus dispansus. Known only from the 'Trilobite Zone'. This species is similar to **Edriocrinus adnascans** in that it forms a low, pyramidal calyx made up of very few plates. **E. dispansus** is, however, a larger species, reaching 20 mm in diameter. This species is often found with a small brachiopod cemented into the basal plates. This suggests the larval crinoid landed on a brachiopod and used it as a host to keep itself above the ocean floor. As the crinoid grew it slowly overwhelmed the brachiopod and later completely incorporated the shell into its base. Rare.



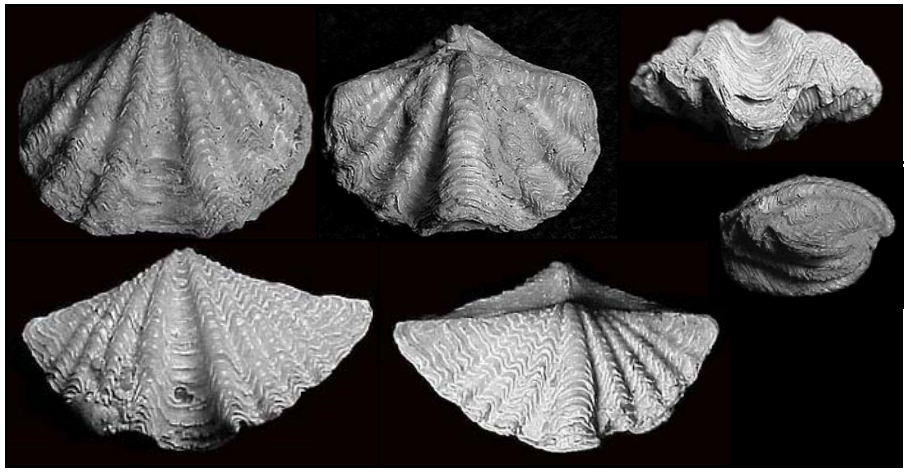
Actinopteria reticulata. A large shell if found complete. Partial specimens indicate sizes of 50 mm. Surface decorated with very strong, concentric growth lines and radial ridges. These give the shell its distinct cross-hatching appearance. Shell very thin which accounts for the damage seen to every specimen. The specimen on the lower left has part of the hinge area preserved towards the top right (the black mass marked 'x'). The growth lines can clearly seen to be radiating from this point. Rare.



'Orthoceras'/Michelinoceras

Traditionally, nearly all straight, simple chambered Silurian and Devonian nautiloids have been assigned to the genus 'Orthoceras'. However, in recent years it has been determined that 'Orthoceras**'** is a purely European genus and does not occur in North America. Specimens once described as 'Orthoceras' should be assigned to the genus **Michelinoceras.** The two species which have been reported from the Birdsong Shale are '**Orthoceras' rude** and **O. pauciseptatum**. Paleozoic nautiloids are in dire need of revision and the specific assignments used here are only tentative.

Michelinoceras rude (small chambered) Top figure.
Michelinoceras pauciseptatum.(large chambered) Bottom figure.

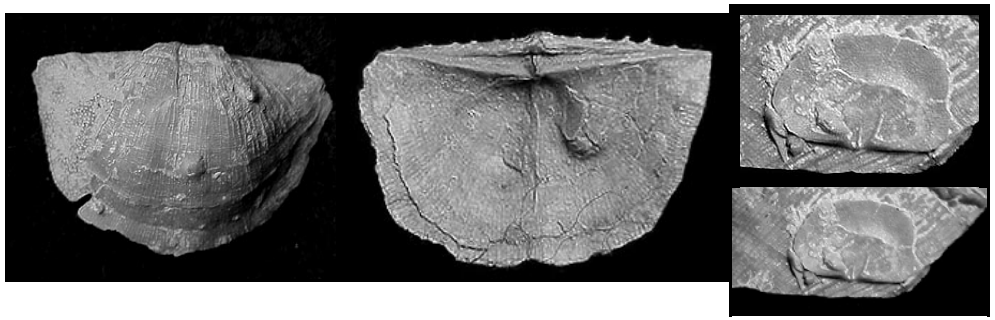


Kozlowskiellina octacostata tennesseensis (Bottom left & middle) & Kozlowskiellina perlamellosa (top row & profile)

