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Juvenile Hexactinellid Sponges from the Middle Devonian Arkona Shale at Hungry Hollow, Southwestern Ontario

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ABSTRACT

Several small hexactinellid sponges, possibly juveniles of *Hydriodictya* Hall & Clarke, 1899 or *Aglithodictya* Hall & Clarke, 1899, occur scattered on a few bedding planes within the lower part of the Middle Devonian upper Arkona Shale at Hungry Hollow, east of Arkona, in southwestern Ontario. These small sponges are broadly obconical to saucer-shaped or urn-shaped, thin-walled, and several have skeletal strands or spicules preserved as casts and molds in the gray shales. Some are partially and crudely pyritized with projecting nodes that may represent bases of spicule tufts or clusters extending out from the principal vertical spicule strands of the skeleton.

INTRODUCTION

Small, possibly juvenile, hexactinellid sponges occur in the Middle Devonian Arkona Shale, and have been collected from quarry exposures of the formation in the Hungry Hollow area, east of Arkona, Middlesex County, on the Parkhill 1:50,000 topographic quadrangle, in southwestern Ontario (Fig. 1). The Arkona Shale is a soft, easily eroded, bluish gray shale or calcareous mudstone that contains a few lenses of argillaceous limestone in the lower part and sandy beds in the upper part. Fossils, such as isolated chonetid and spiriferoid brachiopods, nuculid bivalves, and goniatites, occur throughout the shale, but the small sponges described here came from a single lens, approximately 24 feet below the top of the Arkona Shale and base of the Hungry Hollow Formation (Fig. 2), where the unit is exposed in a shale pit. Similar, though less well-preserved sponges have been observed in beds up to 27 feet below the Hungry Hollow-Arkona contact in the same exposures. The sponges in our collection occur as isolated impressions through a few centimeters of shale. They are partially pyritized and also occur as casts and molds in the shale. The sponges described here came from upper beds of the brachiopod shell layer, above the *Arthrocantha* beds of Brett (1999) and below the band of calcareous nodules.

Landing and Brett (1987) reported that the Arkona Shale is dominantly unbedded and weakly indurated but does contain thin sandstones and nodular carbonate units. They concluded that the shale represents accumulations in a "low energy, relatively shallow, muddy shelf environment." Brett (1999, p. 134) later concluded that the Arkona Shale, and the equivalent Silica Shale of Ohio, accumulated in "relatively offshore deeper water, characterized by muddy bottoms." He also concluded that "the sparsely fossiliferous nature of most of the mudstone suggests rather inhospitable conditions associated with a soft, possibly soupy substrate; and the occurrence of a diminutive, pyritized fossil in some of these shales indicates low-oxygen conditions at least at and below the surface of the sediment."

It is surprising to find filter-feeding sponges in such deposits, and they may have been washed into the area, like the debris in some of the associated crinoidal-brachiopod packstone and grainstone lenses. Landing and Brett (1987) suggested that such coarser clastic units may have resulted from episodic storms that influenced sediments normally below wave base, but above storm wave-base depths. The small, filter-feeding, sponges probably floated or were swept into the area and were not "resident" faunal elements of the soft muddy-bottomed environment.