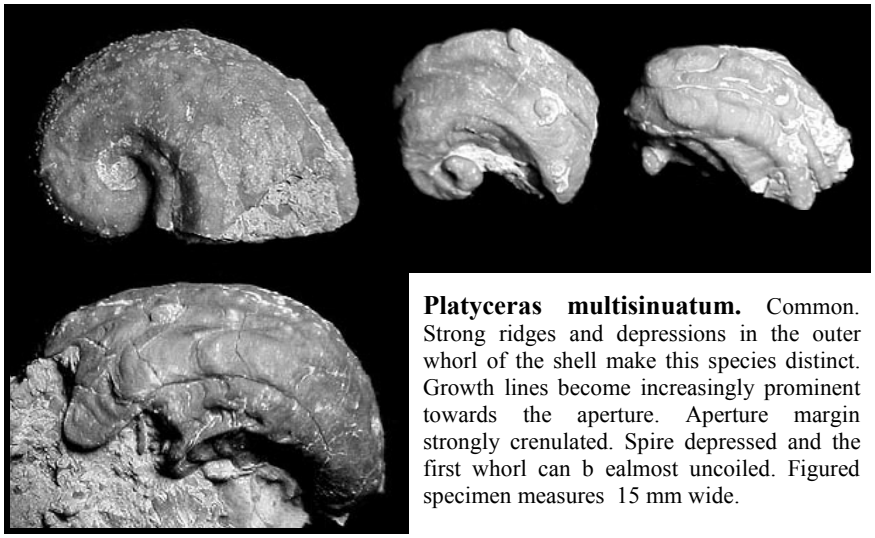
Two species of **Kozlowskiellina** are present in the Birdsong Shale. Both species are biconvex in profile; bear a brachial fold and pedicle sulcus; are tranversely elliptical in outline and bear strong costae & concentric growth lines. **Kozlowskiellina octacostata tennesseensis** is, however, proportionately more elongate with more numerous and closely spaced costae.

Leptaena acuticuspidata. Moderately large shell. Transversely rectangular in outline (bottom left figure). Hinge laterally extended into points, sometimes to such an the extreme that they produce wing-like projections which extend well beyond the rest of the shell (top left). The anterolateral (front) corners of the shell are almost at right angles giving the shell it's distinctly rectangular outline. Plano-convex in profile. Anterior margin and edges of the shell curved strongly downwards. Shell strongly rugate with wide rugae and deep interspaces. Surface finely costellate with low costellae being closely spaced. Often refered to as **Leptaena rhomboidalis** but this species is noticably different (see **L. rhomboidalis** for a fuller description of differences). Very common. Figured specimen is 35 mm wide.

Leptaena rhomboidalis. Moderately common species but rarely found complete. More rounded in outline than **Leptaena acuticuspidata** and mature specimens are considerably larger in size. Also differs from **Leptaena acuticuspidata** in that the shell is more rugate, having up to 20 rugae (compared to 12 in **L. acuticuspidata**) and the costellae are more coarse. Lateral expansion of the hingeline is less extreme.



Leptaenisca concava. Tranvsersely elliptical, concavo-convex shells. Valve convexity is highly variable among specimens but within any given individual the pedicle and brachial valve are almost identicle in form. The surface is costellate with costellae of two distinct sizes. The large costellae are separated by approximately 10 smaller costellae but all are irregular in form, becoming faint or indistinct after only a short distance. The costellae are crossed by delicate rugae which give the shell surface a unique cross-hatched appearance. Immature specimens are often found attached to a host (usually another brachiopod) but mature specimens are completely free living. Previous authors have identified the attached shells as a different species, namely **Liljevallia adnascans,** but as Amsden (1958) states "**Liljevallia** are the immature forms of **Leptaenisca concava**. A number of features point quite clearly to this conclusion: (1) the pedicle interior of the small form seems to be identicle to that of the large; (2) the brachial of the attached shells closely matches that on the brachial umbo of the large; (3) the brachial umbo of the large shells closely matches the curvature of the attached shells; (4) both forms occur together with no matching immature shells for the large **L. concava**, other than the attached shells herein described." Amsden, 1958 p.83.



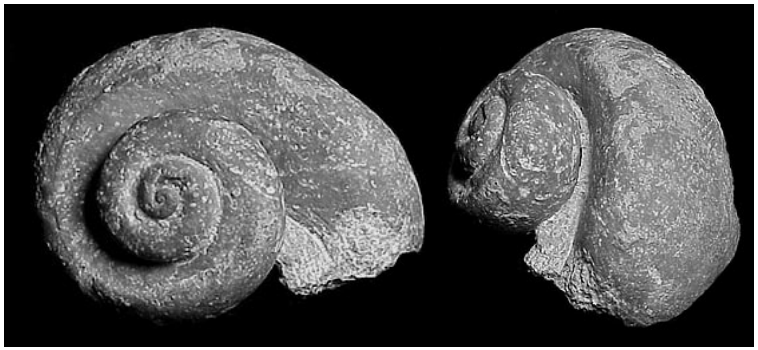
Platyceras multisinuatum. Common. Strong ridges and depressions in the outer whorl of the shell make this species distinct. Growth lines become increasingly prominent towards the aperture. Aperture margin strongly crenulated. Spire depressed and the first whorl can b ealmost uncoiled. Figured specimen measures 15 mm wide.

Platyceras tenuiliratum. Similar to **P. multisinuatum** but differs in that it lacks the ridges and depressions seen in the outer whorls. Surface marked only with very fine growth lines. Spire can be elevated but often compressed. Whorls are all tightly coiled. Small, measures 10-15 mm wide.

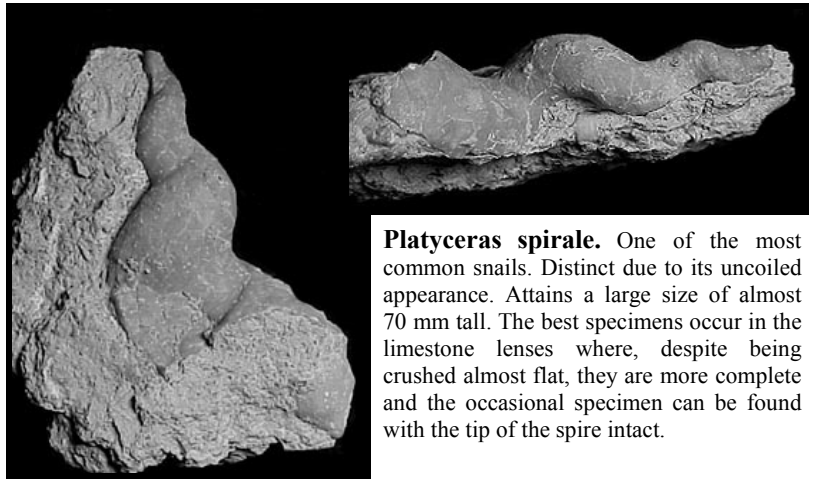
Tentaculites aculus. Rare through out the Birdsong Shale but can be locally abundant in certain beds of the upper strata. The shell is a uniformly tapering cone approximately 10 mm in length, ornamented with strong transverse rings. There are smaller, more subtle rings between the larger ones and these increase in number according to the space between the larger rings.