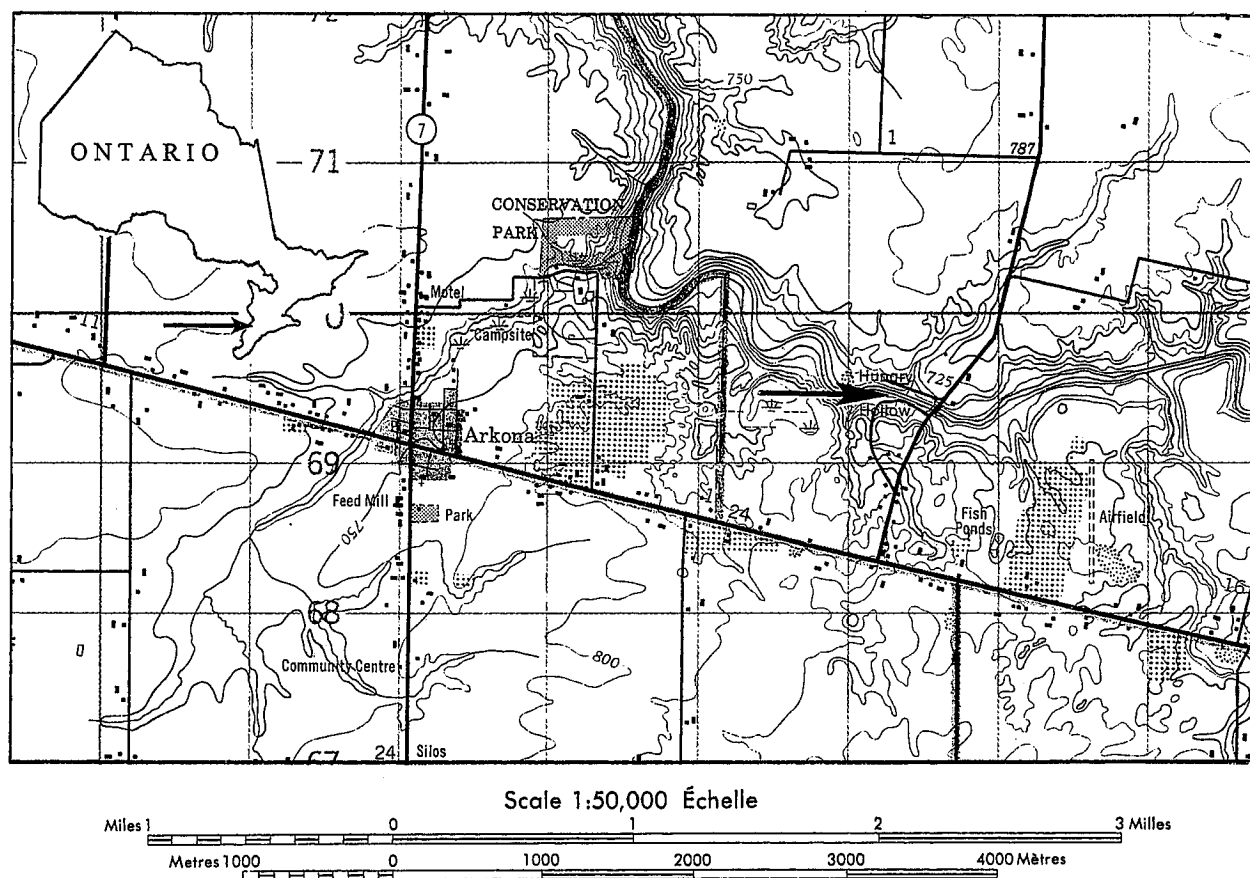


Figure 1. Index map to the Hungry Hollow fossil locality, east of Arkona, Ontario. The collections were made in an abandoned clay pit (arrow) in the Arkona Shale, along the southwest bank of the Ausable River, on the Parkhill (40 P/4) 1:50,000 topographic quadrangle, in southwestern Ontario.

SYSTEMATIC PALEONTOLOGY
Class HEXACTINELLIDA Schmidt, 1870
Order LYSSAKIDA Zittel, 1877

Superfamily DICTYOSPONGIOIDEA
Hall & Clarke, 1899

Family DICTYOSPONGIIDAE Hall & Clarke, 1899
Subfamily and Genus, uncertain

Figures 3, 4

Description.—One of the most nearly complete specimens, USNM 480610, is a vertically flattened, broadly obconical or discoidal, radiate base of sponge (Fig. 3) that was approximately 18 mm in diameter, but is now incomplete. It has a central smooth circular depression, 1.0–1.2 mm in diameter, that may have been the attachment point of a basal root tuft, now gone. From that small depression radiates impressions of an expanding quadrate reticular skeletal mesh with areas showing three different preservations.

One area clearly shows the concentrically quadrulated radiating dictyosponge skeletal structure of long radial strands crossed at right angles by concentric strands or spicule rays (1 of Fig. 3). The radial ridges, as casts of the linear radial skeletal strands, show at least three ranks or size and spacing. Coarsest such strands are 0.4–0.5 mm apart, with new strands inserted to maintain more or less uniform spacing and the structure expands. Second-order and somewhat less prominent strands are spaced approximately 0.2 mm apart, and third-order ones are approximately 0.1 mm apart.

Major or first-order concentric skeletal “rings” are spaced approximately 0.5 mm apart near the central base of the sponge, and 0.7 mm apart in outer areas, as evidenced by coarser ridges in the cast-and-mold impression. Less prominent or lower ridges of intermediate rings are spaced approximately 0.25 mm apart. Smaller or more closely spaced rings are not preserved in this part of the impres-