BIVALVES, GASTROPODS & OTHER MOLLUSCS

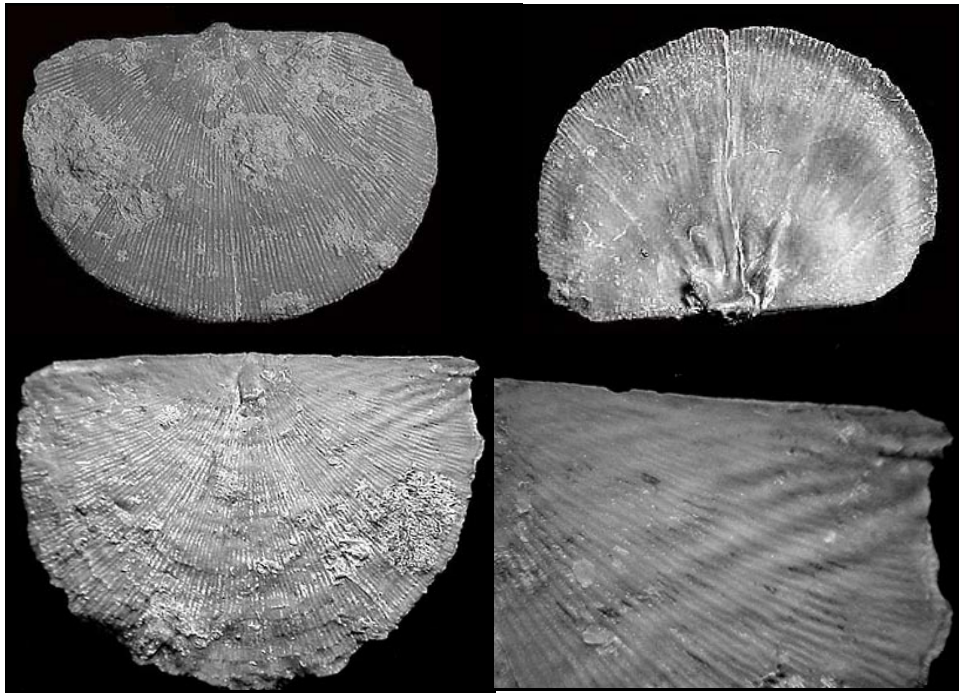
Several types of molluscs are present in the Birdsong Shale but gastropods are by far the most numerous. Nautiloids, bivalves and tentaculitids are present but only in limited numbers. Preservation of Birdsong molluscans is often only fair at best—nautiloids are usually found only as internal moulds; the snails are often crushed and the delicate bivalves are found only as fragments.



Platysoma ventricosa. Extremely rare. Easily distinguishable from all the other species by its large size (almost 50 mm wide). The spire is compressed; the whorls deeply incised. Outermost whorl partially uncoiled.



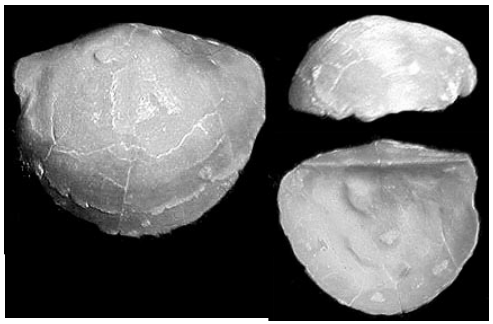
Platyceras spirale. One of the most common snails. Distinct due to its uncoiled appearance. Attains a large size of almost 70 mm tall. The best specimens occur in the limestone lenses where, despite being crushed almost flat, they are more complete and the occasional specimen can be found with the tip of the spire intact.



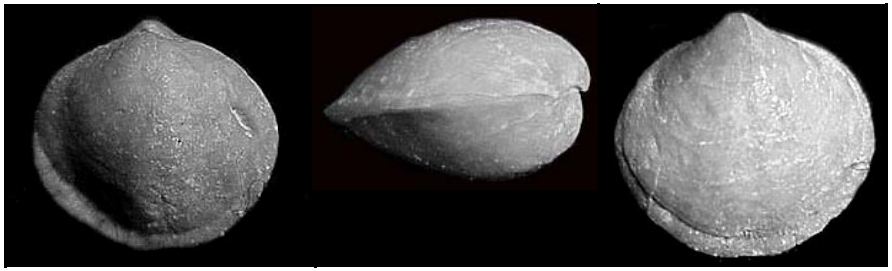
Leptostrophia beckii beckii (Top row) and
Leptostrophia beckii tennesseensis (bottom row)

Both subspecies of this type are large, almost completely flat shells with only minimal convexity near the posterior of the valves. The hingelines are straight and represent the maximum width of the shell. The shells are gently costellate with low, rounded costellae which are crossed by fine concentric growth lines. **Leptostrophia beckii tennesseensis** differs from **L. beckii beckii** in that specimens bear faint undulating rugae which produce a 'wrinkled' appearance to the shell (bottom right). The wrinkling can be faint to remarkably pronounced and is a distinguishing characteristic of this subspecies. Figured specimens are 50 mm wide.