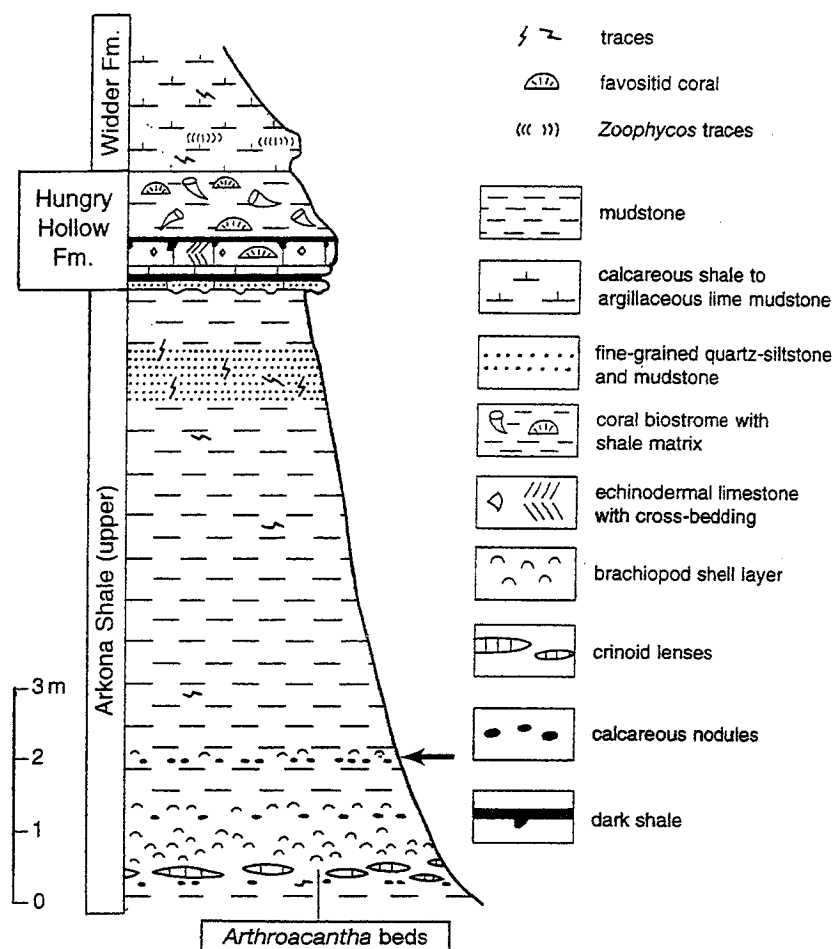


Figure 2. Stratigraphic section of the Devonian Hungry Hollow Formation and the upper part of the Arkona Shale, as exposed in the Hungry Hollow area, along the Ausable River (modified from Brett, 1999). The beds from which the sponges were collected are indicated by the arrow.

sion. A single crudely pyritized hexactine has rays 0.25–0.30 mm long and 0.015–0.02 mm in diameter. This area has pyrite nodules or small cylinders that are 0.04–0.06 mm in diameter aligned along the radial strands. These may represent spicule tufts that project into the gray shale matrix.

A second area is thinly veneered by adhering matrix and does not have the skeletal structure clearly preserved, but has numerous projecting nodes of pyrite (2 of Fig. 3). These nodes are 0.04–0.12 mm in diameter and are radially aligned and moderately uniformly spaced, although some are “skipped,” both radially and concentrically. Radial rows of the nodes are approximately 0.5 mm apart, with new rows inserted to keep the spacing approximately uniform or even.

The smaller third area of the sponge shows a well-preserved impression of the skeletal fabric (3 of Fig. 3). Con-

centric major elements are 0.5–0.60 mm apart, with some pyritized spicule rays approximately 0.02 in diameter at midlength. Tips of such spicules are not preserved. Radial rays or fibers are much longer, are commonly spaced 0.4–0.6 mm apart, and are 0.02–0.03 mm in diameter, as indicated by their ridged impressions. Smallest moderately well preserved skeletal quadrules are approximately 0.08–0.10 mm wide and are bounded by skeletal tracts or spicules rays approximately 0.015–0.02 mm across in the ridged casts. Isolated areas show quadrules that are even smaller and approximately 0.05 mm wide. Rare pyrite nodes, as in the adjacent second area, are of about the same size as there, but here they are part of the pyritized skeleton and are not blanketed by a thin layer of matrix.

A second block, USNM 480611, contains four additional fragments (Fig. 4). All are approximately 1 cm across and show impressions of the radially expanding skeleton.