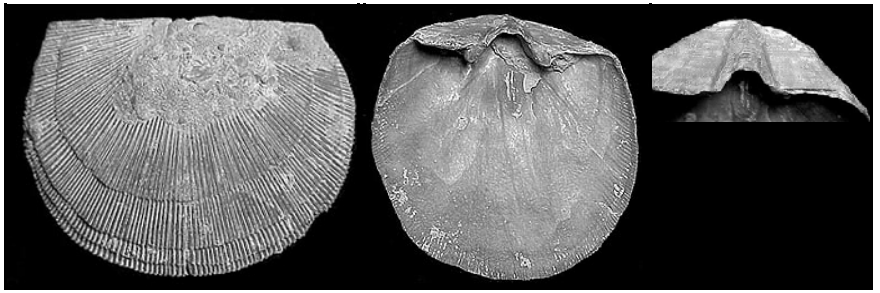
Levenea subcarinata. Common throughout the Birdsong Shale. Biconvex to planoconvex in profile, the pedicle valve being almost completely flat in some specimens. The brachial valve is moderately deep and bears a distinct fold running down midline of shell. The pedicle valve has a shallow sulcus which expands anteriorly in unison with the fold. The shell is finely costellate and can be crossed with concentric growth lines. Average size of this species is 20 mm long. The strong fold and sulcus are a distinguishing characteristic of this species.



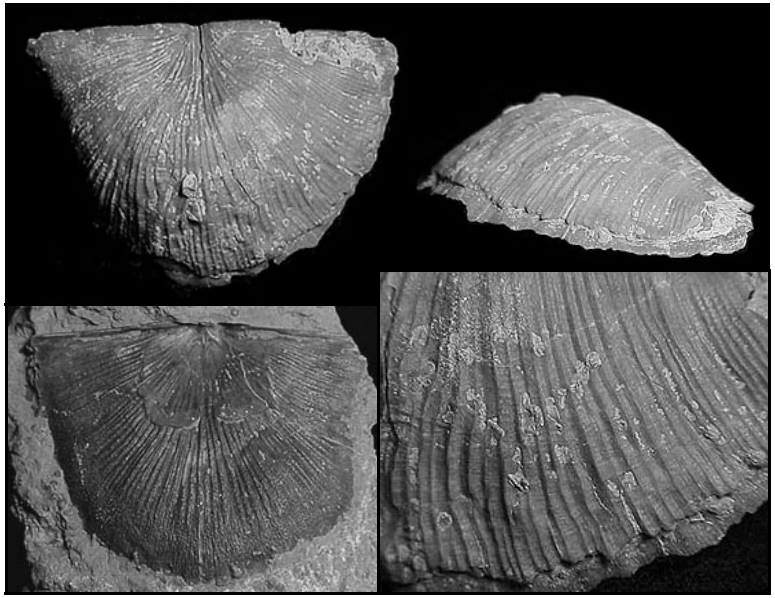
Lissostrophia lindenesis. Extremely rare. "The shell is transverse with the maximum width at or near the hinge. Profile is moderately concavo-convex, the curvature being uniformly developed from back to front; the brachial valve closely parallels the pedicle to produce a shallow living chamber. The surface is smooth with no trace of any radial ornamentation" Amsden (1958 p. 77).



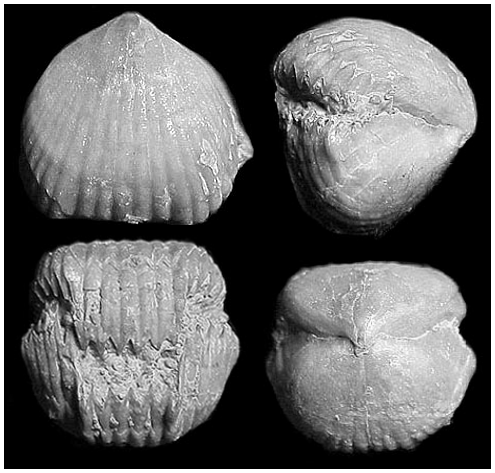
Nucleospira ventricosa. This is small species, rarely measuring 8 mm wide. The shells are biconvex in profile with almost equal convexity of both valves. The shell surface appears almost completely devoid of any type of ornamentation but it is reported that this species is spinose. No specimens have yet been found in the Birdsong Shale with the spines intact suggesting they were extremely delicate. A few concentric growth rings are present and the pedicle valve can bear a faint and shallow sulcus. Usually found with both valves still articulated. Moderately common but easily overlooked.



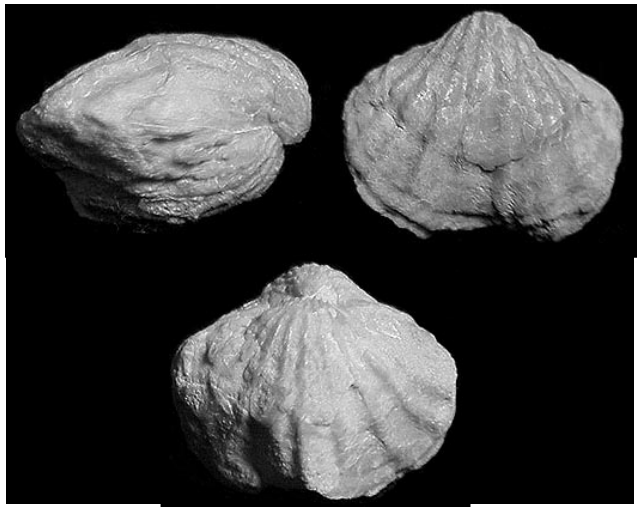
Schuchertella woolworthana. Large species with unusually thick shell. Valves subcircular in outline with straight hinge line. Plano-convex with almost pyramidal profile. Strongly ribbed surface of closely spaced costae. Strong concentric growth lines are grouped in the anterior half of the shell. Very rare. Figured specimen is 40 mm wide.



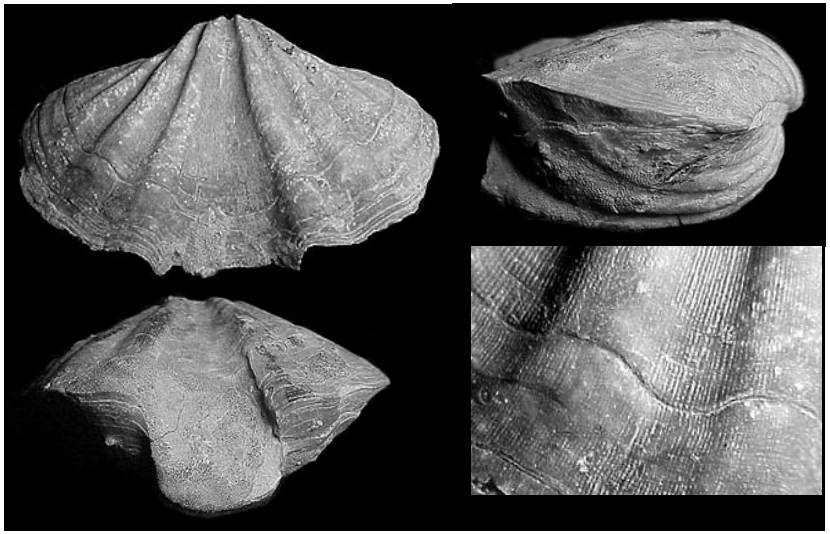
Strophoprion punctulifera holladayi. A large species. Convexi-concave in profile. Pedicle valve is convex whilst the brachial valve is of a concavity which almost exactly matches the pedicle curvature. This forms a shallow living area within the shell in which the soft parts of the animal were housed. Shell has quite strongly defined low and angular costae. Fine filae cross the costae (these can be seen in the bottom right figure between the ribs). Costae are quite irregular, often bending, curving and changing height. Figured specimens are 50 mm wide. Top left image is an exterior view. Bottom left is an interior view of the brachial valve.