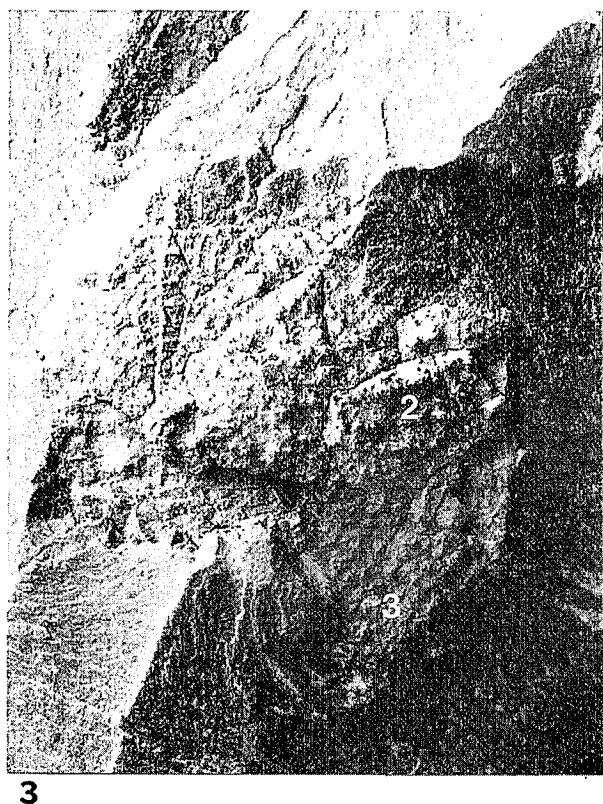


Figure 3. Small hexactinellid sponge from the Arkona Shale, near Hungry Hollow, Middlesex County, Ontario. The flattened sponge shows three different preservations. Radial and concentric strands of the quadrate skeletal net are low ridges (1), above the shallow depression that may have been the position of a basal attachment, now gone. Radial and concentric rows of nodes (2) interrupt a thin layer of matrix that obscures the skeletal net, on the right, and the skeletal structure is also shown below (3), as aligned nodes and ridges in a somewhat more obscure pattern. USNM 480610, X5.

Each has faint cast-and-mold impressions of the quadrangular dictyonine skeletal net. Radial skeletal fibers or tracts are emphasized by aligned pits in troughs of their molds. These pits are negative impressions of the pyrite nodes preserved in part of the specimens described above. They make these impressions appear to be of somewhat prismatic sponges, with nodular radial ridges at prism-face intersections.

A third block, USNM 480612, includes fragments of eight sponges of varying size. These show the gently depressed broad funnel- or bowl-shapes of the small sponges. All these impressions are marked by radial lines of pits that are approximately 0.10 mm in diameter, and a few have preserved pyrite nodules in place. All show limited areas of quadrate dictyonine skeletal structure.



Figure 4. Three small flattened hexactinellid sponges from the Arkona Shale, near Hungry Hollow, Middlesex County, Ontario, showing different preservations as casts and molds in the gray shale. Impressions range from the mold of aligned nodular ridges, in the fragment in the lower left, to moderately well preserved casts of nodes and skeletal rays in the more nearly complete, rounded impression in the upper right, which shows part of the smooth oscular margin at the top. USNM 480611, X5.

Discussion.—Generic identification of these small sponges is uncertain because they could be basal parts of several dictyonine forms. For example, they might be basal areas of *Prismodictya*, for they are faintly prismatic, with radial or longitudinal rows of nodes or spicule tufts. Hall and Clarke (1899, pl. 21, fig. 3) illustrated similarly aligned pits in an impression of *Prismodictya prismatica* Hall & Clarke (1889, 240) and observed that they “probably represent bases of spicular tufts.” We would suggest that the pyrite projections observed in these Arkona sponges are also remnants of tufts, for other spicules are replaced by pyrite in these associated specimens from the Arkona Shale.

Ithacadietia Caster, 1939, from Upper Devonian shales and sandstones exposed in quarries near Ithaca, New York, is a small, elongate, prismatic dictyosponge with radiate spicule tufts at prismatic angles. Caster (1939, p. 16–17)

emphasized the small size of known specimens of the type species of that genus, which is less than half that of the sponges described here.

These Arkona fossils might be basal parts of small, smooth, obconical forms like *Hydriodictya* Hall & Clarke, 1889, or of the small vase- or urn-shaped *Aglithodictya* Hall & Clarke, 1889. In some specimens there may be two layers of vertically flattened skeleton, like that which could have been produced by a vertically flattened *Aglithodictya*, but unflattened growth form of the Arkona sponges is uncertain.

Locality.—The sponges were collected from the Arkona Shale, from approximately 24 feet below the base of the overlying ledge-forming Hungry Hollow Formation, where the shales are exposed in a now-abandoned shale pit along the southern bank of the Ausable River. The clay pit is at Hungry Hollow, approximately 2 miles east of Arkona, in West Williams Township, in Middlesex County, at 43° 04' 17" N., 81° 47' 42" W., or UTM 17435297 E, 4769414 N, on the Parkhill (40 P/4) 1:50,000 topographic quadrangle, in southwestern Ontario (Fig. 1). It is the same as locality Do-1b of McIntosh (2001), that is approximately 190 m downstream from the Sylvan Road bridge over the Ausable River. However, the crinoids from the locality described by McIntosh came from the upper part of the shale, above where the sponges were collected.

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