Sphaerirhynchia lindenensis. This species has subtriangular shells of unequal biconvex profile. Pedicle valve is gently convex, brachial valve is extremely deep. Pedicle valve is sulcate, brachial valve corresponding folded. Both valves costate with well developed, low but wide subangular costae best developed toward the anterior margins. The commissure is extremely crenulated and undulating as a result of the contact between angular costae of the fold and sulcus. Delicate concentric growth rings cross the costae. Moderately common but specimens are often disarticulated or crushed. The figured specimen is 15 mm long.



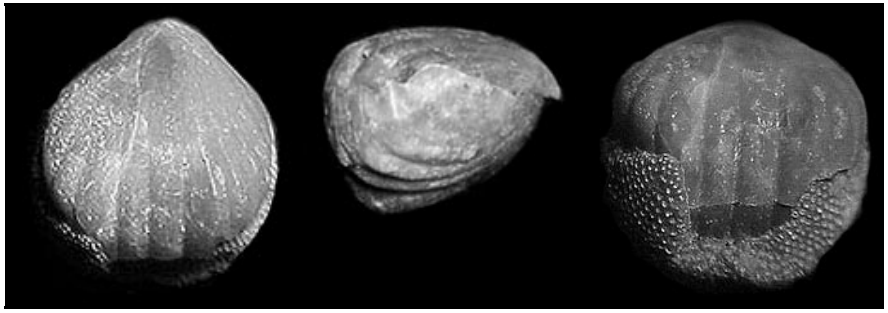
Trematospira costata angusta. Extremely rare. The shell is biconvex in profile and transversely elliptical in outline. Surface is costate with 10 or 12 well defined ribs. Concentric growth lines towards the anterior margins of the valves. Brachial fold & pedicle sulcus gives commissure an undulating appearance (as in **Meristella atoka**). Pedicle hinge is tightly tucked over brachial valve. The figured specimen is 12 mm wide. Figured specimen is from the Devonian of Oklahoma.



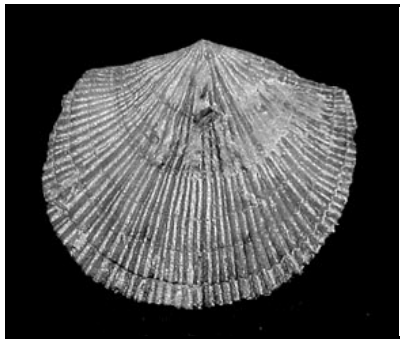
Macropleura macropleura. A large species. Thick shelled and often well preserved. Biconvex in profile with each valve being of almost equal convexity. Strong fold and sulcus both of expand anteriorly. Shell surface plicate with 3 or 4 ribs on either side of sulcus and fold. Surface very finely costellate (see bottom right figure) bearing distinct concentric growth lines. Specimens can measure 70 mm in width. Common.

Meristella laevis. Profile is biconvex. There can be a faint sulcus towards the anterior margin of the shell. Usually no corresponding fold. Strong concentric growth lines. Rare and has only been found in the 'Trilobite Zone'. See **Meristella atoka** for further discussion. Featured specimen is 20 mm long.

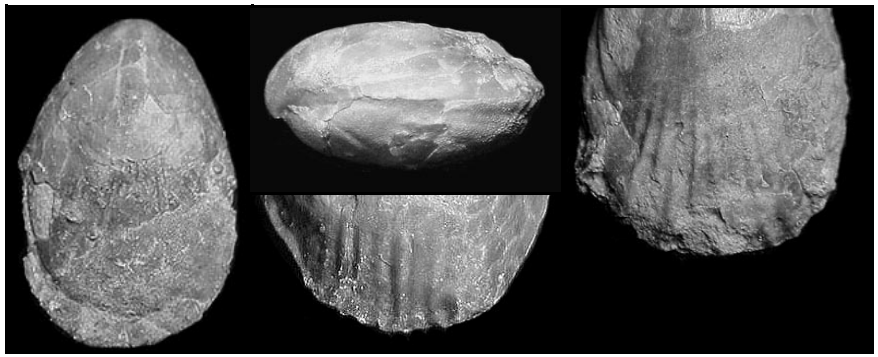
Meristella atoka. Large and moderately common species. Biconvex in profile with valves of almost equal convexity. Brachial valve can be slightly deeper. Subtriangular in outline with mature specimens bearing a deeply incised anterior margin (bottom left figure). Immature shells are usually longer than wide and lack the incised margin. Mature specimens are wider than long. Immature shells are rare but should not be confused with **Meristella laevis** which is longer than wide even in the adult stage. Shell surface is smooth, except for concentric growth lines near the anterior margins. Beak is small and triangular and is hooked over the brachial valve (middle top). The commisure is strongly undulating (bottom right) with the undulation caused by the union of the fold and sulcus. This feature not seen in **M. laevis**. Figured specimens measure 25 mm wide.



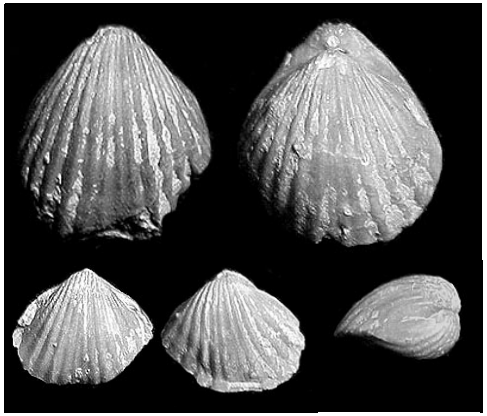
Obturamentella wadei. Small, subcircular to subtriangular shells. Biconvex in profile, the brachial valve of greater convexity. Pedicle valve sulcate, brachial correspondingly folded, albeit gently. Surface costate with broad, rounded costae. Usually a single costae on the sulcus but can be two or three. Can be confused with **Sphaerirhynchia** but is distinguishable by it's smaller size, fewer costae & less convex profile. The deep undulation commissure at the junction of the fold and sulcus is often encrusted by bryozoans. This unusual feature has not been observed in any other species (see figure on the far right). Uncommon. The figured specimens measure 8 mm wide



Orthostrophia strophomenoides. Subcircular outline and biconvex profile. In mature specimens brachial valve more strongly convex than the pedicle. Surface costellate. Costellae crossed by strong concentric growth lines. Brachial valve sulcate, pedicle valve folded. Sulcus expands anteriorly but is most strongly defined at the rear of the shell. Figured specimen is 25 mm wide. Very rare.



Rensellaerina medioplicata. Rare, but attaining considerable size (some specimens measure 40 mm long). This species is very thin shelled and most specimens are missing the shell on the anterior half of each valve. Shells elongate and subelliptical in outline. Subequally biconvex in profile with the pedicle valve showing greater and more variable convexity. Shell surface almost completely smooth but there are approximately 8, low rounded costae towards the anterior margin of each valve. The front margin of each valve is flattened slightly, almost into a shallow sulcus. Found throughout the Birdsong Shale but rare and usually poorly preserved. Figured specimen is 25 mm long



Rhynchospirina globosa (top) & Rhynchospirina formosa (bottom)
Both species are subtraingular in outline and biconvex in profile with a shallow pedicle sulcus and brachial fold. Both are costate with well defined costae. **R.globosa** is the larger of the two species and can be distinguished by its more elongate shape, larger size, larger number of costae (~21 as opposed to ~18) and much more prominent beak which projects over the brachial valve (far right figure). Specimens in top row measure 15 mm, bottom row 8 mm.